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UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/778,515	05/12/2009	7532213	1935CIP2C	1565

57580 7590 04/22/2009

STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA 94042

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Adrian Sfarti, Cupertino, CA;

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

57580 7590 01/05/2009

STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA 94042

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C	1565

TITLE OF INVENTION: BICUBIC SURFACE REAL TIME TESSELATION UNIT

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$755	$300	$0	$1055	04/06/2009

EXAMINER	ART UNIT	CLASS-SUBCLASS
BROOME, SAID A	2628	345-423000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list Strategic Patent Group, P.C.

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____
2 _____
3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☒ Issue Fee

☒ Publication Fee (No small entity discount permitted)

☐ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

☐ A check is enclosed.

☒ Payment by credit card. ~~Form PTO-2038 is attached.~~ via EFS.

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature /Stephen G. Sullivan/ Date 4/1/2009

Typed or printed name Stephen G. Sullivan Registration No. 38,329

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Electronic Patent Application Fee Transmittal

Application Number:	11778515
Filing Date:	16-Jul-2007
Title of Invention:	BICUBIC SURFACE REAL TIME TESSELATION UNIT
First Named Inventor/Applicant Name:	Adrian Sfarti
Filer:	Stephen Grant Sullivan/Jackie Tanda
Attorney Docket Number:	1935CIP2C

Filed as Small Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	2501	1	755	755
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1055**

Electronic Acknowledgement Receipt

EFS ID:	5078391
Application Number:	11778515
International Application Number:	
Confirmation Number:	1565
Title of Invention:	BICUBIC SURFACE REAL TIME TESSELATION UNIT
First Named Inventor/Applicant Name:	Adrian Sfarti
Customer Number:	57580
Filer:	Stephen Grant Sullivan/Jackie Tanda
Filer Authorized By:	Stephen Grant Sullivan
Attorney Docket Number:	1935CIP2C
Receipt Date:	01-APR-2009
Filing Date:	16-JUL-2007
Time Stamp:	16:02:41
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1055
RAM confirmation Number	1429
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Issue Fee Payment (PTO-85B)	1935CIP2C_IssueFeeTransmittal.pdf	96002 2c946932dac9d29ac7f19b5791247c384d2338f9	no	1
Warnings:					
Information:					
2	Fee Worksheet (PTO-06)	fee-info.pdf	31739 949046075997d22139890475e179aa7697025560	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	127741	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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Alexandria, Virginia 22313-1450
www.uspto.gov

Bib Data Sheet

CONFIRMATION NO. 1565

SERIAL NUMBER	FILING OR 371(c) DATE / RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/778,515	07/16/2007	345	2628	1935CIP2C

APPLICANTS

Adrian Sfarti, Cupertino, CA;

**** CONTINUING DATA ***************************

This application is a CON of 10/732,398 12/09/2003 PAT 7,245,299
which is a CIP of 10/436,698 05/12/2003 ABN
which is a CIP of 09/734,438 12/11/2000 PAT 6,563,501
which claims benefit of 60/222,105 07/28/2000

2/9/09

**** FOREIGN APPLICATIONS *********************

IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** SMALL ENTITY **
** 07/30/2007

Foreign Priority claimed	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☒ no	CA	14	19	3
35 USC 119 (a-d) conditions met ☐ yes ☒ no ☐ Met after Allowance				
Verified and Acknowledged Examiner's Signature Initials				

ADDRESS
57580

TITLE

BICUBIC SURFACE REAL TIME TESSELATION UNIT

FILING FEE RECEIVED	FEES: Authority has been given in Paper	
425	No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

UNITED STATES PATENT AND TRADEMARK OFFICE

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NOTICE OF ALLOWANCE AND FEE(S) DUE

57580 7590 01/05/2009

STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA 94042

EXAMINER	
BROOME, SAID A	
ART UNIT	PAPER NUMBER
2628	

DATE MAILED: 01/05/2009

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C	1565

TITLE OF INVENTION: BICUBIC SURFACE REAL TIME TESSELATION UNIT

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$755	$300	$0	$1055	04/06/2009

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

A. Pay TOTAL FEE(S) DUE shown above, or

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PTOL-85 (Rev. 08/07) Approved for use through 08/31/2010.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

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CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

57580 7590 01/05/2009

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MOUNTAIN VIEW, CA 94042

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C	1565

TITLE OF INVENTION: BICUBIC SURFACE REAL TIME TESSELATION UNIT

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$755	$300	$0	$1055	04/06/2009

EXAMINER	ART UNIT	CLASS-SUBCLASS
BROOME, SAID A	2628	345-423000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

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2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,

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1 _____

2 _____

3 _____

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(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**

❑ A check is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C	1565

57580 7590 01/05/2009

STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA 94042

EXAMINER	
BROOME, SAID A	
ART UNIT	PAPER NUMBER
2628	

DATE MAILED: 01/05/2009

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 0 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 0 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

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Notice of Allowability	Application No.	Applicant(s)	
	11/778,515	SFARTI, ADRIAN	
	Examiner	Art Unit	
	SAID BROOME	2628	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed 11/6/08*.

2. ☒ The allowed claim(s) is/are *11-19*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☒ Interview Summary (PTO-413), Paper No./Mail Date *12/30/08* .
7. ☐ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

Interview Summary	Application No.	Applicant(s)	
	11/778,515	SFARTI, ADRIAN	
	Examiner	Art Unit	
	SAID BROOME	2628	

All participants (applicant, applicant's representative, PTO personnel):

(1) *Said Broome*. (3)_____.

(2) *Stephen Sullivan*. (4)_____.

Date of Interview: *29 December 2008*.

Type: a)☒ Telephonic b)☐ Video Conference
c)☐ Personal [copy given to: 1)☐ applicant 2)☐ applicant's representative]

Exhibit shown or demonstration conducted: d)☐ Yes e)☒ No.
If Yes, brief description: _____.

Claim(s) discussed: *19*.

Identification of prior art discussed: *N/A*.

Agreement with respect to the claims f)☒ was reached. g)☐ was not reached. h)☐ N/A.

Substance of Interview including description of the general nature of what was agreed to if an agreement was reached, or any other comments: *Applicant's representative authorized examiner's amendment to enable the method of claim 19 to be tied to an apparatus in the body of the claim*.

(A fuller description, if necessary, and a copy of the amendments which the examiner agreed would render the claims allowable, if available, must be attached. Also, where no copy of the amendments that would render the claims allowable is available, a summary thereof must be attached.)

THE FORMAL WRITTEN REPLY TO THE LAST OFFICE ACTION MUST INCLUDE THE SUBSTANCE OF THE INTERVIEW. (See MPEP Section 713.04). If a reply to the last Office action has already been filed, APPLICANT IS GIVEN A NON-EXTENDABLE PERIOD OF THE LONGER OF ONE MONTH OR THIRTY DAYS FROM THIS INTERVIEW DATE, OR THE MAILING DATE OF THIS INTERVIEW SUMMARY FORM, WHICHEVER IS LATER, TO FILE A STATEMENT OF THE SUBSTANCE OF THE INTERVIEW. See Summary of Record of Interview requirements on reverse side or on attached sheet.

/Said Broome/ Examiner, Art Unit 2628	

DETAILED ACTION

Response to Amendment

1. This office action is in response to an amendment filed on 11/6/2008.

2. Claims 1-10 have been cancelled by the applicant.

3. Claims 11-19 are original.

Examiner's Amendment

An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

Authorization for this examiner's amendment was given in a telephone interview with Stephen Sullivan on December 29, 2008.

Amend the claims as follows:

Claim 19: In line 5 after the word "subdivision" insert the phrase "using the computer system".

Allowable Subject Matter

Claims 11-19 are allowed. The following is an examiner's statement of reasons for allowance:

The prior art references, Fenney et al. (U.S. Patent Publication 2004/0113909), Moreton et al. (U.S. Patent 6,906,716) and Oliver et al. (U.S. Patent 5,561,754), do not teach all the limitations of claims 11-19.

In regards to claim 11, the prior fails to teach or suggest a system, comprising a processor and a graphics processing unit (GPU) coupled to the processor, the GPU comprising a transform unit, a lighting unit, a renderer unit, and a tessellate unit coupled between the transform unit and the lighting unit, wherein objects to be rendered by the GPU are transmitted as control points to the GPU, the transform unit transforms the control points, the tessellate unit executes a first set of instructions for tessellating both rational and non-rational object surfaces expressed in screen coordinates (SC), in real-time, the lighting unit lights vertices of the triangles resultant from tessellation, and the renderer unit renders and displays the triangles by executing a second set of instructions, therefore claims 11-18 are allowable.

In regards to claim 19, the prior fails to teach or suggest a real-time method for tessellating and rendering surfaces of an object on a computer system, comprising (a) performing transformation and tessellation by, (i) for each surface, transforming 16 points, (ii) performing three dimensional surface subdivision using the computer system by subdividing only two cubic curves comprising the surface, (iii) terminating the subdivision termination by expressing the subdivision in screen coordinates (SC) and by measuring curvature in pixels, (iv) for each new view, generating a new subdivision, thereby producing automatic level of detail, (v) preventing cracks at boundaries between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary, (vi) for the current subdivision, generating the vertices, normals, texture coordinates, and displacements used for bump and displacement mapping, and (vii) generating

triangles by connecting neighboring vertices, (viii) for each vertex, calculating the normal, calculating normal displacement for bump mapping, displacing the normal for bump mapping, displacing the vertex for displacement mapping, wherein bump and displacement mapping are executed pixel by pixel for all the points inside each triangle, and (ix) calculating the normal of each triangle; and (b) performing rendering by (i) for each triangle, clipping against a viewing viewport, calculating lighting for additional vertices produced by clipping, and culling backfacing triangles, (ii) projecting all vertices into screen coordinates, and (iii) rendering all the triangles produced after clipping and projection, therefore claim 19 is allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAID BROOME whose telephone number is (571)272-2931. The examiner can normally be reached on M-F 8:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on (571)272-7782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications

may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Said Broome/
Examiner, Art Unit 2628

/Sajous, Wesner/

Primary Examiner, Art Unit 2628

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11778515	SFARTI, ADRIAN
	Examiner	Art Unit
	SAID BROOME	2628

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/02/2008	10/23/2008	12/22/2008						
	1	✓	✓	-						
	2	✓	✓	-						
	3	✓	✓	-						
	4	✓	✓	-						
	5	✓	✓	-						
	6	✓	✓	-						
	7	✓	✓	-						
	8	✓	✓	-						
	9	✓	✓	-						
	10	✓	✓	-						
1	11	✓	=	=						
2	12	✓	=	=						
3	13	✓	=	=						
4	14	✓	=	=						
5	15	✓	=	=						
6	16	✓	=	=						
7	17	✓	=	=						
8	18	✓	=	=						
9	19	✓	=	=						

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11778515	SFARTI, ADRIAN
	Examiner	Art Unit
	SAID BROOME	2628

SEARCHED

Class	Subclass	Date	Examiner

SEARCH NOTES

Search Notes	Date	Examiner
Inventor Name Search	7/2/08	SB
EAST Search (US-PGPUB, USPAT, USCOR, EPO, JPO, DERWENT, IBM_TDB)	7/2/08	SB
Google Search - (http://scholar.google.com)	7/2/08	SB
Updated Inventor Name Search	10/22/08	SB
Updated EAST Search (US-PGPUB, USPAT, USCOR, EPO, JPO, DERWENT, IBM_TDB)	10/23/08	SB
Reviewed Parent Case 10/732,398	10/23/08	SB
Consulted Jason Repko, Kimbinh Nguyen	10/22/08	SB
Google Search - (http://scholar.google.com)	10/23/08	SB
Updated EAST Search (US-PGPUB, USPAT, USCOR, EPO, JPO, DERWENT, IBM_TDB)	12/22/08	SB
Updated Inventor Name Search	12/22/08	SB

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
345	423	12/22/08	SB

Issue Classification	Application/Control No. 11/778,515	Applicant(s)/Patent under Reexamination SFARTI, ADRIAN
	Examiner SAID BROOME	Art Unit 2628

ISSUE CLASSIFICATION

ORIGINAL		INTERNATIONAL CLASSIFICATION									
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED				
345	423	G	06	T	15	/30				/	
CROSS REFERENCES						/				/	
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)										
						/				/	
						/				/	
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						/				/	

/SAID BROOME/ 12/22/08 (Assistant Examiner) (Date)	/Wesner Sajous/ 12/30/2008 (Primary Examiner) (Date)	Total Claims Allowed: 9	
(Legal Instruments Examiner) (Date)		O.G. Print Claim(s) 19	O.G. Print Fig. 8

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		31		61		91		121		151		181
	2		32		62		92		122		152		182
	3		33		63		93		123		153		183
	4		34		64		94		124		154		184
	5		35		65		95		125		155		185
	6		36		66		96		126		156		186
	7		37		67		97		127		157		187
	8		38		68		98		128		158		188
	9		39		69		99		129		159		189
	10		40		70		100		130		160		190
1	11		41		71		101		131		161		191
2	12		42		72		102		132		162		192
3	13		43		73		103		133		163		193
4	14		44		74		104		134		164		194
5	15		45		75		105		135		165		195
6	16		46		76		106		136		166		196
7	17		47		77		107		137		167		197
8	18		48		78		108		138		168		198
9	19		49		79		109		139		169		199
	20		50		80		110		140		170		200
	21		51		81		111		141		171		201
	22		52		82		112		142		172		202
	23		53		83		113		143		173		203
	24		54		84		114		144		174		204
	25		55		85		115		145		175		205
	26		56		86		116		146		176		206
	27		57		87		117		147		177		207
	28		58		88		118		148		178		208
	29		59		89		119		149		179		209
	30		60		90		120		150		180		210

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	(graphics with process$4 with unit) same (render$4 near (object or primitive or polygon or mesh or shape)) same (bus) same (control adj point) same (bicubic near surface)	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:12
L2	13	(bus same (graphics with process$4 with unit)) and (render$4 near (object or primitive or polygon or mesh or shape)) and ((control adj point) same (bicubic near surface))	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:12
L3	3	(render$4 near (object or primitive or polygon or mesh or shape)) and ((control adj point) and (bicubic near surface)) and ((tessellat$4 and transform and lighting and render$4) adj unit)	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:12
L4	7	((control adj point) and (bicubic near surface)) and ((tessellat$4 or transform$4 or light$4 or render$4) adj unit)	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:12
L5	5	(bus same (graphics with process$4 with unit)) and (render$4 near (object or primitive or polygon or mesh or shape)) and ((control adj point) and (bicubic near surface)) and ((tessellat$4 or transform$4 or light$4 or render$4) adj unit)	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:12
L6	3	(graphics with process$4 with unit) and (transform near unit) and (bicubic near surface)	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:12
L7	19	(graphics with process$4 with unit) and (bicubic near surface)	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:12
L8	38	((real adj time) with (tesellat$4 or tesselat$4 or tessellat$4))	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:13
L9	16	((real adj time) with (tesellat$4 or tesselat$4 or tessellat$4)) and ((spline or bicubic) with (surface or patch))	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:13
L10	109	(tesselat$4 or tessellat$4 or tesellat$4) same (real adj time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L11	45	(tesselat$4 or tessellat$4 or tesellat$4) with (real adj time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L12	1	(interactive with digital with three with dimensional with modifying with image with device with control with point)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L13	35	((sub adj (divis$4 or divid$4)) or subdivis$4 or subdivid$4) with (two or plurality or mltiple or many or several or various or numerous) with ((bicubic or (bi adj cubic) or cubic) with (curve or surface or object))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L14	3	(((sub adj (divis$4 or divid$4)) or subdivis$4 or subdivid$4) with (curve or spline) with projection with length with height with (bound$4 adj (box or rectang$4))) same (predetermined with pixel) same (screen adj coordinate)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L15	6	((graphic adj (unit or process$4)) and (prevent$4 with ((crack or inconsistent or break)) same (subdivision or (sub adj (divis$4 or divid$4)))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13

EAST Search History

L16	77	((graphic adj (unit or process$4)) and ((graphic with utility with library) or "GLU"))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L17	10	(sixteen with control with point) same (four same boundar$4 with curve) same (boundar$4 adj (box or rectange or region or square)) same (subdivid$4 or subdivis$4 or (sub adj (divis$4 or divid$4)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L18	10	(sixteen with control with point) same (four same boundar$4 with curve) same (boundar$4 adj (box or rectangle or region or square)) same (subdivid$4 or subdivis$4 or (sub adj (divis$4 or divid$4)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:13
L23	3	((calulat$4 or determin$4) with normal with vertex) and (displacement or bump or ((displacement or bump) adj mapping)) and (displac$4 with vertex) and ((displacement adj mapping) same (pixel same point same triangle))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:15
L24	227	((between or coupled) with (transform with (light$4 or lighting)) with (unit or processor or module))	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:15
L25	49	((between or coupled) with ((transform with (light$4 or lighting)) near (unit or processor or module)))	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:15
L26	3	((between or coupled) with ((transform with (light$4 or lighting)) near (unit or processor or module))) with ((tesellat$4 or tessellat$4 or tesselat$4) near (unit or processor or module)) and ((real near time) or "real-time")	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:15
L27	3	((between or coupled) with ((transform with (light$4 or lighting)) near (unit or processor or module))) same ((tesellat$4 or tessellat$4 or tesselat$4) near (unit or processor or module)) and ((real near time) or "real-time")	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:16
L28	3	((between or coupled) same ((transform with (light$4 or lighting)) near (unit or processor or module))) same ((tesellat$4 or tessellat$4 or tesselat$4) near (unit or processor or module)) and ((real near time) or "real-time")	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:16
L29	13	((transform$4 near (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) with transform$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:16
L30	3	((real-time or (real near time)) and method and tessellating and rendering and surfaces) and (performing and transformation and tessellation) and (transforming and points and vertices and inside and surface) and (performing and three and dimensional and surface and subdivision and subdividing and cubic and curves) and (terminating and subdivision and termination and subdivision and screen and coordinates and measuring and curvature) and (generating and subdivision and automatic and level and detail) and (preventing and cracks and boundaries and adjacent and surfaces)	US-PGPUB; USPAT; USOCR	OR	ON	2008/12/22 12:16
L31	11	((transform$4 near2 (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) near2 (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:16
L32	6	((((tessellat$4 or tesellat$4 or tesselat$4) adj (unit or processor or module or device)) near (between or couple$4 or before or prior or (in near front) or (next near to))) with ((transform$4) near (unit or processor or module or device)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:17

L33	7	((((tessellat$4 or tesellat$4 or tesselat$4) near (unit or processor or module or device)) with (between or couple$4 or before or prior or (in near front) or (next near to))) same ((transform$4) near (unit or processor or module or device)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:17
L34	35	((sub adj (divis$4 or divid$4)) or subdivis$4 or subdivid$4) with (two or plurality or mltiple or many or several or various or numerous) with ((bicubic or (bi adj cubic) or cubic) with (curve or surface or object))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:17
L35	6	((graphic adj (unit or process$4)) and (prevent$4 with ((crack or inconsistent or break)) same (subdivision or (sub adj (divis$4 or divid$4)))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:17
L36	3	((graphic adj (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub adj (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub adj (divis$4 or divid$4))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:17
L37	77	((graphic adj (unit or process$4)) and ((graphic with utility with library) or "GLU"))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:17
L38	8	((subdivis$4 or subdivid$4 or (sub near (divis$4 or divid$4))) same patch same (stor$4 or save or memor$4) same (independent$4 or alone or (by with itself)) same (egde or bound$4 or line or vertice or side))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:18
L39	3	((graphic near (unit or process$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/12/22 12:18
L40	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm.	US-PGPUB	OR	ON	2008/12/22 12:18
L41	670	(345/423).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/12/22 12:18
L42	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and L41	US-PGPUB	OR	ON	2008/12/22 12:18
L43	2	(((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))).clm. and L41	US-PGPUB	OR	ON	2008/12/22 12:18
L44	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm. and L41	US-PGPUB	OR	ON	2008/12/22 12:18
L45	3	(((transform$4 with (unit or processor or system))) same ((((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))).clm. and L41	US-PGPUB	OR	ON	2008/12/22 12:18

L46	0	(((transform$4 with (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) same (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) same (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) same transform$4)).clm. and L41	US-PGPUB	OR	ON	2008/12/22 12:18
L47	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and L41	US-PGPUB	OR	ON	2008/12/22 12:19

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S213	4	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))))).clm.	US-PGPUB	OR	ON	2008/10/23 10:35
S214	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm.	US-PGPUB	OR	ON	2008/10/23 10:35
S222	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:22
S223	3	((sub near (divis$4 or divid$4)) or subdivis$4 or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4) same (two with ((bicubic or (bi adj cubic) or cubic) same (curve or surface or object))).clm.	US-PGPUB	OR	ON	2008/10/23 11:24
S224	4	(((transform$4 with (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) same (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) same (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) same transform$4)).clm.	US-PGPUB	OR	ON	2008/10/23 11:24
S225	9	(((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
S226	4	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device)))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
S227	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
S228	2	(((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
S229	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:26
S230	661	(345/423).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/10/23 11:27
S231	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:27
S232	2	((sub near (divis$4 or divid$4)) or subdivis$4 or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4) same (two with ((bicubic or (bi adj cubic) or cubic) same (curve or surface or object))).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:27
S233	0	(((transform$4 with (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) same (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) same (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) same transform$4)).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:27
S234	3	(((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:27
S235	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device)))).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:27

EAST Search History

S236	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:28
S237	2	(((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:28
S238	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and S230	US-PGPUB	OR	ON	2008/10/23 11:28

PALM INTRANET

Day : Monday
Date: 12/22/2008
Time: 12:10:55

Inventor Name Search Result Office of Public Affairs

Your Search was:

Last Name = SFARTI
First Name = ADRIAN

Application#	Patent#	PG Pub#	Status	Date Filed	Title	Examiner Name	I N
11013039	7295204	20060125824	150	12/14/2004	RAPID ZIPPERING FOR REAL TIME TESSELATION OF BICUBIC SURFACES	REPKO,JASON	S A
10436698	Not Issued	20030189570	161	05/12/2003	BICUBIC SURFACE RENDERING	LUU,MATTHEW	S A
11778515	Not Issued	20080049018	071	07/16/2007	BICUBIC SURFACE REAL TIME TESSELATION UNIT	BROOME,SAID	S A
60222105	Not Issued		159	07/28/2000	BICUBIC SURFACE RENDERING		S A
09669981	Not Issued		168	09/26/2000	GUARD REGION AND ASSOCIATED DISPLAY IMAGE AREA FOR REDUCING CLIPPING OF POLYGONS	GOOD JOHNSON,MOTILEWA	S A
09734438	6563501	20020033821	150	12/11/2000	BICUBIC SURFACE RENDERING	ARNOLD,ADAM	S A
09584463	6529207		150	05/31/2000	IDENTIFYING SILHOUETTE EDGES OF OBJECTS TO APPLY ANTI-ALIASING	PADMANABHAN,MANO	S A
10732398	7245299	20040227755	150	12/09/2003	BICUBIC SURFACE REAL-TIME TESSELATION	BROOME,SAID	S A

					UNIT		
11371507	Not Issued	20070214255	061	03/08/2006	MULTI-NODE COMPUTER SYSTEM COMPONENT PROACTIVE MONITORING AND PROACTIVE REPAIR	IQBAL,NADEEM	S A
11371678	Not Issued	20070214105	071	03/08/2006	NETWORK TOPOLOGY FOR A SCALABLE DATA STORAGE SYSTEM	ENGELSKIRCHEN,JEREMY	S A
10171860	7088398		150	06/14/2002	METHOD AND APPARATUS FOR REGENERATING A CLOCK FOR AUXILIARY DATA TRANSMITTED OVER A SERIAL LINK WITH VIDEO DATA	DESIR,JEAN	S A
10871882	Not Issued		160	06/18/2004	METHOD OF INTEGRATING A PERSONAL COMPUTING SYSTEM AND APPARATUS THEREOF		S A
60590692	Not Issued		159	07/23/2004	DIGITAL CONTENT WATERMARKING		S A
60608003	Not Issued		159	09/07/2004	SYSTEM AND METHOD FOR WATERMARKING AND ENCRYPTION TO PREVENT THE UNAUTHORIZED DUPLICATION OF DIGITAL DATA		S A
10959474	7280108	20050057568	150	10/05/2004	BICUBIC SURFACE RENDERING	REPKO,JASON	S A

Inventor Search Completed: No Records to Display.

Search Another: Inventor Last Name First Name

SFARTI ADRIAN Search

Enter both names for a faster result, even if it is only a few letters.

(To go back use Back button on your browser toolbar)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Sfarti	Date: November 6, 2008
Serial No: 11/778,515	Group Art Unit: 2628
Filed: 7/16/2007	Examiner: Broome, Said A.
Title: BICUBIC SURFACE REAL TIME TESSELATION UNIT	Confirmation No: 1565

RESPONSE UNDER 37 CFR 1.111

Dear Sir:

In response to the Office Action of October 29, 2008, please amend the above-identified application in the following manner:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks/Arguments begin on page 6 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior version, and listings, of claims in the application.

Listing of Claims:

1 (Canceled)

2 (Canceled)

3 (Canceled)

4 (Canceled)

5 (Canceled)

6 (Canceled)

7 (Canceled)

8 (Canceled)

9 (Canceled)

10 (Canceled)

11 (Previously Presented) A system, comprising:

a processor; and

a graphics processing unit (GPU) coupled to the processor, the GPU comprising a transform unit, a lighting unit, a renderer unit, and a tessellate unit coupled between the transform unit and the lighting unit;

wherein objects to be rendered by the GPU are transmitted as control points to the GPU, the transform unit transforms the control points, the tessellate unit executes a first set of instructions for tessellating both rational and non-rational object surfaces expressed in screen coordinates (SC), in real-time, the lighting unit lights vertices of the triangles resultant from tessellation, and the renderer unit renders and displays the triangles by executing a second set of instructions.

12 (Original) The graphics system of claim 11 wherein the first set of instructions simplifies three dimensional surface subdivision of the object surfaces by reducing surface subdivision to a subdivision of two cubic curves by performing instructions for:
for each bicubic surface,

subdividing a boundary curve representing an s interval until a projection of a length of a height of a curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates; and

subdividing the boundary curve representing a t interval until a projection of a length of a height of the curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates.

13 (Original) The graphics system of claim 12 wherein the first set of instructions simplifies three dimensional surface subdivision by reducing it to the subdivision of two cubic curves by simplifying subdivision termination criteria by expressing the termination criteria in screen (SC) coordinates and by measuring curvature in pixels, wherein for each new view, a new subdivision can be generated, producing automatic level of detail.

14 (Original) The graphics system of claim 13 wherein the first set of instructions reduces cracks at the boundaries between surfaces by using a common subdivision for all surfaces sharing a boundary by performing instructions for:

for all bicubic surfaces sharing a same s or t parameter boundary,

choosing as a common subdivision a reunion of the subdivisions in order to prevent cracks showing along the common boundary or a finest subdivision, the finest subdivision being the one with the most points inside the set.

15 (Previously Presented) The graphics system of claim 14 wherein the first set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping are generated by performing instructions for:

for each bicubic surface,

for each pair (si,tj) of parameters, where i and j represent a number of rows and columns, respectively,

calculating texture coordinates (($u_{i,j}$ $v_{i,j}$ $q_{i,j}$) and displacement coordinates ($p_{i,j}$ $r_{i,j}$) for vertex $V_{i,j}$) thru interpolation,

looking up vertex displacement ($dx_{i,j}$, $dy_{i,j}$, $dz_{i,j}$) corresponding to the displacement coordinates ($p_{i,j}$ $r_{i,j}$); and

generating triangles by connecting neighboring vertices.

16 (Original) The graphics system of claim 15 wherein the second set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping by performing instructions for:

for each vertex $V_{i,j}$,

calculating a normal $N_{i,j}$ to that vertex, which was previously transformed in world coordinates

calculating ($dN_{i,j}$) as normal displacement for bump mapping as a function of (si,tj);

calculating $N'_{i,j}=N_{i,j}+dN_{i,j}$ to displace the normal for bump mapping; and

calculating $V'_{i,j}=V_{i,j}+(dx_{i,j}$, $dy_{i,j}$, $dz_{i,j})* N_{i,j}$ to displace the vertex for displacement mapping;

for each triangle,

executing bump and displacement mapping pixel-by-pixel for all the points inside the triangle; and

calculating a normal to the triangle for culling.

17 (Original) The graphics system of claim 11 further including a Graphics Utility Library (GLU) for implementing drivers.

18 (Original) The graphics system of claim 17 wherein the GLU includes several different types of primitives including, strips, fans, meshes, and indexed meshes of surface patches.

19 (Original) A real-time method for tessellating and rendering surfaces of an object on a computer system, comprising:

(a) performing transformation and tessellation by,

(i) for each surface, transforming 16 points;

(ii) performing three dimensional surface subdivision by subdividing only two cubic curves comprising the surface;

(iii) terminating the subdivision termination by expressing the subdivision in screen coordinates (SC) and by measuring curvature in pixels;

(iv) for each new view, generating a new subdivision, thereby producing automatic level of detail;

(v) preventing cracks at boundaries between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary;

(vi) for the current subdivision, generating the vertices, normals, texture coordinates, and displacements used for bump and displacement mapping; and

(vii) generating triangles by connecting neighboring vertices;

(viii) for each vertex, calculating the normal, calculating normal displacement for bump mapping, displacing the normal for bump mapping, displacing the vertex for displacement mapping, wherein bump and displacement mapping are executed pixel by pixel for all the points inside each triangle; and

(ix) calculating the normal of each triangle; and

(b) performing rendering by

(i) for each triangle, clipping against a viewing viewport, calculating lighting for additional vertices produced by clipping, and culling backfacing triangles;

(ii) projecting all vertices into screen coordinates; and

(iii) rendering all the triangles produced after clipping and projection.

REMARKS/ARGUMENTS

This Amendment is in response to the Office Action dated October 29, 2008. Claims 1-19 are pending. Claims 1-10 are rejected, and claims 11-19 are allowed. Claims 1-10 have been canceled. Accordingly, claims 11-19 remain pending in the present application.

In view of the foregoing, Applicant respectfully requests reconsideration and passage to issue of claims now presented. Applicants' attorney believes this application in condition for allowance. Should any unresolved issues remain, Examiner is invited to call Applicants' attorney at the telephone number indicated below.

Respectfully submitted,

Strategic Patent Group, P.C.

/Stephen G. Sullivan/
Stephen G. Sullivan
Attorney/Agent for Applicant(s)
Reg. No. 38,329
Telephone No: 650-969-7474

Date: November 6, 2008

Electronic Acknowledgement Receipt

EFS ID:	4243253
Application Number:	11778515
International Application Number:	
Confirmation Number:	1565
Title of Invention:	Bicubic Surface Real Time Tesselation Unit
First Named Inventor/Applicant Name:	Adrian Sfarti
Customer Number:	57580
Filer:	Stephen Grant Sullivan/Jackie Tanda
Filer Authorized By:	Stephen Grant Sullivan
Attorney Docket Number:	1935CIP2C
Receipt Date:	06-NOV-2008
Filing Date:	16-JUL-2007
Time Stamp:	13:55:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		1935CIP2C_Amend_B.pdf	27229 1a57487f721ce92cb2b64473fc5d8fe259bb9d8d	yes	6

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	6
Warnings:			
Information:			
	Total Files Size (in bytes):	27229	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/778,515	07/16/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☒ RATE ($)	SMALL ENTITY ☒ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	11/06/2008	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 9	Minus	** 20	= 0	X $26 =	0	OR	X $ =	
	Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $110 =	0	OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE	0	OR	TOTAL ADD'L FEE	

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/BRUCE D. HARRISON/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C	1565

57580 7590 10/29/2008

STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA 94042

EXAMINER	
BROOME, SAID A	

ART UNIT	PAPER NUMBER
2628	

MAIL DATE	DELIVERY MODE
10/29/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	11/778,515	SFARTI, ADRIAN	
	Examiner	Art Unit	
	SAID BROOME	2628	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *06 October 2008*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-19* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *11-19* is/are allowed.

6)☒ Claim(s) *1-10* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. This office action is in response to an amendment filed on 10/6/2008.

2. Claims 6, 11 and 15 have been amended by the applicant.

3. Claims 1-5, 7-10, 12-14 and 16-19 are original.

Double Patenting

A rejection based on double patenting of the "same invention" type finds its support in the language of 35 U.S.C. 101 which states that "whoever invents or discovers any new and useful process ... may obtain a patent therefor ..." (Emphasis added). Thus, the term "same invention," in this context, means an invention drawn to identical subject matter. See *Miller v. Eagle Mfg. Co.*, 151 U.S. 186 (1894); *In re Ockert*, 245 F.2d 467, 114 USPQ 330 (CCPA 1957); and *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970).

A statutory type (35 U.S.C. 101) double patenting rejection can be overcome by canceling or amending the conflicting claims so they are no longer coextensive in scope. The filing of a terminal disclaimer cannot overcome a double patenting rejection based upon 35 U.S.C. 101.

Claims 1-10 of the current application 11/778,515 are rejected under 35 U.S.C. 101 as claiming the same invention as that of claims 1-10 of prior U.S. Patent No. 7,245,299, this is a double patenting rejection. Though the preamble of claim 1 recited in the current application 11/778,515 is a slight variation of claim 1 of U.S. Patent 7,245,299, the preamble is not given patentable weight since it is not tied to the body of the claim and is not required to breathe life in

to the invention, therefore the method steps of claim 1 the current application 11/778,515 and claim 1 of U.S. Patent 7,245,299 are rejected under a statutory type double patenting rejection. Table I listed below is provided to show which claims in the current application, 11/778,515, map to claims of U.S. Patent 7,245,299. Table II is provided below to show how all the claimed limitations from the independent claim 1 of the current application 11/778,515 maps to the independent claim 1 of U.S. Patent 7,245,299.

TABLE I

Current Application: 11/778,515	Claims 1-10
U.S. Patent: 7,245,299	Claims 1-10

TABLE II

Current Application: 11/778,515 (Claim 1)	**U.S. Patent: 7,245,299 (Claim 1)**
1. A graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are received as control points of bicubic surfaces, the graphics processing unit comprising:	1. A graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are transmitted to the graphics processing unit over a bus as control points of bicubic surfaces, the graphics processing unit comprising:
a transform unit; a lighting unit; a renderer unit; and	a transform unit; a lighting unit; a renderer unit; and
a tessellate unit coupled between the	a tessellate unit coupled between the

transform unit and the lighting unit for tessellating both rational and non-rational object surfaces in real-time.	transform unit and the lighting unit for tessellating both rational and non-rational object surfaces in real-time.

Allowable Subject Matter

Claims 11-19 are allowed. The following is an examiner's statement of reasons for allowance:

The prior art references, Fenney et al. (U.S. Patent Publication 2004/0113909), Moreton et al. (U.S. Patent 6,906,716) and Oliver et al. (U.S. Patent 5,561,754), do not teach all the limitations of claims 11-19.

In regards to claim 11, the prior fails to teach or suggest a system, comprising a processor and a graphics processing unit (GPU) coupled to the processor, the GPU comprising a transform unit, a lighting unit, a renderer unit, and a tessellate unit coupled between the transform unit and the lighting unit, wherein objects to be rendered t-e-by the GPU are transmitted as control points to the GPU, the transform unit transforms the control points, the tessellate unit executes a first set of instructions for tessellating both rational and non-rational object surfaces expressed in screen coordinates (SC), in real-time, the lighting unit lights vertices of the triangles resultant from tessellation, and the renderer unit renders and displays the triangles by executing a second set of instructions, therefore claims 11-18 are allowable.

In regards to claim 19, the prior fails to teach or suggest a real-time method for tessellating and rendering surfaces of an object on a computer system, comprising (a) performing

transformation and tessellation by, (i) for each surface, transforming 16 points, (ii) performing three dimensional surface subdivision by subdividing only two cubic curves comprising the surface, (iii) terminating the subdivision termination by expressing the subdivision in screen coordinates (SC) and by measuring curvature in pixels, (iv) for each new view, generating a new subdivision, thereby producing automatic level of detail, (v) preventing cracks at boundaries between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary, (vi) for the current subdivision, generating the vertices, normals, texture coordinates, and displacements used for bump and displacement mapping, and (vii) generating triangles by connecting neighboring vertices, (viii) for each vertex, calculating the normal, calculating normal displacement for bump mapping, displacing the normal for bump mapping, displacing the vertex for displacement mapping, wherein bump and displacement mapping are executed pixel by pixel for all the points inside each triangle, and (ix) calculating the normal of each triangle; and (b) performing rendering by (i) for each triangle, clipping against a viewing viewport, calculating lighting for additional vertices produced by clipping, and culling backfacing triangles, (ii) projecting all vertices into screen coordinates, and (iii) rendering all the triangles produced after clipping and projection, therefore claim 19 is allowable.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The prior art patents and non-patent literature on the attached PTO-892 form pertain to subdivision surfaces:

- Kumar, S., Manocha, D., Interactive Display of Large NURBS Models, December 1996, IEEE Transactions on Visualization and Computer Graphics, Vol. 2, No. 4, pp. 323-336.
- Snyder, J., Barr, A., Ray Tracing Complex Models Containing Surface Tessellations, July 1987, Proceedings of the 14th annual conference on Computer graphics and interactive techniques, Vol. 21, No. 4, p. 119-128.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAID BROOME whose telephone number is (571)272-2931. The examiner can normally be reached on M-F 8:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on (571)272-7782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would

like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Ulka Chauhan/
Supervisory Patent Examiner, Art Unit 2628

/Said Broome/
Examiner, Art Unit 2628

Notice of References Cited	Application/Control No. 11/778,515	Applicant(s)/Patent Under Reexamination SFARTI, ADRIAN	
	Examiner SAID BROOME	Art Unit 2628	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
	A	US-			
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Kumar, S., Manocha, D., Interactive Display of Large NURBS Models, December 1996, IEEE Transactions on Visualization and Computer Graphics, Vol. 2, No. 4, pp. 323-336.
	V	Snyder, J., Barr, A., Ray Tracing Complex Models Containing Surface Tessellations, July 1987, Proceedings of the 14th annual conference on Computer graphics and interactive techniques, Vol. 21, No. 4, p. 119-128.
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11778515	SFARTI, ADRIAN
	Examiner	Art Unit
	SAID BROOME	2628

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/02/2008	10/23/2008							
	1	✓	✓							
	2	✓	✓							
	3	✓	✓							
	4	✓	✓							
	5	✓	✓							
	6	✓	✓							
	7	✓	✓							
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	9	✓	✓							
	10	✓	✓							
	11	✓	=							
	12	✓	=							
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	15	✓	=							
	16	✓	=							
	17	✓	=							
	18	✓	=							
	19	✓	=							

PALM INTRANET

Day : Wednesday
Date: 10/22/2008
Time: 19:49:25

Inventor Name Search Result Office of Public Affairs

Your Search was:

Last Name = SFARTI
First Name = ADRIAN

Application#	Patent#	PG Pub#	Status	Date Filed	Title	Examiner Name	I N
11013039	7295204	20060125824	150	12/14/2004	RAPID ZIPPERING FOR REAL TIME TESSELATION OF BICUBIC SURFACES	REPKO,JASON	S A
10436698	Not Issued	20030189570	161	05/12/2003	BICUBIC SURFACE RENDERING	LUU,MATTHEW	S A
11778515	Not Issued	20080049018	071	07/16/2007	BICUBIC SURFACE REAL TIME TESSELATION UNIT	BROOME,SAID	S A
60222105	Not Issued		159	07/28/2000	BICUBIC SURFACE RENDERING		S A
09669981	Not Issued		168	09/26/2000	GUARD REGION AND ASSOCIATED DISPLAY IMAGE AREA FOR REDUCING CLIPPING OF POLYGONS	GOOD JOHNSON,MOTILEWA	S A
09734438	6563501	20020033821	150	12/11/2000	BICUBIC SURFACE RENDERING	ARNOLD,ADAM	S A
09584463	6529207		150	05/31/2000	IDENTIFYING SILHOUETTE EDGES OF OBJECTS TO APPLY ANTI-ALIASING	PADMANABHAN,MANO	S A
10732398	7245299	20040227755	150	12/09/2003	BICUBIC SURFACE REAL-TIME TESSELATION	BROOME,SAID	S A

					UNIT		
11371507	Not Issued	20070214255	071	03/08/2006	MULTI-NODE COMPUTER SYSTEM COMPONENT PROACTIVE MONITORING AND PROACTIVE REPAIR	IQBAL,NADEEM	S A
11371678	Not Issued	20070214105	061	03/08/2006	NETWORK TOPOLOGY FOR A SCALABLE DATA STORAGE SYSTEM	ENGELSKIRCHEN,JEREMY	S A
10171860	7088398		150	06/14/2002	METHOD AND APPARATUS FOR REGENERATING A CLOCK FOR AUXILIARY DATA TRANSMITTED OVER A SERIAL LINK WITH VIDEO DATA	DESIR,JEAN	S A
10871882	Not Issued		160	06/18/2004	METHOD OF INTEGRATING A PERSONAL COMPUTING SYSTEM AND APPARATUS THEREOF		S A
60590692	Not Issued		159	07/23/2004	DIGITAL CONTENT WATERMARKING		S A
60608003	Not Issued		159	09/07/2004	SYSTEM AND METHOD FOR WATERMARKING AND ENCRYPTION TO PREVENT THE UNAUTHORIZED DUPLICATION OF DIGITAL DATA		S A
10959474	7280108	20050057568	150	10/05/2004	BICUBIC SURFACE RENDERING	REPKO,JASON	S A

Inventor Search Completed: No Records to Display.

Search Another: Inventor Last Name First Name

SFARTI ADRIAN Search

Enter both names for a faster result, even if it is only a few letters.

(To go back use Back button on your browser toolbar)

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L23	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:22
L24	3	((sub near (divis$4 or divid$4)) or subdivis$4 or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4) same (two with ((bicubic or (bi adj cubic) or cubic) same (curve or surface or object))).clm.	US-PGPUB	OR	ON	2008/10/23 11:24
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L26	9	(((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L27	4	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device)))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L28	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L29	2	(((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L30	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:26
L31	661	(345/423).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/10/23 11:27
L32	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L33	2	((sub near (divis$4 or divid$4)) or subdivis$4 or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4) same (two with ((bicubic or (bi adj cubic) or cubic) same (curve or surface or object))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L34	0	(((transform$4 with (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) same (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) same (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) same transform$4)).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
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L36	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device)))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L37	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:28
L38	2	(((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:28

EAST Search History

L39	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:28

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L2	41	((sub near (divis$4 or divid$4)) or subdivis$4 or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4) with (two or plurality or multiple or many or several or various or numerous or couple or pair) with ((bicubic or (bi adj cubic) or cubic) with (curve or surface or object))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:28
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L4	2	((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) near (between or couple$4 or before or prior or (in near front) or (next near to))) with ((transform$4) near (unit or processor or module or device)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:29
L5	2	((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) near (between or couple$4 or before or prior or (in near front) or (next near to))) with ((transform$4) near (unit or processor or module or device)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:30
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L7	39	((transform$4 near3 (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near3 (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) same (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) with transform$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:30
L8	0	((calulat$4 or determin$4) with normal with vertex) same (displacement or bump or ((displacement or bump) near3 mapping)) and (displac$4 with vertex) and ((displacement near3 (mapp$4 or map)) same (pixel same point same triangle))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:31
L9	8	((subdivis$4 or subdivid$4 or (sub near (divis$4 or divid$4))) same patch same (stor$4 or save or memor$4) same (independent$4 or alone or (by with itself)) same (egde or bound$4 or line or vertice or side))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:31
L10	180	((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:31

EAST Search History

L11	25	((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) near (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 10:32
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L13	12	("20040227755" | "20060125824" | "5261029" | "5377320" | "5428718" | "5488684" | "5771341" | "5903273" | "6100894" | "6256038" | "6437795" | "6563501").PN. OR ("7280108").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/10/23 10:32
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L15	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm.	US-PGPUB	OR	ON	2008/10/23 10:35
L16	36	((ADRIAN) near2 (SFARTI)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2008/10/23 11:08
L17	3	((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 11:09
L18	8	((subdivis$4 or subdivid$4 or (sub near (divis$4 or divid$4))) same patch same (stor$4 or save or memor$4) same (independent$4 or alone or (by with itself)) same (egde or bound$4 or line or vertice or side))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 11:10
L19	3	((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub adj (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub adj (divis$4 or divid$4))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 11:10
L20	47	((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and (common with boundar$4)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 11:12
L21	191	((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 11:12
L22	191	((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/10/23 11:21
L23	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:22
L24	3	((sub near (divis$4 or divid$4)) or subdivis$4 or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4) same (two with ((bicubic or (bi adj cubic) or cubic) same (curve or surface or object))).clm.	US-PGPUB	OR	ON	2008/10/23 11:24

EAST Search History

L25	4	(((transform$4 with (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) same (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) same (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) same transform$4)).clm.	US-PGPUB	OR	ON	2008/10/23 11:24
L26	9	(((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L27	4	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device)))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L28	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L29	2	(((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))).clm.	US-PGPUB	OR	ON	2008/10/23 11:25
L30	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm.	US-PGPUB	OR	ON	2008/10/23 11:26
L31	661	(345/423).CCLS.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/10/23 11:27
L32	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) same (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L33	2	((sub near (divis$4 or divid$4)) or subdivis$4 or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4) same (two with ((bicubic or (bi adj cubic) or cubic) same (curve or surface or object))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L34	0	(((transform$4 with (prior or before)) with (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) same (prior or before)) with transform$4) or ((transform$4 near (after or subsequent$4)) same (tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4)) or (((tessellat$4 or tesellat$4 or tesselat$4 or subdivid$4) near (after or subsequent$4)) same transform$4)).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L35	3	(((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L36	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device)))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:27
L37	3	(((((tessellat$4 or tesellat$4 or tesselat$4) with (unit or processor or module or device)) and (between or couple$4 or before or prior or (in near front) or (next near to))) and ((transform$4) near (unit or processor or module or device))) and ((light$4 or shad$4 or specular$4) near (unit or processor or module or device))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:28
L38	2	(((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:28
L39	2	(((subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4)) with (screen$4 with coordinat$4)) and (prevent$4 with ((crack$4 or tear$4 or inconsisten$4 or break$4 or rip or ripped)) and (subdivision or subdivid$4 or tessellat$4 or tesellat$4 or tesselat$4 or (sub near (divis$4 or divid$4))))) and ((bump$4 or displacem$4) with (map$4 or mapp$4))).clm. and 31	US-PGPUB	OR	ON	2008/10/23 11:28

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Bicubic surface real-time tesselation unit
A Sfarti - US Patent 7,245,299, 2007 - Google Patents
... All steps are performed in real-time, and steps 0 ... 4 are transformation and tessellation, while steps 5-7 ... For each Bicubic Surface Subdivide the boundary curve ...
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M Kass - Proceedings of the 19th annual conference on Computer ..., 1992 - portal.acm.org
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Method for antialiasing a set of objects represented as a set of two-dimensional distance fields in ...
SF Frisken, RN Perry - US Patent 6,933,952, 2005 - freepatentsonline.com
... Geometric Hermite Approximation of Surface Patch Intersection ... tessellation or an incomplete tessellation of the ... Real-time rendering requirements can force the ...
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[PDF] Constructive Solid Geometry and Volume Rendering
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... 63 A.2 Tessellation of Spline Patches ... from different angles, although still a single slice at a time. ... Other forms of specifying a surface such as an isosurface ...
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[CITATION] PROCEDE SERVANT A EFFECTUER LE RENDU D'UNE ZONE DE GLYPHE COMPOSITE
MDK KAISHA, R PERRY, S FRISKEN... - WO Patent 2,005,088,550, 2005
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[CITATION] PROCEDE DE COMPOSITION D'UN ENSEMBLE DE GLYPHES
MDK KAISHA, S FRISKEN, R PERRY... - WO Patent 2,005,088,549, 2005
Web Search

Key authors: M Kass - R Perry - S Frisken - X Tricoche - G Scheuermann

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BIB DATA SHEET

CONFIRMATION NO. 1565

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/778,515	07/16/2007	345	2628	1935CIP2C

APPLICANTS
Adrian Sfarti, Cupertino, CA;

**** CONTINUING DATA ***************************
This application is a CON of 10/732,398 12/09/2003 PAT 7,245,299
which is a CIP of 10/436,698 05/12/2003 ABN
and is a CIP of 09/734,438 12/11/2000 PAT 6,563,501
which claims benefit of 60/222,105 07/28/2000

**** FOREIGN APPLICATIONS ***************************

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07/30/2007

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /SAID A BROOME/ Examiner's Signature	☐ Met after Allowance SB Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	14	19	3

ADDRESS
STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA 94042
UNITED STATES

TITLE
Bicubic Surface Real Time Tesselation Unit

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11778515	SFARTI, ADRIAN
	Examiner	Art Unit
	SAID BROOME	2628

SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
Inventor Name Search	7/2/08	SB
EAST Search (US-PGPUB, USPAT, USCOR, EPO, JPO, DERWENT, IBM_TDB)	7/2/08	SB
Google Search - (http://scholar.google.com)	7/2/08	SB
Updated Inventor Name Search	10/22/08	SB
Updated EAST Search (US-PGPUB, USPAT, USCOR, EPO, JPO, DERWENT, IBM_TDB)	10/23/08	SB
Reviewed Parent Case 10/732,398	10/23/08	SB
Consulted Jason Repko, Kimbinh Nguyen	10/22/08	SB
Google Search - (http://scholar.google.com)	10/23/08	SB

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
345	423	10/23/08	SB

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination	
	11/778,515	SFARTI, ADRIAN	

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JAB

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Sfarti	Date: October 6, 2008
Serial No: 11/778,515	Group Art Unit: 2628
Filed: 7/16/2007	Examiner: Broome, Said A.
Title: BICUBIC SURFACE REAL TIME TESSELATION UNIT	Confirmation No: 1565

RESPONSE UNDER 37 CFR 1.111

Dear Sir:

In response to the Office Action of July 15, 2008, please amend the above-identified application in the following manner:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims are reflected in the listing of claims which begins on page 4 of this paper.

Remarks/Arguments begin on page 10 of this paper.

Amendments to the Specification:

Please amend the paragraph starting on page 1, line 4, as follows:

The present invention is a continuation of U.S. ~~application serial number 10/732,398~~Patent No. 7,245,299, entitled "Bicubic Surface Real-Time Tesselation Unit", (1935CIP2) ~~filed on December 9, 2003~~issued on July 17, 2007, which is a continuation-in-part of abandoned U.S. application serial number 10/436,698, entitled "Bicubic Surface Rendering," (1935CIP) filed on May 12, 2003, which is a continuation-in-part of U.S. Patent No. 6,563,501 entitled "Bicubic Surface Rendering," issued May 13, 2003, which claims priority of provisional application 60/222,105, filed on July 28, 2000, which are hereby incorporated by reference.

Please amend the paragraph starting on page 2, line 12, as follows:

Figs. 1A and 1B are diagrams illustrating a process for rendering bicubic surfaces. As shown in Figure 1A, the principle used for rendering such a curved surface 10 is to subdivide it into smaller four sided surfaces or tiles 12 by subdividing the intervals that define the parameters s and t. The subdivision continues until the surfaces resulting from subdivision have a curvature, measured in WC space that is below a predetermined threshold. The subdivision of the intervals defining s and t produces a set of numbers {si} where the indexes i and j represent the number of rows and columns in the resulting subdivision, i=1,n and {tj} j=1,m that determine a subdivision of the PC. This subdivision induces a subdivision of the TC, for each pair of parameters (si,tj) we obtain a pair ($u_{i,j}$, $v_{i,j}$) (or a triplet ($u_{i,j}$,$v_{i,j}$, $q_{i,j}$)). Here ui,j=a(si,tj), vi,j=b(si,tj), qi,j=c(si,tj) represent texture coordinates. For each pair (si,tj) we also obtain a Cartesian point (called "vertex") in WC , Vi,j (f(si,tj),g(si,tj),h(si,tj)). A special type of texture, called displacement map having the pair (p,r) as coordinates can be used to generate special lighting effects . For each pair of parameters (si,tj) we also obtain an index pair (pi,j ri,j) that index a displacement value (dxi,j , dyi,j , dzi,j). for the vertex Vi,j .

Please amend the paragraphs on page 10, lines 6-10, as follows:

For each pair (si,tj) of parameters /*All calculations employ some form of direct

evaluation of the variables. Here, i and j represent a number of rows and columns, respectively */

Calculate (texture coordinates ($u_{i,j}$ $v_{i,j}$ $q_{i,j}$) and displacement coordinates ($p_{i,j}$ $r_{i,j}$) for vertex $V_{i,j}$) thru interpolation

/*texture -, displacement map and vertex coordinates as a function of (si,tj)*/

Look up vertex displacement ($dx_{i,j}$, $dy_{i,j}$, $dz_{i,j}$) corresponding to the displacement coordinates ($p_{i,j}$ $r_{i,j}$)

Amendments to the Claims:

This listing of claims will replace all prior version, and listings, of claims in the application.

Listing of Claims:

1 (Original) A graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are received as control points of bicubic surfaces, the graphics processing unit comprising:

a transform unit;

a lighting unit;

a renderer unit; and

a tessellate unit coupled between the transform unit and the lighting unit for tessellating both rational and non-rational object surfaces in real-time.

2 (Original) The graphics processing unit of claim 1 wherein the transform unit transforms the control points, the tessellate unit tessellates the surfaces into triangles by executing a first set of instructions, the lighting unit lights vertices of the triangles, and the renderer unit renders the triangles by executing a second set of instructions.

3 (Original) The graphics processing unit of claim 2 wherein the first set of instructions simplifies three dimensional surface subdivision of the object surfaces by reducing surface subdivision to a subdivision of two cubic curves by performing instructions for:

for each bicubic surface,

subdividing a boundary curve representing an s interval until a projection of a length of a height of a curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates; and

subdividing the boundary curve representing a t interval until a projection of a length of a height of the curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates.

4 (Original) The graphics processing unit of claim 3 wherein the first set of instructions

simplifies three dimensional surface subdivision by reducing it to the subdivision of two cubic curves by simplifying subdivision termination criteria by expressing the termination criteria in screen (SC) coordinates and by measuring curvature in pixels, wherein for each new view, a new subdivision can be generated, producing automatic level of detail.

5 (Original) The graphics processing unit of claim 4 wherein the first set of instructions reduces cracks at the boundaries between surfaces by using a common subdivision for all surfaces sharing a boundary by performing instructions for:

for all bicubic surfaces sharing a same s or t parameter boundary,

choosing as a common subdivision a reunion of the subdivisions in order to prevent cracks showing along the common boundary or a finest subdivision, the finest subdivision being the one with the most points inside the set.

6 (Currently Amended) The graphics processing unit of claim 5 wherein the first set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping are generated by performing instructions for:

for each bicubic surface,

for each pair (si,tj) of parameters, where i and j represent a number of rows and columns, respectively,

calculating texture coordinates $((u_{i,j}\ v_{i,j}\ q_{i,j})$ and displacement coordinates $(p_{i,j}\ r_{i,j})$ for vertex $V_{i,j})$ thru interpolation,

looking up vertex displacement $(dx_{i,j}, dy_{i,j}, dz_{i,j})$ corresponding to the displacement coordinates $(p_{i,j}\ r_{i,j})$; and

generating triangles by connecting neighboring vertices.

7 (Original) The graphics processing unit of claim 6 wherein the second set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping by performing instructions for:

for each vertex $V_{i,j}$,

calculating a normal $N_{i,j}$ to that vertex, which was previously transformed in world coordinates

calculating ($dN_{i,j}$) as normal displacement for bump mapping as a function of (si,tj);

calculating $N'_{i,j}=N_{i,j}+dN_{i,j}$ to displace the normal for bump mapping; and

calculating $V'_{i,j}=V_{i,j}+(dx_{i,j}, dy_{i,j}, dz_{i,j})* N_{i,j}$ to displace the vertex for displacement mapping;

for each triangle,

executing bump and displacement mapping pixel-by-pixel for all the points inside the triangle; and

calculating a normal to the triangle for culling.

8 (Original) The graphics processing unit of claim 1 wherein the tessellate unit is combined with the transform unit and the lighting unit.

9 (Original) The graphics processing unit of claim 1 further including a Graphics Utility Library (GLU) for implementing drivers.

10 (Original) The graphics processing unit of claim 9 wherein the GLU includes several different types of primitives including, strips, fans, meshes, and indexed meshes of surface patches.

11 (Currently Amended) A system, comprising:

a processor; and

a graphics processing unit (GPU) coupled to the processor, the GPU comprising a transform unit, a lighting unit, a renderer unit, and a tessellate unit coupled between the transform unit and the lighting unit;

wherein ~~the processor transmits~~ objects to be rendered ~~to~~ by the GPU are transmitted as control points to the GPU, the transform unit transforms the control points, the tessellate unit executes a first set of instructions for tessellating both rational and non-rational object surfaces expressed in screen coordinates (SC), in real-time, the lighting unit lights vertices of the triangles resultant from tessellation, and the renderer unit renders and displays the triangles by executing a second set of instructions.

12 (Original) The graphics system of claim 11 wherein the first set of instructions simplifies

three dimensional surface subdivision of the object surfaces by reducing surface subdivision to a subdivision of two cubic curves by performing instructions for:

for each bicubic surface,

subdividing a boundary curve representing an s interval until a projection of a length of a height of a curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates; and

subdividing the boundary curve representing a t interval until a projection of a length of a height of the curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates.

13 (Original) The graphics system of claim 12 wherein the first set of instructions simplifies three dimensional surface subdivision by reducing it to the subdivision of two cubic curves by simplifying subdivision termination criteria by expressing the termination criteria in screen (SC) coordinates and by measuring curvature in pixels, wherein for each new view, a new subdivision can be generated, producing automatic level of detail.

14 (Original) The graphics system of claim 13 wherein the first set of instructions reduces cracks at the boundaries between surfaces by using a common subdivision for all surfaces sharing a boundary by performing instructions for:

for all bicubic surfaces sharing a same s or t parameter boundary,

choosing as a common subdivision a reunion of the subdivisions in order to prevent cracks showing along the common boundary or a finest subdivision, the finest subdivision being the one with the most points inside the set.

15 (Currently Amended) The graphics system of claim 14 wherein the first set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping are generated by performing instructions for:

for each bicubic surface,

for each pair (si,tj) <u>of parameters, where i and j represent a number of rows and columns, respectively</u>,

calculating texture coordinates $((u_{i,j}\ v_{i,j}\ q_{i,j})$ and displacement coordinates $(p_{i,j}\ r_{i,j})$ for vertex $V_{i,j})$ thru interpolation,

looking up vertex displacement $(dx_{i,j}, dy_{i,j}, dz_{i,j})$ corresponding to the displacement coordinates $(p_{i,j}\ r_{i,j})$; and

generating triangles by connecting neighboring vertices.

16 (Original) The graphics system of claim 15 wherein the second set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping by performing instructions for:

for each vertex $V_{i,j}$,

calculating a normal $N_{i,j}$ to that vertex, which was previously transformed in world coordinates

calculating $(dN_{i,j})$ as normal displacement for bump mapping as a function of (si,tj);

calculating $N'_{i,j}=N_{i,j}+dN_{i,j}$ to displace the normal for bump mapping; and

calculating $V'_{i,j}=V_{i,j}+(dx_{i,j}, dy_{i,j}, dz_{i,j})* N_{i,j}$ to displace the vertex for displacement mapping;

for each triangle,

executing bump and displacement mapping pixel-by-pixel for all the points inside the triangle; and

calculating a normal to the triangle for culling.

17 (Original) The graphics system of claim 11 further including a Graphics Utility Library (GLU) for implementing drivers.

18 (Original) The graphics system of claim 17 wherein the GLU includes several different types of primitives including, strips, fans, meshes, and indexed meshes of surface patches.

19 (Original) A real-time method for tessellating and rendering surfaces of an object on a computer system, comprising:

(a) performing transformation and tessellation by,

(i) for each surface, transforming 16 points;

(ii) performing three dimensional surface subdivision by subdividing only two cubic curves comprising the surface;

(iii) terminating the subdivision termination by expressing the subdivision in screen coordinates (SC) and by measuring curvature in pixels;

(iv) for each new view, generating a new subdivision, thereby producing automatic level of detail;

(v) preventing cracks at boundaries between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary;

(vi) for the current subdivision, generating the vertices, normals, texture coordinates, and displacements used for bump and displacement mapping; and

(vii) generating triangles by connecting neighboring vertices;

(viii) for each vertex, calculating the normal, calculating normal displacement for bump mapping, displacing the normal for bump mapping, displacing the vertex for displacement mapping, wherein bump and displacement mapping are executed pixel by pixel for all the points inside each triangle; and

(ix) calculating the normal of each triangle; and

(b) performing rendering by

(i) for each triangle, clipping against a viewing viewport, calculating lighting for additional vertices produced by clipping, and culling backfacing triangles;

(ii) projecting all vertices into screen coordinates; and

(iii) rendering all the triangles produced after clipping and projection.

REMARKS/ARGUMENTS

This Amendment is in response to the Office Action dated July 15, 2008. Claims 1-19 are pending. Claims 1-19 are rejected. Claims 6, 11, and 15 have been amended. Accordingly, claims 1-19 remain pending in the present application.

The Specification has been amended to provide patent numbers and issue dates for cross-referenced applications.

§112 Rejection Overcome

The Examiner rejected claims 6, 7, 15 and 16 under 35 USC §112, second paragraph, as being indefinite, for failing to provide language "to clearly define" symbols recited in claims.

In response, both the Specification on pages 2 and 10, and claims 6 and 15 have been amended to provide definitions for the recited symbols. Both the Specification and claims 6 and 15 now make clear that "i and j" represent a number of rows and columns, respectively", ($u_{i,j}$ $v_{i,j}$ $q_{i,j}$) represent texture cooridinates, ($p_{i,j}$ $r_{i,j}$) represent displacement coordinates, and $V_{i,j}$ is a vertex. Support for the amendments may be found in the specification at least on page 2, lines 6-24 and page 10, lines 3-24. These amendments are seen by Applicant as broadening or cosmetic, and as such, is not subject to the prosecution history estoppel imposed by Festo. For the record, Applicant points out that the Supreme Court in Festo noted that a cosmetic amendment would not narrow the patent's scope and thus would not raise the estoppel bar. Accordingly, the rejection under 35 USC §112 has been overcome.

Double Patenting Rejection Overcome

The Examiner rejected claims 11-18 of the current application 11/770 515 under 35 USC §101 over prior US Patent No. 7,245,299 for double patenting. In response, claim 11

has been amended. Claim 11 has been amended to recite "objects to be rendered by the GPU are transmitted as control points to the GPU," rather than the processor transmits the objects. Claim 11 has also been amended to recite that the rational and non-rational object surfaces are "expressed in screen coordinates (SC)", the vertices of the triangles are "resultant from tessellation", and that the renderer unit renders "and displays" the triangles. As claim 11 has been amended and is no longer coextensive in scope with prior US Patent No. 7,245,299, the double patenting rejection has been overcome.

Claims 1-10 and 19 are rejected on the grounds of non-statutory obviousness-double patenting is being unpatentable over the claims of US Patent No. 7,245,299. In response, a terminal disclaimer compliance with 37 CFR 1.312 (c) is filed herewith. US Patent No. 7,245,299 is commonly owned with the present application.

In view of the foregoing, it is submitted that claims 1-19 are allowable. Accordingly, Applicant respectfully requests reconsideration and passage to issue of claims 1-19 as now presented. Should any unresolved issues remain, Examiner is invited to call Applicants' attorney at the telephone number indicated below.

Respectfully submitted,

/Stephen G. Sullivan/
Stephen G. Sullivan
Attorney/Agent for Applicant(s)
Reg. No. 38329
Telephone No: 650 969-7474

Date: October 6, 2008

PTO/SB/26 (01-08)
Approved for use through 02/29/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) 1935CIP2C

In re Application of: Sfarti

Application No.: 11/778,515

Filed: 7/16/2007

For: BICUBIC SURFACE REAL TIME TESSELATION UNIT

The owner*, Adrian Sfarti, of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term **prior patent** No. 7,245,299 as the term of said prior patent is defined in 35 U.S.C. 154 and 173, and as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 and 173 of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☐ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

2. ☒ The undersigned is an attorney or agent of record. Reg. No. 38329

/Stephen G. Sullivan/ — Signature
October 6, 2008 — Date

Stephen G. Sullivan — Typed or printed name

650 969-7474 — Telephone Number

☒ Terminal disclaimer fee under 37 CFR 1.20(d) included.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

This collection of information is required by 37 CFR 1.321. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Patent Application Fee Transmittal

Application Number:	11778515
Filing Date:	16-Jul-2007
Title of Invention:	Bicubic Surface Real Time Tesselation Unit
First Named Inventor/Applicant Name:	Adrian Sfarti
Filer:	Stephen Grant Sullivan/Jackie Tanda
Attorney Docket Number:	1935CIP2C

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Statutory disclaimer	1814	1	140	140
		Total in USD ($)		**140**

Electronic Acknowledgement Receipt

EFS ID:	4064664
Application Number:	11778515
International Application Number:	
Confirmation Number:	1565
Title of Invention:	Bicubic Surface Real Time Tesselation Unit
First Named Inventor/Applicant Name:	Adrian Sfarti
Customer Number:	57580
Filer:	Stephen Grant Sullivan/Jackie Tanda
Filer Authorized By:	Stephen Grant Sullivan
Attorney Docket Number:	1935CIP2C
Receipt Date:	06-OCT-2008
Filing Date:	16-JUL-2007
Time Stamp:	15:06:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$140
RAM confirmation Number	382
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1		1935CIP2C_Amend_A.pdf	49869 4da8835a8fe2aabbc672feb8bdf660d4bbebcaf8	yes	11

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Amendment/Req. Reconsideration-After Non-Final Reject	1	1
Specification	2	3
Claims	4	9
Applicant Arguments/Remarks Made in an Amendment	10	11

Warnings:

Information:

2	Terminal Disclaimer Filed	1935CIP2C_TerminalDiscl.pdf	22170 d4f019a35e174b62031e9ceeb6ebbb521ee42685	no	1

Warnings:

Information:

3	Fee Worksheet (PTO-06)	fee-info.pdf	30130 0000ac6646140 43ac2e6cc8932acc4a0958f30f8	no	2

Warnings:

Information:

Total Files Size (in bytes):	102169

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
11/778,515	07/16/2007	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☒ RATE ($)	SMALL ENTITY ☒ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT	10/06/2008	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 19	Minus	** 20	= 0	X $26 =	0	OR	X $ =	
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $110 =	0	OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE	0	OR	TOTAL ADD'L FEE	

AMENDMENT		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/SHIRELL m. CARMICHAEL/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C	1565

57580 7590 07/15/2008
STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA 94042

EXAMINER	
BROOME, SAID A	

ART UNIT	PAPER NUMBER
2628	

MAIL DATE	DELIVERY MODE
07/15/2008	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	11/778,515	SFARTI, ADRIAN	
	Examiner	Art Unit	
	SAID BROOME	2628	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *16 July 2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-19* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-19* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *8/29/07*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 6, 7, 15 and 16 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 6 and 15 contain the symbols '$u_{i,j}$', '$v_{i,j}$', '$q_{i,j}$', '$p_{i,j}$', '$r_{i,j}$' and '$V_{i,j}$', which each contain the symbols 'i' and 'j', however no language has been provided to clearly define the symbols 'u', 'v', 'q', 'p', 'r', 'V', 'i' and 'j' recited in lines 5-8 of claims 6 and 15 respectively.

Double Patenting

A rejection based on double patenting of the "same invention" type finds its support in the language of 35 U.S.C. 101 which states that "whoever invents or discovers any new and useful process ... may obtain a patent therefor ..." (Emphasis added). Thus, the term "same invention," in this context, means an invention drawn to identical subject matter. See *Miller v. Eagle Mfg. Co.*, 151 U.S. 186 (1894); *In re Ockert*, 245 F.2d 467, 114 USPQ 330 (CCPA 1957); and *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970).

A statutory type (35 U.S.C. 101) double patenting rejection can be overcome by canceling or amending the conflicting claims so they are no longer coextensive in scope. The filing of a terminal disclaimer cannot overcome a double patenting rejection based upon 35 U.S.C. 101.

Claims 11-18 of the current application 11/778515 is rejected under 35 U.S.C. 101 as claiming the same invention as that of claims 11-18 of prior U.S. Patent No. 7,245,299, this is a double patenting rejection. Table I-A listed below is provided to show which claims in the current application, 11/778,515, map to claims of U.S. Patent 7,245,299. Table II-A is provided below to show how all the claimed limitations from the independent claim 11 of the current application 11/778,515 maps to the independent claim 11 of U.S. Patent 7,245,299.

TABLE 1-A

Current Application: 11/778,515	Claims 11-18
U.S. Patent: 7,245,299	Claims 11-18

TABLE II-A

Current Application: 11/778,515 (Claim 11)	**U.S. Patent: 7,245,299 (Claim 11)**
11. A system, comprising: a processor; and a graphics processing unit (GPU) coupled to the processor, the GPU comprising a transform unit, a lighting unit, a renderer unit, and a tessellate unit coupled between the transform unit and the lighting unit;	11. A system, comprising: a processor; and a graphics processing unit (GPU) coupled to the processor, the GPU comprising a transform unit, a lighting unit, a renderer unit, and a tessellate unit coupled between the transform unit and the lighting unit;
wherein the processor transmits objects to be rendered to the GPU as control points, the transform unit transforms the control points, the tessellate unit executes a first set	wherein the processor transmits objects to be rendered to the GPU as control points, the transform unit transforms the control points, the tessellate unit executes a first set

of instructions for tessellating both rational and non-rational object surfaces in real-time, the lighting unit lights vertices of the triangles, and the renderer unit renders the triangles by executing a second set of instructions.	of instructions for tessellating both rational and non-rational object surfaces in real-time the lighting unit lights vertices of the triangles, and the renderer unit renders the triangles by executing a second set of instructions.

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory obviousness-type double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent either

is shown to be commonly owned with this application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement.

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

Claims 1-10 and 19 of the currently examined application 11/778,515 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-10 and 19 of U.S. Patent No. 7,245,299. Although the conflicting claims are not identical, they are not patentably distinct from each other because it would have been obvious to one of ordinary skill in the art that the claim language provided in claim 1 of the current application 11/778,515: "*A graphics processing unit for rendering objects...in which the objects to be rendered are received as control points of bicubic surfaces*…", though it is a slight variation from claim 1 of U.S. Patent No. 7,245,299: "*A graphics processing unit for rendering objects...in which the objects to be rendered are transmitted to the graphics processing unit over a bus as control points of bicubic surfaces*…", is similar in scope and would provide analogous rendering of bicubic surfaces. Therefore in view of the teachings of U.S. Patent No. 7,245,299 (col. 1 lines 23-36: "*Object models are often stored in computer systems in the form of surfaces...the surfaces are generally subdivided or decomposed into triangles in the process of rendering the images...Cubic curves may be generalized to bicubic surfaces*…" and col. 2 lines 42-43: "*The triangle meshes are transmitted over an accelerated graphics port (AGP) bus 6 to the GPU*…"), which discloses that a bus is known in the art to be utilized for transmission of graphics data, such as bicubic surfaces, it would have been obvious to

one skilled in the art at the time of invention to modify the teachings of claim 1 in the current application with the bus taught by claim 1 of U.S. Patent No. 7,245,299 because this modification would enable received graphics data to be transmitted a bus transmission means commonly known in the art that would provide equivalent rendering of bicubic surfaces. The conflicting claims 19 of both the current application and U.S. Patent No. 7,245,299, are also not patentably distinct from each other because it would have been obvious to one of ordinary skill in the art that the claim language provided in claim 19 of the current application 11/778,515: "*A real-time method for tessellating and rendering surfaces of an object on a computer system, comprising... rendering all the triangles produced after clipping and projection.*", though it is a slight variation from claim 19 of U.S. Patent No. 7,245,299: "*A real-time method for tessellating and rendering surfaces of an object on a computer system, comprising...rendering all the triangles produced after clipping and projection, and displaying the generated triangles.*", is similar in scope and would provide analogous real-time tessellation and display of surfaces. Therefore the teachings of claim 19 of U.S. Patent No. 7,245,299, which displays generated triangles, is an obvious variation of the teachings of claim 19 of the current application which discloses rendering generated triangles, in which one skilled in the art at the time of invention would have modified the rendering of triangles generated by claim 19 of the current application, to enable display of the triangles because rendering is a process commonly known in the art to be utilized for display, as disclosed in U.S. Patent No. 7,245,299 col. 1 lines 24-25: "*The process of displaying the object...requires rendering…*".

Table I listed below is provided to show which claims in the current application, 11/778,515, map to claims of U.S. Patent 7,245,299. Table II is provided below to show how all the claimed limitations from the independent claims 1 and 19 of the current application 11/778,515 map to the independent claims 1 and 19 of U.S. Patent 7,245,299, respectively.

TABLE 1

Current Application: 11/778,515	Claims 1-10 and 19
U.S. Patent: 7,245,299	Claims 1-10 and 19

TABLE II

Current Application: 11/778,515 (Claim 1)	**U.S. Patent: 7,245,299 (Claim 1)**
1. A graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are received as control points of bicubic surfaces, the graphics processing unit comprising:	1. A graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are transmitted to the graphics processing unit over a bus as control points of bicubic surfaces, the graphics processing unit comprising:
a transform unit; a lighting unit; a renderer unit; and	a transform unit; a lighting unit; a renderer unit; and
a tessellate unit coupled between the transform unit and the lighting unit for tessellating both rational and non-rational object surfaces in real-time.	a tessellate unit coupled between the transform unit and the lighting unit for tessellating both rational and non-rational object surfaces in real-time.

Current Application: 11/778,515 (Claim 19)	**U.S. Patent: 7,245,299 (Claim 19)**
19. A real-time method for tessellating and rendering surfaces of an object on a computer system, comprising: (a) performing transformation and tessellation by, (i) for each surface, transforming 16 points;	19. A real-time method for tessellating and rendering surfaces of an object on a computer system, comprising: (a) performing transformation and tessellation by, (i) for each surface, transforming 16 points rather than all the vertices inside the surface;
(ii) performing three dimensional surface subdivision by subdividing only two cubic curves comprising the surface; (iii) terminating the subdivision termination by expressing the subdivision in screen coordinates (SC) and by measuring curvature in pixels;	(ii) performing three dimensional surface subdivision by subdividing only two cubic curves comprising the surface; (iii) terminating the subdivision termination by expressing the subdivision in screen coordinates (SC) and by measuring curvature in pixels;
(iv) for each new view, generating a new subdivision, thereby producing automatic level of detail; (v) preventing cracks at boundaries between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary;	(iv) for each new view, generating a new subdivision, thereby producing automatic level of detail; (v) preventing cracks at boundaries between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary;
(vi) for the current subdivision, generating	(vi) for the current subdivision, generating

the vertices, normals, texture coordinates, and displacements used for bump and displacement mapping; and (vii) generating triangles by connecting neighboring vertices;	the vertices, normals, texture coordinates, and displacements used for bump and displacement mapping; and (vii) generating triangles by connecting neighboring vertices;
(viii) for each vertex, calculating the normal, calculating normal displacement for bump mapping, displacing the normal for bump mapping, displacing the vertex for displacement mapping, wherein bump and displacement mapping are executed pixel by pixel for all the points inside each triangle; and (ix) calculating the normal of each triangle; and	(viii) for each vertex, calculating the normal, calculating normal displacement for bump mapping, displacing the normal for bump mapping, displacing the vertex for displacement mapping, wherein bump and displacement mapping are executed pixel by pixel for all the points inside each triangle; and (ix) calculating the normal of each triangle; and
(b) performing rendering by (i) for each triangle, clipping against a viewing viewport, calculating lighting for additional vertices produced by clipping, and culling backfacing triangles; (ii) projecting all vertices into screen coordinates; and	(b) performing rendering by (i) for each triangle, clipping against a viewing viewport, calculating lighting for additional vertices produced by clipping, and culling backfacing triangles; (ii) projecting all vertices into screen coordinates; and
(iii) rendering all the triangles produced after clipping and projection.	(iii) rendering all the triangles produced after clipping and projection, and displaying the generated triangles.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. The prior art patents and publications on the attached PTO-892 form pertain to subdivision surfaces:

- Fenney et al. U.S. Patent Publication 2004/0113909 A1
- Moreton et al. U.S. Patent 6,906,716 B2
- Oliver et al. U.S. Patent 5,561,754

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAID BROOME whose telephone number is (571)272-2931. The examiner can normally be reached on M-F 8:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on (571)272-7782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Kee M Tung/
Supervisory Patent Examiner, Art Unit 2628

/Said Broome/
Examiner, Art Unit 2628

Notice of References Cited	Application/Control No. 11/778,515	Applicant(s)/Patent Under Reexamination SFARTI, ADRIAN	
	Examiner SAID BROOME	Art Unit 2628	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
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*	B	US-6,906,716	06-2005	Moreton et al.	345/423
*	C	US-5,561,754	10-1996	Oliver et al.	345/441
	D	US-			
	E	US-			
	F	US-			
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	I	US-			
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Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11778515	SFARTI, ADRIAN
	Examiner	Art Unit
	SAID BROOME	2628

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	07/02/2008								
	1	✓								
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	17	✓								
	18	✓								
	19	✓								

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	Examiner	Art Unit
	SAID BROOME	2628

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Class	Subclass	Date	Examiner

SEARCH NOTES		
Search Notes	Date	Examiner
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INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	11778515
	Filing Date	2007-07-16
	First Named Inventor	Sfarti
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1935CIP2C

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	Filing Date	2007-07-16
	First Named Inventor	Sfarti
	Art Unit	
	Examiner Name	
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	First Named Inventor	Sfarti
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1935CIP2C

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EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	64	((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) near3 (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:39
L2	178	((transform$4 with (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) with (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:39
L3	13	(bus same (graphics with process$4 with unit)) and (render$4 near (object or primitive or polygon or mesh or shape)) and ((control adj point) same (bicubic near surface))	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:39
L4	216	((between or coupled) with (transform with (light$4 or lighting)) with (unit or processor or module))	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:40
L5	7	((control near2 point) and (bicubic near surface)) and ((tessellat$4 or transform$4 or light$4 or render$4) near3 unit)	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:40
L6	5	(bus same (graphics with process$4 with unit)) and ((generat$4 or output$4 or display$4 or rasteri$5 or render$4) near3 (object or primitive or polygon or mesh or shape)) and ((control adj point) and (bicubic near surface)) and ((tessellat$4 or transform$4 or light$4 or render$4) near3 unit)	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:40
L7	3	((calulat$4 or determin$4) with normal with vertex) and (displacement or bump or ((displacement or bump) adj mapping)) and (displac$4 with vertex) and ((displacement near3 mapping) same (pixel same point same triangle))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:41
L8	7	((transform$4 near (unit or processor or system))) same (((tessellat$4 or tesellat$4 or tesselat$4 or subdivi$4) near (unit or processor or system)) same (coupl$4 or between or prior or next or adjacent$4 or adjacen$4 or after or sucessiv$4))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:41
L9	24	((tesellat$4 or tessellat$4 or tesselat$4) near3 (module or unit or processor)) and ((transform$4 or lighting) near (unit or module or processor))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:41
L10	28	(generat$4 same vertice same normal same (texture or (texture adj coordinate)) same (displacement or bump or ((displacement or bump) near3 mapp$4)))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:42
L11	36	((ADRIAN) near2 (SFARTI)).INV.	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:42
L13	10	("20040113909" | "20040227755" | "20050057568" | "5261029" | "5377320" | "5903273" | "6563501" | "6597356" | "6600488" | "6906716").PN. OR ("7295204").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:42
L14	9	("20010013866" | "5428718" | "5579464" | "5828467" | "6078331" | "6100894" | "6211883" | "6563501" | "6707452").PN. OR ("7227546").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:43
L15	34	((real adj time) with (tesellat$4 or tesselat$4 or tessellat$4))	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:43

EAST Search History

L16	101	(tesselat$4 or tessellat$4 or tesellat$4) same (real adj time)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:43
L17	35	((sub adj (divis$4 or divid$4)) or subdivis$4 or subdivid$4) with (two or plurality or mltiple or many or several or various or numerous) with ((bicubic or (bi adj cubic) or cubic) with (curve or surface or object))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:43
L18	3	(((sub adj (divis$4 or divid$4)) or subdivis$4 or subdivid$4) with (curve or spline) with projection with length with height with (bound$4 adj (box or rectang$4))) same (predetermined with pixel) same (screen adj coordinate)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:44
L19	6	((graphic adj (unit or process$4)) and (prevent$4 with ((crack or inconsistent or break)) same (subdivision or (sub adj (divis$4 or divid$4)))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:44
L20	26	((graphic adj (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub adj (divis$4 or divid$4)))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:44
L21	3	((graphic adj (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub adj (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub adj (divis$4 or divid$4))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:44
L22	66	((graphic adj (unit or process$4)) and ((graphic with utility with library) or "GLU"))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 13:44
L23	10	("20040113909" | "20040227755" | "20050057568" | "5261029" | "5377320" | "5903273" | "6563501" | "6597356" | "6600488" | "6906716").PN. OR ("7295204").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2008/07/02 13:44
L24	2	("7,245,299").PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2008/07/02 13:48
L35	7	((subdivis$4 or subdivid$4 or (sub near (divis$4 or divid$4))) same patch same (stor$4 or save or memor$4) same (independent$4 or alone or (by with itself)) same (egde or bound$4 or line or vertice or side))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 14:00
L36	3	((graphic near (unit or process$4)) and (prevent$4 with ((crack or inconsisten$4 or break)) and (subdivision or (sub near (divis$4 or divid$4))))) and (point same set same most) and (common with boundar$4) and (fine$4 with (subdivision or (sub near (divis$4 or divid$4))))	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/07/02 14:00

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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C

CONFIRMATION NO. 1565

57580
STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA94042

Title: Bicubic Surface Real Time Tesselation Unit

Publication No. US-2008-0049018-A1
Publication Date: 02/28/2008

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

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Pre-Grant Publication Division, 703-605-4283

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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C

CONFIRMATION NO. 1565

57580
STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA94042

Date Mailed. 12/07/2007

NOTICE OF NEW OR REVISED PROJECTED PUBLICATION DATE

The above-identified application has a new or revised projected publication date. The current projected publication date for this application is 02/28/2008. If this is a new projected publication date (there was no previous projected publication date), the application has been cleared by Licensing & Review or a secrecy order has been rescinded and the application is now in the publication queue.

If this is a revised projected publication date (one that is different from a previously communicated projected publication date), the publication date has been revised due to processing delays in the USPTO or the abandonment and subsequent revival of an application. The application is anticipated to be published on a date that is more than six weeks different from the originally-projected publication date.

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
11/778,515	07/16/2007	2628	425	1935CIP2C	19	3

CONFIRMATION NO. 1565

57580
STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA94042

UPDATED FILING RECEIPT

Date Mailed: 10/04/2007

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please write to the Office of Initial Patent Examination's Filing Receipt Corrections. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Adrian Sfarti, Cupertino, CA;

Power of Attorney:

Joseph Sawyer Jr--30801
Michael Woods--33466
Stephen Sullivan--38329
Janyce Mitchell--40095
Michele Liu--44875
Joyce Tom--48681

Domestic Priority data as claimed by applicant

This application is a CON of 10/732,398 12/09/2003 PAT 7,245,299
which is a CIP of 10/436,698 05/12/2003 ABN
and is a CIP of 09/734,438 12/11/2000 PAT 6,563,501
which claims benefit of 60/222,105 07/28/2000

Foreign Applications

If Required, Foreign Filing License Granted: 07/30/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US11/778,515**

Projected Publication Date: 01/10/2008

Non-Publication Request: No

Early Publication Request: No

** SMALL ENTITY **

Title

Bicubic Surface Real Time Tesselation Unit

Preliminary Class

345

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Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

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Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Sfarti	Date: September 27, 2007
Serial No.: 11/778,515	Group Art Unit: To Be Assigned
Filed: 7/16/2007	Examiner: To Be Assigned
Title: Bicubic Surface Real Time Tesselation Unit	Confirmation No: 1565

RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

Dear Sir:

In response to the Notice to File Corrected Application Papers issued 8/1/2007, submitted herewith are 14 sheets of Replacement Drawings containing Figures 1-15 to correct drawing informalities. Applicant's attorney attests that no new matter is introduced by the replacement sheets, and that the sheets are submitted solely to correct drawing informalities.

If any unresolved issues remain, please contact Applicant's attorney at the telephone number indicated below.

Respectfully submitted,

/Stephen G. Sullivan/
Stephen G. Sullivan
Attorney/Agent for Applicant(s)
Reg. No. 38,329
Telephone No: 650 969-7474

Date: September 27, 2007

Electronic Acknowledgement Receipt

EFS ID:	2250143
Application Number:	11778515
International Application Number:	
Confirmation Number:	1565
Title of Invention:	Bicubic Surface Real Time Tesselation Unit
First Named Inventor/Applicant Name:	Adrian Sfarti
Customer Number:	57580
Filer:	Stephen Grant Sullivan/Jackie Tanda
Filer Authorized By:	Stephen Grant Sullivan
Attorney Docket Number:	1935CIP2C
Receipt Date:	27-SEP-2007
Filing Date:	16-JUL-2007
Time Stamp:	15:24:29
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	1935CIP2C_DrawingTransmittal.pdf	10646 e27779e534144efb0ad6bc239615df836b450689	no	1

Warnings:

Information:					
2	Drawings	1935CIP2C_ReplacementDrawings.pdf	2546194 c7f4932d73feaa89dd9209a0f3e8129293597e95	no	14
Warnings:					
Information:					
			Total Files Size (in bytes):	2556840	

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New Applications Under 35 U.S.C. 111
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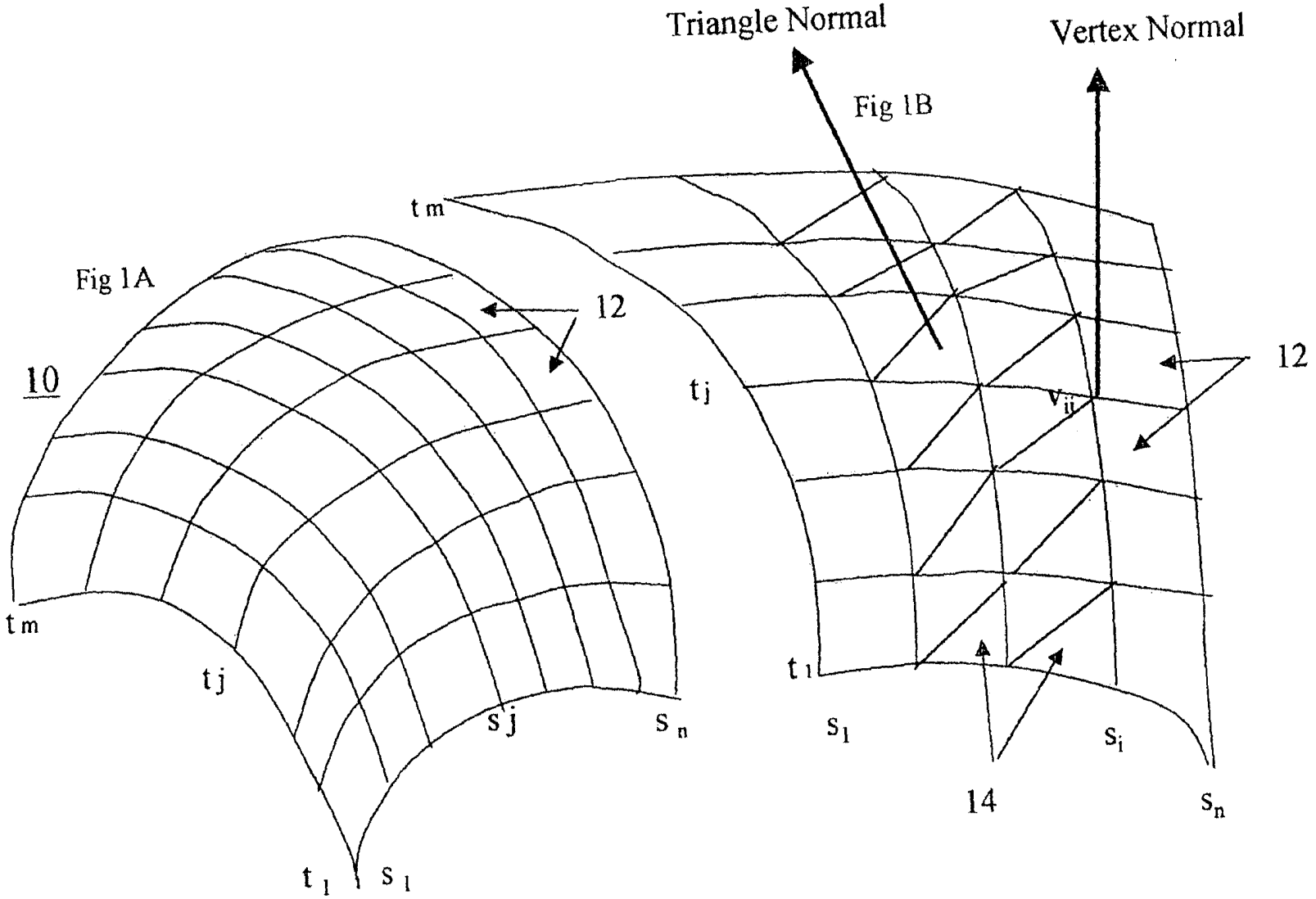
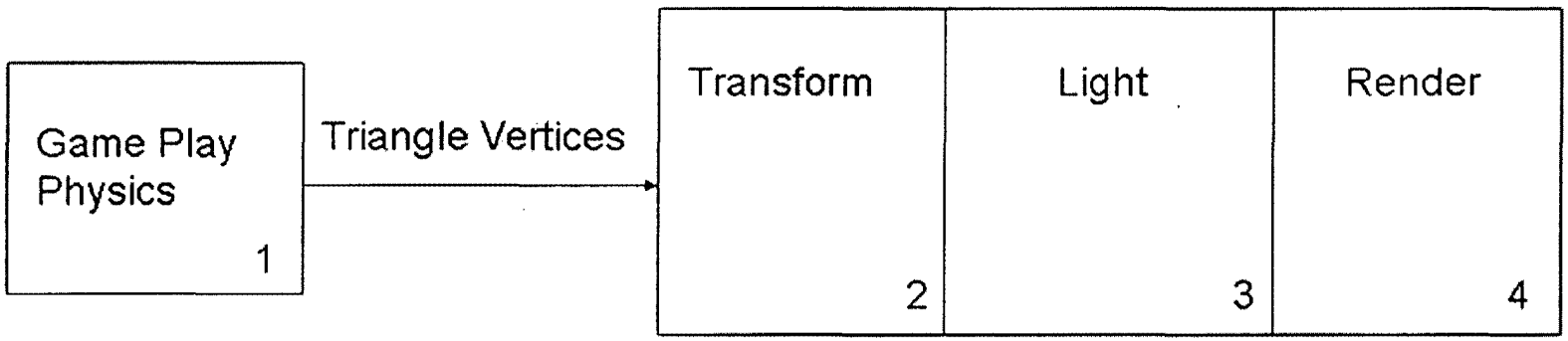
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

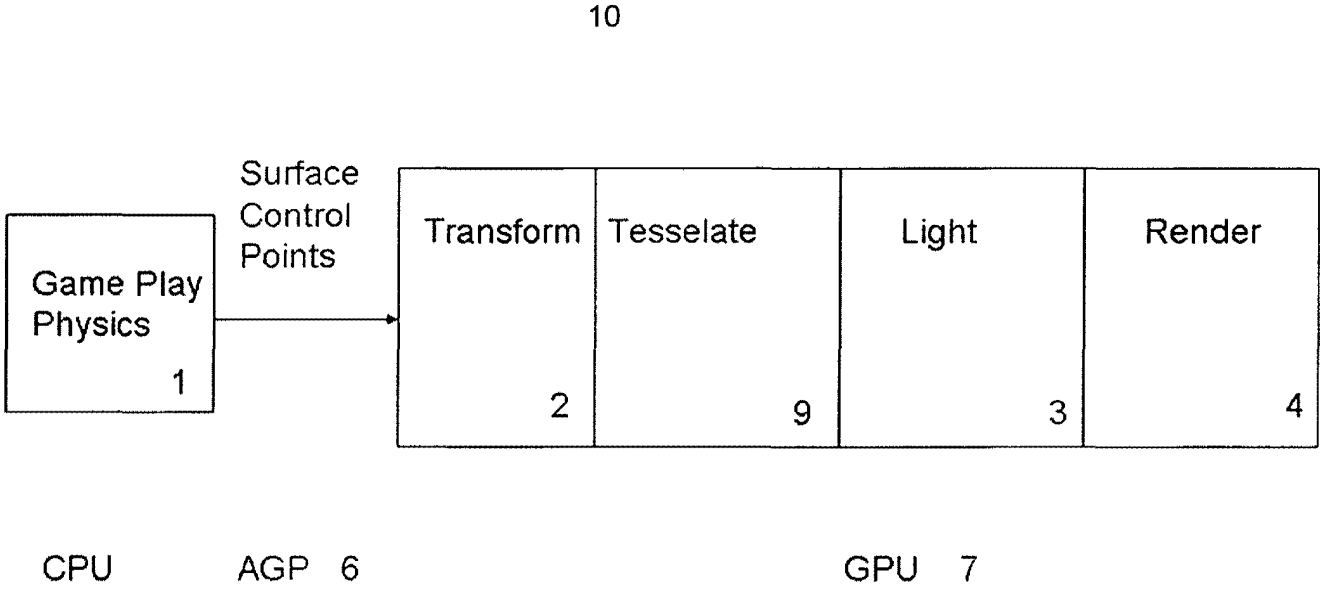


Replacement Sheet



Prior Art

Figure 2


10
Surface
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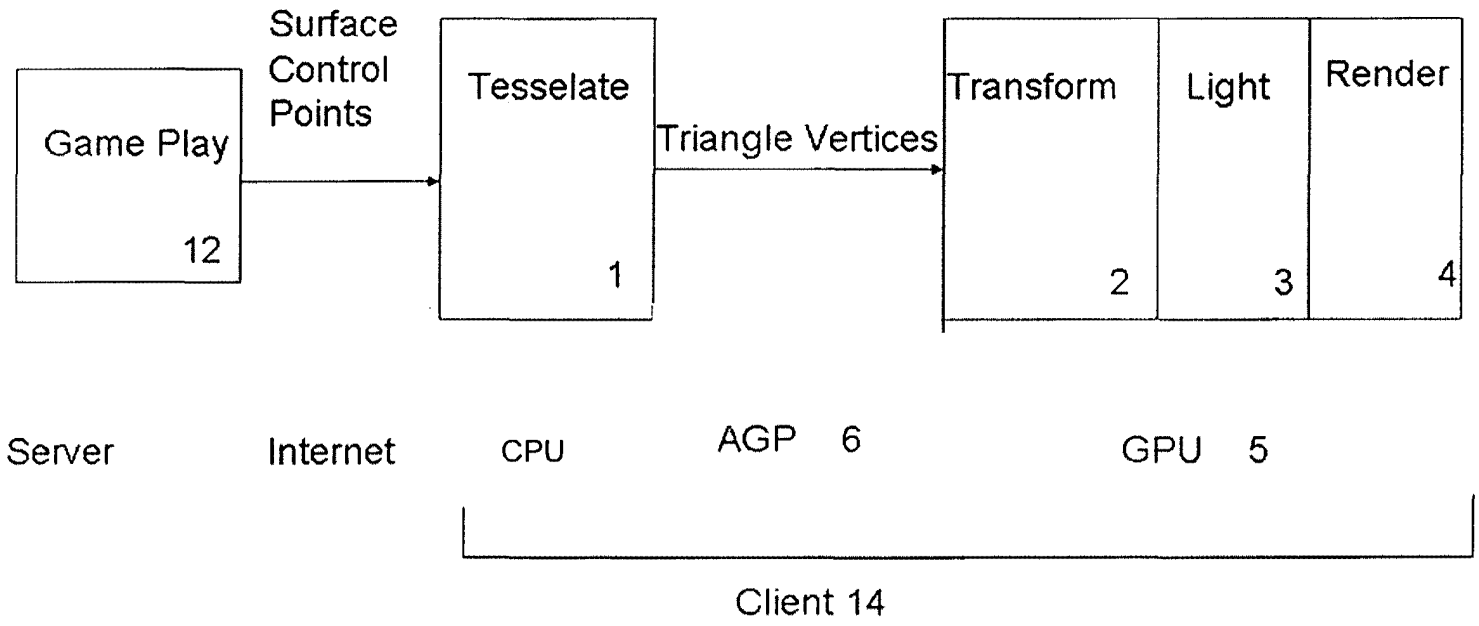
Points
Game Play
Physics
1
Transform
2
Tesselate
9
Light
3
Render
4
CPU
AGP 6
GPU 7

Figure 3


Surface
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Game Play
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Transform
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Light
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Render
4
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CPU
AGP 6
GPU 5
Client 14

Figure 4

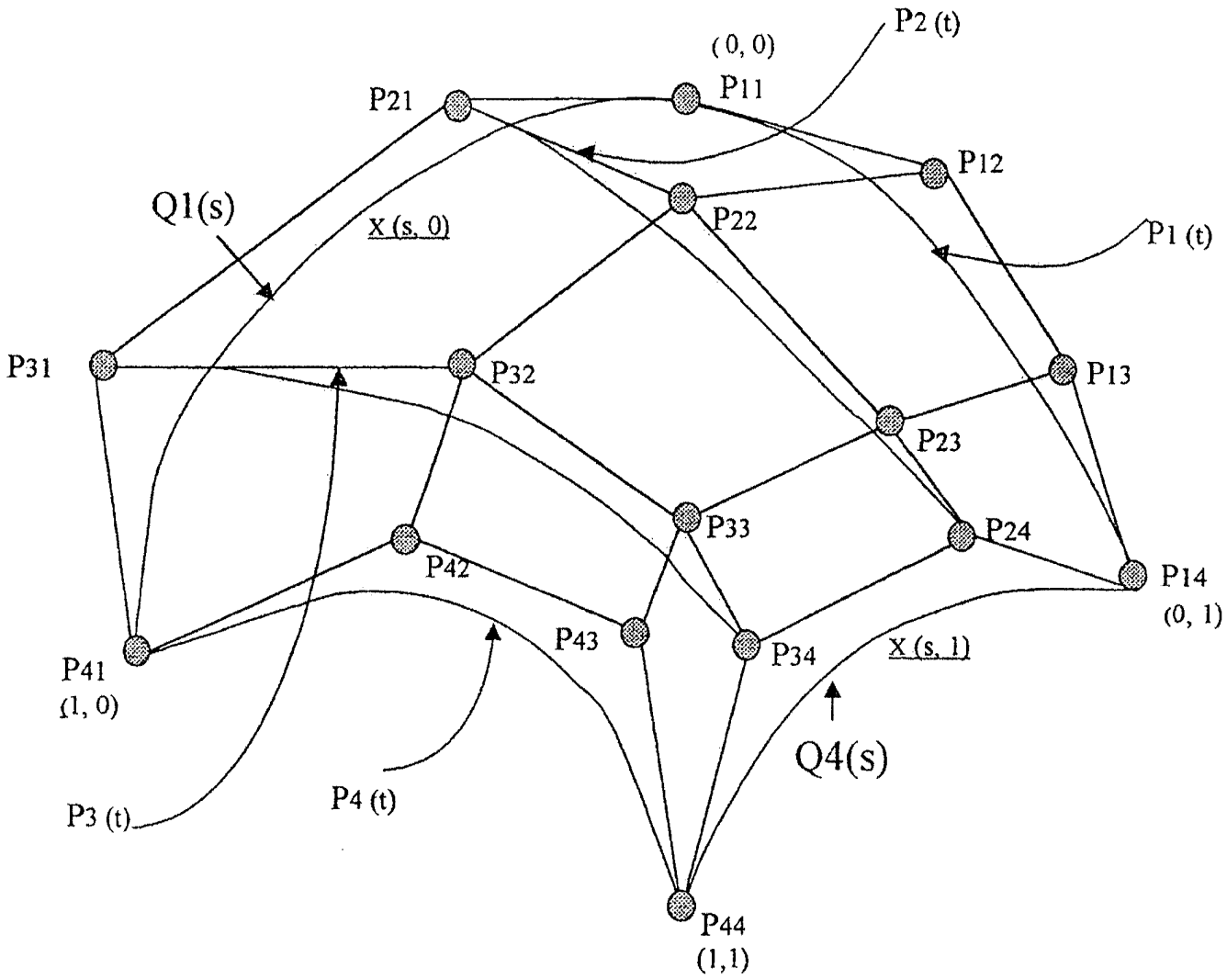


Figure 5

Replacement Sheet

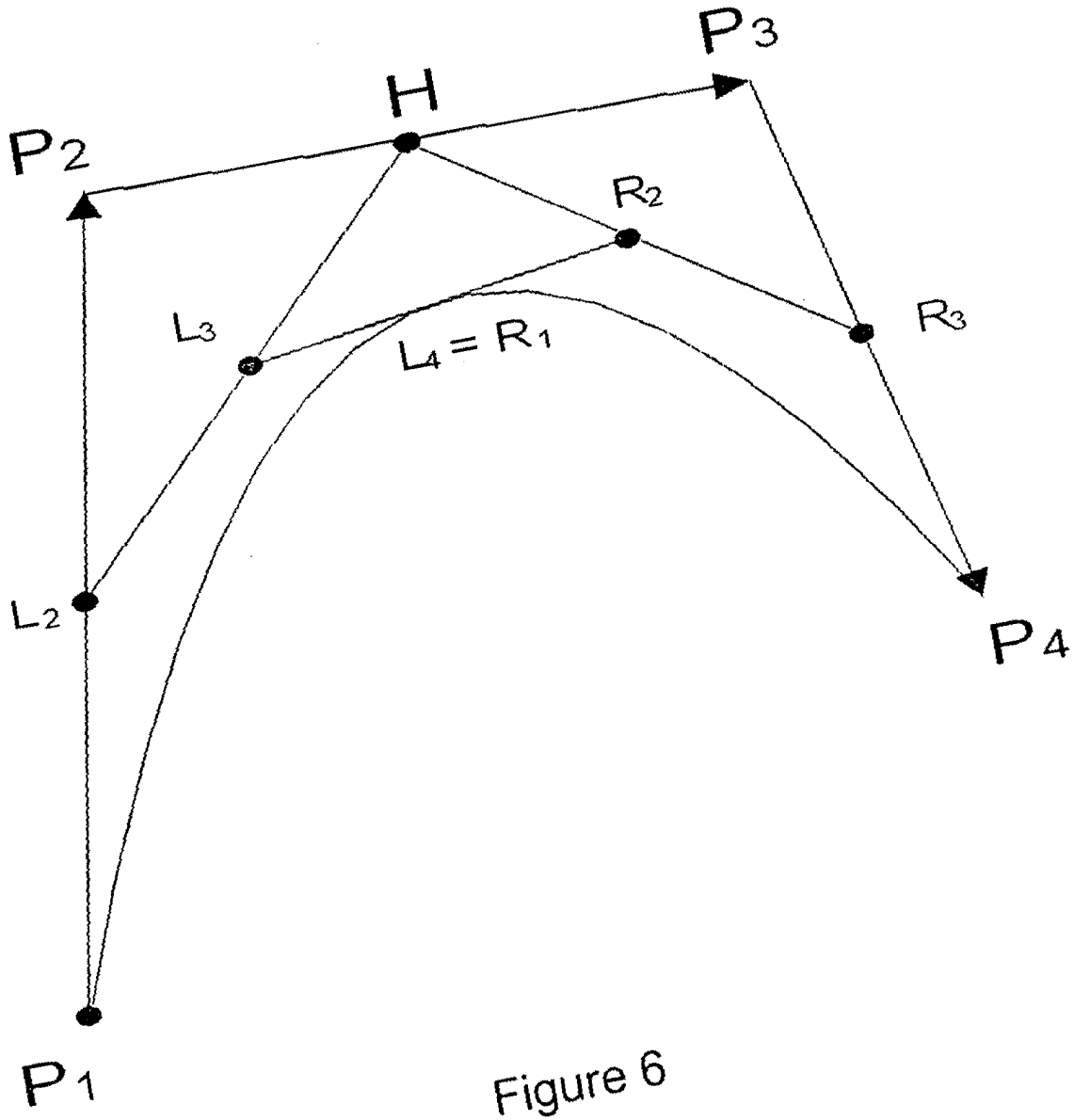
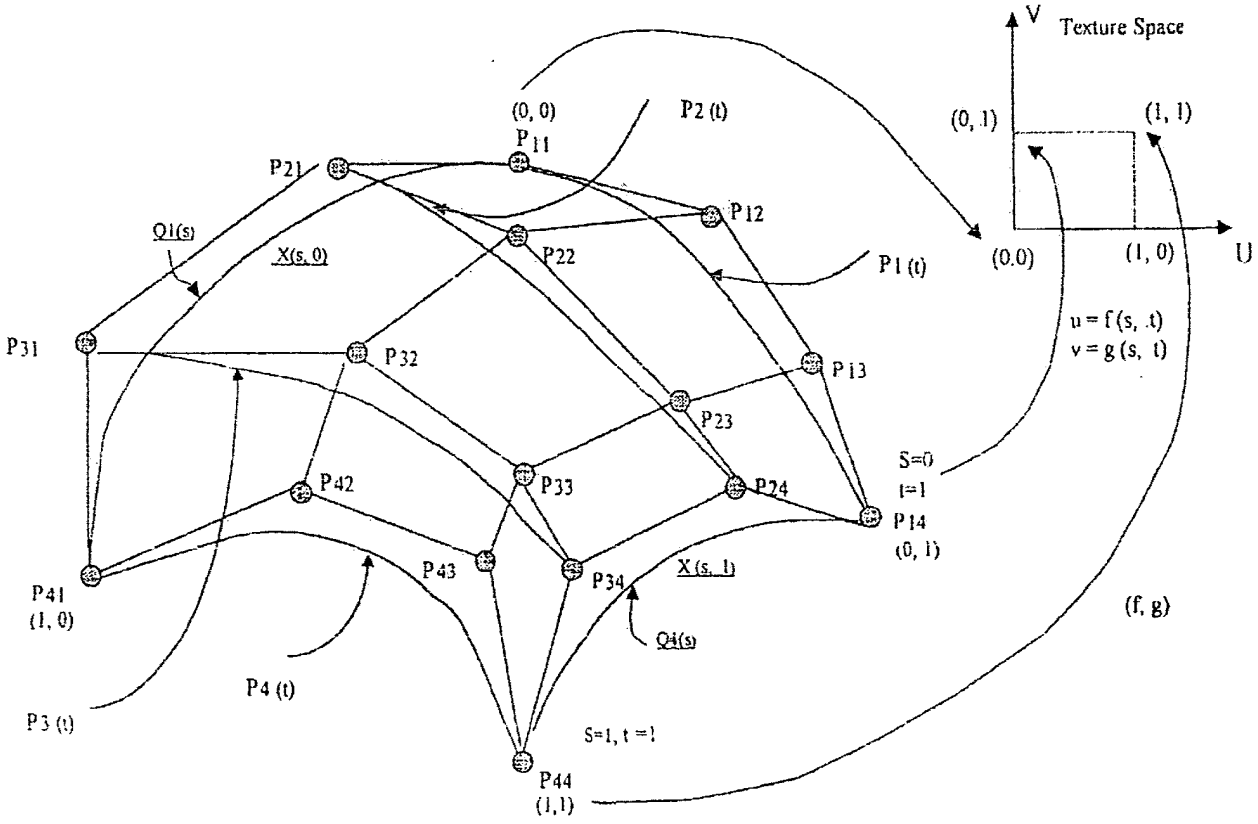


Figure 6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Texture Space
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(1, 1)
(0.0)
(1, 0)
U
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v = g (s, t)
(f, g)
(0, 0)
P11
P21
P2 (t)
P12
Q1(s)
X(s, 0)
P22
P1 (t)
P31
P32
P13
P23
P42
P33
P24
S=0
t=1
P14
(0, 1)
P41
(1, 0)
P43
P34
X(s, 1)
Q4(s)
P4 (t)
P3 (t)
S=1, t =1
P44
(1,1)

Figure 7

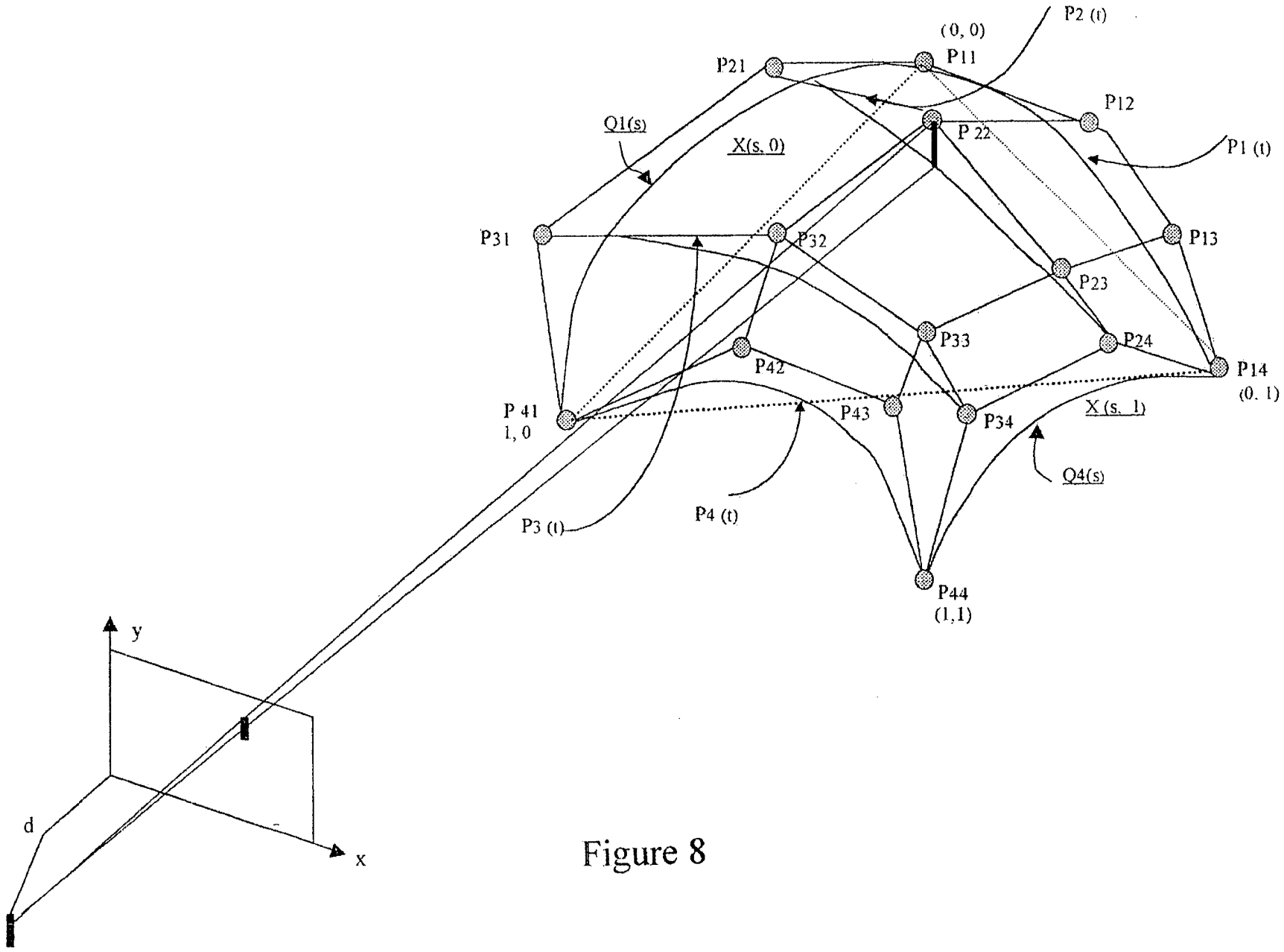


Figure 8

Replacement Sheet

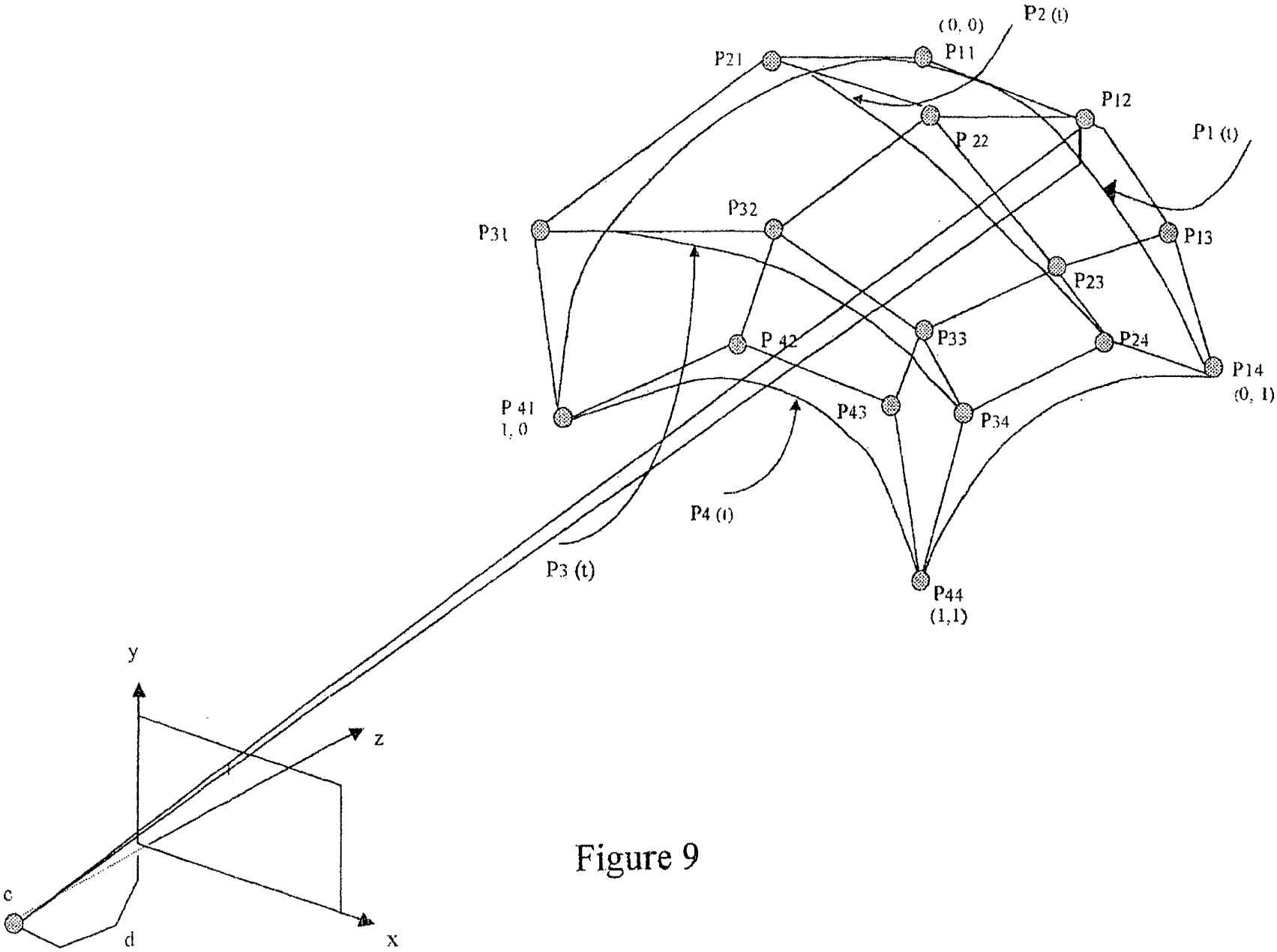
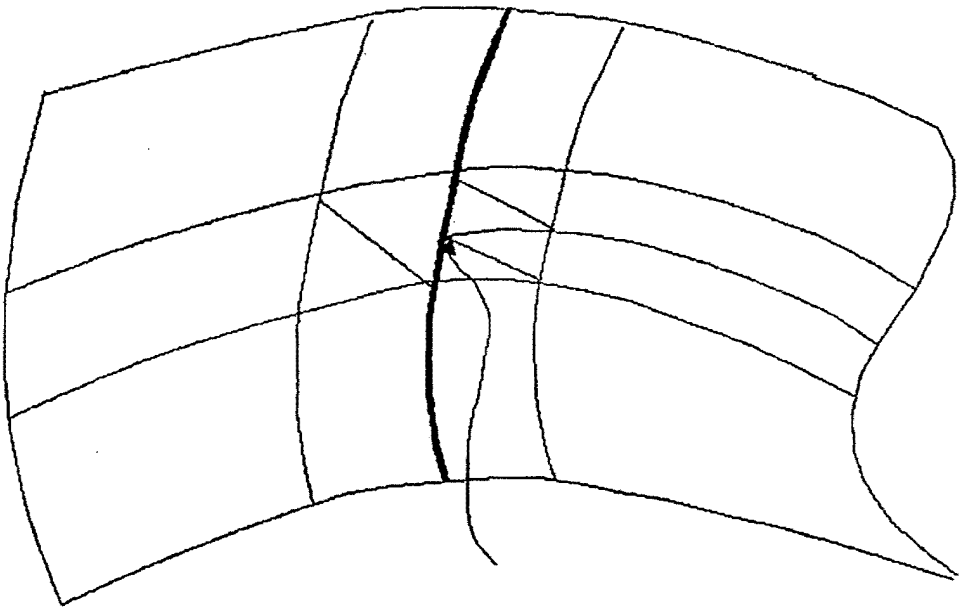


Figure 9

Replacement Sheet



"T-joint"

Figure 10

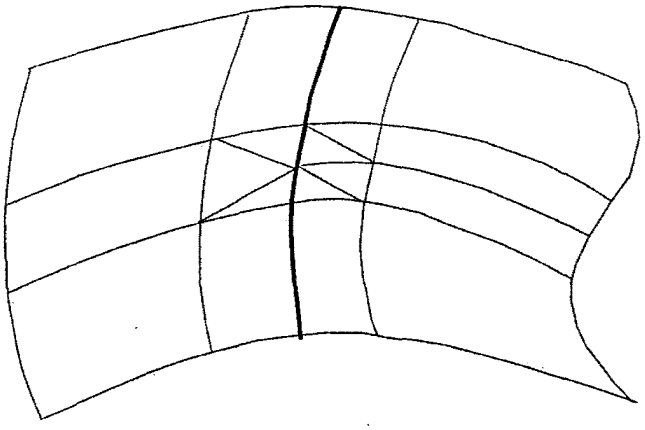


Figure 11

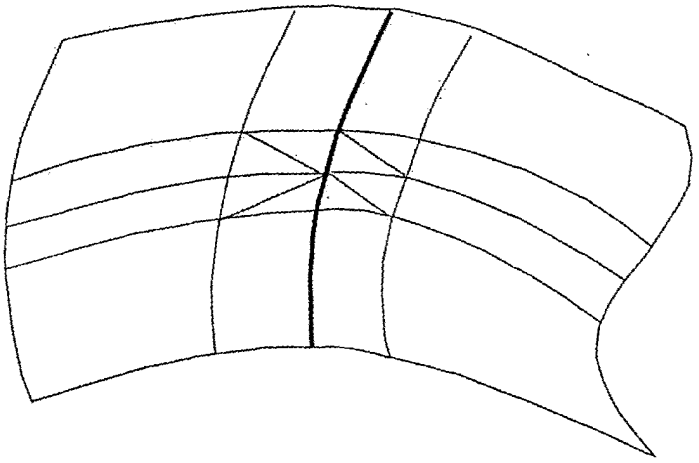
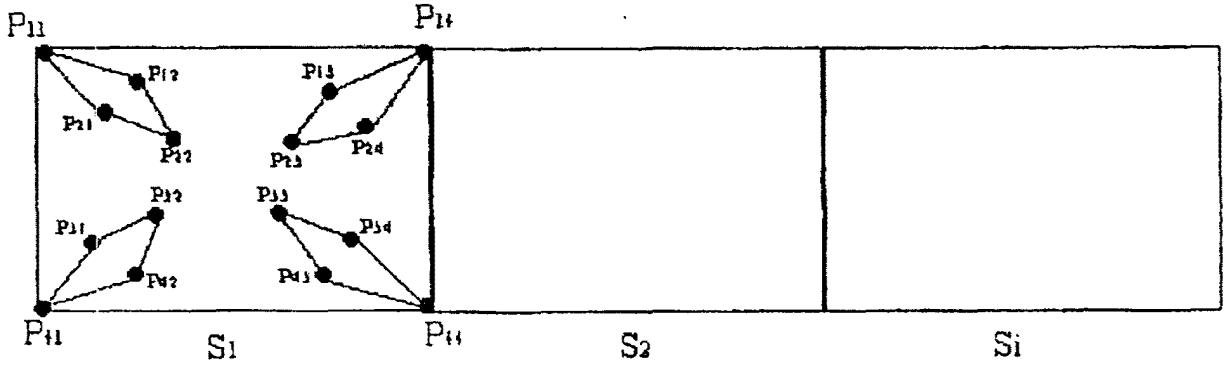


Figure 12

Figure 13

1. Strip (S1, S2, . . . Si, . . .Sn)



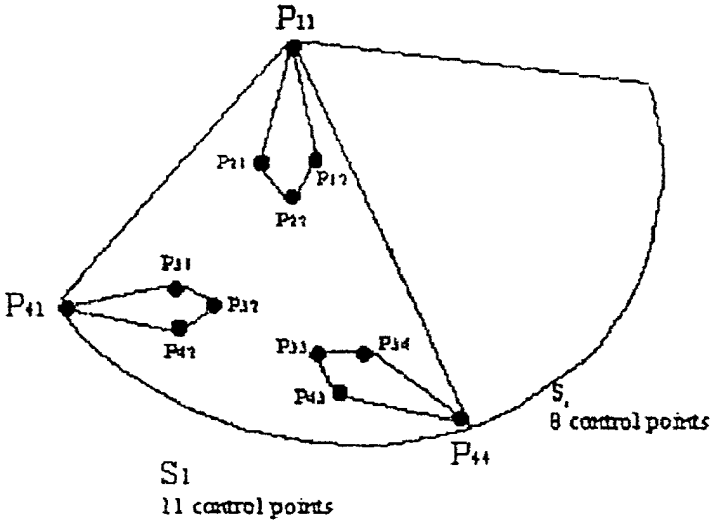
16 control points 12 control points 12 control points

Si { P11, P14, P41, P44 (Color, texture, geometry)
P12 . . . . .P43 (Geometry)
N = outwards pointing normal

Si { P11, P14, P41, P44
P12. . . .P24 P34 . . .P43
N

Figure 14

2. Fan (P11, S1, . . . Si, . . .Sn)



Si { P11, P14, P41, P44
P12 . . . P43, P23, P24
N

Si { P11, P14, P41, P44
P12 . . . P43, P23, P31, P34
N

Mesh (S_{11}, S_{12}, ... S_{1N}, ... S_{21}, ... S_{2N}, ... S_{M1}, ... S_{MN})

S_{M1} 12 Control Points	S_{M2} 9		S_{Mi} 9		S_{MN} 9
S_{21} 12 Control Points	S_{22} 9 Control Points		S_{2i} 9		S_{2N} 9
S_{11} 12 Control Points	S_{12} 12 Control Points		S_{1i} 9		S_{1N} 12

Figure15

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	11778515
	Filing Date	2007-07-16
	First Named Inventor	Sfarti
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1935CIP2C

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	2	5377320		1994-12-27	Abi-Ezzi et al.	
	3	6057848		2000-05-02	Goel	
	4	6211883		2001-04-03	Goel	
	5	6597356		2003-07-22	Moreton et al.	
	6	6624811		2003-09-23	Moreton et al.	
	7	5261029		1993-11-09	Abi-Ezzi et al.	
	8	6563501		2003-05-13	Sfarti	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	11778515
	Filing Date	2007-07-16
	First Named Inventor	Sfarti
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1935CIP2C

	9	5903273		1999-05-11	Mochizuki et al.	
	10	6600488		2003-07-29	Moreton et al.	
	11	6906716		2005-06-14	Moreton et al.	
	12	5428718		1995-06-27	Peterson et al.	
	13	5488684		1996-01-30	Gharachorloo et al.	
	14	6256038		2001-07-03	Krishnamurthy	
	15	5771341		1998-06-23	Huddy	
	16	6100894		2000-08-08	Goel	
	17	6437795		2002-08-20	Brown	

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	Application Number	11778515
	Filing Date	2007-07-16
	First Named Inventor	Sfarti
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1935CIP2C

	1	20030117405		2003-06-26	Hubrecht et al.	
	2	20040227755		2004-11-18	Sfarti	
	3	20050057568		2005-03-17	Sfarti	
	4	20040113909		2004-06-17	Fenney et al.	
	5	20060125824		2006-06-15	Sfarti	

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	1	WO 00/31690	SE		2000-06-02	Larking et al.		☐

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	First Named Inventor	Sfarti
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	2	Xuejun Sheng and Ingo R. Meier, "Generating Topological Structures for Surface Models", November 1995, IEEE Computer Graphics and Applications, Vol. 15, No. 6, pp. 35-41	☐
	3	Jatin Chhugani and Subodh Kumar, "View-Dependent Adaptive Tessellation of Spline Surfaces", March 2001, Proceedings of The 2001 Symposium On Interactive 3D Graphics, pp. 59-62	☐
	4	P.V. Sander, et al., "Multi-Chart Geometry Images", June 2003, Proceedings of the 2003 Eurographics Symposium on Geometry Processing, pp. 146-155	☐
	5	Alyn Rockwood, et al., "Real-Time Rendering of Trimmed Surfaces", July 1989, ACM SIGGRAPH Computer Graphics, Vol. 23, No. 3, pp. 107-116	☐
	6	Fuhua Cheng, "Estimating Subdivision Depths for Rational Curves and Surfaces", April 1992, ACM Transactions on Graphics, Vol. 11, No. 2, pp. 140-151	☐
	7	James Foley, et al., "Computer Graphics: Principles and Practice", 2d Edition, Addison-Wesley Publishing Company, 1990, pp. 511-527	☐

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	Filing Date	2007-07-16
	First Named Inventor	Sfarti
	Art Unit	
	Examiner Name	
	Attorney Docket Number	1935CIP2C

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☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Stephen G. Sullivan/	Date (YYYY-MM-DD)	2007-08-29
Name/Print	Stephen G. Sullivan	Registration Number	38329

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EFS ID:	2139435
Application Number:	11778515
International Application Number:	
Confirmation Number:	1565
Title of Invention:	Bicubic Surface Real Time Tesselation Unit
First Named Inventor/Applicant Name:	Adrian Sfarti
Customer Number:	57580
Filer:	Stephen Grant Sullivan/Jackie Tanda
Filer Authorized By:	Stephen Grant Sullivan
Attorney Docket Number:	1935CIP2C
Receipt Date:	29-AUG-2007
Filing Date:	16-JUL-2007
Time Stamp:	18:41:04
Application Type:	Utility under 35 USC 111(a)

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1	Information Disclosure Statement (IDS) Filed	1935CIP2C_SB08.pdf	876687 0a977738503c443bef85f763034281fdfd574e85	no	6
Warnings:					

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2	Foreign Reference	1935CIP2C_WO1.pdf	805378 fe41bf66b6da3f334a451f84253c703b57e8a462	no	20
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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
11/778,515	07/16/2007		425	1935CIP2C	19	3

CONFIRMATION NO. 1565

57580
STRATEGIC PATENT GROUP, P.C.
P.O. BOX 1329
MOUNTAIN VIEW, CA94042

FILING RECEIPT

Date Mailed: 08/01/2007

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Applicant(s)

Adrian Sfarti, Cupertino, CA;

Power of Attorney:

Joseph Sawyer Jr--30801
Michael Woods--33466
Stephen Sullivan--38329
Janyce Mitchell--40095
Michele Liu--44875
Joyce Tom--48681

Domestic Priority data as claimed by applicant

This application is a CON of 10/732,398 12/09/2003 PAT 7,245,299
which is a CIP of 10/436,698 05/12/2003 ABN
and is a CIP of 09/734,438 12/11/2000 PAT 6,563,501
which claims benefit of 60/222,105 07/28/2000

Foreign Applications

If Required, Foreign Filing License Granted: 07/30/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US11/778,515**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

** SMALL ENTITY **

Title

Bicubic Surface Real Time Tesselation Unit

Preliminary Class

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APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
11/778,515	07/16/2007	Adrian Sfarti	1935CIP2C

CONFIRMATION NO. 1565

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P.O. BOX 1329
MOUNTAIN VIEW, CA 94042

FORMALITIES LETTER

Date Mailed: 08/01/2007

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  - Numbers, letters, and reference characters on the drawings must measure at least 0.32 cm (1/8 inch) in height. See Figure(s) 2,3,4,6,7-10,13,15.
  - The drawings must be made on paper that has a white background (see 37 CFR 1.84 (e)). For example, drawings on graph paper, lined paper, or paper that has a non-white background are not acceptable. See Figure(s) 15.

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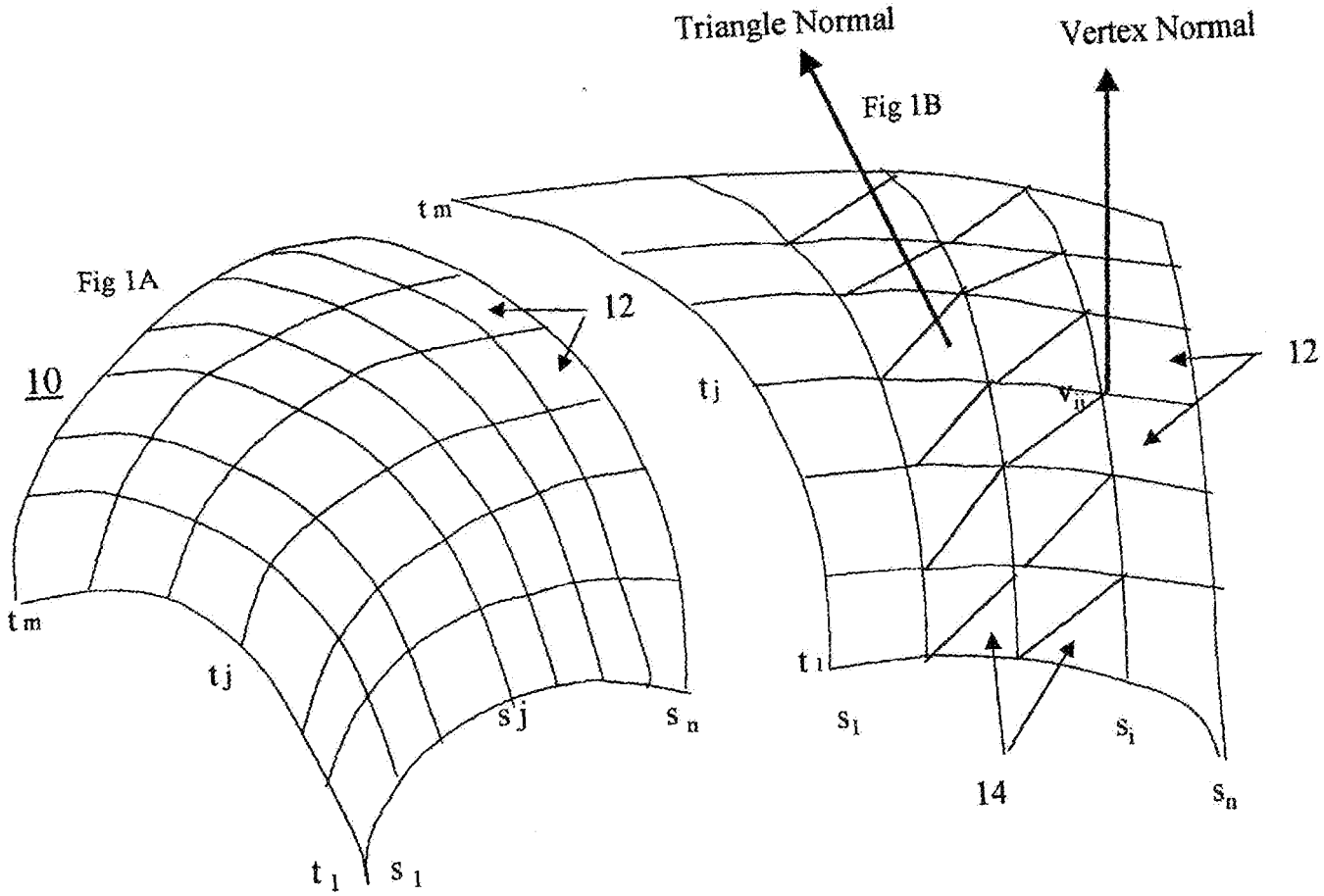

Triangle Normal
Vertex Normal
Fig 1B
Fig 1A
10
12
12
14
t m
t j
t 1
s 1
s j
s n
t m
t j
t 1
s 1
s i
s n
v ij

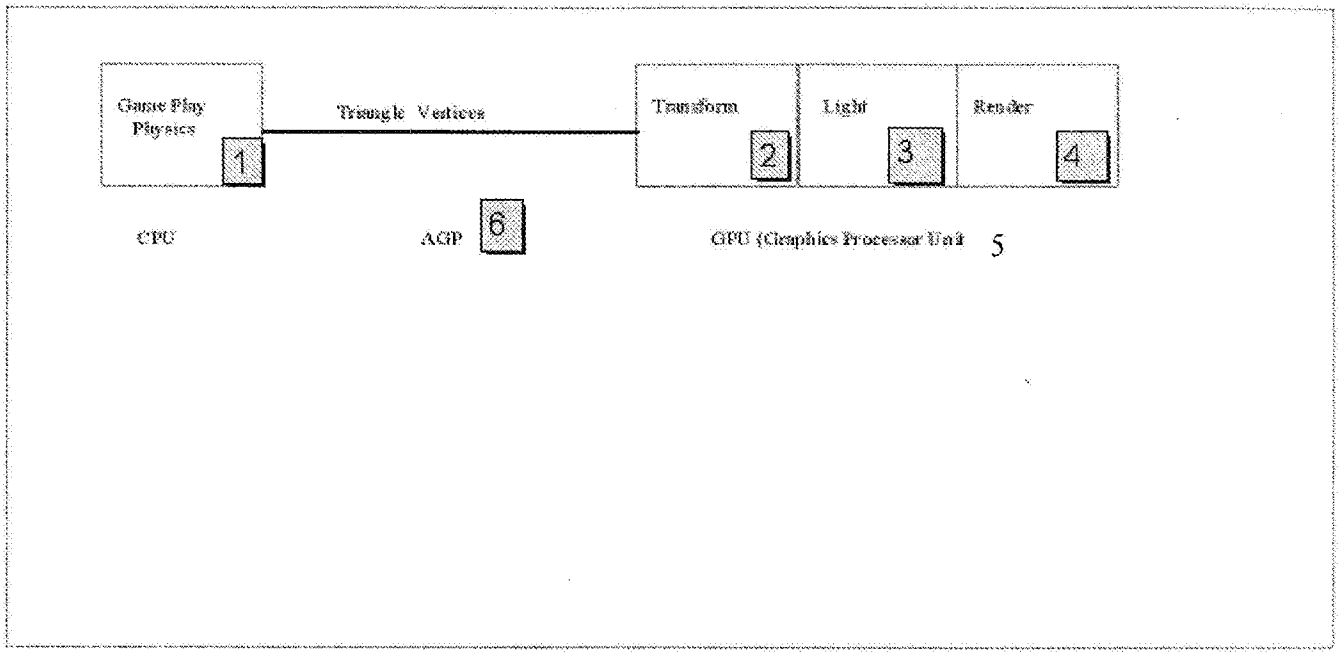


Figure 2 – Prior Art Graphics System Architecture

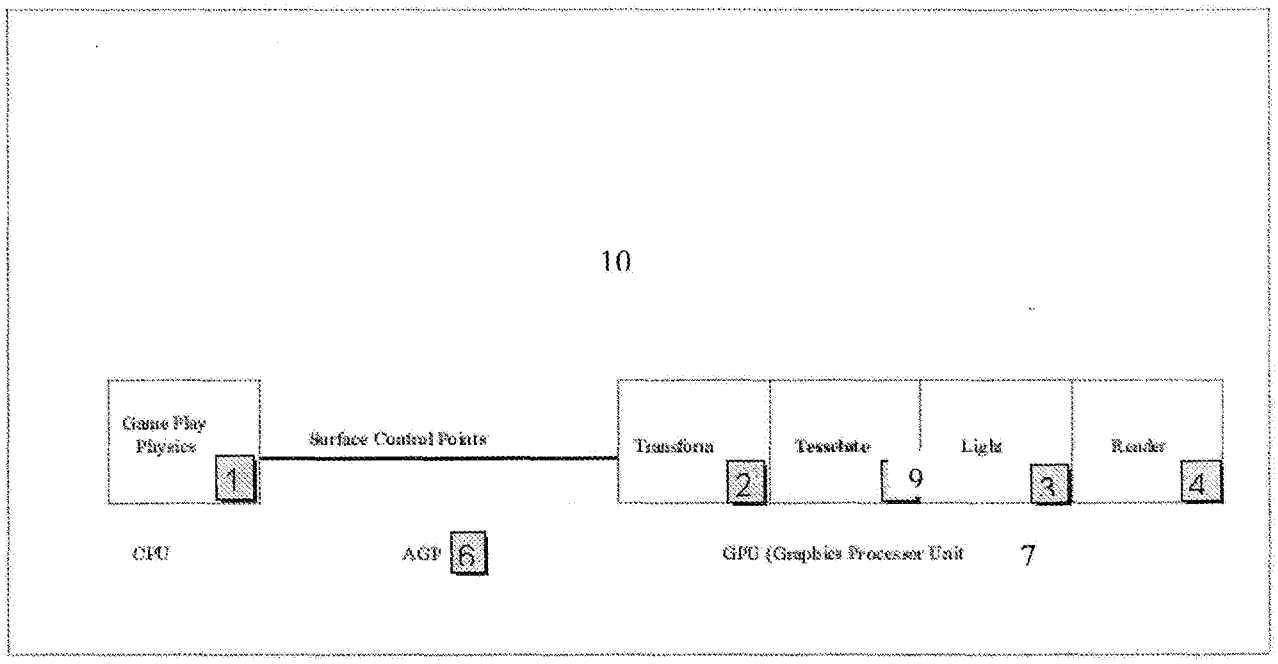

10
Game Play
Physics
1
Surface Control Points
Transform
2
Tessalate
9
Light
3
Render
4
CPU
AGP
6
GPU (Graphics Processor Unit
7

Figure 3

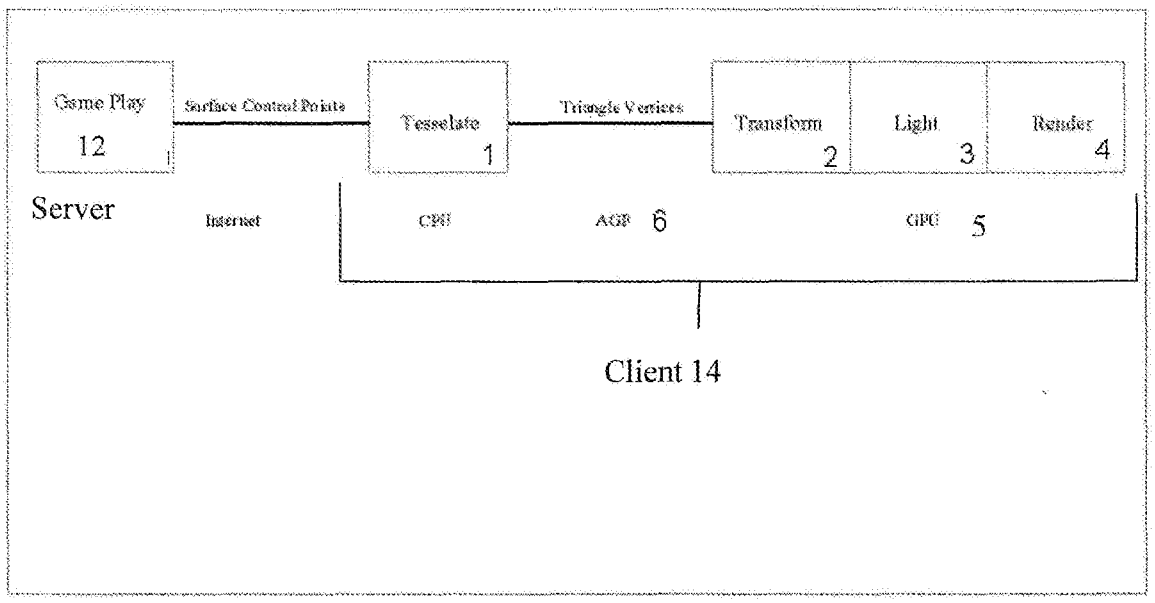

Game Play
12
Surface Control Points
Tesselate
1
Triangle Vertices
Transform
2
Light
3
Render
4
Server
Internet
CPU
AGP
6
GPU
5
Client 14

Figure 4

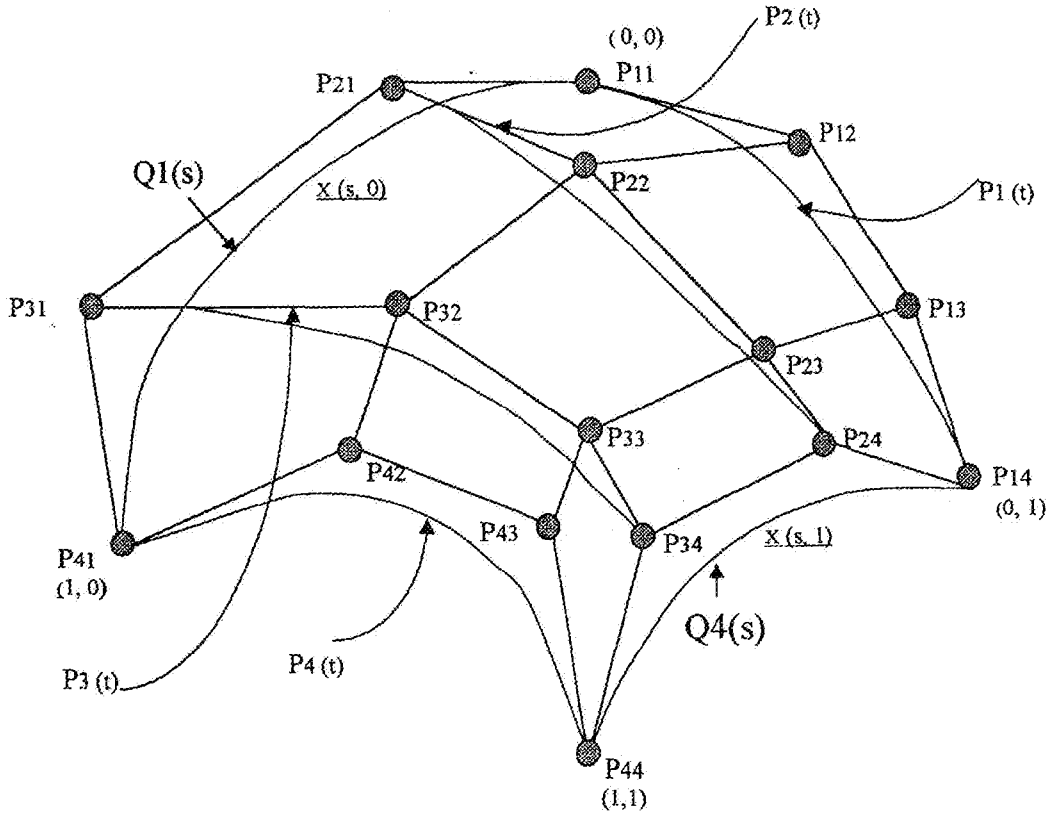

P2 (t)
(0, 0)
P11
P21
P12
Q1(s)
X (s, 0)
P22
P1 (t)
P31
P32
P13
P23
P33
P24
P42
P14
(0, 1)
P43
P34
X (s, 1)
P41
(1, 0)
Q4(s)
P3 (t)
P4 (t)
P44
(1,1)

Figure 5

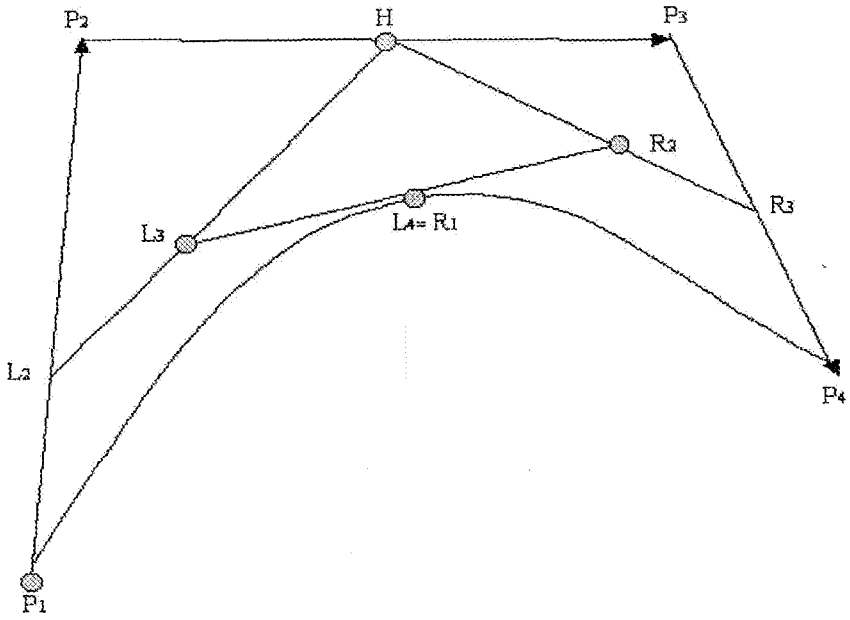


Figure 6

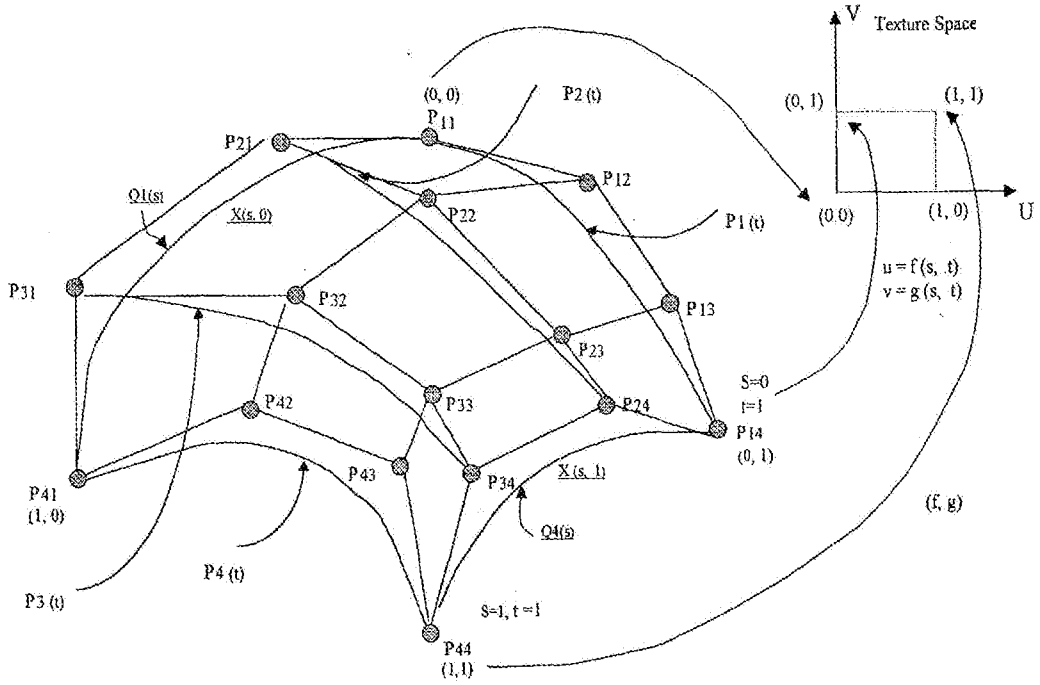

V
Texture Space
(0, 0)
P2 (t)
P11
(0, 1)
(1, 1)
P21
P12
Q1(s)
X(s, 0)
P22
P1 (t)
(0 0)
(1, 0)
U
u = f (s, t)
v = g (s, t)
P31
P32
P13
P23
S=0
t=1
P42
P33
P24
P14
(0, 1)
P41
(1, 0)
P43
P34
X (s, 1)
Q4(s)
(f, g)
P4 (t)
P3 (t)
S=1, t =1
P44
(1,1)

Figure 7

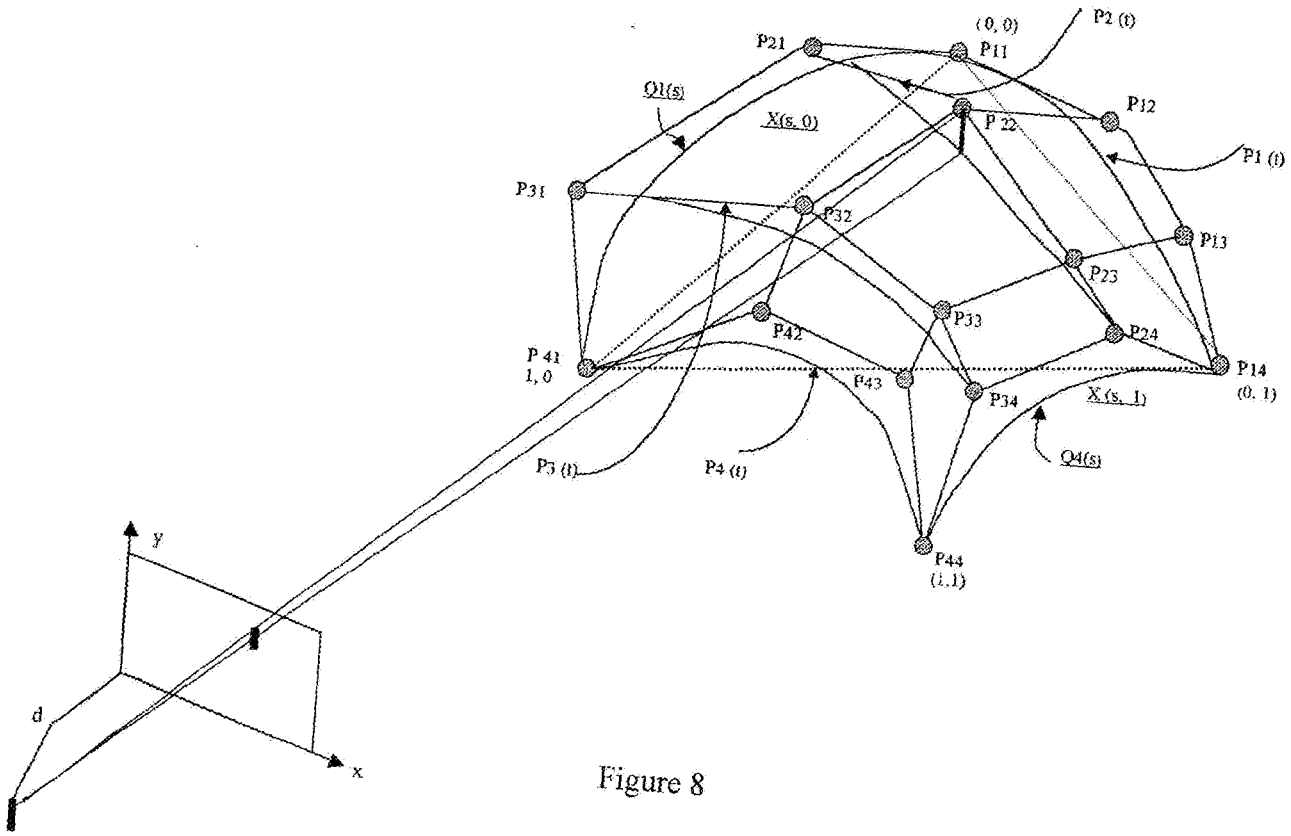

P21
(0, 0)
P11
P2 (t)
Q1(s)
X(s, 0)
P12
P 22
P1 (t)
P31
P32
P13
P23
P33
P42
P24
P 41
1, 0
P43
P14
(0, 1)
P34
X(s, 1)
P3 (t)
P4 (t)
Q4(s)
P44
(1,1)
y
d
x

Figure 8

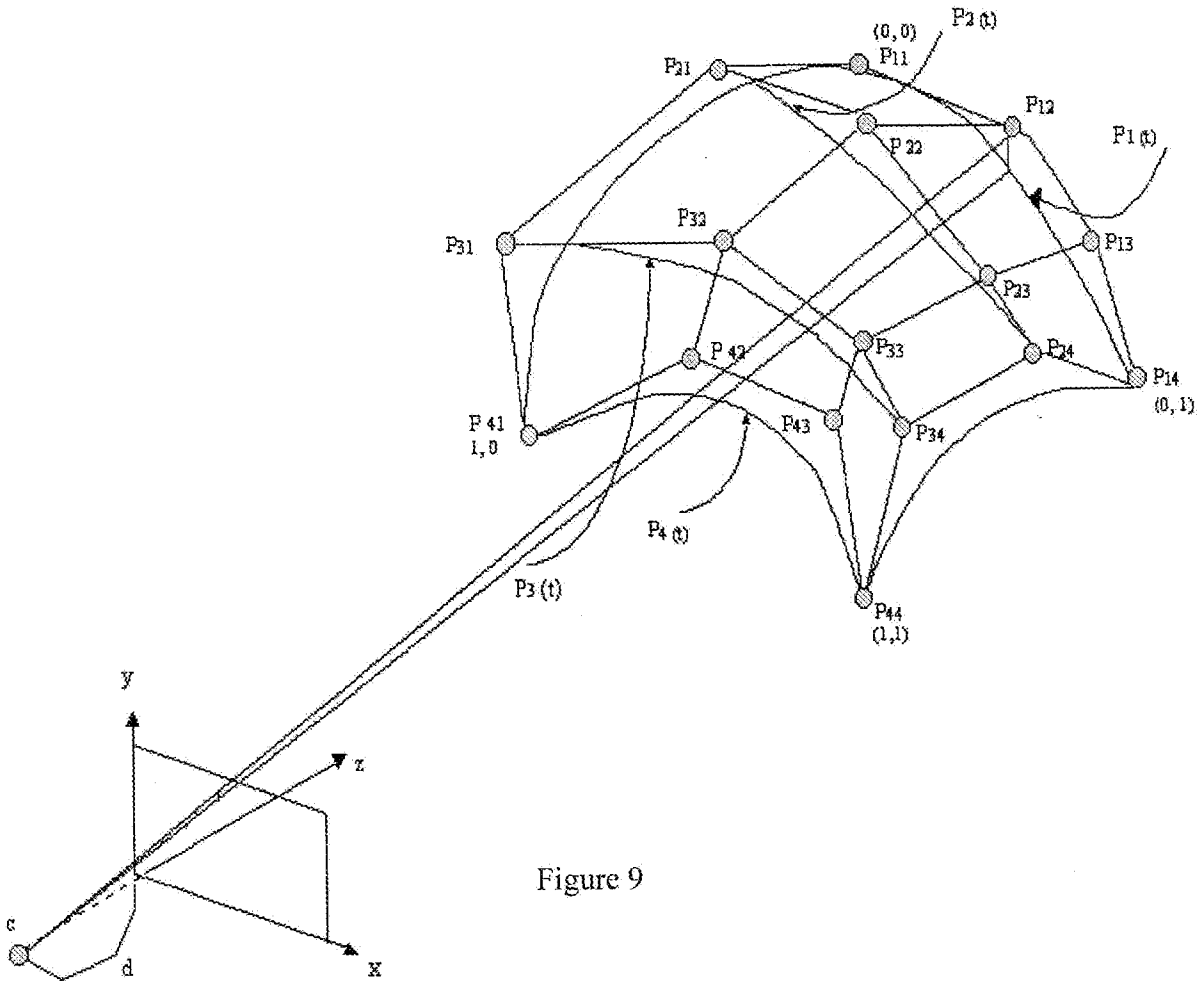

P2 (t)
(0, 0)
P11
P21
P12
P 22
P1 (t)
P31
P32
P13
P23
P 42
P33
P24
P14
(0, 1)
P 41
1, 0
P43
P34
P4 (t)
P3 (t)
P44
(1,1)
y
z
c
d
x

Figure 9

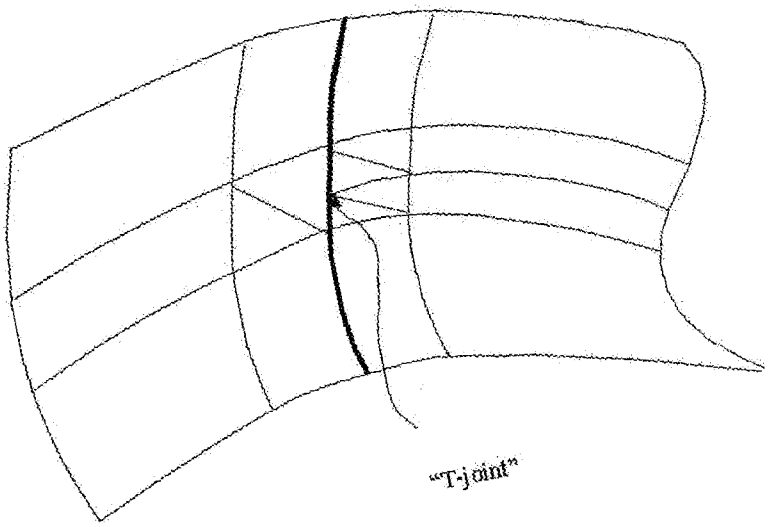


Figure 10

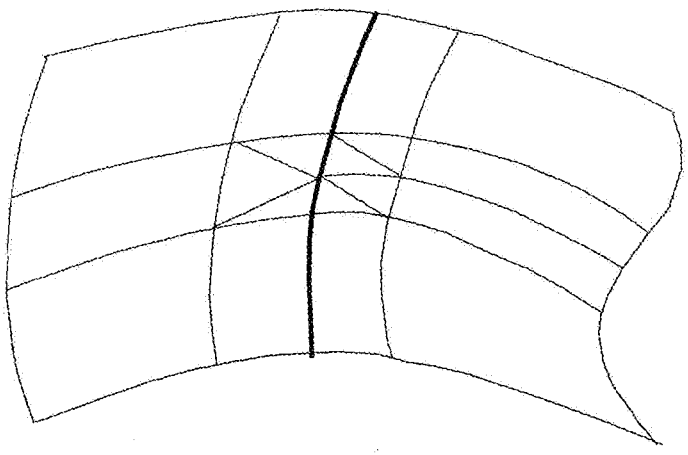


Figure 11

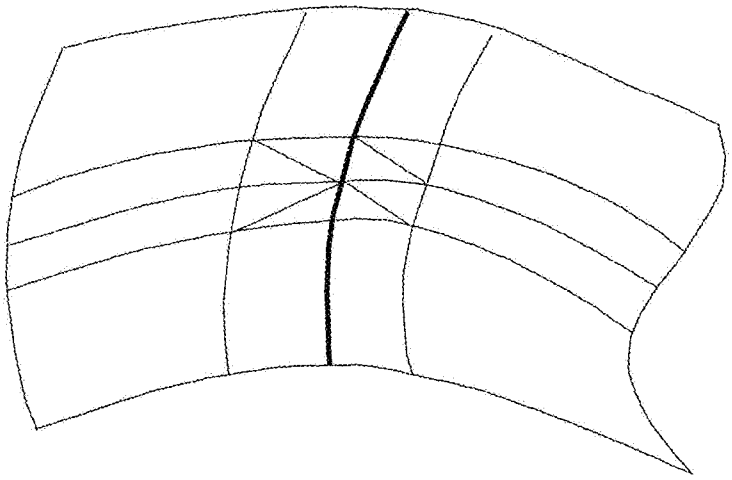
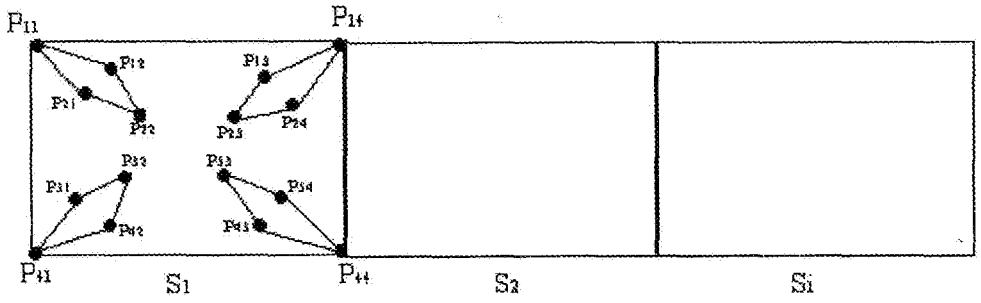


Figure 12

Figure 13

1. **Strip** (S1, S2, . . . Si, . . .Sn)



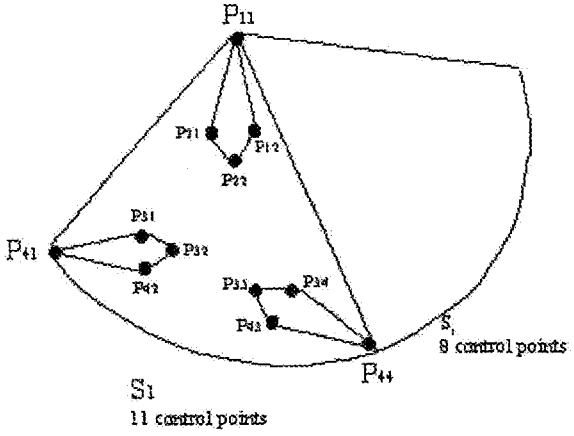
16 control points 12 control points 12 control points

Si { P11, P14, P41, P44 (Color, texture, geometry)
P12 . . . . .P43 (Geometry)
N = outwards pointing normal

Si { P11, P14, P41, P44
P12. . . . P24 P34 . . .P43
N

Figure 14

2. **Fan** (P11, S1, . . . Si, . . .Sn)



S1 { P11, P14, P41, P44
P12 . . . P23, P33, P24
N

Si { P11, P14, P41, P44
P12 . . . P23, P33, P34, P24
N

Figure 15

3. **Mesh** $(S_{11}, S_{12}, \ldots S_{1N}, \ldots S_{21}, \ldots S_{2N}, \ldots S_{M1}, \ldots S_{MN})$

S_{M1} 12 control points	S_{M2} 9		S_{Mi} 9		S_{MN} 9
S_{21} 12 control points	S_{22} 9 control points		S_{2i} 9		S_{2N} 9
S_{11} 16 control points	S_{12} 12 control points		S_{1i} 12		S_{1N} 12

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

■ **Declaration Submitted with Initial Filing**

☐ **Declaration Submitted after Initial Filing (surcharge 37 CFR 1.16(e) required)**

As a below named inventor, I hereby declare that:

My residence/post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

BICUBIC SURFACE REAL-TIME TESSELATION UNIT

the specification of which

■ is attached hereto.

☐ was filed on _____ as US Application Serial No. _____.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment(s) specifically referred to above. I acknowledge the duty to disclose all information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

Foreign Application(s) and/or Claim of Foreign Priority

I hereby claim foreign priority benefits under Title 35, United States Code Section 119 of any foreign application(s) for patent or inventor(s) certificate listed below and have also identified below any foreign application for patent or inventor(s) certificate having a filing date before that of the application on which priority is claimed:

COUNTRY	APPLICATION NUMBER	DATE FILED	PRIORITY CLAIMED UNDER 35 U.S.C. 119
			YES: NO:
			YES: NO:

U.S. Priority Claim

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, Section 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

APPLICATION SERIAL NUMBER	FILING DATE	STATUS(patented/pending/abandoned)
10/436,698	5/12/2003	Pending

Provisional Application

I hereby claim the benefit under Title 35, United States Code Section 119(e) of any United States provisional application(s) listed below:

APPLICATION SERIAL NUMBER	FILING DATE	STATUS(pending)

Docket No: 1935CIP-2

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION (continued)

POWER OF ATTORNEY:
As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) listed below to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Joseph A. Sawyer, Jr., Reg. No. 30,801	Janyce R. Mitchell, Reg. No. 40,095
Stephen G. Sullivan, Reg. No. 38,329	Michele Liu, Reg. No. 44,875
Joyce Tom, Reg. No. 48,681	Michael E. Woods, Reg. No. 33,466

Send Correspondence to:	Direct Telephone Calls To:
SAWYER LAW GROUP LLP	**Stephen G. Sullivan**
P.O. Box 51418	**Phone: (650) 493-4540**
Palo Alto, CA 94303	**Facsimile: (650) 493-4549**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Inventor: **Adrian SFARTI** Citizenship: **USA**

Residence: **20035 Northwind Square**
Cupertino, CA 95014

Post Office Address: **Same**

12/4/03
Date

Inventor's Signature

PTO/SB/14 (02-07)
Approved for use through 02/28/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1935CIP2C
	Application Number	
Title of Invention	Bicubic Surface Real Time Tesselation Unit	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Adrian		Sfarti	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Cupertino	State/Province	CA	Country of Residence i	US

Citizenship under 37 CFR 1.41(b) i: US

Mailing Address of Applicant:

Address 1	20035 Northwind Square		
Address 2			
City	Cupertino	State/Province	CA
Postal Code	95014	Country i	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	57580		
Email Address	stephen@spatents.com	Add Email	Remove Email

Application Information:

Title of the Invention	Bicubic Surface Real Time Tesselation Unit		
Attorney Docket Number	1935CIP2C	Small Entity Status Claimed	☒
Application Type	regular		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)		Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1935CIP2C
	Application Number	
Title of Invention	Bicubic Surface Real Time Tesselation Unit	

Publication Information:
☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐ Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not been and will not be the subject of an application filed in another country, or under a multilateral agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ US Representative (37 CFR 11.9)
Customer Number	57580		

Domestic Priority Information:

This section allows for the applicant to claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c). Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	10732398	2003-12-09
Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation in part of	10436698	2003-05-12
Prior Application Status	Patented		Remove

Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
	Continuation in part of	09734438	2000-12-11	6563501	2003-05-13

Prior Application Status	Abandoned		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	60222105	2000-07-28

Additional Domestic Priority Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	1935CIP2C
	Application Number	
Title of Invention	Bicubic Surface Real Time Tesselation Unit	

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			(•) Yes ( ) No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1 Remove

If the Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information:

Address 1			
Address 2			
City		**State/Province**	
Country [i]		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Stephen G. Sullivan/			Date (YYYY-MM-DD)	2007-07-16
First Name	Stephen	Last Name	Sullivan	Registration Number	38329

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

BICUBIC SURFACE REAL-TIME TESSELATION UNIT

CROSS-REFERENCE TO RELATED APPLICATIONS

The present invention is a continuation of U.S. application serial number 10/732,398, entitled “Bicubic Surface Real-Time Tesselation Unit”, (1935CIP2) filed on December 9, 2003, which is a continuation-in-part of U.S. application serial number 10/436,698, entitled “Bicubic Surface Rendering,“ (1935CIP) filed on May 12, 2003, which is a continuation-in-part of U.S. Patent No. 6,563,501 entitled “Bicubic Surface Rendering,” issued May 13, 2003, which claims priority of provisional application 60/222,105, filed on July 28, 2000, which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates to computer graphics, and more specifically to a method and apparatus for rendering bicubic surfaces in real-time on a computer system.

BACKGROUND OF THE INVENTION

Object models are often stored in computer systems in the form of surfaces. The process of displaying the object (corresponding to the object model) generally requires rendering, which usually refers to mapping the object model onto a two dimensional surface. At least when the surfaces are curved, the surfaces are generally subdivided or decomposed into triangles in the process of rendering the images.

A cubic parametric curve is defined by the positions and tangents at the curve's end points. A Bezier curve, as shown in Figure 5 for example, is defined by a geometry matrix of four points (P1-P4) that are defined by the intersections of the tangent vectors at the end points of the curve. Changing the locations of the points changes the shape of the curve.

Cubic curves may be generalized to bicubic surfaces by defining cubic equations of two parameters, s and t. In other words, bicubic surfaces are defined as parametric surfaces where the (x,y,z) coordinates in a space called "world coordinates" (WC) of each point of the surface are functions of s and t, defined by a geometry matrix P comprising 16 control points (Figure 5).

While the parameters s and t describe a closed unidimensional interval (typically the interval [0,1]) the points (x,y,z) describe the surface:

x=f(s,t), y=g(s,t) , z=h(s,t) sε[0,1] , t.ε[0,1], where ε represents an interval between the two coordinates in the parenthesis.

The space determined by s and t, the bidimensional interval [0,1]x[0,1] is called "parameter coordinates" (PC). Textures described in a space called "texture coordinates" (TC) that can be two or even three dimensional are described by sets of points of two ((u,v)) or three coordinates ((u,v,q)). The process of attaching a texture to a surface is called "texture - object association " and consists of associating u, v and q with the parameters s and t via some function:

u=a(s,t) v=b(s,t) (and q=c(s,t))

Figs. 1A and 1B are diagrams illustrating a process for rendering bicubic surfaces. As shown in Figure 1A, the principle used for rendering such a curved surface 10 is to subdivide it into smaller four sided surfaces or tiles 12 by subdividing the intervals that define the parameters s and t. The subdivision continues until the surfaces resulting from subdivision have a curvature, measured in WC space that is below a predetermined threshold. The subdivision of the intervals defining s and t produces a set of numbers {si} i=1,n and {tj} j=1,m that determine a subdivision of the PC. This subdivision induces a subdivision of the TC, for each pair (si,tj) we obtain a pair ($u_{i,j}$, $v_{i,j}$) (or a triplet ($u_{i,j}$,$v_{i,j}$, $q_{i,j}$)). Here ui,j=a(si,tj), vi,j=b(si,tj), qi,j=c(si,tj). For each pair (si,tj) we also obtain a point (called “vertex”) in WC , Vi,j (f(si,tj),g(si,tj),h(si,tj)). A special type of texture, called displacement map having the pair (p,r) as coordinates can be used to generate special lighting effects . For each pair (si,tj) we also obtain a pair (pi,j ri,j) that index a displacement value (dxi,j , dyi,j , dzi,j). for the vertex Vi,j .

This process is executed off-line because the subdivision of the surfaces and the measurement of the resulting curvature are very time consuming. As shown in Figure 1B, when all resulting four sided surfaces (tiles) 12 is below a certain curvature threshold, each such resultant four-sided surface 12 is then divided into two triangles 14 (because they are easily rendered by dedicated hardware) and each triangle surface gets the normal to its surface calculated and each triangle vertex also gets its normal calculated. The normals

are used later on for lighting calculations.

Furthermore, each vertex or triangle plane normal needs to be transformed when the surface is transformed in response to a change of view of the surface, a computationally intensive process that may need dedicated hardware. Also, there is no accounting for the fact that the surfaces are actually rendered in a space called "screen coordinates" (SC) after a process called "projection" which distorts such surfaces to the point where we need to take into consideration the curvature in SC, not in WC.

The state of the art in today's hardware architecture for rendering relies overwhelmingly on triangle databases such as meshes, strips, fans. The current state of the art in the computer graphics industry is described in Figure 2, which shows an architecture of a conventional computer graphics system, including the architecture of a graphics processing unit (GPU). A CPU 1, executes a software application in the form of a game play or a physical or chemical simulation, etc., in which objects to be rendered are represented as triangle meshes in an object database stored in memory. The triangle meshes are transmitted over an accelerated graphics port (AGP) bus 6 to the GPU 5, which is typically part of a display adapter (video card). The AGP bus 6 is a high-speed port that is designed for the display adapter only to provide a direct connection between the card and memory. The GPU 5 includes a transform unit 2, a lighting unit 3 and a renderer unit 4.

The object modeling in the application is executed on parametric surfaces such as nurbs, Bezier, splines, and the surfaces are subdivided or tessellated off-line and stored as triangle vertices in a triangle database by means of commercially available tools, such as the Alias suite. The triangle vertices are then transmitted from the CPU 1 (the triangle server) to the GPU 5 (the rendering engine) at the time for rendering. Previous attempts to execute the tessellation in hardware in real-time have not been successful because of the severe limitations of the implementation so the current state of the art has been off-line tessellation.

Unfortunately, the off-line tessellation produces a fixed triangulation that may exhibit an excessively large number of very small triangles when the object is far away. Triangle rendering in this case is dominated by the processing of vertices (transformation, lighting)

and by the triangle setup (the calculation of the color and texture gradients). Since triangles may reduce to a pixel or less, it is obvious that this is an inefficient treatment.

Conversely, when the object is very close to the viewer, the composing triangles may appear very large and the object looses its smoothness appearance, looking more like a polyhedron.

The increase in the scene complexity has pushed up the number of triangles, which has pushed up the demands for higher bus bandwidth. For example, the bus 6 that connects the CPU 1 with the GPU 5 has increased 8x in frequency, from AGP 1x to AGP 8x in the PC space in the last few years. There are physical constraints in terms of signal propagation that preclude the continuation of the frequency increase in bus design.

With the advent of faster arithmetic it has become possible to change the current architecture such that the CPU 1 will serve parametric patches and the renderer 5 will triangulate such patches in real-time. There are very few past attempts of implementing real-time tesselation in hardware. Sun Corporation tried in the mid-80's to implement such a machine. The implementation was based on an architecture described in a paper by Lien, Sheue-Ling, Shantz, Michael, Pratt, Vaughan "Adaptive Forward Differencing for Rendering Curves and Surfaces", Siggraph '87 Proceedings, pp. 111-118 and in a series of associated patents. The implementation was not a technical and commercial success because it made no good use of triangle based rendering, trying instead to render the surfaces pixel by pixel. The idea was to use adaptive forward differencing in interpolating infinitesimally close parallel cubic curves imbedded into the bicubic. The main drawback was that sometimes the curves were too close together, resulting into pixel overstrikes and other times the curves were too far apart, leaving gaps. Another drawback was that the method is slow.

In the early 90's Nvidia Corporation made an attempt to introduce a biquadric based hardware renderer. The attempt was not a technical and commercial success because biquadrics have an insufficient number of degrees of freedom, all the models use bicubics, none of the models uses biquadrics.

More currently, Henry Moreton from Nvidia has resurrected the real-time tesselation unit described in the US Patent 6,597,356 entitled "Integrated Tesselator in a Graphics

Processing Unit," issued July 22, 2003. Moreton's invention doesn't directly tesselate patches in real-time, but rather uses triangle meshes pre-tesselated off-line in conjunction with a proprietary stitching method that avoids cracking and popping at the seams between the triangle meshes representing surface patches. His tesselator unit outputs triangle databases to be rendered by the existing components of the 3D graphics hardware.

Accordingly, what is needed is a system and method for performing tessellation in real-time. The present invention addresses such a need.

SUMMARY OF THE INVENTION

The present invention provides a graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are received as control points of bicubic surfaces. According to the method and system disclosed herein, the graphics processing unit includes a transform unit, a lighting unit, a renderer unit, and a tessellate unit for tessellating both rational and non-rational object surfaces in real-time.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with reference to the accompanying drawings, wherein:

Figures 1A and 1B are diagrams illustrating a process for rendering bicubic surfaces.

Figure 2 describes the current architecture of a computer graphics system, in specific the current architecture of a graphics processing unit (GPU).

Figure 3 describes the new architecture of a GPU that includes a Tessellator Unit inserted between the Transform Unit and the Light Unit.

Figure 4 describes the architecture of an internet system employing multiple

CPU's at the receiving end performing real-time tessellation.

Figure 5 illustrates a bicubic surface.

Figure 6 describes the recursive subdivision of the convex hull of a Bezier curve.

Figure 7 describes the texture mapping process.

Figure 8 illustrates the recursive subdivision of the convex hull of a bicubic surface.

Figure 9 shows how to calculate one criterion for terminating the subdivision.

Figure 10 shows how cracks can appear at the T-joints on the boundary curves between surfaces.

Figure 11 shows how to "zipper" the cracks at the T-joints.

Figure 12 shows how using the same subdivision for neighboring surfaces completely avoids the cracks.

Figure 13 shows an example of a strip of surfaces.

Figure 14 shows an example of a fan of surfaces.

Figure 15 shows an example of a mesh of surfaces.

DESCRIPTION OF THE INVENTION

The present invention is directed to a method and apparatus for minimizing the number of computations required for the subdivision of bicubic surfaces into triangles for real-time tessellation. The following description is presented to enable one of ordinary skill in the art to make and use the invention and is provided in the context of a patent application and its requirements. Various modifications to the preferred embodiment will be readily apparent to those skilled in the art and the generic principles herein may be applied to other embodiments. Thus, the present invention is not intended to be limited to

the embodiment shown but is to be accorded the widest scope consistent with the principles and features described herein.

Because prior art methods for performing surface subdivision are so slow and limited, a method is needed for rendering a curved surface that minimizes the number of required computations, such that the images can potentially be rendered in real-time (as opposed to off-line).

US Patent No. 6,563,501, by the Applicant of the present application, provides an improved method and system for rendering bicubic surfaces of an object on a computer system. Each bicubic surface is defined by sixteen control points and bounded by four boundary curves, and each boundary curve is formed by boundary box of line segments formed between four of the control points. The method and system include transforming only the control points of the surface given a view of the object, rather than points across the entire bicubic surface. Next, a pair of orthogonal boundary curves to process is selected. After the boundary curves have been selected, each of the curves is iteratively subdivided, as shown in Figure 6, wherein two new curves are generated with each subdivision. The subdivision of each of the curves is terminated when the curves satisfy a flatness threshold expressed in screen coordinates, whereby the number of computations required to render the object is minimized.

The method disclosed in the '501 patent minimizes the number of computations required for rendering of an object model by requiring that only two orthogonal curves of the surface be subdivided, as shown in Figure 8. As the number of computations is decreased, the entire rendering process can potentially be performed in real-time. In addition, the computations for subdivision are performed by expressing the criteria of terminating the subdivision in the screen coordinates (SC). As the curvature is estimated based on how flat it appears to be in SC (pixels), rather than how curved it is in WC, the number of computations required may further be minimized. As a result, the possibility of rendering images in real-time is further enhanced. In addition, allowing the curvature to be measured in SC units also allows for accommodating the distance to the viewer, thus giving the process an "automatic level of detail" capability.

The present invention utilizes the above method for minimizing the number of

computations required for the subdivision of bicubic surfaces into triangles in order to provide an improved architecture for the computer graphics pipeline hardware. The improved architecture replaces triangle mesh transformation and rendering with a system that transforms bicubic patches and tesselates the patches in real-time. This process is executed in a real-time tesselation unit that replaces the conventional transformation unit present in the prior art hardware 3D architectures.

According to the present invention, the reduction in computations is attained by reducing the subdivision to the subdivision on only two orthogonal curves. In addition, the criteria for sub-division may be determined in SC. The description is provided with reference to Bezier surfaces for illustration. Due to such features, the present invention may enable objects to be subdivided and rendered in real-time. The partition into triangles may also be adapted to the distance between the surface and the viewer resulting in an optimal number of triangles. As a result, the effect of automatic level of detail may be obtained, whereby the number of resulting triangles is inversely proportional with the distance between the surface and the viewer. The normals to the resulting tiles are also generated in real-time by using the cross product of the vectors that form the edges of the tiles. The texture coordinates associated with the vertices of the resulting triangles are computed in real-time by evaluating the functions: u=a(s,t) v=b(s,t). The whole process is directly influenced by the distance between viewer and object, the SC space plays a major role in the computations.

The steps involved in the combined subdivision and rendering of bicubic surfaces in accordance with the present invention are described below in pseudo code. As will be appreciated by one of ordinary skill in the art, the text between the "/*" and "*/" symbols denote comments explaining the pseudo code. All steps are performed in real-time, and steps 0 through 4 are transformation and tessellation, while steps 5 – 7 are rendering.

Step 0

/* For each surface transform only 16 points instead of transforming all the vertices inside the surface. There is no need to transform the normals to the vertices since they are generated at step 4 */.

For each bicubic surface

Transform the 16 control points and the single normal that determine the surface

Step 1

/* Simplify the three dimensional surface subdivision by reducing it to the subdivision of two cubic curves */.

For each bicubic surface

Subdivide the boundary curve representing s interval until the projection of the length of the height of the

curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates.

Subdivide the boundary curve representing t interval until the projection of the length of the height of the curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates. /*Simplify the subdivision termination criteria by expressing it in screen coordinates (SC) and by measuring the curvature in pixels. For each new view, a new subdivision can be generated, producing automatic level of detail */.

Step 2

For all bicubic surfaces sharing a same parameter (either s or t) boundary

Choose as the common subdivision the reunion of the subdivisions in order to prevent cracks showing along the common boundary. – OR-

Choose as the common subdivision the finest subdivision (the one with the most points inside the set)

/* Prevent cracks at the boundary between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary */

Step 3

/* Generate the vertices, normals, the texture coordinates, and the displacements used for bump and displacement mapping for the present subdivision */

For each bicubic surface

For each pair (si,tj) /*All calculations employ some form of direct evaluation of the variables */

Calculate (($u_{i,j}$ $v_{i,j}$ $q_{i,j}$) ($p_{i,j}$ $r_{i,j}$) $V_{i,j}$) thru interpolation

/*texture , displacement map and vertex coordinates as a function of (si,tj)*/

Look up vertex displacement ($dx_{i,j}$, $dy_{i,j}$, $dz_{i,j}$) corresponding to ($p_{i,j}$ $r_{i,j}$)

Generate triangles by connecting neighboring vertices.

Step 4

For each vertex $V_{i,j}$

Calculate the normal $N_{i,j}$ to that vertex /* Already transformed in WC */

Calculate ($dN_{i,j}$) /*normal displacement for bump mapping as a function of (si,tj)*/

$N'_{i,j}=N_{i,j}+dN_{i,j}$ /*displace the normal for bump mapping*/

$V'_{i,j}=V_{i,j}+(dx_{i,j}, dy_{i,j}, dz_{i,j})* N_{i,j}$ /*displace the vertex for displacement mapping*/

/* bump and displacement mapping are executed in the renderer, pixel by pixel for all the points inside each triangle */

For each triangle

Calculate the normal to the triangle /*used for culling */

Step 5

For each triangle

Clip against the viewing viewport

Calculate lighting for the additional vertices produced by clipping

Cull backfacing triangles

Step 6

Project all the vertices Vi,j into screen coordinates (SC)

Step 7

Render all the triangles produced after clipping and projection

Referring now to Figure 3, a block diagram of the graphics system of the present invention is shown, where like components from Figure 2 have like reference numerals. The present invention utilizes the above algorithm to provide an improved graphics system 10. The system 10 includes CPU 1 and GPU 7. According to the present invention, the GPU 7 includes a transform unit 2, a lighting unit 3, a renderer unit 4, and a tessellate unit 9 coupled between the transform unit 2 and the lighting unit 3 for tessellating both rational and non-rational object surfaces in real-time.

In operation, the CPU 1 executes a software application and transmits over the AGP bus 6 the object database expressed in a compressed format as control points of the bicubic surfaces. The control points of the bicubic surfaces are transformed by the transform unit 2, and then the surfaces are tessellated into triangles by the tessellate unit 9. The tessellate unit 9 executes the microcode described above in the Step 1 through Step 4, thereby affecting the real-time tessellation. The vertices of the triangles are then lit by the lighting unit 3 and the triangles are rendered by the renderer unit 4 executing steps 5 through 7.

Figure 4 is a diagram illustrating architecture of a network-based graphics system targeting for performing real-time tessellation for online gaming according to a second preferred embodiment of the present invention. This second embodiment targets the interactive multi-player game play over a network, such as the Internet in which multiple client computers 14 comprising a CPU 1 and GPU 5 are in communication with a server 12. The server 12 sends object databases over the Internet in the form of control points for bicubic patches to the CPUs 1 for tessellation of the databases into triangles. The CPUs 1

then transfer the triangles to conventional GPU's 5 comprising transform units 2, lighting units 3 and renderer units 4. In this embodiment, it is the CPUs 1 that execute the microcode steps 0 though 4 described above to effect the real-time tessellation. Note, that the CPUs 1 also execute Step 0, the transformation of the control points.

Referring again to US Patent No. 6,563,501, we use the described subdivision algorithm while applying our termination criterion. The geometric adaptive subdivision induces a corresponding parametric subdivision.

L1=P1
L2=(P1+P2)/2
H=(P2+P3)/2
L3=(L2+H)/2
R4=P4
R3=(P3+P4)/2
R2=(R3+H)/2
R1=L4=(L3+R2)/2

The geometry vectors of the resulting left and right cubic curves may be expressed as follows:

$$GL = \begin{vmatrix} L1 \\ L2 \\ L3 \\ L4 \end{vmatrix} = 1/8^* \begin{vmatrix} 8&0&0&0 \\ 4&4&0&0 \\ 2&4&2&0 \\ 1&3&3&1 \end{vmatrix} * \begin{vmatrix} P1 \\ P2 \\ P3 \\ P4 \end{vmatrix} = 1/8*DL*G$$

where $$DL = \begin{vmatrix} 8&0&0&0 \\ 4&4&0&0 \\ 2&4&2&0 \\ 1&3&3&1 \end{vmatrix}$$

$$G = \begin{vmatrix} P1 \\ P2 \\ P3 \\ P4 \end{vmatrix}$$

$$GR = \begin{vmatrix} R1 \\ R2 \\ R3 \end{vmatrix} = 1/8^* \begin{vmatrix} 1&3&3&1 \\ 0&2&4&2 \\ 0&0&4&4 \end{vmatrix} * \begin{vmatrix} P1 \\ P2 \\ P3 \end{vmatrix} = 1/8*DR*G$$

| R4 | | 0 0 0 8 | | P4 |

where DR = | 0 2 4 2 |
| 1 3 3 1 |
| 0 0 4 4 |
| 0 0 0 8 |

The edge subdivision results into a subdivision of the parametric intervals s $\{s_0,s_1,\ldots s_i,\ldots s_m\}$ and t $\{t_0,t_1,\ldots t_j,\ldots t_n\}$. Only these two parametric subdivisions are stored for each surface since this is all the information needed to calculate the vertices,

$V_{ij}=V(x(s_i,t_j),y(s_i,t_j),z(s_i,t_j))$ i=1,m, j=1,n

$x(s,t)=S*Mb*Px*Mb^t*T$ wherein S=[s3 s2 s 1] T=$[t3\ t2\ t\ 1]^t$ The superscript t indicates transposition

| -1 +3 -3 +1 |
Mb= | +3 -6 +3 0 | Mb^t is the transposed of matrix Mb
| -3 +3 0 0 |
| +1 0 0 0 |

| P11 P12 P13 P14 |
Px= | P21 P22 P23 P24 |
| P31 P32 P34 P34 |
| P41 P42 P43 P44 |x

$y(s,t)=S*Mb*Py*Mb^t*T$

where

| P11 P12 P13 P14 |
Py= | P21 P22 P23 P24 |
| P31 P32 P34 P34 |
| P41 P42 P43 P44 |y

$z(s,t)=S*Mb*Pz*Mb^t*T$

For s=constant the matrix $M=S*Mb*Pz*Mb^t$ is constant and the calculation of the vertices V(x(s,t),y(s,t),z(s,t)) reduces to the evaluation of the vector T and of the product M*T. Therefore, the generation of vertices is comparable with vertex transformation. Note that the vertices are generated already transformed in place because the parent bicubic

surface has already been transformed.

In order to determine the vertex normals for each generated vertex $V_{i,j}$ we calculate the cross product between the edge entering the vertex and the edge exiting it and we make sure that we pick the sense that makes an acute angle with the normal to the surface:

$$N_{i,j} = P_{i-1,j} P_{i,j} \times P_{i,j} P_{i,j+1} / \text{length} (P_{i-1,j} P_{i,j} \times P_{i,j} P_{i,j+1})$$

If bump mapping or displacement mapping are enabled we need to calculate additional data:

$N'_{i,j}=N_{i,j}+dN_{i,j}$ /*displace the normal for bump mapping, pixel by pixel in the renderer section */

$P'_{i,j}=P_{i,j}+ (dx_{i,j} , dy_{i,j} , dz_{i,j})* N_{i,j}$ /*displace the point P for displacement mapping, pixel by pixel */

We calculate the texture coordinates through bilinear interpolation, as shown in Figure 7. The parameterization of the surface produces a natural interpolation of the texture coordinates, see Figure 7 for details. In our algorithm we calculate the texture coordinates corresponding to the new vertices every time a surface is retesselated while bump and displacement mapping are executed on a pixel by pixel basis in the renderer as in the conventional architectures. There is no attempt to execute bump or displacement mapping on a per triangle vertex basis because this approach would result into a varying level of detail with each tesselation.

The subdivision algorithm described in US Patent no. 6,563,501 applied to non rational surfaces. In a further embodiment of the present invention, the algorithm is extended to another class of surfaces, non uniform rational B-spline surfaces, or NURBS. Nurbs are a very important form of modeling 3-D objects in computer graphics. A non-

uniform rational B-spline surface of degree (p, q) is defined by

$$S(s,t) = [\Sigma^{m}_{i=1} \Sigma^{n}_{j=1} N_{i,p}(s)\, N_{j,q}(t)\, w_{i,j}\, P_{i,j}] / \Sigma^{m}_{i=1} \Sigma^{n}_{j=1} N_{i,p}(s)\, N_{j,q}(t)\, w_{i,j}$$

Such a surface lies within a convex hull formed by its control points. To fix the idea, let's pick m=n=4. There are 16 control points, P11 through P44 (similar to the Bezier surfaces). The surface lies within the convex hull formed by P11 thru P44.

Now consider any one of the curves:

$$C(s)=[\Sigma^{m}_{i=1}\ N_{i,p}(s)\, w_{i,j}\, P_i] / \Sigma^{m}_{i=1} N_{i,p}(s)\, w_i$$

where p is the order, $N_{i,p}(s)$ are the B-spline basis functions, P_i are control points, and with the weight of is the last ordinate of the homogeneous point. The curve lies within the convex hull formed by the control points.

Such a curve can be obtained by fixing one of the two parameters s or t in the surface description. For example s=variable, t=0 produces such a curve. Like in the case of Bezier surfaces, there are 8 such curves, 4 boundary ones and 4 internal ones.

The subdivision of the surface reduces to the subdivision of the convex hull of the boundary curves or of the internal curves as described in the case of the Bezier surfaces.

Referring to Figure 9, the subdivision termination criterion is shown, as described in US Patent no. 6,563,501:

Maximum {distance (P12 to line (P11, P14), distance (P13 to line (P11, P14)}*2d/(P12z+P13z) <n

AND

Maximum {distance (P24 to line (P14, P44), distance (P34 to line (P14, P44)}*2d/(P24z+P34z) <n

where n is a number expressed in pixels or fraction of pixels. However, artifacts may be produced with n starting at 1, especially along a silhouette. Starting values for n may also

include .5 and n>1, for reasons of rapid prototyping and previewing.

According to a further aspect of the present invention, a more general criterion is provided:

Maximum {distance (P22 to line (P42, P12), distance (P32 to line (P42, P12)}*2d/(P42z+P12z) AND

Maximum {distance (P33 to line (P43, P13), distance (P23 to line (P43, P13)}*2d/(P43z+P13z) < n

AND

Maximum {distance (P22 to line (P21, P24), distance (P23 to line (P21, P24)}*2d/(P21z+P24z) AND

Maximum {distance (P32 to line (P31, P34), distance (P33 to line (P31, P34)}*2d/(P31z+P34z) < n

AND

Maximum {distance (P12 to line (P11, P14), distance (P13 to line (P11, P14)}*2d/(P12z+P13z) AND

Maximum {distance (P42 to line (P41, P44), distance (P43 to line (P41, P44)}*2d/(P42z+P43z) <n

AND

Maximum {distance (P24 to line (P14, P44), distance (P34 to line (P14, P44)}*2d/(P24z+P34z) AND

Maximum {distance (P21 to line (P11, P41), distance (P31 to line (P11, P41)}*2d/(P11z+P41z) <n

The above criterion is the most general criterion and it will work for any class of surface, both rational and non-rational. It will also work for deformable surfaces. It will work for surfaces that are more curved along the boundary or more curved internally. Since the curvature of deformable surfaces can switch between being boundary-limited and internally-limited the flatness of both types of curves will need to be measured at the start of the tesselation associated with each instance of the surface. The pair of orthogonal

curves used for tesselation can then be one of: both boundary, both internal, one boundary and one internal.

Yet another embodiment, the subdivision termination criteria may be used for the control of the numerically controlled machines. The criterion described below is calculated in object coordinates. In the formulas described below "tol" represents the tolerance, expressed in units of measurement (typically micrometers) accepted for the processing of the surfaces of the machined parts:

Maximum {distance (P22 to line (P42, P12), distance (P32 to line (P42, P12)} AND
Maximum {distance (P33 to line (P43, P13), distance (P23 to line (P43, P13)}< tol
AND
Maximum {distance (P22 to line (P21, P24), distance (P23 to line (P21, P24)} AND
Maximum {distance (P32 to line (P31, P34), distance (P33 to line (P31, P34)}< tol
AND
Maximum {distance (P12 to line (P11, P14), distance (P13 to line (P11, P14)} AND
Maximum {distance (P42 to line (P41, P44), distance (P43 to line (P41, P44)} <tol
AND
Maximum {distance (P24 to line (P14, P44), distance (P34 to line (P14, P44)} AND
Maximum {distance (P21 to line (P11, P41), distance (P31 to line (P11, P41)} <tol

If there are no special prevention methods, cracks may appear at the boundary between abutting patches. This is mainly due to the fact that the patches are subdivided independently of each other. Abutting patches may and do exhibit different curvatures resulting into different subdivisions. For example, in Figure 10 we see that the right-hand patch has a finer subdivision than the left-hand one. At the boundary we see how a "T-joint" has been formed. When rendering the parallel strips of triangles to the left and to the right of the common boundary a crack may become visible in the area of the T-joint.

One of the approaches disclosed herein exhibits identical straight edges for the two

patches sharing the boundary. The other implementation exhibits even stronger continuity; the subpatches generated through subdivision form continuous strips orthogonal to the shared boundary. This is due to the fact that abutting patches are forced to have the same parametric subdivision. The present invention provides two different crack prevention methods, each employing a slightly different subdivision algorithm.

1. In order to avoid cracks between patches use a "zipper approach" to fix the triangle strips that result at the four borders of the surface. All four boundary curves for the patches situated at the edge of the object are used. See Figure 11 for a rendering of the "zipper" approach. Note that adjacent patches have different parametric subdivisions resulting into different triangle meshes. In this embodiment each patch is subdivided independently. All the subdivisions for all the edges of all the patches are stored. Due to this approach, a common boundary curve between two patches may be subdivided differently inside each of the abutting patches that form the respective boundary. Where two patches abut along a common boundary curve, the strips of triangles on the two sides of the common boundary are compared: if there are triangle vertices belonging to a first strip that are not exactly coincident with the vertices of the second strip, the non-coincident vertices from the first triangle strip are copied into the second strip resulting in a strip with more triangles. Figure 10 shows how the triangle strip on the right side of the boundary curve produces a vertex (a "T-joint") inside the edge of a triangle belonging to the strip on the left of the boundary. In Figure 11, the "T-joint" has been removed by connecting two edges that emerge from the vertex that originated the "T-joint".

2. In order to avoid cracks between patches, use a second pass that generates the reunion of the subdivisions for all the patches in a patch strip. All four boundary curves for the patches situated at the edge of the object are used. See Figure 12 for a rendering of this approach. Note that in this case surfaces that share, for example, as parametric boundary, will share the same subdivision in s throughout the surface. The tessellation is deferred until after the subdivisions are generated. Once the subdivisions have been generated all the patches can be tessellated and rendered independent of each other. This makes this approach extremely attractive for parallel processing.

In a preferred embodiment, in order to facilitate the design of drivers for the architecture shown in Figure 3, the present invention provides a Graphics Utility Library (GLU). The GLU includes several different types of primitives including, strips, fans, meshes, and indexed meshes of surface patches.

Below, the first three primitives are described. Referring to Figure 13, in a strip, the first patch contributes 16 vertices, each subsequent patch contributes only 12 because 4 are shared with the previous patch. Of the 16 vertices of the first patch, S1, only 4, the corners P11, P14, P41, P44 have color and texture attributes, the remaining 12 have only geometry attributes. Of the 12 vertices of each subsequent patch, Si, in the strip only one, P44 has color and texture attributes. This fact explains the reduction of the memory footprint and of the bus bandwidth necessary for transmitting the primitive from the CPU to the GPU over the AGP bus. The compression is further increased by the fact that a patch will be expanded into potentially many triangles by the tessellator unit inside the GPU. Each patch has an outward pointing normal.

Referring to Figure 14, each patch has only 3 boundary curves, the fourth boundary having collapsed to the center of the fan. The first patch in the strip enumeration has 11 vertices, each subsequent patch having 8. Vertex P11, listed first in the fan definition, is the center of the fan and has color and texture attributes in addition to geometric ones. The first patch, S1, has two vertices with color and texture attributes, P41 and P44; the remaining 9 have only geometric attributes. Each subsequent patch, Si, has only one vertex with all the attributes.

Referring to Figure 15, in a mesh, the anchor patch, S11 has 16 vertices, all the patches in the horizontal and vertical strips attached to S11 have 12 and all the other patches have 9.

A further embodiment of the present invention provides a method for accelerating rendering. A well known technique used for accelerating rendering is backface culling, which a method which discards triangles that are facing away from the viewer. It is beneficial to extend this technique to cover backfacing surfaces. This way, we avoid the computational costs of tesselating surfaces that face away from the user. Our proposed method discards such surfaces as a whole, before even starting the tesselation

computation.

Referring to Figure 9, observe that the convex hull is made up of 13 planar side panels ({P41,P44,P43,P42}, {P44,P34,P33,P43}, …{P33,P23,P22,P32}) and one bottom panel ({P44,P41,P11,P14}) that may not be planar in most cases. The order of listing the vertices in each of the 14 panels coincides with the outwards pointing normal. If any of the 13 side panels is front facing than the surface may be (at least partially) front facing. Therefore, the criterion for culling the patch as backfacing is:

If ANY of the panels of the type {P41, P44, P43, P42} is front facing then the patch should not be culled.

An alternative criterion can be given as:

If the bottom panel {P44, P41, P11, P14} is backfacing then the patch should not be culled. This criterion means that since the bottom panel {P44, P41, P11, P14} is backfacing, there may be other panels in the convex hull that may be front facing. This being the case, the patch should not be considered as being backfacing and should not be culled.

A method and system has been disclosed for performing tessellation in real-time in a GPU. Software written according to the present invention is to be stored in some form of computer-readable medium, such as memory or CD-ROM, or transmitted over a network, and executed by a processor. Although the present invention has been described in accordance with the embodiments shown, one of ordinary skill in the art will readily recognize that there could be variations to the embodiments and those variations would be within the spirit and scope of the present invention. Accordingly, many modifications may be made by one of ordinary skill in the art without departing from the spirit and scope of the appended claims.

CLAIMS

What is claimed is:

1 A graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are received as control points of bicubic surfaces, the graphics processing unit comprising:

a transform unit;

a lighting unit;

a renderer unit; and

a tessellate unit coupled between the transform unit and the lighting unit for tessellating both rational and non-rational object surfaces in real-time.

2 The graphics processing unit of claim 1 wherein the transform unit transforms the control points, the tessellate unit tessellates the surfaces into triangles by executing a first set of instructions, the lighting unit lights vertices of the triangles, and the renderer unit renders the triangles by executing a second set of instructions.

3 The graphics processing unit of claim 2 wherein the first set of instructions simplifies three dimensional surface subdivision of the object surfaces by reducing surface subdivision to a subdivision of two cubic curves by performing instructions for:

for each bicubic surface,

subdividing a boundary curve representing an s interval until a projection of a length of a height of a curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates; and

subdividing the boundary curve representing a t interval until a projection of a length of a height of the curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates.

4 The graphics processing unit of claim 3 wherein the first set of instructions simplifies

three dimensional surface subdivision by reducing it to the subdivision of two cubic curves by simplifying subdivision termination criteria by expressing the termination criteria in screen (SC) coordinates and by measuring curvature in pixels, wherein for each new view, a new subdivision can be generated, producing automatic level of detail.

5 The graphics processing unit of claim 4 wherein the first set of instructions reduces cracks at the boundaries between surfaces by using a common subdivision for all surfaces sharing a boundary by performing instructions for:

for all bicubic surfaces sharing a same s or t parameter boundary,

choosing as a common subdivision a reunion of the subdivisions in order to prevent cracks showing along the common boundary or a finest subdivision, the finest subdivision being the one with the most points inside the set.

6 The graphics processing unit of claim 5 wherein the first set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping are generated by performing instructions for:

for each bicubic surface,

for each pair (si,tj),

calculating $((u_{i,j}\, v_{i,j}\ q_{i,j})\ (p_{i,j}\, r_{i,j})\ V_{i,j})$ thru interpolation,

looking up vertex displacement $(dx_{i,j}\ ,\ dy_{i,j}\ ,\ dz_{i,j})$ corresponding to $(p_{i,j}\ r_{i,j})$; and

generating triangles by connecting neighboring vertices.

7 The graphics processing unit of claim 6 wherein the second set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping by performing instructions for:

for each vertex $V_{i,j}$,

calculating a normal $N_{i,j}$ to that vertex, which was previously transformed in world coordinates

calculating ($dN_{i,j}$) as normal displacement for bump mapping as a function of (si,tj);

calculating $N'_{i,j}=N_{i,j}+dN_{i,j}$ to displace the normal for bump mapping; and

calculating $V'_{i,j}=V_{i,j}+(dx_{i,j}, dy_{i,j}, dz_{i,j})* N_{i,j}$ to displace the vertex for displacement mapping;

for each triangle,

executing bump and displacement mapping pixel-by-pixel for all the points inside the triangle; and

calculating a normal to the triangle for culling.

8 The graphics processing unit of claim 1 wherein the tessellate unit is combined with the transform unit and the lighting unit.

9 The graphics processing unit of claim 1 further including a Graphics Utility Library (GLU) for implementing drivers.

10 The graphics processing unit of claim 9 wherein the GLU includes several different types of primitives including, strips, fans, meshes, and indexed meshes of surface patches.

11 A system, comprising:

a processor; and

a graphics processing unit (GPU) coupled to the processor, the GPU comprising a transform unit, a lighting unit, a renderer unit, and a tessellate unit coupled between the transform unit and the lighting unit;

wherein the processor transmits objects to be rendered to the GPU as control points, the transform unit transforms the control points, the tessellate unit executes a first set of instructions for tessellating both rational and non-rational object surfaces in real-time, the lighting unit lights vertices of the triangles, and the renderer unit renders the triangles by executing a second set of instructions.

12 The graphics system of claim 11 wherein the first set of instructions simplifies three dimensional surface subdivision of the object surfaces by reducing surface subdivision to a subdivision of two cubic curves by performing instructions for:

for each bicubic surface,

subdividing a boundary curve representing an s interval until a projection of a length of a height of a curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates; and

subdividing the boundary curve representing a t interval until a projection of a length of a height of the curve bounding box is below a certain predetermined number of pixels as measured in screen coordinates.

13 The graphics system of claim 12 wherein the first set of instructions simplifies three dimensional surface subdivision by reducing it to the subdivision of two cubic curves by simplifying subdivision termination criteria by expressing the termination criteria in screen (SC) coordinates and by measuring curvature in pixels, wherein for each new view, a new subdivision can be generated, producing automatic level of detail.

14 The graphics system of claim 13 wherein the first set of instructions reduces cracks at the boundaries between surfaces by using a common subdivision for all surfaces sharing a boundary by performing instructions for:

for all bicubic surfaces sharing a same s or t parameter boundary,

choosing as a common subdivision a reunion of the subdivisions in order to prevent cracks showing along the common boundary or a finest subdivision, the finest subdivision being the one with the most points inside the set.

15 The graphics system of claim 14 wherein the first set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping are generated by performing instructions for:

for each bicubic surface,

for each pair (si,tj),

calculating $((u_{i,j}\ v_{i,j}\ q_{i,j})\ (p_{i,j}\ r_{i,j})\ V_{i,j})$ thru interpolation,

looking up vertex displacement $(dx_{i,j}, dy_{i,j}, dz_{i,j})$ corresponding to $(p_{i,j}\ r_{i,j})$; and

generating triangles by connecting neighboring vertices.

16 The graphics system of claim 15 wherein the second set of instructions generates vertices, normals, texture coordinates, and displacements used for bump and displacement mapping by performing instructions for:

for each vertex $V_{i,j}$,

calculating a normal $N_{i,j}$ to that vertex, which was previously transformed in world coordinates

calculating $(dN_{i,j})$ as normal displacement for bump mapping as a function of (si,tj);

calculating $N'_{i,j}=N_{i,j}+dN_{i,j}$ to displace the normal for bump mapping; and

calculating $V'_{i,j}=V_{i,j}+(dx_{i,j}, dy_{i,j}, dz_{i,j})^* N_{i,j}$ to displace the vertex for displacement mapping;

for each triangle,

executing bump and displacement mapping pixel-by-pixel for all the points inside the triangle; and

calculating a normal to the triangle for culling.

17 The graphics system of claim 11 further including a Graphics Utility Library (GLU) for implementing drivers.

18 The graphics system of claim 17 wherein the GLU includes several different types of primitives including, strips, fans, meshes, and indexed meshes of surface patches.

19 A real-time method for tessellating and rendering surfaces of an object on a computer system, comprising:

(a) performing transformation and tessellation by,

(i) for each surface, transforming 16 points;

(ii) performing three dimensional surface subdivision by subdividing only two cubic curves comprising the surface;

(iii) terminating the subdivision termination by expressing the subdivision in screen coordinates (SC) and by measuring curvature in pixels;

(iv) for each new view, generating a new subdivision, thereby producing automatic level of detail;

(v) preventing cracks at boundaries between adjacent surfaces by using a common subdivision for all surfaces sharing a boundary;

(vi) for the current subdivision, generating the vertices, normals, texture coordinates, and displacements used for bump and displacement mapping; and

(vii) generating triangles by connecting neighboring vertices;

(viii) for each vertex, calculating the normal, calculating normal displacement for bump mapping, displacing the normal for bump mapping, displacing the vertex for displacement mapping, wherein bump and displacement mapping are executed pixel by pixel for all the points inside each triangle; and

(ix) calculating the normal of each triangle; and

(b) performing rendering by

(i) for each triangle, clipping against a viewing viewport, calculating lighting for additional vertices produced by clipping, and culling backfacing triangles;

(ii) projecting all vertices into screen coordinates; and

(iii) rendering all the triangles produced after clipping and projection.

ABSTRACT

The present invention provides a graphics processing unit for rendering objects from a software application executing on a processing unit in which the objects to be rendered are received as control points of bicubic surfaces. According to the method and system disclosed herein, the graphics processing unit includes a transform unit, a lighting unit, a renderer unit, and a tessellate unit for tessellating both rational and non-rational object surfaces in real-time.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	BICUBIC SURFACE REAL-TIME TESSELATION UNIT
First Named Inventor/Applicant Name:	Adrian Sfarti
Filer:	Stephen Grant Sullivan/Jackie Tanda
Attorney Docket Number:	1935CIP2C

Filed as Small Entity

Utility Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility filing Fee (Electronic filing)	4011	1	75	75
Utility Search Fee	2111	1	250	250
Utility Examination Fee	2311	1	100	100
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**425**

Electronic Acknowledgement Receipt

EFS ID:	1977084
Application Number:	11778515
International Application Number:	
Confirmation Number:	1565
Title of Invention:	BICUBIC SURFACE REAL-TIME TESSELATION UNIT
First Named Inventor/Applicant Name:	Adrian Sfarti
Customer Number:	57580
Filer:	Stephen Grant Sullivan/Jackie Tanda
Filer Authorized By:	Stephen Grant Sullivan
Attorney Docket Number:	1935CIP2C
Receipt Date:	16-JUL-2007
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Time Stamp:	18:25:42
Application Type:	Utility under 35 USC 111(a)

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Deposit Account	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)

1	Drawings	1935CIP2C_Figures.pdf	3170768 d8a13a593c269a208ddc8500fbb66dcb4c5aa935	no	14
Warnings:					
Information:					
2	Oath or Declaration filed	1935CIP2C_Dec_prior.pdf	950655 72c37c8772979551f542d323ac1decdbb092ae4b	no	2
Warnings:					
Information:					
3	Application Data Sheet	1935CIP2C_ADS.pdf	1001690 c0def422d562885a2f3067be35db3a41bcafe439	no	4
Warnings:					
Information:					
4		1935CIP2C_PatAppln.pdf	118279 c31b1739c477d4a516f12d86f60b5e6d2162c128	yes	27

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	20
Claims	21	26
Abstract	27	27

Warnings:					
Information:					
5	Fee Worksheet (PTO-06)	fee-info.pdf	8380 d445e9e08dce1413b94850bb65ce6c11eebff44	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	5249772	

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

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New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

7/16/07

PTO/SB/06 (12-04)
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PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

11/778,515

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)		OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))				75			
SEARCH FEE (37 CFR 1.16(k), (i), or (m))				250			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))				100			
TOTAL CLAIMS (37 CFR 1.16(i))	19 minus 20 =		X$25=		OR	X$50	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =		X$100=			X$200=	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			N/A			N/A	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	425		TOTAL	

APPLICATION AS AMENDED – PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)	OR	RATE ($)	ADDITIONAL FEE ($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comment on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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