PROVISIONAL APPLICATION FOR PATENT

System and method for real time assessment of a picture quality

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ABSTRACT

A system and method for real time assessment of a picture quality produced on multiple sensor device as a smartphone, including data from device sensors like image sensor, accelerometer and gyroscope. This data will be used to produced multiple quality indicators.These values are combined to form a total image quality. The way the combing is done can be configured by the user or be done automatically to give emphasis on certain values. The indication can given before the user has taken the image, and may be given again when the picture is taken, depending on configuration. These quality indicators, including the total indicator, are save along with the final image to be used by other software.

BACKGROUND OF THE INVENTION

Image quality has been assessed by various methods. For example measuring the details and acutance of an image (full reference, no reference, partial reference) via various methods like DCT measurements. Other methods included using gyroscope to measure is the image is leveled or not, or even an accelerometer to hint of device shake. Few are done in real time, like the image level. There are methods to evaluate image blur or evaluate image details like:

1. "A No-Reference Objective Image Sharpness Metric Based on the Notion of Just Noticeable Blur (JNB)" (IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 18, NO. 4, APRIL 2009)
2. "Blur determination in the compressed domain using DCT information" 1999 International Conference on Image Processing, 386 - 390 vol.2

There are methods and programs that use motion detection to tell the user when it is best to press the shutter button, but they don't give a quality evaluation after the user pressed the shutter button. This invention is about combining data from multiple sensors and multiple quality indicators, using today available GPU and CPU to calculate in real time each quality indicator, and about forming a combined total indicator to be shown to the user before and after he has pressed the shutter button.

SUMMARY OF THE INVENTION

In general, each available sensor send its data to another component that process this raw data and outputs a related processed data. From that data (and perhaps some configuration or other sensor input) a quality indicator is formed.
This can be seen in drawing 1 which form a part of this specification.
There are many qualities indicators, depending on device capabilities and implementation:

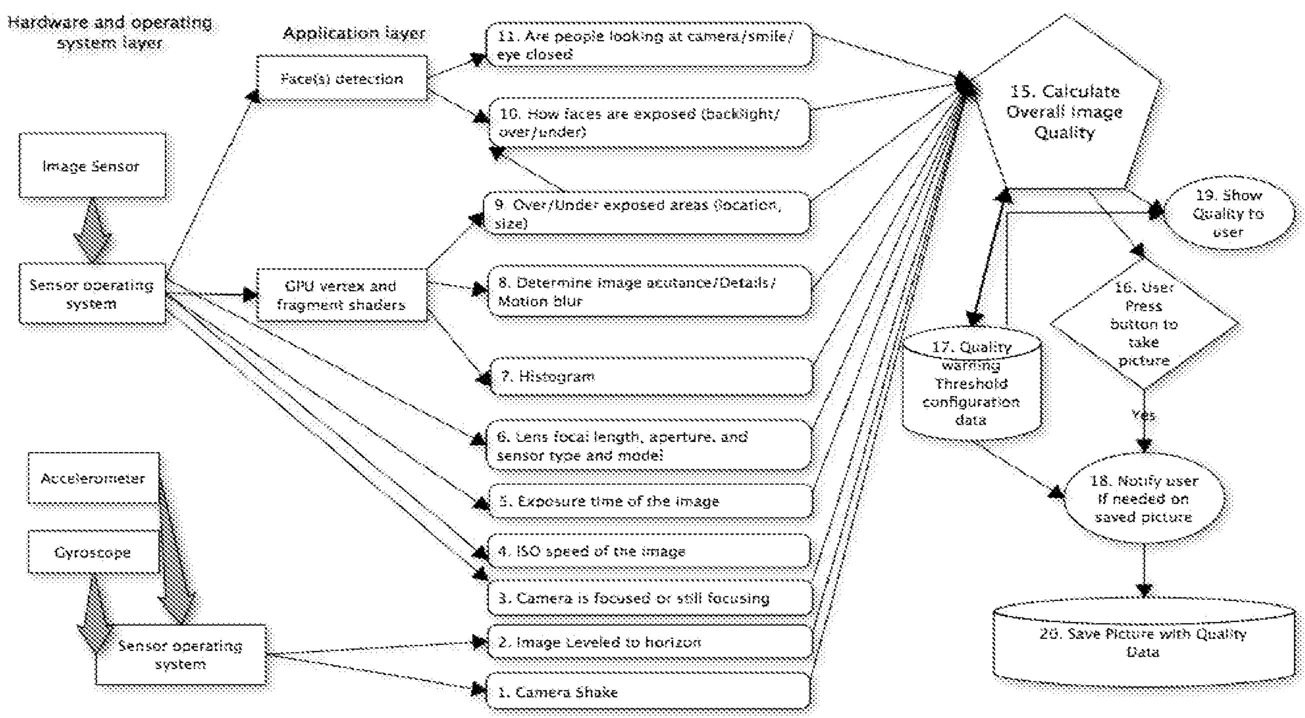
1. Image leveled to the horizon
2. motion detection
3. camera is focused or still focusing
4. ISO level and how it is related to the specific sensor
5. Exposure time and how is it related to the scene taken if data available
6. Lens focal length, aperture, focus distance and sensor type and model.
7. Histogram evaluation
8. Image details (acutance, corners detected, DCT coefficient for high details, image sharpness)
9. Under and over exposure area
10. Face detection and over or under exposed area near faces.

11. Face detection and is face is smiling and/or looking at camera

These indicators are passed to a component (item 15) that analyzes the relevance of each of them, and with some configuration data (item 17) spills out a "total" quality value.
The quality indicator can be shown to the user if configured to (item 19).
Also, given an optional configurable "minimum" quality, a further indication to the user can be made if the image is bellow this quality.
When the user presses the "shutter" button o take the picture (item 16) another indication to the user may be shown (item 18), dependent on configuration.
After the user presses the shutter button the image will be saved (item 20) along the quality indication including the total quality. This can be inside the image exif extension or another file.
In another embodiment it can also be that the image will not be saved or deleted after taken if it is bellow some quality indicator threshold including the total quality indicator.

BRIEF EXPLANATION OF DIAGRAM 1

On the left side of the diagram are the hardware sensor. The bulk arrows indicate raw data transfer to the operating system operating these sensors. As we go from left to right we go into the application layer that uses the input provided from these sensors as the image frame, full image when taken, image parameters and data from raw gyroscope and accelerometer. In another embodiment the application layer can take whatever raw data available from these sensor and bypass the most convenient operating system API that provide the sensor data.
Face detection can be made in the operating system or application layer.
The GPU is is programed with vertex and fragment shaders to facilitate real time data input to the application like histogram, image details and over/under exposed areas.
As we go further to the right of the diagram the quality indicators are created following the logic described herein. These parameters are passed to the application logic as to calculate overall image quality, user warnings and saving of the final image.



DETAILED DESCRIPTION OF THE INVENTION

The invention described herein consists of a system and method for real time assessment of picture quality produced on multiple sensors device as a smartphone. In one embodiment, all of the sensors like image sensor, accelerometer, and gyroscope and so on are embedded in one device. It can be that they are divided in different devices, but send their data to one device where the total indicator is calculated.
Typically, today's smartphone include all these sensor and hardware inside the smartphone.
But it is possible that the image will be sent to the device from an external camera via a cable or Wi-Fi.
Image sensor sends its data to the device operating system that may send the whole image or a preview of it to the GPU at a rate of X frame per second.
This image data is passed to various programed GPU vertex and fragment shaders. This will be used for fast calculation of some of the quality indicators.
The following are each quality indicator and how it is calculated:

1. Image leveled to horizon
The device gyroscope (and accelerometer if available) is used to calculate device angle to the horizon, or how the device is leveled. Using this data a quality indicator for device leveled according to its orientation is calculated. For example, zero to 3 degrees is quality "excellent", 3 to 5 degrees is quality "good" and so on. Take notice that the device may be held horizontally or vertically by the user.

2. Motion detection
Device accelerometer data (and gyroscope if available) can be used to determine if the device is accelerating related to the ground reference frame. This calculation can be done via the software embedded in the sensors, the device operating system or manually calculated by software running on the device. Acceleration related to the ground is given as pitch yow and roll or any other method, to indicated acceleration in 3 axis. These values are used to give a quality indicator on camera shake in real time.

3. Camera is focus or still focusing
The device image sensor may send a signal to the application software component (via the operating system) that the image sensor is focused or still focusing. This will be used to form an "excellent" quality for focused and "bad" quality indicator for still focusing.

4. ISO level and camera hardware exposure data
Data as ISO level, exposure time, focal length, and aperture and focus area is sent from the image sensor to the device operating system to the application software component.
Depending on the device capabilities, like max and minimum ISO, a quality indicator is produced. High ISO gives bad quality vs low ISO that gives high quality indicator.
An optional exposure time quality indicator may be created, if a minimum exposure time is configured.

5. Exposure time
Depending on the scene, the exposure time could give another quality indicator.
For example if we are taking a picture of a dog, we need a fast exposure, so the dog will not be blurred. This could be in conjunction with the detail indicator.

6. Lens focal length, aperture, focus distance, sensor type and model and depth of field
Depending on the device capabilities to change focal length and aperture, and given a known configured scene, a quality indicator can be given to how these parameters confront to the given

scene. For example, a scene with a baby taken 50 cm from him, with a Nikon D300, 50mm focal length lens, aperture of 1.8, means the depth of field will be 2.7 cm. This means that the baby face will not be fully in focus, and a bad quality can be give. For a same configuration with f/8 aperture, an excellent quality can be given.

7. Image Histogram

Using the image frame and some GPU shaders, a histogram can be calculated in real time. In Photography it is well know how a "good" and "bad" histogram looks.
For "typical" images, those with an average range of light and dark areas, a good histogram will basically look like a bell curve that's centered around the center of the graph. A full explanation will be out of the scope of this document, but a bad histogram mean that the colors of the image are mostly pushed to right or to the left.
This data can also be used as a quality indicator, given a threshold configuration.

8. Image details

There are many known algorithms to extract image quality. There are full reference, no reference or partial reference.
For example blur can be detected via "A No-Reference Objective Image Sharpness Metric Based on the Notion of Just Noticeable Blur (JNB)" (IEEE TRANSACTIONS ON IMAGE PROCESSING, VOL. 18, NO. 4, APRIL 2009)
Must algorithms will take too long on current CPU and if can be implemented, may be slow on a GPU as well, but as the technology progresses, these algorithms can be implemented to for a real time, or near real time image quality indicator.
Still, algorithms like Harris corner detection or its variants like Shi Tomas corners detection can be used to determine if the image frame we have now has more or less details then the previous frame. Combine that with data from the gyroscope and accelerometer, we can know if the device has moved and with this partial reference know if the quality has severely deteriorated or got better. These algorithms may have parameters like sensitivity and threshold for Harris corner detection. The preferred input for these parameters can come from the image sensor like ISO used.
Other algorithms can be to calculate the image acutance, or calculating the image DCT coefficient and look for a high sum of high coefficient ("Blur determination in the compressed domain using DCT information" 1999 International Conference on Image Processing, 386 - 390 vol.2)
from each of these algorithms one can determine a quality indicator.

9.Under and over exposure areas

Given a configurable under and over threshold (say 5% from pure white and 3% from pure black) the image frame given to the GPU is processed to calculate areas that are under exposed and areas that are over exposed. The image frame is divided to a configurable number of areas, say 256 areas or 1024 areas. If over a configurable number of percentage of pixels in the area (say 95%) are under or over exposed, the area is marked as under or over exposed.

10. Face detection and over or under exposed area near faces

Face detection can be provided in the application layer or as a service provided by the operating system API or even image sensor raw output data.
This data can be used in combination with the under/over exposure area calculated before, to determine if the faces are under or over exposed, or more likely if there is a particular over exposed area near the face.
If so, the average luminance of the face is calculated. If it is bellow a threshold, this may indicate the face is underexposed (backlight). This will give a low quality indicator for this "face underexposed" indicator.

11. Face detection and is face is smiling and/or looking at camera
Using the face location, one can determine if the person in each face is smiling and/or looking at the camera. This data can be used for another quality indicator.
Say over 90% of the faces are looking at the camera and 80% are smiling equals an "Excellent" quality, while none are looking and none are smiling indicating a "bad" quality.

Combining the separate quality indicator to a total quality indicator
Each device may have different hardware capabilities, thereby will not include all the possible quality indicators or will not be able to process details indicators due to a slow hardware.
Some indicators may be ignored if configured so by the user. We are now left with a set of indicators to work with.
To come out with a total quality indicator, we will use a weight function, giving each indicator a configured weight.

$$\sum_{a \in A} f(a)w(a)$$

In this formula f(a) is the quality indicator for indicator a out of A possible.
w(a) is the related weight function. Each weight function may be configured by the user, take into account the device capabilities or mix the two. It is also possible that the formula a weight function of one indicator will take into account the data from other quality indicator of quality indicators weight functions.
For example a quality indicator indicating the device has not yet reach focus (item 4) will be given a high weight relative to other quality indicator as "person not looking to camera" (item 5.4)
The sum of f(a)*w(a) will give an un-normalized total quality indicator. It will need to be normalized to fit a quality spectrum shown to the user (for example a spectrum shown to user can be an integer between 1 to 5) or saved alongside the image file.
From that we will get the total quality indicator.

Using the total quality indicator
The total quality indicator can be shown to the user in real time. Also, given a configurable "minimum" quality, an indication to the user can be made if the image total quality indicator is below this minimum.
The indication can show just the total quality or the all the quality indicators below a certain threshold. The indication can be a number of even an icon representing the quality.
For example 5 smiles, each represent a quality indicator.
Smiling face – Good, crying face – bad and so on.
In one embodiment, the picture will be saved without the user having to press a "shutter" button.
If the user needs to press a "shutter" button to actually save the picture, then after the picture is taken, the user can be warned of low quality if needed and configured so.
After in image is taken, the user may have an option to see some or all the quality indicators, and from that get a details sense of what he can do to get a better picture from that specific scene.
It can also be that the image will not be saved or deleted if it is bellow some quality indicator threshold including the total quality indicator.
After the image is saved, the qualities indicators will be saved along with the image so it can be used afterwards.
The user may choose to get suggestions from the application on how to improve the next shot. The application will use the quality indicators and their correlation to answer that.

Claims:

What is claimed is:

1. A system and method for real time calculations of image quality indicators explained herein.
2. A system and method according to claim 1 where the quality indicators are shown to the user before he actually takes the picture.
3. A system and method according to claim 1 where the total quality indicator is shown to the user before he actually takes the picture.
4. A system and method according to claim 1 where the total quality indicator is shown to the user after he took the picture.
5. A system and method according to claim 1 where the quality indicators are saved along with the image, for example inside the exif data
6. A system and method according to claim 1 where the quality indicators are used to decide if to save the image taken.
7. A system and method according to claim 1 where the quality indicators are used suggest to the user how to improve the picture he is taking.