UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSARA INC.
Petitioner

v.

MOTIVE TECHNOLOGIES, INC.
Patent Owner

Case IPR2026-00034
U.S. Patent No. 12,136,276

PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 12,136,276

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I. INTRODUCTION

U.S. Patent No. 12,136,276 (“the ’276 patent”) claims nothing more than routine camera-calibration techniques long used in autonomous systems/ADAS (advanced driver assist systems).

For Ground 1, Choe renders claims 1–20 obvious by teaching the complete loop: roadway image capture; horizon/lane detection and overlay; user edits; recomputation of pitch/yaw/roll; and client–server calibration with results uploaded to the vehicle.

Under Ground 2, any alleged transmission or remote processing gap in Choe is closed by Davies’s conventional, bidirectional transmission of high-resolution/annotated imagery to remote GUIs with processed outputs returned to update local parameters.

Building on those showings, Grounds 3A and 3B render claims 4, 11, and 17 obvious: Kuehnle’s motion-based acceptance (using frames only above a predefined speed/duration) applied to Choe’s (and Choe+Davies) in-drive capture yields predictable gains: better accuracy, less drift, and more robust lane detection.

Independently, for Ground 4, Westmacot’s line-editing/parameter-recalculation in view of Tal’s networked pipeline for raw/processed (including overlaid) images sent to a server and disseminated back to clients yields the same result.

The references collectively disclose each element of the challenged claims, and provide clear reasons to combine: improving calibration accuracy, reducing sensor drift, and enhancing robustness of lane detection. For these reasons, the Board should institute trial and find the challenged claims of the ’276 patent unpatentable.

II. U.S. PATENT NO. 12,136,276

A. Overview

The ’276 patent, titled “Camera Initialization for Lane Detection and Distance Estimation using Single-View Geometry,” describes conventional lane-detection/calibration in automotive machine learning systems via a “network-based initialization system” that ingests video, identifies lane/horizon lines, and computes camera parameters. EX1001, 1:14–16, 1:43–51; EX1003, ¶28. The ’276 patent uses four blocks: device 230 (vehicle camera/processor), camera-initialization service 232, annotator device 234, and initialization service 236. *Id.*, 5:1–7:18. Device 230 sends frames, service 232 detects lines, computes parameters (height, viewing angle, road-plane normal), overlays them, then forwards the overlaid images to annotator device 234, a workstation/web app, for confirmation or edits. *Id.*, 5:1–59, 6:6–16. If edited, annotator 234 may send a revised image to service 236 (deep learning/artificial intelligence) for parameter prediction and return updated parameters via service 232 to device 230. *Id.*, 6:33–54, 7:9–18.

B. Prosecution History

The prosecution of the ’276 patent involved one Office Action and response, with no amendments. The Examiner rejected claims 21–22 and 28 for non-statutory double patenting over U.S. Patent No. 11,875,580 (“the ’580 patent”) and claims 21–40 under §103 over Kwant1 (US 2019/0034740) and Kwant2 (US 2019/0102674). EX1002, 119, 122; EX1003, ¶¶93-95.

In response, the Applicant filed a terminal disclaimer and argued: (1) Kwant1 lacks visualization or overlay of a horizon line, showing only object annotations (EX1002, 137); (2) Kwant2 teaches model training, not modification or verification of a line (EX1002, 138–139); and (3) Kwant2 computes only neural-network weights, not camera parameters (EX1002, 139). EX1003, ¶¶93-95.

The Examiner then allowed all claims. As this Petition shows, Choe, Davies, Westmacot, and Tal disclose the very features leading to allowance. EX1003, ¶¶430-434. None were applied during prosecution, and only Westmacot was cited in the IDS.

C. Level of Ordinary Skill in the Art

A person of ordinary skill in the art (“POSA”) at the time of the alleged invention would have had a Bachelor’s in Computer Science with a focus on computer/machine vision, and at least two years of experience with each of: (1) machine learning (including neural network) methods as applied to machine/computer vision and (2) classical machine/computer vision algorithms (e.g., edge detection, line identification, computation of camera parameters from horizon line, etc.). EX1003, ¶98. Additional education could serve as a substitute for the experience requirement. *Id.* This petition is supported by an expert declaration of Dr. Trevor Darrell. See EX1003, ¶¶1-27.

D. Claim Construction

Samsara has construed the terms according to their ordinary and customary meanings as understood by a POSA in view of the specification. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-13 (Fed. Cir. 2005).

III. IDENTIFICATION OF THE CHALLENGE (37 C.F.R. § 42.104(B))

A. Prior Art

The earliest priority date the ’276 patent can claim is October 4, 2021—the filing date of its parent application. The Grounds in this Petition rely on the following prior-art references:

Reference	Exhibit(s)	Date	Prior Art
Choe (and its Patent Center filed drawings presented merely for enhanced clarity)	EX1005 EX1006	Published Dec. 31, 2020	§102(a)(1)-(2)
Westmacot	EX1008	Published Sept. 19, 2019	§102(a)(1)-(2)
Davies	EX1007	Published August 28, 2014	§102(a)(1)-(2)

Reference	Exhibit(s)	Date	Prior Art
Tal	EX1009	Filed Jul 15, 2020	§102(a)(2)
Kuehnle	EX1010	Published March 5, 2009	§102(a)(1)-(2)

B. Grounds

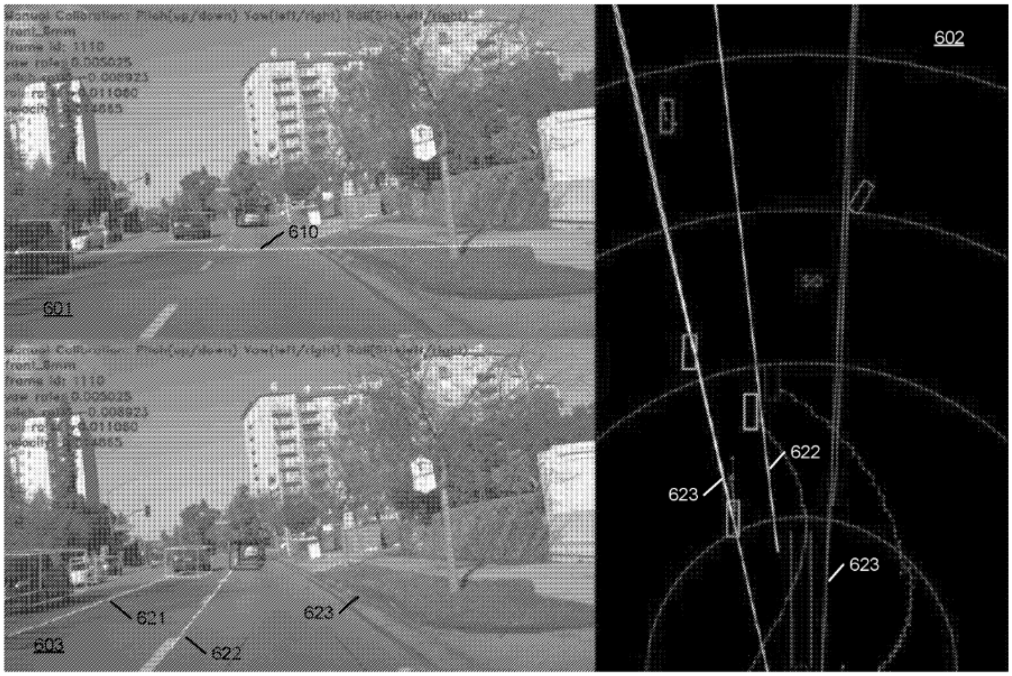
Ground	Basis	Reference(s)	Claims
1	§103	Choe	1-3, 5-10, 12-16, 18-20
2	§103	Choe and Davies	1-3, 5-10, 12-16, 18-20
3A/3B	§103	3A: Choe in view Kuehnle; 3B: Choe in view of Davies and further in view of Kuehnle	4, 11, 17
4	§103	Westmacot and Tal	1-20

IV. OVERVIEW OF THE PRIOR ART

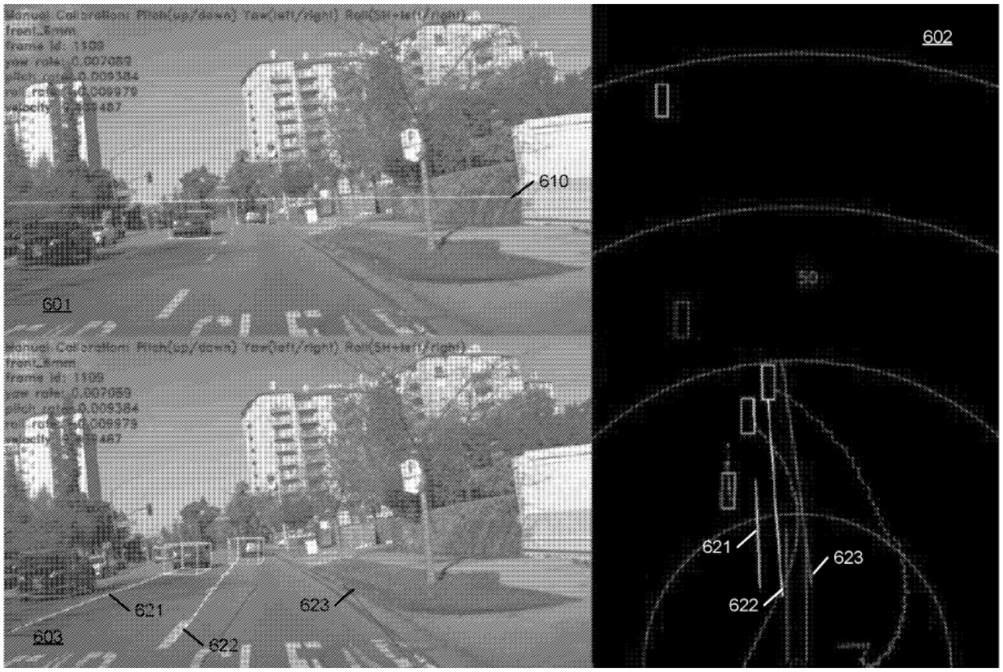
As the following prior art establishes, manually calibrating a camera to detect traffic lanes was well known. EX1003, ¶29. As part of the calibration process, it was known how to overlay video frames with a horizon line, and then use that horizon line or an adjusted horizon line to calculate the camera's pitch, yaw, and roll. EX1003, ¶¶29-53.

A. Choe

Choe is directed to "calibrating a sensor system of an autonomous driving vehicle," noting sensors require periodic calibration but "a lack of efficient sensor calibration systems" existed. EX1005, ¶¶[0001], [0003]; EX1003, ¶55. Choe calibrates a camera for lane detection by receiving still or video images over a network; for video, the "images" are frames, as shown in Figures 6A–6B. EX1005, ¶¶[0018], [0022], FIGs. 6A–6B; ; EX1003, ¶56.



EX1005, FIG. 6A.



EX1005, FIG. 6B.

After receiving video frames, Choe determines a horizon line "based on the camera's hardware settings" or via "predictive models," EX1005, ¶¶[0015], [0030], and identifies horizon and lane lines through a perception process. *Id.*, ¶¶[0016], [0056], [0059], FIG. 7; EX1003, ¶57. Choe then superimposes the horizon and lane lines onto the video frames, rendering images with the overlays. *Id.*, ¶¶[0016], [0050]; EX1003, ¶58.

EX1006, FIG. 6A (excerpt, annotated); EX1005, FIG. 6A.

Choe overlays horizon/lane lines and displays them in a "visualizer" UI, EX1005, ¶[0014; the user aligns the overlays via keyboard/joystick/voice, e.g., arrow keys to adjust line position. EX1005, ¶¶[0014]–[0015], [0055]–[0057]; EX1003, ¶59. Choe then recalculates camera parameters, e.g., pitch from the difference between the initial and updated horizon (and similarly yaw/roll), and transmits the updated parameters back to the vehicle, EX1005, ¶¶[0014]–[0016], [0057]; EX1003, ¶¶60-61.

B. Westmacot

Westmacot addresses generating training data for a machine-learning road detector by automating/semi-automating road-image annotation, replacing labor-intensive manual labeling. EX1008, pp. 1-3; EX1003, ¶71. Westmacot annotates road structure (road surface, lanes) from frames captured as a vehicle drives, EX1008, pp. 1, 22, detects a horizon and lane lines, and computes camera "reference parameters" (e.g., height, orientation), *id*., pp. 24, 44, 3233; EX1003, ¶¶72-80. A "human fixer" then refines results, adjusts/adds lines and edits parameters (e.g., height/crop), via the annotation UI shown in Figures 18–24. EX1008, pp. 19, 34; EX1003, ¶¶72-80. Examples of the user interface are shown below.

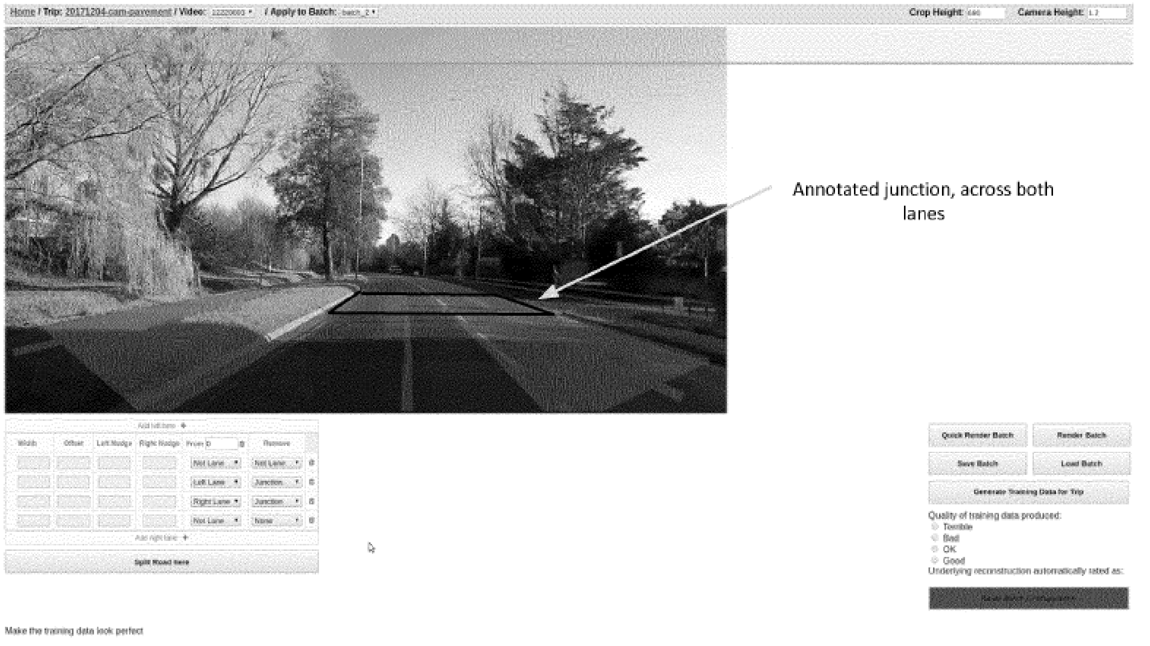
Home / Trip: 2018-02-27-london-priority2 / Video: 12160009 / Batch: batch_9

Crop Height: 724

Camera Height: 1.7

Fig. 18

EX1008, FIG. 18.



Home / Trip: 20171204-cam-pavement / Video: 12220003 / Apply to Batch: batch_2

Make the training data look perfect

Press 'shift-r' key to render the entire batch with the current configuration, the left and right arrow keys to move through the images and the up and down arrow keys to adjust the configuration settings

Other keys: Camera Height (c), Calculate Height From Mesh (a), Offset (o), Image Height (i), Lane Width (l)

EX1008, FIG. 22.

Westmacot determines camera parameters directly from captured images. EX1008, pp. 3, 6-7. Westmacot explains that “one or more parameters of the image capture device … may be derived from (only) the image data captured by the image capture device.” *Id.*, p. 3. For example, the expected road structure may be determined from a road normal vector, defined as “the surface normal of the road relative to the camera.” *Id.*, pp. 5, 25, which can be estimated from the image as:

$$\mathbf{n} = \frac{1}{\sum_{i=2}^{N-2} \|\mathbf{n}_i\|} \sum_{i=2}^{N-2} \mathbf{n}_i$$

$$\mathbf{n}_i = \mathbf{R}_i^{-1}(\mathbf{m}_{i-1,i} \otimes \mathbf{m}_{i,i+1}),$$

Id., pp. 5, 24, 26-27, 39-40, FIGs. 8-9, 16, 27 (additional details on the road plane normal).

Westmacot's Figure 26, shown below, illustrates the camera height (h) and road normal (n) in relation to the determined lane lines.

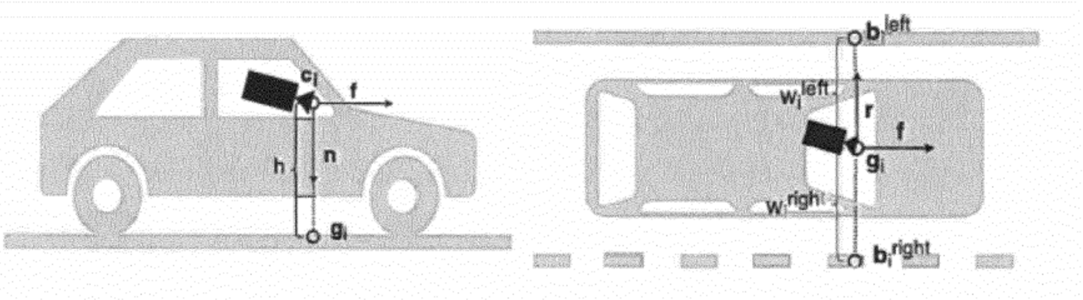


Fig. 26

EX1008, FIG. 26.

C. Davies

Davies is directed to "adjusting an image, e.g., an image horizon, for a vehicle mounted camera." EX1007, ¶[0002]; EX1003, ¶62. It describes a system that adjusts images "in response to at least one vehicle mounted sensor," EX1007,

¶[0006], with adjustments performed automatically using "telemetry of a vehicle from a plurality of sensors," *id.*, ¶[0007]; EX1003, ¶¶63-67.

Davies further discloses that these adjustments may be performed onboard or remotely over a network. EX1007, ¶¶[0042]–[0044], [0059]; EX1003, ¶68. As shown in Figure 8, the vehicle's server 101 communicates with a third-party server 103 via network 106, where the server 103 may "include an application server providing applications and/or computer executable code implementing any of the interfaces/methodologies disclosed."EX1007, ¶[0064], FIG. 8; EX1003, ¶¶69-70.

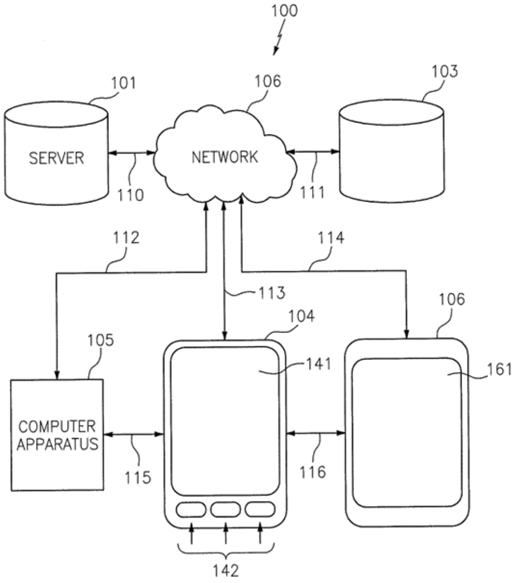


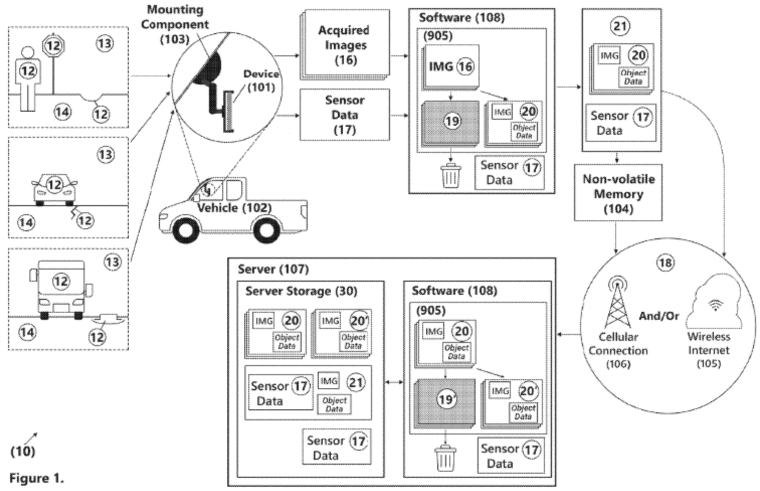
FIG. 8

EX1007, FIG. 8.

D. Tal

Tal discloses systems for image processing that "captur[e] digital images containing objects of interest … [and] transmit[] object data … over a communications network to a server … located remotely from the system." EX1009, ¶[0012]; EX1003, ¶¶81, 83. Using neural networks, Tal identifies "landmarks" such as "lane markings 12 and edge 12 on a road." *Id.*, ¶[0116].

As shown in Figure 1, digital images may be captured by "one or more imaging devices 101 … preferably with network communication capabilities to a communications network 18." EX1009, ¶[0027], FIG. 1; EX1003, ¶82. The images are transmitted to a remote server for further processing, and Tal explains it is "advantageous … to send object data 21 by the device 101 to the server 107 … in order to take advantage of the image 16 processing and acquisition efficiencies." EX1009, ¶[0027]; EX1003, ¶84-87.



EX1009, FIG. 1.

E. Kuehnle

Kuehnle discloses a system "for online calibration of a video system … in connection with an image-based road characterization … for detecting roadway scenes in vehicles." EX1010, 1; EX1003, ¶88. To determine camera orientation, Kuehnle detects vanishing points using a "long term average vanishing point" computed through time-filtering methods. EX1010, 3; EX1003, ¶¶88-89. These time-filtering methods consider both vehicle speed and elapsed time. EX1010, 11–13; EX1003, ¶89. Kuehnle specifies that extrapolation of vanishing points "require[s] that the vehicle is moving with at least a certain speed, so that low speed maneuvering … is not taking place." EX1010, 11–12; EX1003, ¶89. The system "calculates a long term average vanishing point location … from a sequence of images," from which "the static yaw and pitch angle of the camera is deduced." EX1010, 3, 13; EX1003, ¶90.

V. GROUND 1: CHOE RENDERS OBVIOUS CLAIMS 1-3, 5-10, 12-16 AND 18-20.

Choe teaches the full '276 calibration workflow: capturing roadway images; detecting horizon/lane lines; superimposing and user-updating those lines; computing pitch/yaw/roll from the updated lines; and using a client–server architecture that performs calibration off-board and returns results to the vehicle, thus rendering independent claims 1, 8, and 15 (and dependents) obvious. See

EX1005, ¶¶[0014]–[0018], [0025], [0031], [0044]–[0053], [0059]–[0060], FIGs. 1, 6A–6B, 7; EX1003, ¶¶100, 102.

To the extent Patent Owner disputes explicit transmission of the overlaid image and receipt of the updated line, a POSA would implement the disclosed user-adjustment at Choe's server: Choe already provides the line-editing interface and the ADV-network, so sending the overlaid image to the server for review and returning the new line (second position) is a routine within-reference allocation of disclosed functions with predictable results. *See* EX1005, ¶¶[0016]–[0018], [0025], [0031], [0044]–[0053]; EX1003, ¶101.

A. Independent Claim 1

1. [1Pre] "A method comprising"

Choe discloses this element, describing "processes or *methods* … [that] may be performed by processing logic that comprises hardware (e.g., circuitry, dedicated logic, etc.), software (e.g., embodied on a non-transitory computer readable medium), or a combination of both." EX1005, ¶[0064]: EX1003, ¶¶104-105.

2. [1A] "receiving an image of a roadway recorded by a camera device installed within a vehicle"

Choe discloses this element. EX1003, ¶¶106-111. Choe's ADV includes cameras 211 "to capture images of the environment surrounding the autonomous vehicle," EX1005, ¶¶[0020]–[0022], FIG. 2, "in response to a first image captured by a camera of an ADV, a horizon line is determined … [and] one or more lane lines are determined" via perception, EX1005, ¶[0015], and sensor data includes "an image … processed by perception module 302 … determining a horizon line representing a vanishing point of a road," EX1005, ¶¶[0045], [0048]. Claim 1 likewise recites determining a horizon line from "a first image … [2D] view from the viewpoint of the ADV." Accordingly, Choe teaches "receiving an image of a roadway recorded by a camera device installed within a vehicle." EX1003, ¶¶106-111.

3. [1B] "detecting a horizon line in the image"

Choe discloses this element in two ways. EX1003, ¶¶112–122.

First, Choe discloses detecting a horizon line from an image captured by the ADV's camera: "in response to a first image captured by a camera of an ADV, a horizon line is determined based on the camera's hardware settings." EX1005, ¶¶[0015], [0048]. Perception module 302 performs "image processing … determining a horizon line representing a vanishing point of a road." *Id.*, ¶[0045]; EX1003, ¶114. Figure 6A illustrates horizon line 610 "determined and placed on a location within image 601 based on the hardware setting of the targeted camera." EX1005, ¶[0055].

EX1006, FIG. 6A (excerpt, annotated).

Process 700 similarly confirms that "processing logic determines a horizon line … based on a pitch angle of a camera that captured a first image." EX1005, ¶[0059]; EX1003, ¶116.

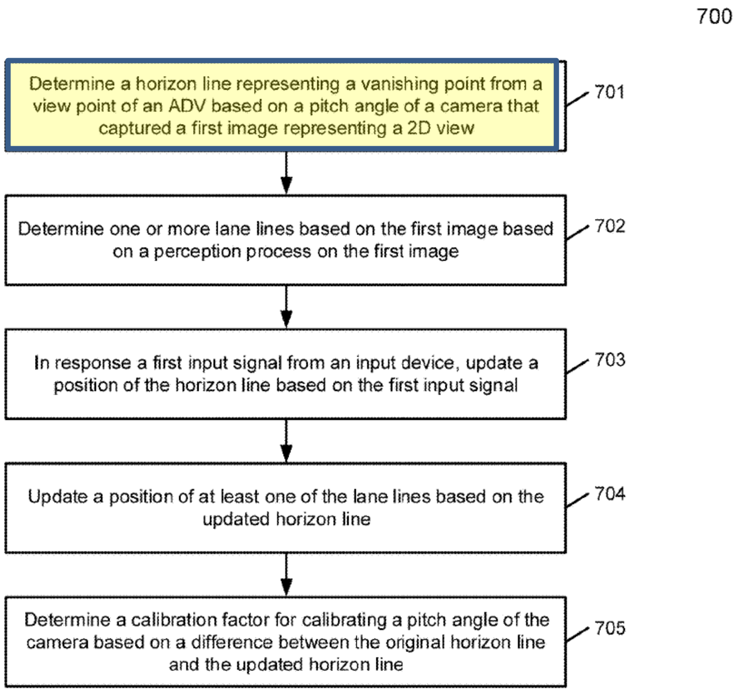


FIG. 7

EX1006, FIG. 7.

Second, Choe discloses detecting a horizon line using predictive models. Machine learning engine 122 generates predictive models 124, including calibration algorithms for use by ADVs. EX1005, ¶[0030], FIG. 1. A POSA would have understood these models predict horizon and lane lines, which may then be manually adjusted ("[t]he input signal may represent an incremental adjustment … of the horizon line"). *Id.*, ¶[0015]; EX1003, ¶¶118-119. After prediction and adjustment, the horizon line is re-identified and used by other modules: "sensor data is … processed by perception module 302 … determining a horizon line … [and] the result … can be utilized by other modules such as prediction module

303." EX1005, ¶[0045]; EX1003, ¶¶120-121.

Thus, Choe discloses "determining" a horizon line in an image captured by an in-vehicle camera, as recited in claim 1.

4. [1C] "overlaying a line on the image to generate an overlaid image"

In either form of horizon line detection described in Choe, direct detection by perception module 302 or predictive generation by models 124, Choe expressly discloses this element. EX1003, ¶¶123-126. Choe discloses superimposing the horizon line on the image (regardless of which form of detection), which a POSA would understand as "overlaying" the line. *Id.*, ¶124. For example, Choe explains that "the first image with the horizon line superimposed thereon is displayed … [and] updated … to give a visual feedback to a user." EX1005, ¶¶[0016], [0015], [0046], [0048], [0055]–[0059], FIGs. 6A–6B.

Choe's figures confirm this overlay. Figure 6A shows the horizon line superimposed on image 601 with "frame id: 1110," which Choe notes is "too low" and requires manual adjustment. EX1005, ¶[0057], FIG. 6A; EX1006, FIG. 6A. An image with the horizon line superimposed is, by definition, an "overlaid image." EX1003, ¶124.

EX1006, FIG. 6A (excerpt, annotated).

Accordingly, Choe discloses "overlaying a line on the image to generate an overlaid image" as recited in claim 1. EX1003, ¶126.

5. [1D] "transmitting the overlaid image to a computing device over a network"

Choe renders obvious this element. EX1003, ¶¶127–141. Choe expressly teaches a networked ADV-server architecture: the ADV "may be communicatively coupled to one or more servers 103–104 over a network 102," where "network 102 may be … [LAN, WAN such as the Internet, cellular, satellite], … wired or wireless," and "wireless communication system 112 … allow[s] communication … with servers 103–104 over network 102." EX1005 ¶¶[0018], [0025].

Choe also permits server-side calibration: "sensor calibration system 125 may be hosted by server 103 to calibrate sensors … offline based on the images and/or point clouds captured by the sensors," and "the calibration result can then be uploaded onto the vehicle to be utilized online during the image processing." EX1005, ¶¶[0031], [0044]. At the same time, Choe teaches local/manual calibration in which "the first image with the horizon line superimposed thereon is displayed … [and] updated … to give a visual feedback to a user," with horizon and lane lines overlaid and adjusted. EX1005, ¶¶[0016], [0014]–[0017], [0049]–[0057], FIGs. 6A–6B. These disclosures confirm Choe's calibration imagery includes annotated overlays, not merely raw sensor data.

While Choe does not expressly state that these overlaid images are transmitted, a POSA would view that as a routine implementation in Choe's disclosed architecture. Choe already (i) generates annotated calibration views with horizon/lane lines "superimposed" and updated for user feedback, EX1005, ¶¶[0014]–[0017], [0049]–[0057], and (ii) performs calibration remotely: "sensor calibration system 125 may be hosted by server 103," with "the calibration result … uploaded onto the vehicle," EX1005, ¶¶[0031], [0044]), and over network 102 (LAN/WAN/Internet/cellular/satellite), EX1005, ¶[0018]. *See* EX1005, ¶[0025]. For remote calibration and user interaction to function as disclosed in Choe, the same processed, overlaid views must be sent so they can be rendered and adjusted at the remote terminal, merely allocating disclosed functionality across Choe's client–server design. *See* EX1005, ¶¶[0014]–[0017], [0018], [0025], [0031], [0044], [0049]–[0057]; EX1003 ¶¶128-132.

The motivations for transmission are straightforward. Sending the overlaid image ensures consistency by allowing remote personnel to see exactly what the vehicle displays, avoiding redundant detection and reducing server compute. Overlays already encode perception results and user adjustments, and annotated frames further support Choe's server-side training, drift monitoring, and audit functions. EX1005, ¶¶[0029]–[0031]; EX1003, ¶135. In human-in-the-loop scenarios, transmitting the same UI view used in-vehicle provides clear calibration context. EX1003, ¶138.

Implementation would require only routine design choices, either rasterizing overlays into a composite image or transmitting raw frames with overlay metadata, both obvious to try within Choe's disclosed networked framework and with a reasonable expectation of success. EX1005, ¶¶[0014]–[0017], [0049]–[0057], [0018], [0025]. Bandwidth concerns are immaterial, as overlays add negligible size and Choe already contemplates Internet, cellular, and offline uploads. EX1005, ¶¶[0018], [0031]. Nothing in Choe teaches away; transmitting annotated images is a predictable extension of its architecture. EX1003, ¶140.

6. [1E] receiving a modification of the line from the computing device, the modification comprising a new line at a second position;

Choe renders obvious this element. EX1003, ¶¶142-153.

Choe already teaches user-driven edits to overlaid roadway features: "in response to a second input signal … the position of at least one of the lane lines is modified … [and] a second calibration factor … is determined based on the modification," and "a user may modify a detected horizon line or lane line … [and] the calibration module may then compute a calibration parameter based on the modified line." EX1005, ¶¶[0017], [0052]–[0053]. These disclosures mean the system receives a modification yielding "a new line at a second position." At the same time, Choe also teaches a client–server framework: "Sensor calibration system 125 may be hosted by server 103 … based on the images … captured," with "the calibration result … uploaded onto the vehicle," and the ADV communicates via LAN/WAN/Internet/cellular/satellite. EX1005, ¶¶[0031], [0044], [0018], [0025]. Thus, Choe expressly contemplates the vehicle receiving updated calibration from a remote computing device (the server), i.e., receipt of the server-side modification to the line/line-based parameters.

In view of these teachings, a POSA would implement the same line-adjustment at the server: transmit the overlaid frame to server 103, have the server receive the user's edit, i.e., a new line at a second position, and return updated calibration to the vehicle, because, in the Federal Circuit's words, selecting where to perform a disclosed function within a client–server system is a "simple design choice" among "two predictable choices." *Uber Techs., Inc. v. X One, Inc.*, 957 F.3d 1334, 1342–43 (Fed. Cir. 2020) ("a simple design choice," "two predictable choices," and "server-side plotting … was a design choice"); *see also CRFD Rsch., Inc. v. Matal*, 876 F.3d 1330, 1347 (Fed. Cir. 2017) (obvious where "there were only two predictable choices—perform the claimed method on the terminal or on the server—and both were within the technical grasp of the skilled artisan"); *ACCO Brands Corp. v. Fellowes, Inc.*, 813 F.3d 1361, 1370 (Fed. Cir. 2016) ("The ordinary artisan would then be left with two design choices … [e]ach of these two design choices is an obvious combination of prior-art elements.").

Courts allow "common sense" to supply the rationale for straightforward implementation details. *See Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d 1324, 1329–30 (Fed. Cir. 2009) ("Common sense has long been recognized to inform the analysis of obviousness if explained with sufficient reasoning."); *Wyers v. Master Lock Co.*, 616 F.3d 1231, 1240–41, 1245–46 (Fed. Cir. 2010) (obviousness may rest on "logic, judgment, and common sense," and some implementations are "simply a matter of common sense"). Placing Choe's disclosed line-editing on the server is a predictable, routine variant that improves remote verification (letting reviewers "see what the vehicle sees") and reduces in-vehicle load, without changing Choe's operation. EX1005, ¶¶[0015]–[0017], [0049]–[0053], [0018], [0025], [0031], [0044]; EX1003, ¶¶145-152.

7. [1F] computing a camera parameter based on the new line

Choe discloses this element. EX1003, ¶¶154–162. This step does not limit where computation occurs. Whether performed locally or remotely, Choe discloses the element. *Id*. Choe teaches that "in response to a first image … a horizon line is determined … [and] in response to a first input signal … the position of the horizon line is updated … [and] a first calibration factor … is determined … based on a difference between the initial horizon line and the updated horizon line." EX1005, ¶¶[0015], [0049]. Likewise, "in response to a second input signal … the position of at least one of the lane lines is modified … [and] a second calibration factor … for … yaw … [and] in response to a third signal … a third calibration factor … for … roll." EX1005, ¶¶[0017], [0052]–[0053].

Choe's process flow confirms: "At block 705, processing logic determines a calibration factor … based on the difference between the initial horizon line and the updated horizon line." EX1005, ¶[0059], FIG. 7.

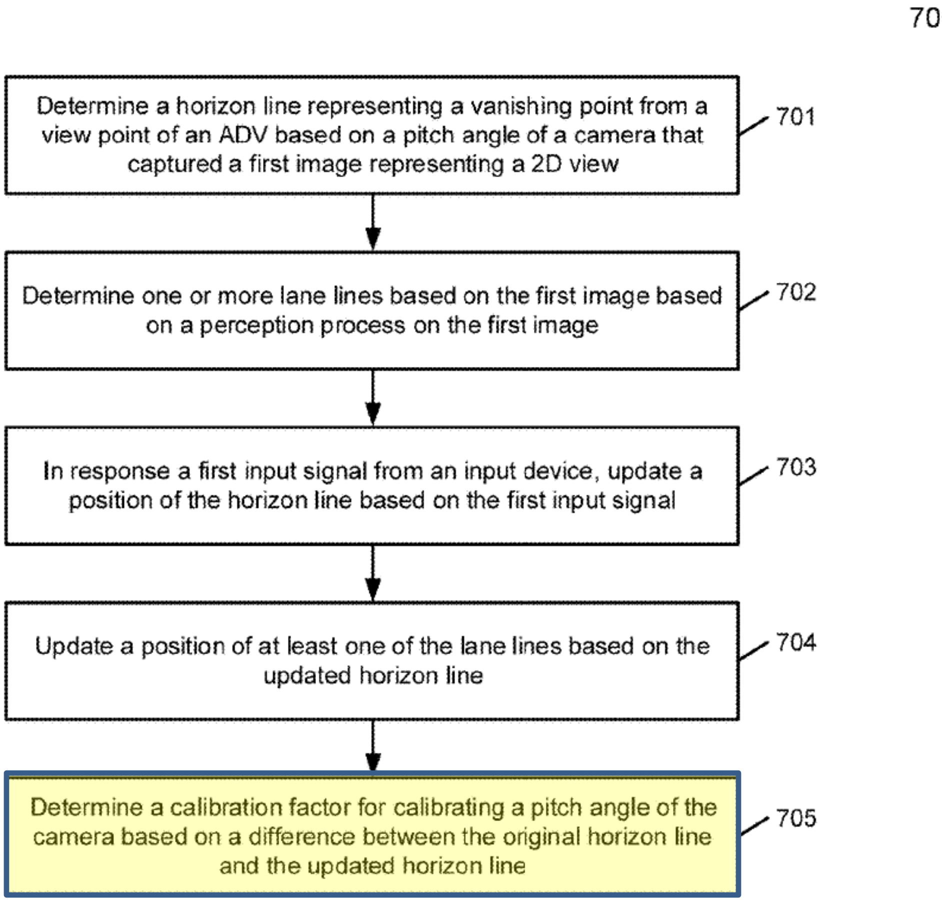


FIG. 7

EX1005, FIG. 7 (annotated).

A POSA would recognize these "calibration factors" as camera parameters, described as correction values used to calibrate the pitch, yaw, and roll of the camera hardware. EX1005, ¶¶[0015], [0017], [0049]–[0053], [0059]. Choe further explains that these values may be computed locally by calibration system 308 or remotely by server-based calibration system 125. *Id.*; EX1003, ¶¶159-161.

In short, Choe explicitly discloses that each time a line is updated to a new position, calibration factors (*i.e.*, camera parameters) for pitch, yaw, and roll are computed from that line. EX1003, ¶162. Thus, Choe discloses element 1[F].

8. [1G] transmitting data representing the camera parameter to the camera device.

Choe discloses this element. EX1003, ¶¶163-169. Regardless of whether the claim is satisfied by (i) in-vehicle delivery (e.g., an in-vehicle calibration module sending updated pitch/yaw/roll over the vehicle bus) or (ii) off-board computation with parameters returned and forwarded to the camera, Choe teaches both.

Choe confirms that calibration parameters are not merely generated but fed back. Choe describes feedback of computed calibration values to adjust the sensor: "the calibration factors can be utilized by software applications such as a perception module to adjust the image processing parameters such as pitch, yaw, and roll angles to compensate the hardware during the image processing." EX1005, ¶[0017]. It further states that calibration factor calculator 406 "feeds [calibration factors] back to perception module 302 or other software modules such that the software modules can perform proper adjustment … to compensate the hardware settings of the sensors." EX1005, ¶[0047]. Choe also teaches remote/offline calibration with return of results: "sensor calibration system 125 may be hosted by server 103 … offline based on the images … captured by the sensors," and "the calibration result can then be uploaded onto the vehicle to be utilized online." EX1005, ¶¶[0031], [0044].

Accordingly, Choe discloses not only generating calibration parameters from updated line positions but also transmitting those parameters, whether locally via modules 406/308 or remotely from server 103, back to the camera device to update its operation. EX1003, ¶¶166-168. Thus, Choe discloses element 1[G].

B. Claim 2: "the camera parameter comprises one of camera height, viewing angle, and road plane normal."

Choe renders obvious camera parameters corresponding to camera height, viewing angle, and road-plane normal. EX1003 ¶¶170–181. After overlaying horizon and lane lines, Choe teaches that "in response to a first input signal (e.g., an up or down arrow key) … a position of the horizon line is updated … [and] a first calibration factor … for calibrating a pitch angle of the camera [is] determined." EX1005 ¶¶[0015], [0049]. Similarly, second and third inputs yield calibration factors for yaw and roll. EX1005 ¶¶[0017], [0052]–[0053].

Mapping is straightforward: the claimed "viewing angle" corresponds to Choe's pitch from horizon displacement; the "road-plane normal" follows from the combined pitch, yaw, and roll orientation; and although Choe does not state "camera height," a POSA would recognize that pitch calibration depends on camera mounting height, making it obvious in the same geometry. EX1003 ¶174.

Accordingly, Choe's computed pitch, yaw, and roll are interchangeable formulations of the claimed camera parameters, satisfying claim 2. EX1005 ¶¶[0015], [0017], [0049]–[0053]; EX1003 ¶¶180–181.

C. Claim 3: "receiving the image of the roadway comprises receiving an image of the roadway while the vehicle is moving."

Choe discloses this element. EX1003, ¶¶182-186. Choe expressly states: "The above processes can be utilized online while the vehicle is driving and real-time images are captured to calibrate the sensors in real-time," EX1005, ¶[0017]. Choe further shows horizon/lane updates and corresponding pitch/yaw/roll computation during operation, EX1005, ¶¶[0052]–[0054], [0059] (Block 705), and confirms that "while autonomous vehicle 101 is moving along the route," the system obtains real-time environment data from sensors, EX1005, ¶[0028]. Accordingly, Choe teaches receiving roadway images and calibrating while the vehicle is moving, satisfying claim 3. EX1005, ¶[0028]; EX1003, ¶186. Accordingly, Choe discloses claim 3.

D. Claim 5: "transmitting the overlaid image to the computing device over the network comprises transmitting the overlaid image to a web-based application."

Choe renders obvious claim 5. EX1003, ¶¶187-196. Choe teaches a networked architecture where autonomous vehicles communicate with remote servers over networks such as the Internet, cellular, or satellite: "Network configuration 100 includes autonomous vehicle 101 … coupled to one or more servers 103–104 over network 102," which "may be … the Internet, a cellular network, [or] a satellite network." EX1005 ¶[0018]. "Wireless communication system 112 … can wirelessly communicate with … servers 103–104 over network

102." EX1005 ¶[0025]. Calibration may occur remotely, with results uploaded back to vehicles: "Sensor calibration system 125 may be hosted by server 103 … [and] the calibration parameters … uploaded to the corresponding vehicles." EX1005 ¶¶[0031], [0044].

A POSA would have understood these disclosures render it obvious to transmit overlaid images to a web-based application. EX1003, ¶¶191-195. Choe already teaches generating overlaid images locally, EX1005, ¶¶[0015]–[0017], [0055]–[0057], transmitting sensor imagery and calibration data over the Internet to servers, EX1005, ¶¶[0018], [0025], [0031], [0044], and server-hosted calibration functionality, EX1005, ¶¶[0031], [0044]. A "web-based application" is simply a conventional way to implement server-hosted processing and visualization over the Internet. EX1003, ¶191. Using a web-based interface would have been a predictable choice among finite design options (e.g., desktop client, native application, or web application), yielding no unexpected result.

The motivation would have been clear: a web-based application enables calibration personnel or servers to view and verify annotated images (horizon and lane line overlays) without requiring specialized local software, supporting Choe's goals of server-hosted calibration, fleet-wide analytics, and human-in-the-loop verification. EX1005, ¶¶[0029]–[0031], [0044].

In *KSR*, the Supreme Court held that when there are "a finite number of identified, predictable solutions," pursuing a known option is likely the product of ordinary skill and common sense, not innovation. *KSR*, 550 U.S. at 421. Selecting a web-based interface instead of a desktop or native client to implement Choe's server-hosted calibration is precisely such a predictable design choice, no different than the application of "common sense" found obvious in *Perfect Web Techs.*, 587 F.3d at 1329–30; *see also Wyers*, 616 F.3d at 1239 (obviousness may rest on combining familiar elements "according to known methods" to yield predictable results); *Leapfrog Enters., Inc. v. Fisher-Price, Inc.*, 485 F.3d 1157, 1161 (Fed. Cir. 2007) (updating known systems with conventional technology is obvious).

Accordingly, transmitting the overlaid image to a web-based application is an obvious implementation of Choe's disclosed Internet-based calibration system. EX1003, ¶196.

E. Claim 6: "receiving the modification of the line from the computing device comprises receiving an identification of a new horizon line by a user of the computing device."

Choe renders obvious this element. EX1003, ¶¶197-204. Choe expressly teaches user-driven overlay adjustment—"in response to a second input … the position of at least one of the lane lines is modified … [and] a second calibration factor … is determined based on the modification." EX1005 ¶[0017]; see also ¶¶[0015], [0049]–[0053]. A POSA would view this as the user identifying a new horizon-line position adopted for pitch/yaw/roll calibration. EX1003 ¶198.

Choe also discloses a client-server calibration setup where captured images are processed remotely and results uploaded back to the vehicle. EX1005 ¶¶[0018], [0025], [0031], [0044]. A POSA would naturally allocate the user-adjustment step to the server so the overlaid image is transmitted for review and the updated line returned—merely distributing known functions within Choe's architecture with predictable results. EX1003 ¶¶199–200.

Under *KSR*, this is straightforward: Choe teaches user-guided line setting with recalibration from the updated line, EX1005 ¶¶[0015], [0017], [0049]–[0053], [0055]–[0057], and networked ADV-server calibration. EX1005, ¶¶[0018], [0025], [0031], [0044]; EX1003, ¶¶210-211. Implementing the user-identification step at the disclosed server (sending the overlaid image for remote review and returning the modified line) is a permissible within-reference combination: "[c]ombining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness." *Boston Scientific Scimed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009). More broadly, the Federal Circuit has confirmed that an obviousness determination may rest on a single prior-art reference when that reference discloses all elements; in that posture, the Board "was not required to make any finding regarding a motivation to combine." *Realtime Data, LLC v. Iancu*, No. 18-1154, slip op. at 8–9 (Fed. Cir. Jan. 10, 2019). Likewise, placing

Choe's already-disclosed edit operation on its already-disclosed server is a "simple design choice" between "two predictable choices" (server-side vs. device-side) that yields predictable results under *KSR*. *Uber Techs., Inc. v. X One*, Inc., 957 F.3d 1334, 1342–47 (Fed. Cir. 2020). Accordingly, Choe renders obvious claim 6. EX1003, ¶¶201-204.

F. Claim 7: "transmitting the data representing the camera parameter to the camera device further comprises recomputing the camera parameter based on the modification of the line."

Choe discloses this element. EX1003, ¶¶205-212. Choe explicitly discloses that each time a line is modified, the calibration system recomputes the corresponding camera parameter. EX1003, ¶206. For example: "in response to a first input signal … a position of the horizon line is updated … [and] a first calibration factor … is determined for calibrating a pitch angle of the camera based on a difference between the initial horizon line and the updated horizon line." EX1005, ¶¶[0015], [0049]. Likewise: "in response to a second input signal … the position of at least one of the lane lines is modified … [and] a second calibration factor for calibrating a yaw angle … [and] in response to a third signal … a third calibration factor for calibrating a roll angle …" EX1005, ¶¶[0017], [0052]–[0053].

Choe's Figure 7 confirms this iterative process: "At block 705, processing logic determines a calibration factor or parameter for calibrating a pitch angle of the camera based on the difference between the initial horizon line and the updated horizon line" EX1005, ¶[0059]. Each adjustment to the horizon or lane line triggers recomputation of the calibration factor. EX1003, ¶210.

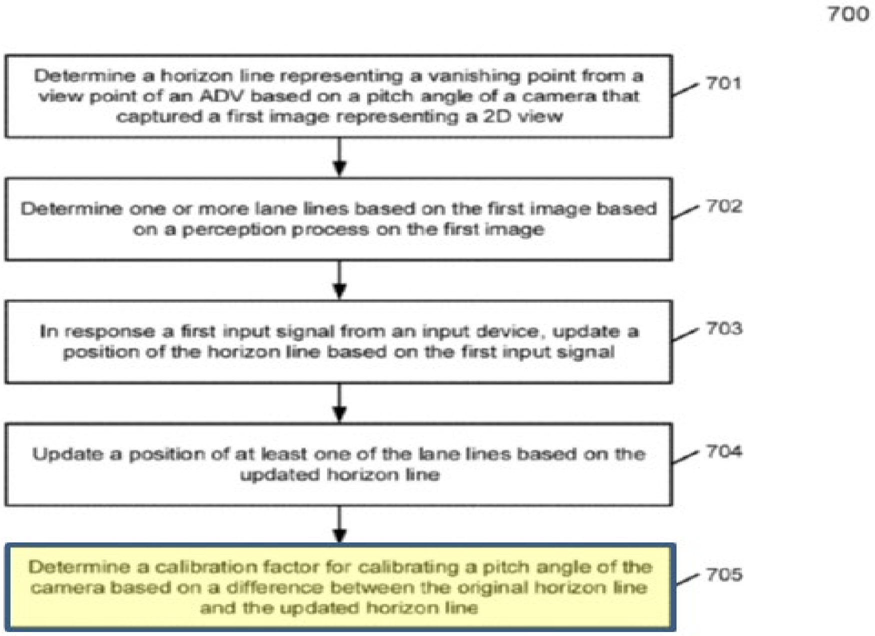


FIG. 7

EX1005, FIG. 7 (annotated).

Choe further explains that once these recalculated parameters are determined, they are transmitted back to the system to adjust the camera or applied by perception software to compensate the hardware: "The calibration factors can be utilized by software applications such as a perception module to adjust the image processing parameters such as pitch, yaw, and roll angles to compensate the hardware during the image processing". EX1005, ¶¶[0017], [0047], [0031], [0044] (upload to vehicle); EX1003, ¶210. Accordingly, Choe discloses claim 7. EX1003, ¶212.

G. Claims 8-10, 12-16 18-20 are obvious over Choe.

Claims 8-10, 12-16 18-20 are likewise rendered obvious by Choe. EX1003, ¶¶213-219. These claims merely restate the substantive limitations of claims 1-3 and 6-7 in alternative statutory forms (computer-readable medium and device). Claim 8 recites the method of claim 1 in CRM form; claims 9-10 and 13-14 correspond to dependent claims 2-3 and 6-7; claim 15 mirrors claims 1 and 8 in device form; and claims 16 and 19-20 track the features of claims 3 and 13-14.

Choe discloses implementing the calibration functionality in both software and hardware, including perception module 302, calibration module 308, processors, and storage. EX1005, ¶¶[0032]-[0034], [0044], [0047]. Because claims 8-10, 12-16 18-20 add no substantive limitations beyond those already rendered obvious in claims 1-3 and 5-7, they too are rendered obvious by Choe. EX1003, ¶¶213-219.

VI. GROUND 2: CHOE IN VIEW OF DAVIES RENDERS OBVIOUS CLAIMS 1-3, 5-10, 12-16 AND 18-20.

Choe in view of Davies renders obvious claims 1-3, 5-10, 12-16 and 18-20.

A. A POSA would have been motivated to combine Choe with Davies.

1. Choe

As explained in Ground 1, Choe discloses a complete calibration workflow in which the ADV captures roadway images, determines and overlays horizon/lane lines, allows user adjustments to those lines, and recomputes pitch/yaw/roll from the updated geometry. EX1005, ¶¶[0015], [0017], [0049]–[0053], [0059]; EX1003, ¶220. It also teaches a client-server architecture where images are sent to a server-hosted calibration system and results are uploaded back to the vehicle. EX1005, ¶¶[0018], [0025], [0031], [0044]; EX1003, ¶220. A POSA would recognize that, for such remote calibration and user interaction to function, the same processed, annotated views used locally must be transmitted over the network so they can be rendered at the remote terminal. EX1003, ¶220. Choe suggests this arrangement but does not explicitly spell out the transport mechanics. *See* EX1005, ¶¶[0014]–[0017], [0031], [0044], [0049]–[0057]; EX1003, ¶¶220-221. Looking for routine implementation details, a POSA would consult complementary references, and Davies provides exactly that by expressly teaching wireless, bidirectional transmission of processed/annotated imagery and calibration data between a vehicle device and a remote server, with remote modifications returned to update local parameters. EX1007, ¶¶[0059], [0063]–[0069], claim 24; EX1003, ¶¶222-223.

2. Davies

Davies squarely teaches remote transmission, operator adjustment, and return of processed outputs. It describes capturing 4K images onsite and "transport[ing] the captured images to an operations base ('OB') … e.g., a production truck away from the field," EX1007, ¶[0042]; at the OB, an operator uses a GUI "to navigate the full raster 4K image and maneuver the selective … extraction window," EX1007, ¶[0044]. The "output … is provided to a router … [and] can be taken live … or … ingested at a server … for later playout." EX1007, ¶[0045]. Davies further teaches distributing processing to address bandwidth: "some or all of image adjustment may be performed on the vehicle … particularly useful … in wireless transmission applications where a reduced data package can take advantage of bandwidth limitations," EX1007, ¶[0059], and confirms that an "adjusted image is transmitted via wireless protocol to an external computing device." EX1007, claim 24.

Taken together, these disclosures show a bidirectional, networked workflow in which processed/annotated imagery is sent to a remote computing device for human interaction and the adjusted output is returned for further processing, which are implementation details that aligns directly with Choe's remote calibration framework.[1]

3. ***KSR***

A POSA would have known how and why to combine Choe with Davies and would have had a reasonable expectation of success because the references disclose complementary elements that operate exactly as KSR predicts.

Choe discloses the full calibration loop: capture roadway images, overlay horizon/lane lines, accept user adjustments, and recompute pitch/yaw/roll and a

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[1] To the extent Patent Owner contends that Davies's remote OB workflow and its optional on-vehicle processing are distinct embodiments, combining embodiments within a single reference is permissible where a POSA would do so. The Federal Circuit has held that "[c]ombining two embodiments disclosed adjacent to each other in a prior art patent does not require a leap of inventiveness." *Boston Scientific SciMed, Inc. v. Cordis Corp.*, 554 F.3d 982, 991 (Fed. Cir. 2009). A reference also "must be considered for everything that it teaches, not simply the described invention or a preferred embodiment." *In re Applied Materials, Inc.*, 692 F.3d 1289, 1298 (Fed. Cir. 2012) (citing *EWP Corp. v. Reliance Universal, Inc.*, 755 F.2d 898, 907 (Fed. Cir. 1985)).

client–server model where calibration “may be hosted by server 103” with results uploaded to the vehicle. EX1005, ¶¶[0015], [0017], [0049]–[0053], [0018], [0031], [0044]; EX1003, ¶¶226-228. Davies supplies the routine transport/UI layer: a server 101 with client devices 104-106 on network 106 that “may manipulate, share, transmit, and/or receive” system data; images are sent offsite to an operations base, adjusted via GUI 1114, and processed outputs routed back. EX1007, ¶¶[0066]-[0070], [0041]-[0045], [0047]; EX1003, ¶¶229-214. Davies also teaches bandwidth-aware split processing to “take advantage of bandwidth limitations.” EX1007, ¶[0059]. A POSA would have found it obvious and understood *how* and *why* to combine Choe and Davies, transmitting and editing annotated calibration views off-vehicle represents a predictable combination of known elements according to their established functions with a reasonable expectation of success. EX1003, ¶234.

A POSA would have known *how* to combine these complementary teachings yields the claimed networked interaction in a predictable way: Choe’s overlaid calibration image is transmitted to a remote device for user modification; the user identifies the corrected line at a second position; the updated geometry/parameters are returned and applied, which is nothing more than using known elements for their established functions. EX1005, ¶¶[0015], [0017], [0031], [0044], [0049]–[0053]; EX1007 ¶¶[0041]–[0047], [0066]–[0070]; EX1003, ¶¶233-234.

A POSA would have known *why* to combine Choe and Davies because the motivations are straightforward and well recognized: verification and consistency (send the same annotated view Choe already displays so remote reviewers "see what the vehicle sees," avoiding re-detection/divergence), human-in-the-loop oversight and fleet QA (server-hosted review across vehicles), computational offload (shift the adjustment/solve to the server Choe already contemplates), and bandwidth efficiency (Davies teaches reduced data packages to "take advantage of bandwidth limitations," implemented by transmitting lightweight overlay geometry/deltas and returning parameters). EX1005, ¶¶[0016], [0049]–[0057], [0018], [0031], [0044]; EX1007, ¶[0059]; EX1003, ¶¶235-245.

A POSA would have reasonably expected success in making this combination because both Choe and Davies address camera calibration in distributed environments, and each element functions as expected when combined. Nothing in either reference teaches away. Indeed, Choe expressly allows that "embodiments … may be modified without departing from the broader spirit and scope of the disclosure." EX1005, ¶[0066]; *see also DyStar Textilfarben GmbH v. C.H. Patrick Co.*, 464 F.3d 1356, 1364 (Fed. Cir. 2006) (reference does not teach away absent criticism or discouragement); EX1003, ¶¶246-250.

B. Claim 1

Choe alone discloses or renders obvious every step of claim 1. Section V.A. To the extent Patent Owner contends that Choe alone does not render obvious elements 1[D] and 1[E], those features would have been obvious in view of Davies. Davies expressly describes wireless transmission of adjusted/processed images and image data to and from external computing devices, which further confirms the obviousness of performing elements 1[D]–1[G] over a network.. EX1007, ¶¶[0059], [0063]–[0069], claim 24; EX1003, ¶251.

1. 1[Pre]-1[C], 1[F], 1[G]

Choe discloses elements 1[Pre]-1[C], 1[F], 1[G]. Sections V.A.1-4, 7, 8. EX1003, ¶252. Choe discloses receiving roadway images from in-vehicle cameras, detecting and determining horizon/lane lines, and superimposing them on the image. EX1005, ¶¶[0014]–[0017], [0045]–[0046], [0049]–[0057], FIGs. 6A–6B. Choe also discloses computing computer calibration parameters from user-updated lines and transmitting data representing the camera parameter to the camera device. EX1005, ¶¶[0015], [0017], [0031], [0044], [0049]–[0053], [0059]–[0060].

2. 1[D]: "transmitting the overlaid image to a computing device over a network"

Choe in view of Davies renders obvious element 1[D]. EX1003, ¶253.

As discussed above, Choe renders obvious element 1[D]. But to the extent PO argues to the contrary, it certainly would have been obvious in view of Davies. EX1003, ¶255.

a. Choe

Choe describes a networked ADV coupled to servers over LAN/WAN/Internet/cellular links, EX1005, ¶¶[0018], [0025], server-hosted calibration "based on the images and/or point clouds captured by the sensors," *id.*, ¶[0031], and uploading calibration results back to the vehicle, *id.*, ¶[0044]. EX1003, ¶254. Choe also generates and updates overlaid images locally, e.g., horizon line 610 and lane lines 621–623, in real time. EX1005, ¶¶[0014]–[0017], [0049]–[0057], FIGs. 6A–6B; EX1003, ¶254.

b. Davies

Davies discloses a vision-processing/calibration system in which vehicle-captured images are sent to an external computing device for operator review and adjustment. For example, images are "transport[ed] … to an operations base ('OB') … e.g., a production truck away from the field," EX1007, ¶[0042], where a GUI lets an operator "navigate the full raster 4K image and maneuver the selective … extraction window," EX007, ¶[0044]. EX1003, ¶256. The "output … is provided to a router … [and] can be taken live … or … ingested at a server … for later playout," EX1007, ¶[0045], allowing the adjusted imagery to be routed back into the system. EX1003, ¶256. Davies also teaches bandwidth-aware split processing: "some or all of image adjustment may be performed on the vehicle … particularly useful … in wireless transmission applications where a reduced data package can take advantage of bandwidth limitations." EX1007, ¶[0059]; *see also* EX1007, claim 24; EX1003, ¶256.

c. ***KSR***

A POSA would have found it obvious to transmit overlaid (not just raw) images over Choe's existing network for several predictable, technical reasons: (i) **verification/consistency**: remote systems "see what the vehicle sees" without re-running overlay detection, reducing divergence; (ii) **computational efficiency**: overlays already encode local perception and user edits, so sending them avoids redundant processing on the server; and (iii) **fleet-level analytics and human-in-the-loop review**: central access to annotated frames enables troubleshooting, auditing, and standardization. EX1003, ¶¶257-262.

Choe supplies the overlay and networking framework, EX1005, ¶¶[0014]–[0017], [0049]–[0057], [0018], [0025], [0031], [0044]; Davies supplies the explicit bidirectional workflow, EX1007, ¶¶[0059], [0063]–[0069], claim 24. Implementing transmission of overlaid images would have been a predictable implementation within the finite set of conventional options (e.g., rasterized composites or raw frames with overlay metadata), with a reasonable expectation of success. EX1003, ¶258.

Accordingly, Choe in view of Davies renders obvious element 1[D].

3. 1[E]: "receiving a modification of the line … comprising a new line at a second position"

Choe in view of Davies renders obvious element 1[E]. EX1003, ¶¶263-276. As discussed above, Choe alone renders obvious element 1[E]. But to the extent PO argues to the contrary, it certainly would have been obvious in view of Davies. EX1003, ¶266.

a. Choe

Choe teaches the substance of this step: after overlaying roadway features, the system accepts user input that "modif[ies]" the position of a line and then uses the modified line for calibration, e.g., "in response to a second input signal … the position of at least one of the lane lines is modified … [and] a second calibration factor … is determined based on the modification," and "a user may modify a detected horizon line or lane line … [and] the calibration module may then compute a calibration parameter based on the modified line." EX1005, ¶¶[0017], [0052]–[0053]; EX1003, ¶264. Choe also discloses a client-server calibration architecture in which "sensor calibration system 125 may be hosted by server 103 … based on the images … captured by the sensors," with "the calibration result …

uploaded onto the vehicle." EX1005, ¶¶[0031], [0044]; *see also* EX1005, ¶¶[0018], [0025]; EX1003, ¶265.

b. Davies

Davies provides the routine network and GUI framework for performing the same line-modification step remotely and returning results. Davies teaches sending captured images "to an operations base … away from the field," where an operator uses a GUI to "navigate the full raster 4K image" and the "output … [is] ingested at a server." EX1007 ¶¶[0042]–[0045]; EX1003 ¶267. Davies also discloses split on-vehicle/offsite processing for wireless transmission efficiency and a client-server network where users "manipulate, share, transmit, and/or receive" data. EX1007 ¶¶[0059], [0066]–[0070]; EX1003 ¶267.

c. ***KSR***

Combining these complementary teachings in Choe and Davies yields the predictable result: the same user-driven line modification Choe performs locally is executed on the remote device (per Davies), and the calibration system receives that modified line, i.e., a "new line at a second position," over the disclosed network. This is a routine allocation of known functions across Choe's architecture, using Davies's conventional transport/GUI workflow, with obvious benefits (consistency, human-in-the-loop oversight, and bandwidth efficiency by sending lightweight line coordinates/overlays) and a reasonable expectation of success. EX1005, ¶¶[0014]–[0017], [0031], [0044], [0049]–[0057]; EX1007, ¶¶[0042]–[0045], [0059], [0066]–[0070]; EX1003, ¶¶268-276.

Accordingly, Choe in view of Davies renders obvious element 1[E].

C. Claims 2-3 and 5-7

Claims 2-7 are likewise obvious over Choe in view of Davies for the same reasons set out under Ground 1, with Davies supplying any alleged gaps. Each dependent claim merely narrows the core overlay-modify-recompute workflow of claim 1 in ways already taught by Choe or that would have been obvious to a POSA once Davies's explicit two-way (vehicle ↔ external device) calibration framework is incorporated. EX1003, ¶277.

1. Claim 2 (camera height, viewing angle, road-plane normal).

Choe explicitly discloses claim 2. Section V.B; EX1003, ¶278.

Choe teaches computing pitch, yaw, and roll whenever a line is adjusted: pitch from horizon-line modifications and yaw/roll from lane-line changes. EX1005, ¶¶[0015], [0017], [0049], [0052]–[0053], [0059]. A POSA would have understood that these angles define the camera's viewing angle and, by straightforward application of projective geometry, the road-plane normal. EX1003, ¶278. Further, because Choe's pitch calculation is based on the horizon line relative to the roadway, a POSA would have recognized that this calculation directly corresponds to the camera's effective mounting height. EX1003, ¶278.

Claim 2 is therefore obvious. EX1003, ¶278.

2. Claim 3 (image received while the vehicle is moving).

Choe explicitly discloses claim 3. Section V.C; EX1003, ¶279.

Choe teaches online calibration "while the vehicle is driving and real-time images are captured," EX1005, ¶[0017], and continuous perception while the ADV "is moving along the route," *id.*, ¶[0028]. Claim 3 is therefore obvious. EX1003, ¶279.

3. Claim 5 (transmit to a web-based application).

Claim 5 is obvious over Choe in view of Davies. EX1003, ¶¶280-285.

a. Choe

Choe does not expressly specify delivery via a web application, but it already contemplates the exact deployment model: an ADV communicates with remote servers "over a network 102," which "may be … the Internet," via a wireless communication system that talks to "servers 103–104 over network 102"; calibration "may be hosted by server 103 … based on the images … captured by the sensors," and "the calibration result can then be uploaded onto the vehicle." EX1005, ¶¶[0018], [0025], [0031], [0044]; EX1003, ¶280. Those teachings align with how a web-based application operates in practice: Internet-connected servers hosting an interface that renders the same overlaid calibration views Choe generates. *See id.*, ¶¶[0014]–[0017], [0049]–[0057]; EX1003, ¶280.

b. Davies

Davies reinforces and operationalizes this remote UI pattern: images captured on the vehicle are “transport[ed] … to an operations base,” where an operator, via a GUI, “navigate[s] the full raster 4K image and maneuver[s] the selective … extraction window,” with the processed output “provided to a router … [and] ingested at a server” for continued use; processing can be split between on-vehicle and remote processors “particularly useful … in wireless transmission applications,” and modified data can be returned to the vehicle, EX1007 ¶¶[0042]–[0045], [0059], [0063]. That is functionally equivalent to hosting the calibration interface as a web-based application that receives and displays the overlaid image, enables adjustments, and returns updates. EX1003, ¶¶283-284.

c. ***KSR***

A POSITA would have been motivated to implement the remote interface as a browser-based web application, one of a few routine alternatives (web client vs. native client), to integrate Choe’s Internet-connected, server-hosted calibration framework with the remote GUI workflow taught by Davies. Doing so would simply substitute a known interface technology for the same client-server exchange, using Choe’s existing network infrastructure to transmit calibration imagery and parameters. The combination would predictably allow remote operators to view and adjust overlaid calibration images through a standard browser, with a reasonable expectation of success given that web visualization, HTTP streaming, and remote GUI editing were mature and commonly integrated technologies. *See* EX1005, ¶¶[0018], [0025], [0031], [0044]; EX1007, ¶¶[0042]–[0045], [0059], [0063]; EX1003, ¶284-285.

4. Claim 6 (receiving a user identification of a new horizon line).

Claim 6 is obvious over Choe in view of Davies. EX1003, ¶286.

a. Choe

Choe teaches user-driven horizon-line setting. Choe superimposes a horizon line on the captured frame and permits the user to adjust it via keys/joystick/voice, with calibration recomputed from the updated geometry: "in response to a first input signal (e.g., an up or down arrow key) … a position of the horizon line is updated … [and] a first calibration factor … is determined … based on a difference between the initial horizon line and the updated horizon line," and "a user may modify a detected horizon line or lane line by providing input through an input device … the calibration module may then compute a calibration parameter based on the modified line." EX1005, ¶¶[0015], [0052]–[0053]; *see also* EX1005, ¶¶[0017], [0049]; EX1003, ¶286. Functionally, the user's adjustment is an identification of the new horizon line position that the system receives and uses for calibration.

b. Davies

Davies supplies the networked, remote UI context in which the same user identification is performed off-vehicle and returned to the system. It discloses transporting captured images to an external operations base where an operator, via a GUI, "navigate[s] the full raster 4K image and maneuver[s] the selective … extraction window," with "processing … either offsite … or onsite," and the adjusted outputs routed back into the system; processing can be split between on-vehicle and remote processors "particularly useful … in wireless transmission applications." EX1007, ¶¶[0042]–[0045], [0059]; EX1003, ¶286.

c. KSR

A POSA would therefore implement Choe's line-adjustment step on the remote GUI so the external user identifies a new horizon line, transmits that identification over the network, and the vehicle/server uses it to recompute calibration, which is nothing more than applying known elements (Choe's user-set horizon line and Davies's remote, bidirectional GUI workflow) according to their established functions with predictable results. EX1005, ¶¶[0015], [0017], [0049], [0052]–[0053]; EX1007, ¶¶[0042]–[0045], [0059]; Section VI.A; EX1003, ¶286. Claim 6 is therefore obvious. EX1003, ¶286.

5. Claim 7 (recomputing the camera parameter based on the modification).

Claim 7 is obvious over Choe in view of Davies. EX1003, ¶287.

a. Choe

Choe already does exactly this: every line adjustment triggers recalculation of the relevant parameter (pitch/yaw/roll). EX1005, ¶¶[0015], [0017], [0049], [0052]–[0053], [0059]; EX1003, ¶287.

If Patent Owner argues that Choe does not describe performing this recomputation remotely, Davies fills this gap.

b. Davies

Davies reinforces and extends this by making clear that the adjustment/recalculation loop can run off-vehicle: captured images are transported to an offsite operations base where an operator manipulates them via a GUI, and "the output … is provided to a router … [and] can be taken live … or … ingested at a server … for later playout," with processing "either offsite … or onsite," and with processing split between on-vehicle and external processors "particularly useful … in wireless transmission applications." EX1007, ¶¶[0042]–[0045], [0059]; EX1003, ¶288.

c. *KSR*

A POSA would understand that Choe's same recalculation step (pitch/yaw/roll from the updated line) can be performed at the remote node and the resulting adjusted data returned. Under KSR, combining Choe's explicit "modify line → recompute parameter" loop with Davies's routine offboard processing and return path is a predictable use of known elements. Whether the user moves the line locally or on a remote GUI, the system recomputes the same camera parameters from the new line position and applies them, which is an expected, straightforward implementation with a reasonable expectation of success. EX1005, ¶¶[0015], [0017], [0049], [0052]–[0053]; EX1007, ¶¶[0042]–[0045], [0059]; EX1003, ¶288.

A POSA would have been motivated to combine these complementary teachings. EX1003, ¶289. By the priority date, distributing computation between onboard and server-side processors was a standard design in autonomous driving systems to conserve vehicle resources and ensure consistency across fleets, as supported by contemporaneous art. Thus, applying Davies's routine remote-processing framework to Choe's recalculation workflow would have been the predictable use of known techniques, with a reasonable expectation of success. EX1003, ¶288. Claim 7 is therefore obvious. *Id.*

D. Claims 8-10, 12-16, and 18-20

Claims 8–10, 12–16, and 18–20 are likewise obvious over Choe in view of Davies. EX1003 ¶290. These claims merely restate the substantive limitations of claims 1–3 and 5–7 in computer-readable medium or device form.

Choe already discloses implementing the calibration functionality in software and hardware through its perception module 302, calibration module 308, processors, and storage, EX1005, ¶¶[0032]–[0034], [0044], [0047]. Davies reinforces that such calibration processes may be performed locally or remotely by an external computing device. EX1007, ¶¶[0059], [0063]–[0069]. Because claims 8-10, 12-16, and 18-20 add nothing of substance beyond the limitations already rendered obvious in claims 1-3 and 5-7, they too are unpatentable over Choe in view of Davies. EX1003, ¶290.

VII. GROUNDS 3A/3B: CHOE IN VIEW OF KUEHNLE (GROUND 3A) AND CHOE IN VIEW OF DAVIES AND FURTHER IN VIEW OF KUEHNLE (GROUND 3B) RENDER OBVIOUS CLAIMS 4, 11, AND 17.

Grounds 1 and 2 established the obviousness of the independent claims (Choe alone; Choe in view of Davies). Building on that foundation, Grounds 3A and 3B show dependent claims 4, 11, and 17 are likewise unpatentable: Choe in view of Kuehnle (Ground 3A) and Choe in view of Davies, further in view of Kuehnle (Ground 3B), render these claims obvious.

A. Claims 4, 11, and 17: "receiving the image of the roadway while the vehicle is moving comprises detecting that the vehicle is traveling above a pre-defined speed or for a pre-defined duration." (Grounds 3A/3B)

1. Choe (Ground 3A) and Choe in view of Davies (Ground 3B)

Choe in view of Kuehnle (Ground 3A) and Choe in view of Davies and further in view of Kuehnle (Ground 3B) render obvious claims 4, 11, and 17. EX1003, ¶¶291-301.

For both grounds, Choe already performs calibration "online while the vehicle is driving and real-time images are captured." EX1005 ¶[0017]. While driving, it collects "real-time … data detected … by sensor system 115" and logs "speeds, accelerations, [and] decelerations." EX1005 ¶¶[0028]–[0029]. Although Choe suggests use of speed and time telemetry, it does not explicitly link minimum speed or elapsed duration to triggering calibration updates. EX1003 ¶292.

Similarly, under Ground 3B, Davies ties calibration and image adjustment to vehicle dynamics, using telemetry such as "gyro data, vehicle angle, attitude, altitude, speed, acceleration, traction, [and] navigational data" to decide when updates occur. EX1007 ¶[0031]; EX1003 ¶293. Davies also bases calibration on multiple frames, describing "receiving image data … [and] data from … vehicle mounted sensor[s]" to refine the image horizon over time. EX1007 ¶[0057]; EX1003 ¶293. Yet Davies likewise does not explicitly condition calibration on speed or time thresholds.

A POSA considering Choe alone (Ground 3A) or Choe in view of Davies (Ground 3B) would have found it obvious to look to Kuehnle, which expressly requires calibration only when the vehicle moves "with at least a certain speed" and applies "time-filtering methods from a sequence of images." EX1010, 3, 11–13. These safeguards address the same issue recognized in Choe and Davies: ensuring calibration updates occur only under stable, representative driving conditions. EX1003 ¶¶294–301.

2. Kuehnle

Kuehnle discloses an online calibration method for vehicle-mounted video systems that determines camera pitch and yaw from vanishing points and requires calibration only when the vehicle travels above a set speed or for a defined duration. It states that calibration "require[s] that the vehicle is moving with at least a certain speed … so that low speed maneuvering … is not taking place," and that the system evaluates "the current speed data of the vehicle." EX1010, 11–12; EX1003 ¶294.

Kuehnle also applies a temporal filter, computing a "long term average vanishing point … from a sequence of images" and deducing yaw and pitch from that averaged data, with weighting that "decreases with time (as in a recursive averaging filter)." EX1010, 3, 13; EX1003 ¶295.

Accordingly, Kuehnle teaches both a predefined speed threshold and duration requirement, satisfying the claimed condition for calibration only when the vehicle is moving above a set speed or for a set time.

3. ***KSR***

Under KSR (for both grounds), a POSA would have found it obvious to add Kuehnle's speed and duration conditions as a "combination of familiar elements according to their established functions," with only predictable options such as setting a minimum vehicle speed or elapsed duration. KSR, 550 U.S. at 421; EX1003 ¶¶297–298. Choe already provides the necessary telemetry, and Kuehnle shows how to use it—by conditioning calibration updates on predefined thresholds. Choosing a threshold (e.g., 5 km/h or 10 s) is a routine engineering step to avoid recalibration during idle or parking and ensure stable forward motion.

For Ground 3B, applying Kuehnle's time-filtering to Choe/Davies's multi-frame refinement is simply using known averaging to suppress transient noise. EX1003 ¶299.

Across both grounds, a POSA would expect success because each reference addresses the same problem (accurate in-motion camera calibration) and Kuehnle's thresholds mitigate the transient risks noted in Choe and Davies. The combination applies known elements in predictable ways, rendering claims 4, 11, and 17 obvious in view of Choe + Kuehnle or Choe + Davies + Kuehnle. EX1003 ¶¶300–301.

VIII. GROUND 4: WESTMACOT IN VIEW OF TAL RENDERS OBVIOUS CLAIMS 1-20.

A POSA would have found claims 1–20 obvious in view of Westmacot in combination with Tal. EX1003, ¶302.

A. A POSA would have been motivated to combine Westmacot and Tal.

1. Westmacot

Westmacot discloses a road-annotation and calibration system for autonomous vehicles. Vehicle-mounted cameras capture roadway images, from which geometric features like the horizon line are computed. An annotation interface overlays lane lines on the images and allows users to shift or add boundaries, with edits propagated through a 3D road model via model adaptation component 410. EX1008, 30–32, 34–35, FIGs. 3, 7, 15, 30–32; EX1003 ¶¶303–304. Parameter computation component 408 recalculates camera parameters—height (H), offset (S), forward point, horizon line, lane width (W), and center (C) and updates other modules accordingly. In sum, Westmacot teaches the same workflow as the challenged claims: image capture, overlay of horizon and lane lines, user modification, and recalculation of camera parameters.

2. Tal

Tal discloses a bidirectional, networked vision pipeline where both raw and processed imagery, including overlays, are exchanged between an in-vehicle device and a server. Selected image frames or unprocessed images may be transmitted in real time. EX1009 ¶[0027]; EX1003 ¶305. Connectivity includes Wi-Fi "to upload a large volume of data" and cellular links for continuous updates. EX1009 ¶¶[0064]–[0065]. The server "organizing, storing, processing and disseminating … object data 21" can store "image data 16, sensor data 17, [and] processed data 20," with processing split between client and server (Fig. 4). EX1009 ¶¶[0050]–[0051], [0066]. Overlays accompany the imagery: processed data "can be overlayed on the image … [and] flattened/merged," or "stored and sent separately." EX1009 ¶[0052]. Tal thus provides what Westmacot may lack: (i) network transmission of overlaid images, (ii) remote client-server processing and modification, and (iii) return transmission of processed results or parameters. EX1009 ¶¶[0027], [0050]–[0052], [0064]–[0066]; EX1003 ¶307.

3. *KSR*

Taken together, Westmacot and Tal teach the full scope of claims 1–20, and a POSA would have known *how* and *why* to combine with a reasonable expectation of success. EX1003 ¶308.

Westmacot captures roadway images, overlays horizon and lane lines, allows user modification, and computes camera parameters (e.g., height, offset, horizon line, lane width, center), but does not explicitly transmit these outputs beyond the local system. Given its goal of scalable training, remote access is implied. Tal fills any gap, teaching transmission of raw and processed images, including overlays and calibration data, between vehicles and servers for analysis and feedback. EX1009 ¶¶[0027], [0030], [0052], [0075], [0138]; EX1003 ¶308.

A POSA would combine these teachings to enable distributed processing, remote annotation, and fleet-wide calibration consistency. Tal's networked pipeline distributes Westmacot's annotated images and parameters for training and calibration, extends its UI for collaborative editing, and returns recalculated parameters (e.g., height, offset, horizon line) to the vehicle, closing the calibration loop. EX1008 FIGs. 6 (408), 25 (412); EX1009 ¶¶[0027], [0030], [0052], [0075], [0138]; EX1003 ¶309.

Westmacot's annotated outputs, confined to internal modules (e.g., 410, 416), are ideal for ML pipelines. EX1003, ¶311 Tal teaches transmitting these over wireless or cellular networks for centralized aggregation, distributed annotation, and calibration consistency—routine by the priority date. Integrating Tal's transmission framework would predictably enhance scalability and accuracy.

EX1009 ¶¶[0027], [0030], [0052], [0059], [0063], [0075], [0138]; EX1003 ¶¶310, 312.

Both references operate in the same field, autonomous-vehicle image processing and calibration, and complement each other: Westmacot generates the annotations; Tal enables their remote refinement. Their combination is the "predictable use of prior art elements according to their established functions." KSR, 550 U.S. at 417. Nothing teaches away, and a POSA would have every expectation of success. EX1003 ¶¶313-315.

B. Independent Claim 1

1. [1Pre] "A method comprising"

Westmacot discloses a method in autonomous vehicle contexts: vehicle-mounted cameras capture roadway frames; the system overlays horizon/lane lines, permits user adjustment, and updates camera/reference parameters based on those adjustments, mapping directly to the steps of claim 1. EX1003 ¶316; EX1008, Background; First/Second Aspects; FIGs. 3, 7, 15, 30–32.

2. [1A] "receiving an image of a roadway recorded by a camera device installed within a vehicle"

Westmacot discloses this element. EX1003, ¶317.

Westmacot explains that "training images are like the images that will be seen from cameras in the autonomous vehicle" and are annotated to mark the road surface or lane pixels. EX1008, 3. It further teaches "a method of annotating frames of a time sequence of frames captured by at least one travelling vehicle" and "receiving a time sequence of images as captured by an image capture device of a travelling vehicle." EX1008, 1, 5, 9, 14, 68, 11; EX1003, ¶¶318-319. Westmacot also provides a concrete example: roadway videos "captured with a standard Nextbase 402G Professional dashcam … mounted on the inside of the car windscreen, roughly along the centre line of the vehicle." EX1008, 1, 5, 9, 14, 68, 11. Figure 3 shows "vehicle 300 … compris[ing] an image capture device 302" feeding images to processor 304 and memory 306. EX1008, FIGs. 3, 7, 15, 30–32; EX1003, ¶320.

Accordingly, Westmacot discloses "receiving an image of a roadway recorded by a camera device installed within a vehicle." EX1003, ¶321.

3. [1B] "detecting a horizon line in the image"

Westmacot discloses this element. EX1003, ¶¶322-330.

Westmacot explains that the road surface normal vector can be projected onto the image plane "to provide a line across the image that would match the horizon … (the 'horizon line' as that term is used herein)." EX1008, 44, FIG. 16; EX1003, ¶323. It further states that camera orientation is estimated from roadway geometry: "the vector difference xt+1 — xt-1 lies (approximately) parallel to the vehicle's longitudinal axis … to estimate the angular offset of the camera 302 relative to the vehicle 300," EX1008, 43, which is detection of the horizon line for pitch reference. EX1003, ¶324.

Westmacot also describes estimating "a 3D location of the camera 302 at the time that image was captured," EX1008, 37, which a POSA would understand requires horizon alignment to map 2D image coordinates to 3D world coordinates. EX1003, ¶¶325-329. Finally, Westmacot explains that horizon detection enables automatic lane annotation: "it is possible to fully automatically generate annotation of the lane … using only images captured from a low-cost and un-calibrated image capture device." ," EX1008, 48. Accordingly, Westmacot discloses "detecting a horizon line in the image." EX1003, ¶330.

4. [1C] "overlaying a line on the image to generate an overlaid image"

Westmacot discloses this element. EX1003, ¶¶331-337.

Westmacot teaches overlaying annotation lines on roadway images for user display. The rendering component "can render … captured images … overlaid with … annotation data A(n)," EX1008, 51, and Figure 6 shows lane boundaries R1 and R2 projected onto the image for user adjustment. The "annotation interface … provides a human annotator with the ability to view the frames … with the currently rendered lanes projected … [which] can be widened, narrowed and moved … Immediate feedback is provided via projection in the 2D camera view." EX1008, 35.

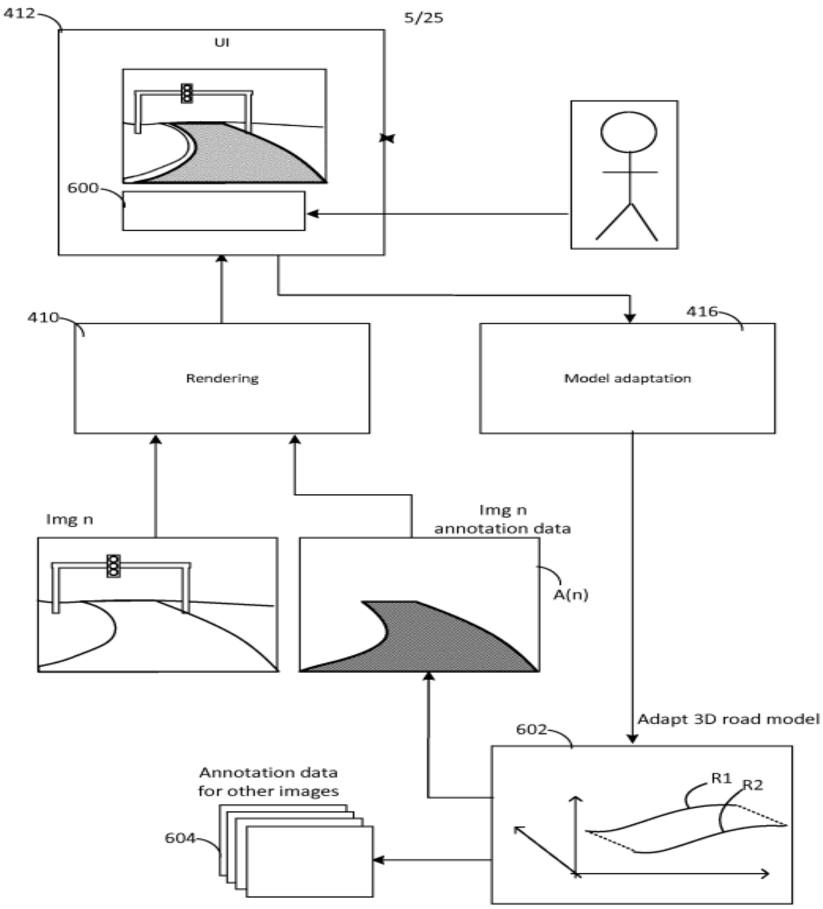

FIG. 6

EX1008, FIG. 6.

Figure 25 likewise shows captured images with annotations for road, ego-lane, and lane instance. EX1008, 24.

EX1008, FIG. 25.

Westmacot also identifies the horizon line as an overlaid feature: "the plane … perpendicular to this road surface normal vector … will provide a line … that would match the horizon." EX1008, 46, FIG. 16. It further teaches projecting the 3D road model into the image plane so "those images can be efficiently annotated … [and] … overlaid on the displayed image." EX1008, 73.

Accordingly, Westmacot discloses overlaying horizon and lane lines on roadway images to generate overlaid images. EX1003, ¶337.

5. [1D] "transmitting the overlaid image to a computing device over a network"

Westmacot in view of Tal renders this element obvious. EX1003, ¶¶338-346.

a. Westmacot

Westmacot discloses creating and storing roadway images with overlaid annotations, but does not expressly transmit them over a network. Westmacot teaches that "the processor 304 receives the captured images from the image capture device 302, and stores them in a memory 306, from which they can be retrieved for use," and that "the annotation data may be displayed with the image (e.g. overlaid on the image)" EX1008, 23, FIGs. 3, 6, 25. Its rendering component "can render … captured images … overlaid with … annotation data A(n)," and annotation data is stored in electronic storage 414 "from which it can be accessed or retrieved." EX1008, 35. Thus, annotated images exist digitally within Westmacot's system. EX1003, ¶339.

b. Tal

Tal complements Westmacot by teaching network transmission of annotated images through a bidirectional vehicle-vision pipeline. Vehicle-mounted cameras capture "digital images 16," and either "unprocessed image(s) 16" or "resultant processed image data 20" are sent to a server in real time. EX1009 ¶[0027]; EX1003 ¶341. Tal emphasizes two-way communication: processed image data and sensor data "is transmitted to the server 107 as object data 21," while unprocessed images may also be sent for server-side processing. EX1009 ¶¶[0099], [0101]; EX1003 ¶341.

Server processing performs neural inference to produce "bounding boxes 1002, polygons 1003, masks 1004, and landmarks 1005" as part of the processed image data, i.e., annotated imagery. EX1009 ¶[0114]. The server then "communicate[s] with Client(s) 1208 … allow[ing] users to handle the incidents 12 using a user interface 1209," displaying results in map, list, or gallery views. EX1009 ¶¶[0138], [0148]–[0153].

In sum, Tal discloses a feedback loop where raw or partially processed images are uploaded to the server, further processed, and the annotated results returned to client devices (including the vehicle). A POSA would recognize this as a conventional mechanism for transmitting overlaid images and related data in autonomous-driving systems. EX1003 ¶¶342-343.

c. ***KSR***

A POSA would have known *how* and *why* to combine these complementary teachings. Section VII.A; EX1003, ¶344. Westmacot generates and stores annotated images. Tal teaches transmitting such images across wireless/cellular networks. Network-based sharing of annotated images was standard in autonomous driving pipelines for training, validation, and review. Applying Tal's routine transmission mechanisms to Westmacot's digital overlays would have been the predictable use of known techniques, with a reasonable expectation of success. Section VII.A; EX1003, ¶¶345-346.

Accordingly, Westmacot in view of Tal renders obvious "transmitting the overlaid image to a computing device over a network."

6. [1E] "receiving a modification of the line from the computing device, the modification comprising a new line at a second position"

Westmacot in view of Tal renders this element obvious. EX1003, ¶¶347-358.

a. Westmacot

Westmacot teaches user-driven modification of overlaid lines via its annotation interface (UI 412): "the user can modify the annotation data A(n) … to better align the assumed lane boundaries R1, R2 with the actual lane boundaries." EX1008, 33, 37, FIGs. 6, 18–25. Such edits generate "a new line at a second position" that propagates through the dataset. Westmacot also overlays the horizon line: "the plane … perpendicular to this road surface normal vector … provide[s] a line … that would match the horizon." EX1008, 46, FIG. 16. A POSA would have recognized the same modification mechanism applies to horizon lines as to lane lines. EX1003, ¶350. Thus, Westmacot supplies the "what": user-generated line modifications that create a new line position, but does not expressly disclose the network-based receipt of the user's line modification.

b. Tal

Tal supplies the how: "over a network." Tal reinforces Westmacot by teaching a bidirectional vision pipeline where vehicle cameras capture "digital images 16" and transmit either "unprocessed image(s) 16" or "processed image data 20" to a server. EX1009 ¶[0027]. The server receives "processed image data 20 and sensor data 17 … as object data 21," performs inference to generate "bounding boxes 1002, polygons 1003, masks 1004, [and] landmarks 1005," and communicates results to client devices via a user interface. EX1009 ¶¶[0099], [0101], [0114], [0138], [0148]–[0153]. In short, Tal discloses a feedback loop where raw or processed images are sent to the server and annotated results returned, i.e., conventional mechanisms for transmitting overlaid images in AV systems. EX1003 ¶351.

c. ***KSR***

Sending Westmacot's edited line through Tal's channel so the peer node receives that modification is a predictable combination of complementary teachings. It is simply applying a known technique in an analogous context: Westmacot's edits (endpoints, deltas, spline coefficients, or a replace-line message) are routine payloads Tal already carries. A POSA would be motivated by scalability (server offload), collaboration/consistency (shared remote annotation), and seamless cloud integration, and would reasonably expect success, yielding exactly the claimed receipt of a modified line at a second position. Section VII.A.

Accordingly, the combination renders obvious "a new line at a second position." EX1003, ¶¶352-358.

7. [1F] computing a camera parameter based on the new line

Westmacot in view of Tal renders this element obvious. EX1003, ¶¶359-367.

a. Westmacot

Westmacot discloses computing camera parameters from the geometry of detected or modified lines. Westmacot's "parameter computation component 408" calculates values such as camera height (H), lateral offset (S), forward point, horizon line, and lane width (W), all derived from roadway line geometry. EX1008, 34–37, 42–49, FIG. 3. These parameters update when lane boundaries are adjusted to keep the 3D road model consistent with captured images, for example, adjusting lane width W adapts the road model and automatically propagates new annotations. EX1008, 37. Westmacot also explains that camera orientation is derived from lane tangents, the horizon line from intersecting the road-surface normal with the image plane, and camera height/offset from reconstructed road geometry. EX1008, 29–30, 34–35, 39–40, 47, FIGs. 15–16. Recalculating camera parameters obviously follows directly from line modifications. EX1003, ¶¶360-361. But Westmacot does not expressly disclose distributing and recomputing calibration data across a network.

b. Tal

Tal expressly teaches distribution, so even if PO argues Westmacot computes calibration locally, Tal teaches performing those computations remotely and sharing results across the network. Specifically, Tal discloses transmitting roadway imagery and detection/overlay data from the in-vehicle device to a remote server, either as "unprocessed image(s) 16" or "processed image data 20", over wireless or cellular links. EX1009, ¶¶[0027], [0030], [0052], [0075]). At the remote site, the server processes the received images to produce calibration-related outputs or modified image information, which can be accessed via a web application for annotation, calibration, or review. EX1009, Summary, FIG. 12, ¶[0138]. These teachings confirm a distributed calibration framework in which remote operations complement Westmacot's local computations and make results available back to the vehicle or use. EX1003, ¶362.

c. *KSR*

A POSA would have known *how* and *why* combining these disclosures is a routine application of known distributed processing. The motivations are clear: (i) verification and consistency across systems, (ii) reduced onboard processing load, and (iii) enabling human-in-the-loop calibration with remote updates returned in real time. EX1003, ¶¶363-367.

Accordingly, Westmacot discloses computing camera parameters from line geometry, and in view of Tal, it would have been obvious to implement this in a networked architecture where recalculations occur locally or remotely, the combination being nothing more than the predictable use of known techniques yielding updated parameters from new line positions. Section VII.A; *KSR*, 550 U.S. at 416; *Wyers*, 616 F.3d 1231, 1240 (Fed. Cir. 2010) ("[O]bviousness may be found where a combination of familiar elements according to known methods yields no more than predictable results."); EX1003, ¶367.

8. [1G] transmitting data representing the camera parameter to the camera device.

Westmacot in view of Tal renders this element obvious. EX1003, ¶368.

a. Westmacot

Westmacot computes camera parameters (height H, offset S, lane width W, forward point, horizon line, orientation) using its "parameter computation component 408" and shares them with model adaptation 410, rendering 416, and UI 412 to update the 3D road model. EX1008, 34–37, 42–49, FIGs. 3, 6, 25, 30–32. PO may argue Westmacot does not expressly disclose transmitting parameters back to the camera device (302). Tal fills this gap. EX1003, ¶369.

b. Tal

Tal teaches a two-way, networked pipeline for image-derived calibration data: "digital images 16 … and … resultant processed image data 20 … [are] transmitted to the server 107," EX1009, ¶[0027]; processing may be on-device, on the server, or shared "in FIG. 4 … shared/distributed processing environment 400," with "the server 107 … organizing, storing, processing and disseminating … object data 21," EX1009, ¶¶[0030], [0138]. It further clarifies that "some or all of image adjustment may be performed on the vehicle" and a "second portion … on the server 107," yielding "bandwidth transmission savings" when only refined outputs are returned. EX1009, ¶¶[0052], [0075]. Thus, Tal supplies the missing implementation for computing calibration remotely and returning results to the originating camera device. EX1003, ¶370.

c. *KSR*

A POSA would have known *how* and *why* to extend Westmacot's internal parameter sharing to the camera device using Tal's feedback loop. The benefits are clear: enabling self-calibration. EX1009, ¶[0063]), reducing onboard load through distributed processing, and ensuring consistent results. EX1003, ¶¶371-374. This is a predictable use of known techniques with a reasonable expectation of success. Section VII.A; EX1003, ¶375.

C. Claim 2

Claim 2 recites that the “camera parameter comprises one of camera height, viewing angle, and road plane normal.” Westmacot discloses all three. EX1003 ¶¶376-377.

Camera height: Westmacot computes “the height H of the camera 302 above the road,” either measured directly or derived from a reconstructed surface mesh averaging the camera path’s height. EX1008, 28, 32, 34, 47, FIGs. 3, 3A, 5; EX1003 ¶378.

Viewing angle: The system captures camera orientation as a “forward point” and “horizon line,” where the forward point is “the pixel the car appears to head toward” and the horizon line derives from the road-surface normal projected onto the image plane. EX1008, 35, 42–43, 46; EX1003 ¶379.

Road plane normal: Westmacot estimates the road normal n by taking the cross product of motion vectors in the road plane. EX1008, 28, FIG. 27; EX1003 ¶380.

Thus, Westmacot calculates camera height, viewing angle, and road plane normal as part of its calibration process, satisfying claim 2. EX1003 ¶381.

D. Claim 3

Claim 3 recites “receiving an image of the roadway while the vehicle is moving.” Westmacot discloses this. EX1003 ¶382.

Westmacot teaches “receiving a time sequence of two-dimensional images … captured by an image capture device of [a] travelling vehicle” to “reconstruct … a path travelled by the vehicle.” EX1008, 5, 9. Figure 3 shows “vehicle 300 … used to capture road images … frames of short video segments recorded as the vehicle drives along a road.” EX1008, 24. The system relies on imagery captured in motion, “driving the car is itself a form of annotation,” and uses dashcam videos filtered to include “only frames … at least 1m apart according to GPS.” EX1008, 20–21, 24.

Thus, Westmacot teaches receiving roadway images while the vehicle is moving, satisfying claim 3. EX1003 ¶383.

E. Claim 4

Claim 4 recites that “receiving the image of the roadway while the vehicle is moving comprises detecting that the vehicle is traveling above a pre-defined speed or for a pre-defined duration.” Westmacot in view of Tal renders claim 4 obvious. EX1003, ¶384.

Westmacot filters images so frames are captured only when the vehicle is moving: “to remove parts where the car moves very slow or stands still … only frames that are at least 1m apart according [to] GPS are included.” EX1008, 24. A POSA would recognize this distance cutoff as equivalent to applying a minimum speed or duration threshold, since fixed-interval sampling excludes idle or low-speed periods. EX1003 ¶385.

It would have been obvious to use speed or time thresholds instead of distance, as autonomous driving systems routinely gated imagery using telemetry (distance, speed, or time) to exclude non-driving frames. EX1003 ¶¶386–387.

Even if not express in Westmacot, Tal confirms this by transmitting roadway images with telemetry including position, speed, and motion data. EX1009 ¶¶[0027], [0030], [0052], [0075], [0138].

A POSA would have known *how* and *why* to combine Westmacot’s distance-based filtering with Tal’s speed/time metadata to ensure images reflect meaningful driving conditions, thereby improving calibration accuracy, training consistency, and system efficiency. EX1003 ¶¶389–392.

F. Claim 5

Claim 5 recites that transmitting the overlaid image comprises transmitting it to a web-based application. Westmacot in view of Tal renders this claim obvious. EX1003, ¶393.

Westmacot discloses capturing roadway images, overlaying annotation data, and transmitting that data within its system for training and calibration. EX1008

FIG. 3 (UI 412; rendering 416; storage 414). While it produces digitized overlaid images suitable for transmission, it does not expressly explain how end users access them. EX1003 ¶¶394–395.

Tal fills this potential gap by teaching that transmitted images are accessible via a web interface: servers "serve as gateway to users via web access and present data … in a meaningful and intuitive manner," and users may log in through "a user interface … either a web application … or a client/server application." EX1009 Summary, ¶[0138], FIG. 12; EX1003 ¶¶396-397.

A POSA would have known *how* and *why* to combine. EX1003 ¶¶398–402. Westmacot provides annotated images; Tal offers the conventional web-based mechanism for distributing and viewing them. By the priority date, web delivery was standard for remote collaboration, offering scalability, platform independence, and low deployment cost. Integrating Tal's web interface into Westmacot's image pipeline would predictably enhance accessibility, support distributed annotation, and streamline training.

Thus, applying Tal's web-access model to Westmacot's system represents a routine, predictable improvement with a reasonable expectation of success, rendering claim 5 obvious. EX1003 ¶403.

G. Claim 6

Claim 6 recites receiving “an identification of a new horizon line from the computing device.” Westmacot in view of Tal renders this obvious. EX1003, ¶404.

Westmacot teaches automatic horizon-line computation by projecting the road-surface normal onto the image plane. EX1008, 46, FIG. 16; EX1003, ¶¶405-406. It notes that parameters may require manual correction during the “human fixer” stage. EX1008, 49. Its annotation interface (UI 412) allows users to adjust roadway feature lines such as lane boundaries, with edits propagated through the 3D road model. EX1008, 35, 51, FIGs. 6, 25. A POSA would recognize that the same mechanism applies to correcting the horizon line—user adjustments in the interface would similarly update the overlay and trigger parameter recalculation to maintain consistent camera calibration. EX1003 ¶407.

Even if not express, Tal reinforces this by teaching that roadway images and calibration parameters are presented through computing-device interfaces for user input, e.g., “device 101 … [with] user interface 119 … display … orientation … settings, parameters.” EX1009, UI 119, ¶[0138], ¶[0035]; EX1003, ¶408. Tal describes manual roadway-feature identification on tablets and smartphones, confirming such interactions were conventional.

A POSA would have known *how* and *why* to combine, extending Westmacot’s interface from lane-line edits to horizon-line adjustment. Both are geometric calibration primitives, and enabling horizon-line correction would predictably reduce pitch misalignment and improve accuracy. EX1003 ¶¶409–414.

Accordingly, Westmacot in view of Tal renders claim 6 obvious as a straightforward application of known techniques with a reasonable expectation of success. EX1003 ¶414.

H. Claim 7

Westmacot in view of Tal renders claim 7 obvious. EX1003, ¶415.

Westmacot's component 408 computes and updates camera parameters (height H, offset S, orientation, lane width W) when line geometry is adjusted—e.g., "a user can adjust … W … [and] the annotation data … [is] automatically adapted." EX1008, 34–35, 49, FIG. 4; EX1003 ¶¶416-417.

Even if not express, Tal teaches a bidirectional pipeline where raw or processed imagery and calibration data are exchanged between vehicles and servers. EX1009 ¶¶[0027], [0030], [0052], [0075], [0138], FIG. 12; EX1003, ¶418.

A POSA would have combined these teachings. EX1003 ¶419. Westmacot shows parameter recalculation following line edits, while Tal shows bidirectional data transmission. Together, they suggest transmitting recalculated parameters back to the vehicle, completing the calibration loop. The motivations are clear: (i) calibration feedback: updating camera settings or embedding metadata (EX1009 ¶[0063]); (ii) consistency: servers distributing recalculated parameters across devices (EX1009 ¶¶[0027], [0030], [0052], [0075]); and (iii) predictability: feedback loops returning calibration data were conventional by the priority date. EX1003 ¶¶419–423.

Accordingly, combining Westmacot and Tal renders claim 7 obvious as a routine application of known elements with a reasonable expectation of success. EX1003 ¶¶419–423; Section VII.A.

I. Claims 8-20 are obvious over Westmacot and Tal.

Claims 8-20 are obvious over Westmacot and Tal. EX1003, ¶¶424-425. These claims merely restate the substantive limitations of claims 1-7 in alternative statutory forms, i.e., as computer-readable medium and device claims. Accordingly, because claims 8-20 add no substantive limitations beyond those already rendered obvious by Westmacot in view Tal for claims 1-7, they too are obvious. EX1003, ¶425.

IX. NO OBJECTIVE INDICIA OF PATENTABILITY

Petitioner is unaware of any objective indicia of non-obviousness. If PO alleges objective indicia in its POPR, Petitioner requests a response.

X. MANDATORY NOTICES

A. Real Party in Interest

Petitioner Samsara Inc. ("Samsara") is the only real party-in-interest.

B. Related Matters

Motive asserted the '276 patent in the Northern District of California (Case No. 3:24-cv-00902) in an amended complaint filed on July 9, 2025. EX1013. In the same amended complaint, Motive also asserted U.S. Patent No. 12,062,243 (the "'243 Patent"). The '276 patent is a child of the '580 patent. An IPR trial (IPR2025-00574) was instituted against the '580 patent on August 27, 2025.

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XI. GROUNDS FOR STANDING

Samsara certifies the ’276 patent is available for IPR and that Samsara is not barred or estopped from requesting IPR of the ’276 patent challenging the patent claims on the grounds identified in this Petition.

XII. CONCLUSION

Grounds 1, 2, 3A/B, and 4 show that the ’276 patent inventors did not originate calibrating vehicle-mounted cameras using horizon lines, lane lines, or human-in-the-loop annotation, nor were they first to disclose recalculating camera parameters when those lines are modified. Such calibration methods, including automatic horizon and lane detection, operator correction of overlays, and parameter updates, were well known long before the ’276 patent’s priority date. The Board should therefore institute inter partes review and cancel the challenged claims.

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITATION, TYPEFACE REQUIREMENTS, AND TYPE STYLE REQUIREMENTS

1. This Petition complies with the type-volume limitation of 14,000 words, comprising 13,930 words, excluding the parts exempted by 37 C.F.R. § 42.24(a).

2. This Petition complies with the general format requirements of 37 C.F.R. § 42.6(a) and has been prepared using Microsoft® Word in 14-point Times New Roman.

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CERTIFICATION OF SERVICE (37 C.F.R. §§ 42.6(e), 42.105(a))

The undersigned hereby certifies that the above-captioned **PETITION FOR *INTER PARTES* REVIEW OF U.S. PATENT NO. 12,136,276** and all supporting exhibits were served via FedEx Express® on October 17, 2025, in their entireties on the following:

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