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

DECLARATION OF SCOTT ANDREWS

I, Scott Andrews, do hereby declare and state as follows:

I. BACKGROUND AND QUALIFICATIONS

1. I am currently a consultant for Cogenia Partners, LLC, focusing on systems engineering, business development, and technical strategy supporting automotive and information technology. I have been in this position since 2001.

2. I have acted in various roles as a technical expert and consultant in many areas involving automotive systems. For example, I was a technical consultant for a sensor-supplemented message validation system for vehicle-to-vehicle communication-based collision warning/avoidance systems in a project sponsored by the U.S. Dept. of Transportation's National Highway Traffic Safety Administration (NHTSA). I served as the technical lead on a project to develop requirements for connected vehicle safety systems in preparation for NHTSA regulations governing such systems. I also serve as a technical consultant on multiple projects sponsored by the Federal Highway Administration (FHWA) related to connected vehicle technology research.

3. I have over 30 years of professional experience in the field of automotive technologies and systems, including vehicle sensor systems and vehicle safety and control systems. Further, I have authored numerous published technical papers and am a named inventor on 11 U.S. and foreign patents.

4. I received a Bachelor of Science degree in Electrical Engineering

from University of California, Irvine in 1977 and a Master of Science degree in Electronic Engineering from Stanford University in 1982.

5. From 1977 to 1979, I worked at Ford Aerospace where I designed, tested and delivered microwave radar receiver systems.

6. From 1979 to 1983, I worked at Teledyne Microwave, where I developed high reliability microwave components and developed CAD tools.

7. From 1983 to 1996, I worked at TRW, Inc., having held various positions. Specifically, from 1983 to 1985, I was a Member of the technical staff and a Department Manager in the Space Electronics sector. Between 1985 and 1990, I was also a project manager working on various communications systems projects including the U.S. Department of Defense Advanced Research Projects Administration (then ARPA, and now DARPA) MIMIC Program. Between 1990 and 1993, I was also the Manager of the MMIC (monolithic-microwave-integrated-circuit) Products Organization. In this role, I developed business strategy and managed customer and R&D programs. During this time, I also developed the first single chip 94 GHz Radar, used for automotive cruise control and anti-collision systems. In 1993, I transferred to the TRW Automotive Electronics Group, and managed about 30 engineers in the Systems Engineering and Advanced Product Development organization. In this role, I managed advanced development programs such as automotive radar, adaptive cruise control, occupant sensing,

automatic crash notification systems, in-vehicle information systems, and other emerging transportation products.

8. I was employed as a Project General Manager in the Electronics Division of Toyota Motor Corporation. I worked at Toyota headquarters in Toyota City, Japan from April 1996 to around April 2000. Between July 1999 and April 2000, I transitioned from working in Japan to working in a Toyota office in San Jose, CA. In this position, I was responsible for leading the development of vehicle telematics systems, infotainment systems, including on-board and off-board navigation systems, traffic information systems, vehicle communications systems, safety applications, and automated vehicle control systems.

9. In 1998, I founded the Automotive Multimedia Interface Collaboration, a consortium of car makers developing standards for in-vehicle computing and interfaces between consumer multimedia systems and consumer electronics devices. This work resulted in a variety of standards for vehicle interfaces, user interfaces and vehicle software management that were eventually transferred to other standards organizations such as ISO and the OSGi Alliance.

10. In the various positions mentioned above, I was responsible for research and development projects relating to numerous vehicle information systems, user interface systems, sensory systems, control systems and safety systems, and also had the opportunity to collaborate with numerous researchers

and suppliers to the auto industry. I therefore believe that I have a detailed understanding of the state of the art during the relevant period, as well as a sound basis for opining how persons of skill in the art at that time would understand the technical issues in this case.

11. In 2000, I founded Cogenia, Inc. to develop enterprise class data management software systems. I served as the company's Chief Executive Officer until 2001, when I created Cogenia Partners, my current consulting firm.

12. A copy of my *curriculum vitae* is attached hereto, and it includes a listing of my prior experience in litigation matters as an expert.

II. ASSIGNMENT AND MATERIALS CONSIDERED

11. I submit this declaration in support of Motive Technologies, Inc.'s Patent Owner Preliminary Response to Samsara Inc.'s Petition for *inter partes* review of U.S. Patent No. 12,136,276 ("the '276 patent").

12. I am not an employee of Motive Technologies or of any affiliate or subsidiary thereof.

13. My consulting firm, Cogenia Partners, LLC, is being compensated for my time at a rate of $800 per hour.

14. My compensation is in no way dependent upon the substance of the opinions I offer below, or upon the outcome of the petition for *inter partes* review.

15. I have been asked to provide certain opinions relating to the patentability of the ’276 patent and the viability of the grounds presented in the Petition. Specifically, I have been asked to provide my opinion regarding (i) the level of ordinary skill in the art to which the ’276 patent pertains and (ii) whether any grounds in the Petition show any basis to find claims 1-20 of the ’276 patent unpatentable as being obvious in view of the prior art asserted in the Petition.

16. Given the preliminary nature of the Patent Owner’s Preliminary Response, the opinions expressed in this declaration are not exhaustive of my opinions on the patentability of claims 1-20 of the ’276 patent. Therefore, the fact that I do not address a particular point should not be understood to indicate any opinion on my part that any positions advanced by Petitioner or its expert are meritorious.

17. In forming my opinions, I have reviewed the Petition, including its exhibits, the declaration of Dr. Trevor Darrell in support of the Petition, the ’276 patent disclosure (including materials incorporated by reference) and its prosecution history, as well as the following patents and publications:

a) U.S. Publication No. 2020/0410704 to Choe *et al.* (“Choe,” Ex. 1005);

b) U.S. Publication No. 2014/0240500 to Davies (“Davies,” Ex. 1007);

c) PCT Publication No. WO 2019/175286 to Westmacot (“Westmacot,” Ex. 1008);

d) U.S. Publication No. 2022/0019829 to Tal ("Tal," Ex. 1009); and

e) PCT Publication No. WO 2009/027090 to Kuehnle ("Kuehnle," Ex. 1010).

III. OVERVIEW OF THE '276 PATENT AND ITS PROSECUTION

18. The '276 patent is a continuation of an application (No. 17/493,011) that matured into U.S. Patent No. 11,875,580. The inventors of the '276 patent described that is common to use automotive sensors for detection of objects on the road, but in situations where multiple cameras or sensors, such as Lidar or Radar are needed, cost can become an issue. Ex. 1001 at 1:17-24. The inventors further noted that monocular (*i.e.*, single lens, single field of view) cameras can also be used, but these "require[d] the location of the camera to be predefined or preset." *Id*. at 1:21-24.

19. The '276 patent describes embodiments for "using a monocular camera (*e.g.*, an image sensor) that may be retrofitted and adjustable within the vehicle such as, the vehicle's dashboard." *Id*. at 1:28-31. "Upon driving, the camera initializes itself to determine its height with respect to the ground as well as a road plane normal. Thus, the camera may be installed in various positions and later re-initialized or recalibrated as needed." *Id*. at 1:31-34.

20. The method may, for example, be used to provide "a network-based initialization system." *See e.g., id*. at 1:44-59. The specification describes that:

> [A] server-side system receives a video comprising a set of image frames and identifies one or more lines in the video using a predictive model (e.g., a convolutional neural network). In one embodiment, the lines can include a horizon line. After identifying the horizon line, the system computes some camera parameters (e.g., height, viewing angle, road plane normal, etc.) based on the horizon line. The system then overlays the computed horizon line on the video and transmits it to an annotator device for manual review. In response, the annotator device can transmit a confirmation indicating the horizon line was accurate. In some embodiments, the annotator device can reject the horizon line and manually add the horizon line. Once the horizon line is confirmed, the system returns the camera parameters to the calling party (e.g., a camera onboard a vehicle).

Id.

21. Such a network-based camera initialization service provides a robust approach to initializing dash-cams in a reliable way using “a remote computing device executing the camera initialization service 232,” for example, “an application running on a remote server.” *See e.g., id*. at 5:21-28.

22. In connection with Figure 2 of the ’276 patent (reproduced below), the specification describes a remote or network-based initialization service wherein the in-vehicle camera sends a video to a network-based initialization service 232. For example:

> FIG. 2 is a swim lane diagram illustrating a method for initializing a camera according to some embodiments.

> In process 202, a device 230 (e.g., a camera and processor installed in a vehicle) captures a video, represented as, for example, a set of one or more images. In an embodiment, process 202 can include capturing a sequence of frames.

Id. at 4:66-5:4.

> Once process 202 records a video of the preset duration, it transmits a camera initialization event to a camera initialization service 232 in transmission 204.

Id. at 5:21-23.

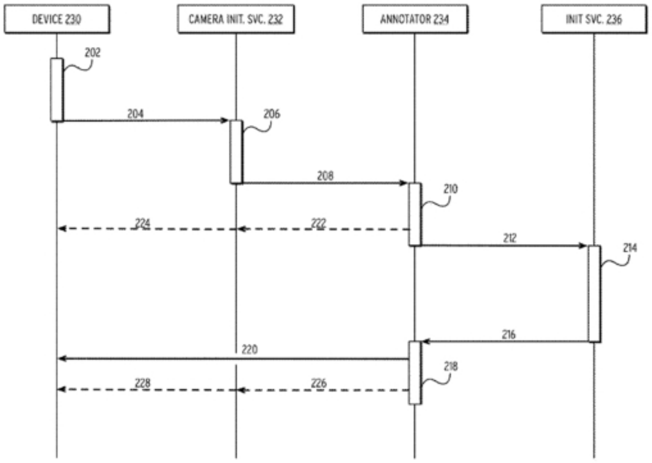

FIG. 2

Id. at Fig. 2.

23. Service 232 determines various features in the video such as lane lines and horizon lines, which are then overlaid on the video.

> In the illustrated embodiment, the camera initialization service 232 can comprise a remote computing device executing the camera

> initialization service 232. For example, the camera initialization service 232 can comprise an application running on a emote server.

Id. at 5:23-28.

> In process 206, the camera initialization service 232 receives the video transmitted in transmission 204. In an embodiment, the camera initialization service 232 can comprise a remote endpoint configured to receive network requests and process the request body (i.e., the video). In an embodiment, the camera initialization service 232 detects lane and horizon lines in the video using a predictive model, such as a deep learning or other AI model.

Id. at 5:29-33.

> In general, the model can output a set of lane and horizon lines identified by key points or markers. In one embodiment, if process 206 can detect at least two lanes (e.g., identified by three independent lane lines), process 206 can further include computing camera parameters for the device 230 that recorded the video. Further detail on computing camera properties based on detected lane lines is provided in commonly-owned application Ser. No. 17/173,950, filed Feb. 11, 2021, and incorporated by reference in its entirety. As one example, process 206 can predict the camera height, viewing angle, and road plane normal.

Id. at 5:43-55.

24. This overlaid video is then provided to an annotator 234, wherein a human operator verifies, and if necessary corrects the overlaid lane lines and

horizon line, and passes the corrected overlaid video to an initialization service 236 which determines, using the corrected lane lines and horizon lines, the camera initialization parameters, specifically the height of the camera from the road plane, and the pitch, yaw, and roll angles relative to the road plane normal.

> In an embodiment, process 206 overlays the computed lane and horizon lines on the original video file, generating an overlaid video file. An example of such an overlaid video file is provided in FIG. 3C. … Process 206 can then transmit this overlaid video file to an annotator device 234 in transmission 208

Id. at 5:56-64.

> In an embodiment, the annotator device 234 can comprise a workstation or web-based application allowing for human review of automatically detected horizon and lane lines. When the annotator device 234 receives an overlaid video file, process 210 presents the overlaid video file to the human annotator. The process 210 then requests that the human annotator confirm the lane lines (if present) and horizon in the overlaid video file. If the annotator confirms the overlaid lines, the annotator can accept the lines and transmit its acceptance back to the camera initialization service 232 in transmission 222. In response, the camera initialization service 232 can then transmit the generated camera parameters back to the device 230 in transmission 224.

Id. at 6:6-19.

25. These calibration parameters are then used to transform subsequent video data so that it can be used to accurately determine lane widths, object

locations, and such, for example, as described in connection with Figure 7 (reproduced below):

> FIG. 7 is a flow diagram illustrating a method for initializing a camera installed in a vehicle according to some embodiments of the disclosure. As described above, the method may only need be performed once per camera or can be performed on demand (e.g., in response to a change in camera orientation or angle) as part of a recalibration or reinitialization procedure.

Id. at 14:14-20.

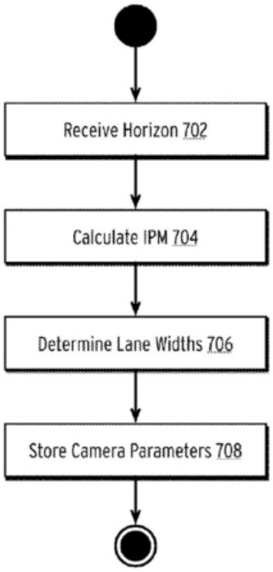

FIG. 7

Id. at Fig. 7.

> In step 702, the method receives a horizon line detected using a CNN or similar model. As discussed above, in some embodiments, the horizon line can be determined by a local neural network (as in FIGS. 3A and 3B) or via a remote data source (as in FIG. 2). In step 704, the

> method computes the IPM for a camera and rectifies the sample images. In an embodiment, step 704 comprises computing a road plane normal vector (ii) using an intrinsic camera matrix (K) and the detected horizon (lh) according to:
>
> $n=K^T l_h$ (Equation 1)
>
> where K^T comprises the transpose of the intrinsic camera matrix. In an embodiment, the intrinsic camera matrix comprises the geometric properties of the camera. After computing the plane normal (n), the method computes the IPM (H) using:
>
> $H=KRK^{-1}$ (Equation 2)
>
> where H is the rectification homography which will rotate the camera view to align its Z-axis with the road plane normal, and R is the rotation matrix defined by:
>
> $R=[l_h \times n;\ (l_h \times n) \times -n;\ -n]$

Id. at 14:21-44.

26. During prosecution, the applicant initially cancelled original claims 1-20 and submitted a new set of claims (claims 21-40), asserting that no new subject matter had been added. Ex. 1002 at 0090-96.

27. On June 12, 2024, the examiner issued an office action rejecting claims 21-40 as being “not patentably distinct” from the claims of the parent ’580 patent, and also as being obvious under U.S. Patent Publication No. 2019/0034740 to Kwant et al. (“Kwant1”) and U.S. Patent Publication No. 2019/0102674 to Kwant et al. (“Kwant2”). *Id*. at 0119-27.

28. Among other things, the examiner asserted that Kwant1 discloses claim element 1[c], “overlaying a line on the image to generate an overlaid image,” citing to Figure 4 of Kwant1, and also discloses claim element 1[d], citing Kwant1’s disclosure of step 607 of Figure 6 wherein “the horizon estimation platform 105 labels or annotates one or more map features depicted in the image based on the horizon.” *Id*. at 0123.

29. In response, the applicant argued that while Kwant1 did determine a horizon line, there was not any sort of overlay or “visualization” of a line on the image, and thus Kwant1 did not disclose claim elements 1[c] or 1[d], that is, overlaying a line on the image, and transmitting the overlaid image to a computing device over a network. *Id*. at 0136-37.

30. The examiner also asserted that while Kwant1 did not disclose claim elements 1[e], 1[f], or 1[g], these were disclosed by Kwant2, which disclosed a “learner module” that adjusted the parameters of a prediction system to cause the predicted results to match the “ground truth.” *Id*. at 0123. (In this case, Kwant2’s predictions were associated with classifying objects in images, so a “prediction” would be what the model output as the classification, and the “ground truth” was what classification the model actually had.)

31. In response, first, the applicant argued that the modified parameters in Kwant2 were predictive model parameters, not camera parameters as claimed. *Id*.

at 0139. Second, the applicant argued that the output of Kwant2's learning process was simply a "label" (*i.e.,* the classification name: "accurate" or "not accurate"), and there was no disclosure by Kwant2 of the generation of a second horizon line as claimed:

> There is no evidence that Kwant2 receives a horizontal line, predicts a new horizontal line, and then compares the new horizontal line to a third horizontal line.

Id.

32. Following these, and other applicant remarks, the examiner allowed the claims with no further amendments. *Id*. at 0169-78.

IV. TECHNICAL BACKGROUND

33. A key element of the calibration process described in the '276 patent involves determining a horizon line in the captured image. This is important because the apparent horizon line in the image will differ from the true world horizon line because of errors in the pitch, yaw, roll, and height of the camera. It is these errors that the '276 patent camera calibration process seeks to determine, so that they can be factored out of any subsequent image analysis.

34. The '276 patent describes two approaches to detecting the horizon line. One of these is a geometric approach to calculate key points in the image that can be used to analytically determine the horizon line, and the other uses a trained neural net to detect this line in the image directly.

35. The geometric approach is useful to explain what is meant by "horizon line" in the ’276 patent. The "horizon line" claimed in the ’276 patent is the actual horizon in the captured image. For example, as described in U.S. Patent Application Ser. No. 17/173,950, filed Feb. 11, 2021 (later issued as U.S. Patent No. 11,798,187 ("the ’187 patent"), and incorporated by reference in its entirety in the ’276 patent (*see* ’276 patent at 5:49-53), the horizon line is positioned at a forward vanishing point (V) defined at the point where the parallel lane lines meet, and at least one of the two lateral vanishing points VL. For example:

> …the method initializes an estimation of a vanishing line (i.e., horizon) from these fitted lines. In one embodiment, two sets of vanishing points (VPs) are initialized: forward and lateral VPs. In one embodiment, forward VPs can be found from the cross product of the world parallel lines. For lateral vanishing points, in one embodiment, the method uses cross-ratios of three real-world parallel lines which are the lane lines. Once a set of forward and lateral VPs is found, the method use a horizon estimation algorithm to find the best fitting horizon l_h.

’187 patent at 7:10-19; *see also id*. at 7:20-59.

36. These cross ratios are illustrated in Figures 10A and 10B of the ’187 patent (reproduced below):

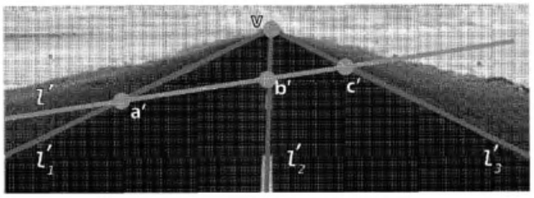

FIG. 10A

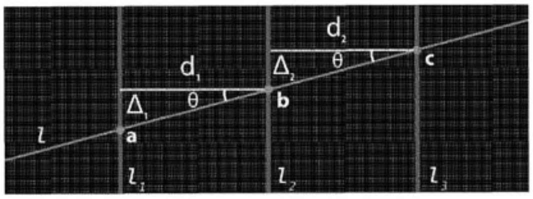

FIG. 10B

These figures also appear in a related paper authored by the inventors of the ’187 patent, titled “Real-time Vehicle Distance Estimation Using Single View Geometry” (“the Ali reference,” Ex. 2009).

37. As can be appreciated in the figures above, the horizon line will pass through the forward vanishing point V shown in Figure 10A. But with only a single (forward) vanishing point V, this line could have any arbitrary orientation (tilt or roll). The tilt of the horizon line is then determined by identifying one or two lateral vanishing points. These are determined by drawing an arbitrary diagonal line that crosses the three lane boundaries. The first line is shown as *l’* in Figure 10A. This line crosses the three lane lines defining segments a’b’, and b’c’, which exhibit a particular relationship with the separation of the lane lines (d_1 and d_2 in Figure 10B). Figure 10B is a top down view of the lane lines, wherein the

lane lines are parallel (a basic and reasonable assumption with this method). While not shown in the ’187 patent, drawing a second diagonal line that exhibits the same cross ratios as the line *l’* will define an intersection point (in this example, to the right of the forward vanishing point), and this is the lateral vanishing point. A line drawn between the forward and lateral vanishing points represents the horizon line in the image.

38. This process can be more clearly understood by reviewing Figure 8.6 (reproduced below) of Hartley and Zisserman (Ex. 2010), a textbook that is referenced in the Ali reference mentioned above. Figure 8.6 illustrates the same process using two lateral vanishing points:

8.6 Vanishing points and vanishing lines 217

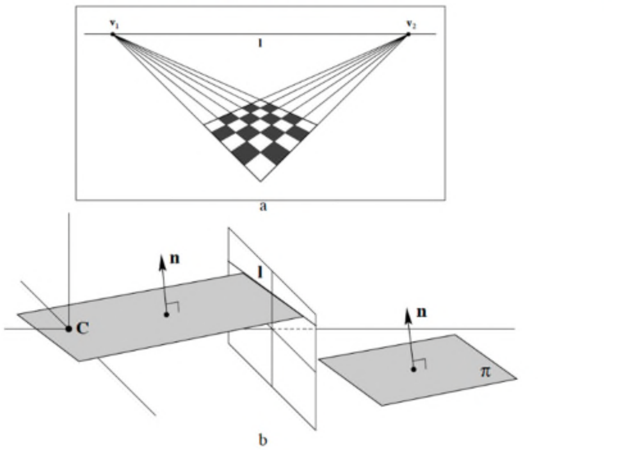

Fig. 8.16. **Vanishing line formation.** *(a) The two sets of parallel lines on the scene plane converge to the vanishing points* $\mathbf{v}_1$ *and* $\mathbf{v}_2$ *in the image. The line* $\mathbf{l}$ *through* $\mathbf{v}_1$ *and* $\mathbf{v}_2$ *is the vanishing line of the plane. (b) The vanishing line* $\mathbf{l}$ *of a plane* $\boldsymbol{\pi}$ *is obtained by intersecting the image plane with a plane through the camera centre* $\mathbf{C}$ *and parallel to* $\boldsymbol{\pi}$.

39. Importantly, the horizon line determined in this way represents the horizon as viewed from the uncalibrated camera, and thus, this line may then be used as described in the ’276 patent to determine the pitch, roll, yaw and height of

the camera so that these errors may be removed from any subsequent image analysis.

V. <u>CHALLENGED CLAIMS</u>

40. The Grounds in the Petition seek invalidation of claims 1-20 of the ’276 patent (“Challenged Claims”).

41. Claims 1, 8, and 15 are the independent claims. The elements of these claims are substantively similar, with claim 1 being directed toward a method, claim 8 being directed toward a non-transitory medium storing a computer program to carry out the same method steps of claim 1, and claim 15 directed to a device including a processor and storage medium for storing a program to carry out the same method steps of claim 1.

42. Claim 1 of the ’276 patent is reproduced below:

> A method comprising:
>
> [a] receiving an image of a roadway recorded by a camera device installed within a vehicle;
>
> [b] detecting a horizon line in the image;
>
> [c] overlaying a line on the image to generate an overlaid image;
>
> [d] transmitting the overlaid image to a computing device over a network;
>
> [e] receiving a modification of the line from the computing device, the modification comprising a new line at a second position;
>
> [f] computing a camera parameter based on the new line; and

> [g] transmitting data representing the camera parameter to the camera device.

VI. LEGAL STANDARDS

A. Claim Construction

43. In rendering the opinions set forth in this declaration, I have read the claims from the perspective of a person of ordinary skill in the art ("POSITA") at the time of the invention, in 2021. I understand that in this *inter partes* review, the claims are construed in the same manner as in district court, to have their plain and ordinary meaning in the context of the specification and prosecution history.

B. Person of Ordinary Skill in the Art

44. I understand that a hypothetical POSITA is considered to have the normal skills and knowledge of a person in a certain technical field, as of the time of the invention at issue. I understand that factors that may be considered in determining the level of ordinary skill in the art include: (1) the education level of the inventor; (2) the types of problems encountered in the art; (3) the prior art solutions to those problems; (4) the rapidity with which innovations are made; (5) the sophistication of the technology; and (6) the education level of active workers in the field. I also understand that a POSITA is a hypothetical person who is presumed to be aware of the universe of available prior art.

45. The '276 patent "relate[s] to automotive systems and to machine

learning systems for analyzing sensor data in such systems.” Ex. 1001 at 1:14-16. The problem addressed by the ’276 patent is the initialization of cameras in automotive systems. Moreover, the references relied upon in the Petition are also related to sensor systems in the automotive field. *See e.g.*, Ex. 1005 at [0001] (“disclosure relate generally to operating autonomous vehicles”); Ex. 1007 at 1823 (“[l]ane detection is of critical importance to both self-driving cars as well as advanced driver assistance systems”); Ex. 1008 (“[d]istance estimation is required for advanced driver assistance systems (ADAS) as well as self-driving cars”); Ex. 1010 at 1:13-14 (“[a] rapidly emerging technology is autonomous vehicles (Avs) that can navigate by themselves …”). Thus, some experience or training with automotive systems is needed for the appropriate level of ordinary skill in the relevant art.

46. In my opinion, in October, 2021, a POSITA of the ’276 patent would have at least a Bachelor’s Degree in Engineering or Computer Science with one or two years training and/or experience in design of software for camera/sensor systems in the automotive industry.

47. Petitioner’s proposed definition of a POSITA is limited to “machine learning (including neural network) as applied to computer vision” and “classical” machine/computer vision algorithms.” However, none of the claims of the ’276 patent relate to machine learning, neural networks, or specific elements of

machine/computer vision algorithms. Claim 1 requires the determination of a horizon line and ultimately, the determination of camera calibration parameters, but the claims do not specify the manner, or any algorithm in which those parameters are determined. Petitioner's proposed definition of a POSITA also ignores the value of any training or experience in "automotive systems," which is the main technology area of the '276 patent. In the automotive industry, the type of problems a POSITA would encounter are not the same type of problems as someone doing research or working in more generic computer vision technology. In the automotive industry, the problems that arise typically involve the application of other technologies to solve problems specific to vehicles, driving, etc. A person with the skills and background the Petitioner proposes would be more likely working in research or development of underlying computer vision algorithms or technology. Thus, in my opinion, Petitioner's proposed POSITA is not correct.

48. In sum, based on my experience, training, and education, I consider myself (both now and as of October 2021) to be a person of at least ordinary, or expert, skill in the art with respect to the '276 patent.

C. Obviousness

49. I understand that a patent claim is unpatentable and invalid if the subject matter of the claim as a whole would have been obvious to a POSITA as of the time of the invention at issue. I understand that the following factors must be

evaluated to determine whether the claimed subject matter is obvious: (1) the scope and content of the prior art; (2) the difference or differences, if any, between each claim of the patent and the prior art; and (3) the level of ordinary skill in the art at the time the patent was filed. Unlike anticipation, which allows consideration of only one item of prior art, I understand that obviousness may be shown by considering more than one item of prior art. Moreover, I have been informed and I understand that so-called objective indicia of non-obviousness, also known as "secondary considerations," like the following are also to be considered when assessing obviousness: (1) commercial success; (2) long-felt but unresolved needs; (3) copying of the invention by others in the field; (4) initial expressions of disbelief by experts in the field; (5) failure of others to solve the problem that the inventor solved; and (6) unexpected results. I also understand that evidence of objective indicia of non-obviousness must be commensurate in scope with the claimed subject matter.

VII. GROUND 1 – ALLEGED OBVIOUSNESS OF CLAIMS 1, 8, AND 15 BASED ON CHOE ALONE

50. Petitioner asserts that Choe (Ex. 1005) renders obvious independent claims 1, 8, and 15 and dependent claims 2-3, 5-7, 9, 10, 12-14, 16, and 18-20. Based on the evidence cited by Petitioner and Dr. Darrell, I disagree.

A. Claim Elements 1[d] and 1[e]: "transmitting the overlaid image to a computing device over a network" and "receiving a modification of the line from the computing device, the modification comprising a new line at a second position"

51. I note that while in general the steps of method claims are not required to be performed in any particular order, in some cases the language of the claim does require a particular order of steps. In claim 1, element 1[d] requires that the overlaid image be transmitted to a computing device over a network, which means that the image must be overlaid with the horizon line *prior* to being transmitted to the computing device, that is, while it is still at the location where it was initially captured (*i.e.*, in the vehicle).

52. Petitioner and Dr. Darrell identify servers 103-104, in communication with the vehicle over network 102, as the claimed "computing device," and contend that the vehicle captures the image, and sends it to the server for processing. For example: "Critically, Choe discloses that the calibration can be performed remotely based on images captured by the vehicle's sensors." Darrell Decl. at ¶ 130; *see also* Pet. at 20-21.

53. Dr. Darrell, however, offers an incomplete and inaccurate description of Choe. Choe discloses an embodiment wherein all of the described processes are performed within the vehicle itself. Specifically, in reference to its Figure 1 (reproduced below), Choe discloses that autonomous driving vehicle 101 includes, among other things, sensor system 115, and perception and planning system 110.

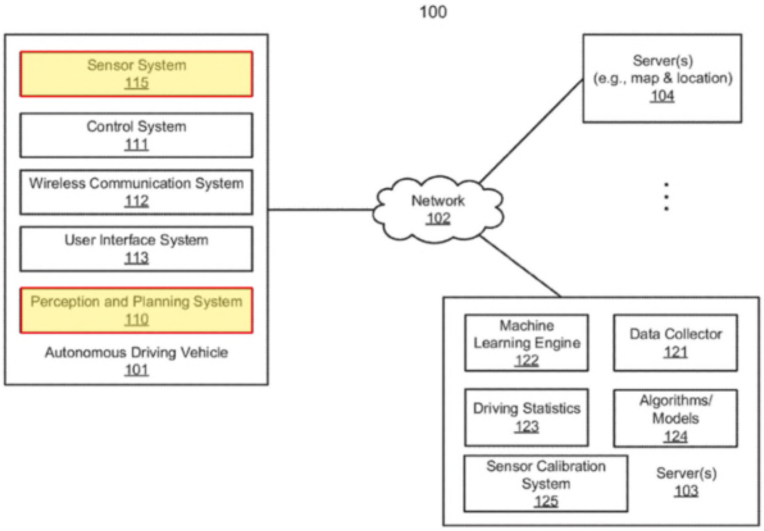

FIG. 1

54. In one embodiment, Choe further describes that the processes of determining lane lines, identifying the horizon line, overlaying a line on the image and then presenting the overlaid image to a human annotator who can adjust the line using input keys on the user interface are all performed by perception and planning system 110 in the autonomous driving vehicle. For example, in connection with Figure 3, Choe describes that functions of the perception and planning module 110 are performed in the autonomous driving vehicle:

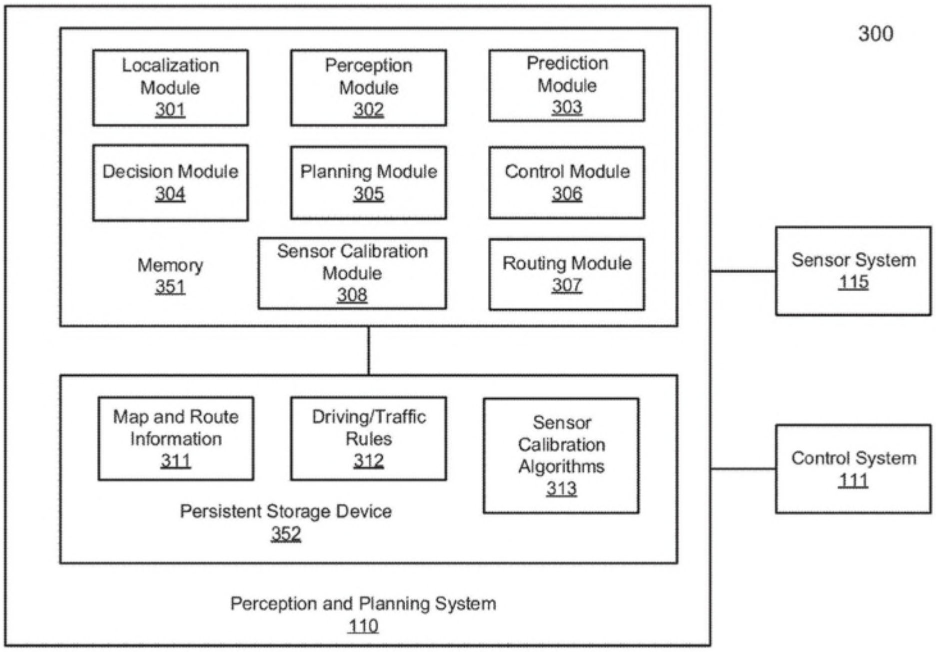

FIG. 3A

> FIGS. 3A and 3B are block diagrams illustrating an example of a perception and planning system used with an autonomous vehicle according to one embodiment. ***System 300 may be implemented as a part of autonomous vehicle 101 of FIG. 1 including, but is not limited to, perception and planning system 110, control system 111, and sensor system 115.*** Referring to FIGS. 3A-3B, perception and planning system 110 includes, but is not limited to, localization module 301, perception module 302, prediction module 303, decision module 304, planning module 305, control module 306, routing module 307, and sensor calibration module or system 308.

Ex. 1005 at [0032] (emphasis added).

55. In connection with Figure 4, Choe describes that the perception module 302, which is part of the perception and planning system 110 located in the

autonomous driving vehicle processes the captured image and determines a horizon line.

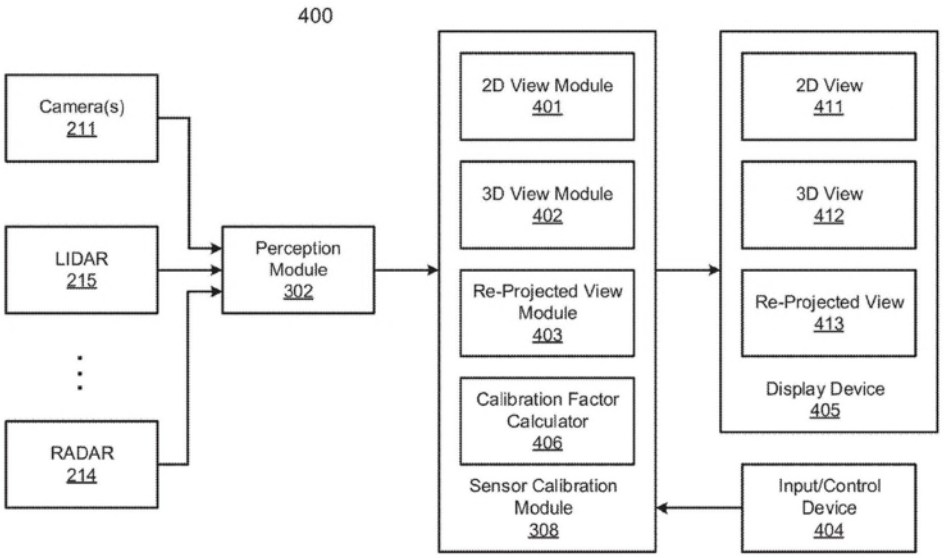

FIG. 4

> Referring to FIG. 4, as described above, perception module 302 receives sensor data from a variety of sensors such as camera 211, LIDAR 215, and RADAR 214. For camera 211, sensor data may include an image and for LIDAR 215, the corresponding sensor data may include a point cloud image. ***The sensor data is then processed by perception module 302 such as image processing, including detecting an object within the image and determining a horizon line representing a vanishing point of a road.*** The result of the perception processing can be utilized by other modules such as prediction module 303 and planning module 305 for autonomous driving.

Ex. 1005 at [0045] (emphasis added).

56. Choe further describes that the 2D and 3D view modules then display the image with the lane lines and horizon lines overlaid.

> According to one embodiment, s***ensor calibration module 308 includes a 2D rendering module 401, a 3D rendering module 402***, and a 2D reprojecting module 403. In response to an image captured by camera 211 and processed by perception module 302, ***2D rendering module 401 is configured to render a 2D view including superimposing a horizon line onto the image according to the camera setting (e.g., hardware preset pitch angle). The 2D view image is then displayed on display device 405 as part of 2D view 411***. Based on the 2D view image, 3D rendering module 412 is configured to render a 3D view such as a top-down view using other 3D information such as sensor data obtained from LIDAR 215 and RADAR 214. ***The 3D view image is then displayed on display device 405 as part of 3D view 412***.

Ex. 1005 at [0046] (emphasis added).

57. Choe then describes that using an input device, a user may then modify the horizon and lane lines, while viewing the 2D and 3D displays until the user is satisfied that the lines are properly positioned on the image.

> The processed first image having the detected objects, lane lines, and the horizon line is provided to sensor calibration module 308.
>
> In response to a first input signal (e.g., an up or down arrow keypress) received from an input device (e.g., a keyboard, a joystick, a microphone to receive voice interactive commands), a position of the horizon line is updated based on the first input signal and a position of

> at least one of the lane lines is updated based on the updated horizon line. The input signal may represent an incremental value for adjusting the position of the horizon line. A first calibration factor or first correction value is determined for calibrating a pitch angle of the camera based on a difference between the initial horizon line and the updated horizon line.

Ex. 1005 at [0048], [0049]. Choe describes a similar process for determining calibration factors for yaw and roll. *See, e.g.*, *id*. at [0052], [0053]. Thus, in this embodiment, because the vehicle performs the camera calibration all on its own, the overlaid image is never transmitted to a remote server over a network, because it is not necessary.

58. Choe also describes that while this process can be performed in real time while the vehicle is driving, in another embodiment, it may also be performed offline at a remote server, for example:

> The first, second, and third images are concurrently displayed within the first, second, and third display areas respectively. The processes similar to the above process can be implemented to determine calibration factors for LIDAR and/or RADAR devices. ***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. Alternatively, the above processes can be performed offline based on the previously captured images or point clouds.***

Ex. 1005 at [0054] *(*emphasis added).

> In one embodiment, sensor calibration system 125 may be hosted by server 103 to calibrate sensors such as cameras, LIDAR, and/or RADAR devices offline based on the images and/or point clouds captured by the sensors. ***The sensor calibration process may be performed offline based on the previously captured sensor data captured by the targeted sensors of ADVs. The calibration parameters can then be uploaded to the corresponding vehicles and utilized by autonomous driving software to calibrate and compensate the corresponding sensors***.

Ex. 1005 at [0030]; *see also id*. at [0031], [0044].

59. In Choe's embodiments where the calibration process is carried out offline at a remote server, the image data is captured by the sensor (*e.g.*, camera), and is sent to the server, where the above process of determining lane lines, a horizon line, overlaying these on the image and then having a human annotator correct the positions of the lines is all performed at the server, and the calibration parameters are sent back to the camera system. In this case, *the overlaid image is generated at the server*, and thus, an *overlaid image* is not transmitted to a remote computing device (*i.e.*, server). Instead, only a raw image is transmitted.

60. Similarly, in the remote processing embodiment, since the calibration parameters are determined at the server from the corrected overlay lines, the image

with the corrected overlay lines is not sent back to the sensor (camera), because it is not necessary. Instead, *only the calibration parameters are sent*.

61. Petitioner acknowledges that Choe teaches these two different types of solutions or embodiments: "(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." Pet. at 27; Darrell Decl. at ¶ 133.

B. Alleged Motivations to Modify Choe

62. Petitioner and Dr. Darrell then assert that it would have been obvious to a POSITA to modify Choe's system to incorporate the transmission of an overlaid image from a vehicle to a remote server. For example, Dr. Darrell opines that "A POSITA would have recognized that for remote calibration and user interaction to function, the very same processed views used locally must be transmitted over the network so they can be rendered at the remote terminal." Darrell Decl. at ¶ 133.

63. However, Choe already describes that in the off-board embodiment, the rendering engines that would perform the overlay process are part of perception module 308, which includes the 2D rendering module 410, the 3D rendering module 402, and the 2D reprojecting module 403, all of which are described as performing the line overlay processes. In the off-board processing embodiment,

Choe explicitly states that calibration module 308 (containing the rendering modules 401, 402, and 403) is located at the server 103, and processes images captures by the (on-board) sensor. For example:

> …Sensor calibration module 308 may be implemented as a part of perception module 302 or communicatively coupled to perception module 302. ***The functionalities of sensor calibration module 308 may be maintained in a data analytics system such as server 103 to perform a sensor calibration of a sensor offline based on the images captured by the corresponding sensor.***

Ex. 1005 at [0044] (emphasis added).

> According to one embodiment, ***sensor calibration module 308 includes a 2D rendering module 401, a 3D rendering module 402, and a 2D reprojecting module 403.*** In response to an image captured by camera 211 and processed by perception module 302, ***2D rendering module 401 is configured to render a 2D view including superimposing a horizon line onto the image according to the camera setting*** (e.g., hardware preset pitch angle). The 2D view image is then displayed on display device 405 as part of 2D view 411.

Ex. 1005 at [0046] (emphasis added).

64. Thus, contrary to Dr. Darrell's opinion, Choe explicitly describes that in the off-board embodiment, *the horizon line is overlaid on the image by the very component (calibration module 308) that is located at the off board server*. In fact, to overlay the horizon line onboard the vehicle, then transmit the overlaid image to

the server for annotation, and subsequently transmit the overlay modification back to vehicle system would require implementing portions of Choe's calibration module 308 in the vehicle, and portions of that same module in the server 103. But Dr. Darrell and Petitioner both fail to identify any credible motivation for a POSITA to do so.

65. Dr. Darrell opines that "The technical motivations are clear. A POSITA would understand that transmitting the overlaid image ensures verification and consistency, allowing remote calibration systems or personnel to see what the vehicle sees rather than redundantly recomputing overlays and risking divergence." Darrell Decl. at ¶ 135. Yet there is no reason that performing these operations as Choe describes them (entirely on-board the vehicle or entirely off-board at a server) would lead to any sort of redundancy or verification and consistency problems. To the contrary, since Choe describes that the annotation process includes revising and re-projecting the 2D image using module 403, separating the initial horizon line overlay step from the annotation and re-projection steps would increase complexity and would likely lead to *greater* potential for errors and inconsistency.

66. Dr. Darrell also opines that "Choe's server-side data collector and machine-learning engine, which generate predictive models for calibration, would further benefit from annotated frames for training, drift monitoring, and calibration

audit trails." Darrell Decl. at ¶ 137. This opinion appears to be a remnant of his declaration in support of the petition for *inter partes* review of the parent patent, U.S. Patent No. 11,875,580 (the '580 patent), which, unlike the '276 patent *requires* a predictive model and AI based feature recognition. The '276 patent claims are silent on this topic, and thus any benefit (not conceded) that such a configuration might bring to an AI-based detection system is irrelevant to the '276 patent.

67. In my opinion, given Choe's lucid explanation of the two embodiments, and the lack of any rational reasoning to split up these processes, Dr. Darrell's opinions smell like hindsight bias. Simply stated, because he is being taught a particular sequence and approach by the '276 patent that differs from that described by Choe, he suggests that it would be obvious to modify Choe in an unnatural way, with fabricated benefits so that it matches the method set forth in claim 1 (as well as claims 8 and 15) of the '276 patent. It thus would not have been obvious to a POSITA to modify Choe's system to incorporate the receipt of an overlaid image by the vehicle from a remote server, and Petitioner and Dr. Darrell fail to identify any credible motivation for a POSITA to do so.

68. Independent claims 8 and 15 mirror the same claim elements as claim 1, but in other statutory forms. For all the same reasons set forth above, with respect to those claims, Petitioner and Dr. Darrell's assertions are likewise

incorrect and invalid. Further, because Petitioner and Dr. Darrell fail to show that any of independent claims 1, 8, or 15 are invalid, they also fail to show that any claims that depend therefrom, including claims 2, 3, 5-7, 9, 10, 12-14, 16, and 18-20, are invalid.

VIII. GROUND 2 – ALLEGED OBVIOUSNESS OF CLAIMS 1-3, 5-10, 12-16, AND 18-20 BASED ON CHOE IN VIEW OF DAVIES

A. Alleged Motivations to Combine Choe with Davies

69. With respect to Ground 2, Dr. Darrell opines that "a POSITA would have recognized that for such remote calibration and user interaction to function, the very same processed, annotated views used locally must be transmitted over the network so they can be rendered at the remote terminal. The only aspect not expressly detailed in Choe is the specific mechanics of how the processed and annotated images are made available for remote calibration." Darrell Decl. at ¶ 221. I disagree. Choe provides *substantial* detail about how the processed and annotated images are made available, both for local (on-board) and remote (off-board) calibration. For example, in connection with Figures 6A and 6B (reproduced below with annotation in red), Choe explains:

> FIGS. 6A-6B are screenshots illustrating a graphical user interface of a sensor calibration system according to one embodiment. Referring to FIG. 6A, in this example, the system is calibrating a pitch angle of a camera. Image 601 was captured by a camera to be calibrated and processed by perception module 302, including detecting objects

> shown on the image indicated by the bounding boxes in this example. In addition, horizon line 610 is determined and placed on a location within image 601 based on the hardware setting of the targeted camera. Image 601 may be rendered by 2D rendering module 401 and displayed within a first display area of a display device as a 2D view.

Ex. 1005 at [0055].

> Based on the image 601, image 602 representing a 3D view, in this example, a top-down view, is generated based on the image 601 and other 3D information, for example, provided by a LIDAR device and/or RADAR device. Image 602 may be rendered by 3D rendering module 402 and displayed within a second display area of the display device. Image 402 includes one or more lane lines 621-623 positioned based on the position of horizon line 610. In addition, optional image 603, referred to herein as a 2D re-projected view, is generated based on 2D view image 601 and 3D view image 602, including projecting lane lines 621-623 onto the 2D view.

Ex. 1005 at [0056].

> From the top-down view, when a pitch angle of a camera has been calibrated, lane lines 621-623 should be relatively or substantially parallel. In this example, assuming horizon line 610 is too low, which causes lane lines to be diverged. Similarly, if the horizon line 610 is too high, as shown in FIG. 6B, lane lines 621-623 shown in 3D view 602 would be converged. By displaying the top-down view based on the position of horizon line 610, a user can calibrate the pitch angle by adjusting the position horizon line 610, for example, using an up-arrow key or a down-arrow key of a keyboard as an input device, until lane

> lines 621-623 are relatively parallel on the 3D view 602. An input device can also be a joystick or a microphone that can receive a voice interactive command from a user. Similarly, the yaw angle and the roll angle of a camera can also be calibrated using the techniques as described above.

Ex. 1005 at [0057].

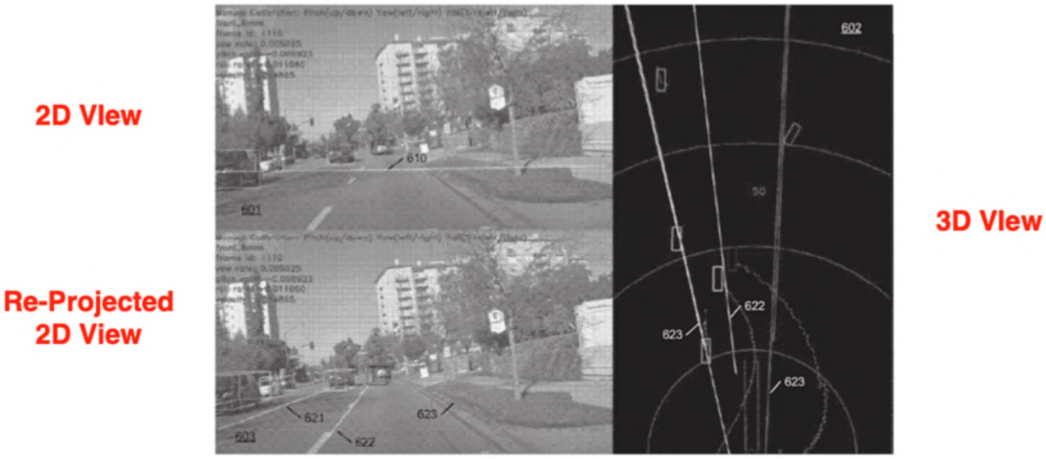

FIG. 6A

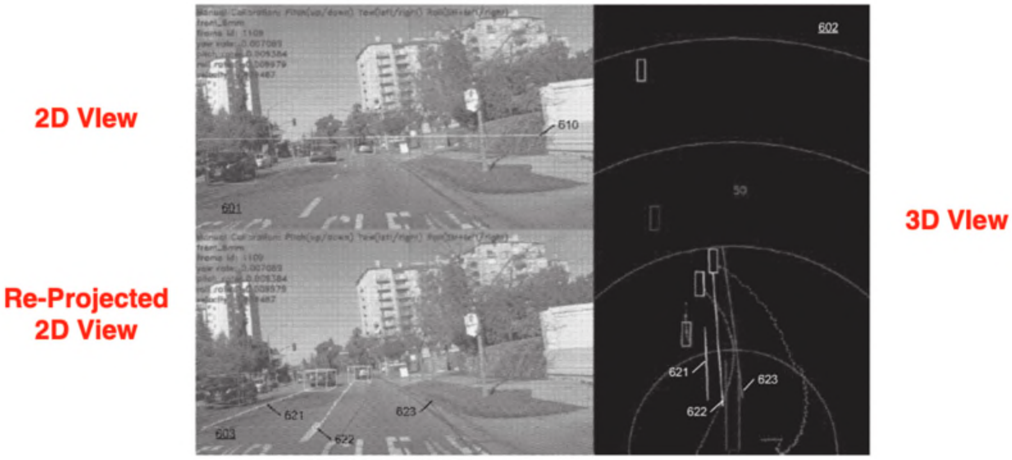

FIG. 6B

Ex. 1005 at Figs. 6A, 6B (annotations added in red).

70. Given this detailed explanation by Choe, nothing about this process is more or less difficult, to perform locally (on-board) versus remotely (off-board), and Dr. Darrell’s opinion that a POSITA would be compelled to look to other references to obtain guidance is entirely without merit.

71. Dr. Darrell and Petitioner then assert that, given this (doubtful) motivation to seek guidance from other references, a POSITA would have looked to Davies who describes sending annotated images to and from a remote server. Notwithstanding the hindsight-driven nature of this assertion and the greater complexity of a system that places portions of a well-defined process in one location and the balance in another (*see* Ground 1 discussion above), Davies describes an entirely different type of image “adjustment” than Choe.

72. In Davies, the image is rotated automatically based on vehicle sensor data to correct for roll induced by the vehicle pose, not for calibration purposes, and not as a result of any horizon detection or human annotation. In fact, the images are adjusted for the purpose of *presentation* to a viewing audience. An example provided by Davies is that of adjusting the tilt of the image from a race car as it travels around a banked curve. There is no superposition of a horizon line on the image and no human annotation, and the adjusted image is not sent back to the vehicle for any purpose (because it is intended to be presented instead to an audience, for example TV viewers). Thus, Davies is so substantially far afield of

Choe that, in my opinion, a POSITA would not have considered Davies to even be analogous art to Choe.

73. But even if Davies were considered analogous art to Choe (which it should not), Dr. Darrell and Petitioner also fail to clearly articulate why a POSITA would have been motivated to combine the teachings of Davies with the teachings of Choe, or why a POSITA would have had a reasonable expectation of success. *See* Pet. at 38-40; Darrell Decl. at ¶¶ 224-250. Dr. Darrell devotes twelve pages to his motivation discussion, and still fails to articulate with any rational opinion as to why a POSITA would have been so motivated.

74. For example, his first of five reasons is simply conclusory: "a POSITA would have been motivated to integrate Davies's conventional methods of transmitting annotated or adjusted images over a network into Choe's server-hosted calibration framework, enabling transmission of overlaid calibration views to remote devices." Darrell Decl. at ¶ 224. This merely states that a POSITA seeking to enable transmission would have been motivated to use a method of transmission, which while painfully obvious, provides no explanation as to *why* a POSITA would have applied Davies' particular method of transmission to Choe, especially when Choe's system does not require improvement, and Davies' method does not appear to actually improve anything in Choe.

75. Choe is directed to calibrating an image sensor while Davies is directed to adjusting an image. Dr. Davies and Petitioner fail to explain the relationship between the two disclosed systems, including addressing any similarities and/or differences between the problems Choe and Davies attempted to solve and any similarities and/or differences between their approaches.

76. Dr. Darrell next opines that "a POSITA would have been motivated to leverage Davies's teachings on remote processing and GUI-based interaction to extend Choe's calibration loop beyond the vehicle, so that calibration factors recomputed from line modifications could be derived externally and returned to the system." Darrell Decl. at ¶ 224. As an initial matter, Choe does not describe returning line modifications to the vehicle, that is what the '276 patent teaches. Choe merely describes either determining calibration parameters in the vehicle, or sending the image off board to a server, and then returning calibration parameters from the server to the vehicle.

77. Moreover, Choe already describes "extending the calibration loop beyond the vehicle, so that calibration factors recomputed from line modifications could be derived externally." While Choe offers no opinions about the relative benefits of the two approaches he offers, his off-board server based approach specifically provides for "extend[ing]" the calibration process off board the vehicle, allowing a user at a server to derive modifications (to the line) externally

and computing (or recomputing) calibration parameters based on the line modifications," so Davies provides no improvement on this front.

78. Dr. Darrell next opines that "a POSITA would have been motivated to ensure verification and consistency across annotators by transmitting the same overlaid horizon and lane images from Choe to remote operators." *Id.* But Choe and Davies are both silent about any need to ensure verification and consistency across annotators, and neither reference offers any description of such activities. Nor do they provide any mechanisms by which they would ensure verification or assure consistency. For example, neither Choe nor Davies describe multiple annotators (inside or outside of the vehicle) annotating the same image (in fact Davies offers no suggestion of any annotation), and somehow conferring to assure consistency. This rationale, if that's what one could call it, appears to be nothing more than a fabrication created by Dr. Darrell in support of his goal of identifying a combination that reads on the claims of the '276 patent.

79. Dr. Darrell next proffers the inexplicable rationale that "a POSITA would have been motivated to expand Choe's human-in-the-loop calibration to include remote experts, as Davies teaches, to enhance oversight, error correction, and fleet-level quality control." *Id.* Yet, both Choe and Davies are silent about quality control, error correction or oversight. In fact, the only description of human involvement in the process is Davies' description that operators may choose

selected portions of a video and merge them with other selected video to, for example, show an athlete on a field from multiple points of view. *See e.g.*, Ex. 1007 at [0043], [0044], [0048]. Yet this is more of a video editing and compilation process than one of quality control, error correction or oversight.

80. And finally, Dr. Darrell asserts that a POSITA would have been motivated to "adopt Davies's disclosure of bandwidth-efficient transmission by sending lightweight overlay adjustments rather than raw video streams, reducing network load while maintaining calibration accuracy." *Id*. Yet neither Choe nor Davies describe any concerns about "bandwidth efficient transmission" or "lightweight overlay adjustments." In fact, as described in depth above, neither reference describes sending any sort of overlays, lightweight or otherwise, and even if they did, this is exactly opposite of what is claimed by the '276 patent, wherein an overlaid image is transmitted, not a raw un-overlaid image as in Choe, and not an adjusted but not overlaid image as in Davies. And, neither Choe nor Davies teach or suggest only transmitting the overlay without the image (*i.e.*, a "lightweight overlay adjustment). As a result, in my opinion, despite its length, Dr. Darrell's discussion of the motivation to combine Choe with Davies has no merit whatsoever, and appears to be based on an array of assumptions about the benefit and desirability of features that neither Choe nor Davies describe, and which their combination is not able to deliver.

B. Davies Fails to Cure Choe's Deficiencies

81. Even if Davies were considered to be analogous art and a POSITA would have been motivated to combine Choe with Davies (assertions I disagree with), Davies utterly fails to cure Choe's deficiencies outlined above in Ground 1 with respect to claim elements 1[d] and 1[e].

1. Claim Element 1[d]: "transmitting the overlaid image to a computing device over a network"

82. Regarding claim element 1[d], first, Davies describes sending the raw image data from the vehicle camera to a server, and this is not the claimed "overlaid image." For example, in connection with its Figure 3 (reproduced below), Davies describes that the image captured by the vehicle camera is sent, together with sensor data, from the vehicle to a server:

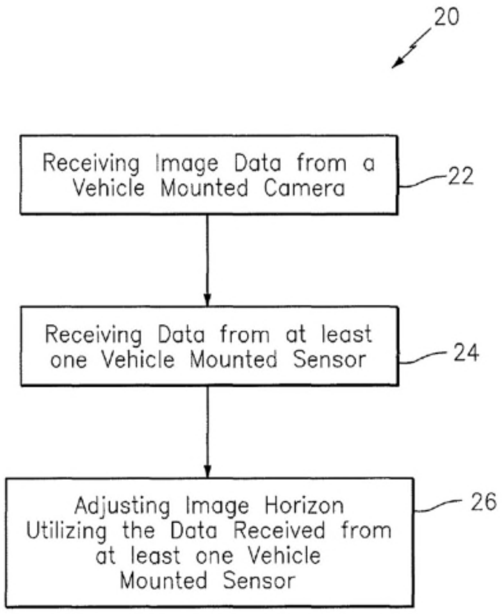

FIG. 3

Ex. 1007 at Fig. 3.

> Referring now to FIG. 3, an exemplary method for adjusting an image for a vehicle mounted camera is illustrated generally at 20, including receiving image data from a vehicle mounted camera described at box 22), receiving data from at least one vehicle mounted sensor (described at box 24), and adjusting the image horizon utilizing the data received from the at least one vehicle mounted sensor (described at box 26).

Ex. 1007 at [0057].

83. Second, Dr. Darrell and Petitioner fail to explain the relationship between Choe's teachings of modifying a superimposed line and Davies' teachings of adjusting images. Even in the situation described by Davies wherein the image adjustment is performed in the vehicle (*see e.g.* Ex. 1007 at [0058]), the adjustment is merely a rotation of the image performed as a "video effect."

> In exemplary embodiments, such adjusting of the image horizon may be applied as a digital video effect, such that actual manipulation of a vehicle mounted camera is unnecessary. Further, any type of image horizon adjustment is contemplated, whether or not such adjustment results in matching image horizon with a skyline horizon.

Ex. 1007 at [0058].

84. There is no description of any overlaid lane or horizon lines, so Davies cannot possibly satisfy the requirement to transmit an "overlaid image," regardless of whether the image "adjustment" is performed in the vehicle and then

transmitted to the server, or as above, the image and the vehicle data are transmitted to the server and the adjustment is performed at the server.

2. Claim Element 1[e]: "receiving a modification of the line from the computing device, the modification comprising a new line at a second position"

85. Regarding claim element 1[e], first, Dr. Darrell and Petitioner fail to show that Davies discloses overlaying a line on an image, let alone how such a line is modified in Davies' system. As described above, Davies simply tilts the image according to sensor data from the vehicle. There is no detection of a horizon, no superposition of a detected horizon on the image, and thus, there is no correction of any horizon line.

86. Second, Davies does not describe receiving a corrected (second) horizon line by the vehicle system. In part this is because there is no line to correct, and no corrected line to receive. In addition, the reception that Davies does describe is not a line or an image with a corrected line superimposed on it because Davies' adjusted image is used for presentation to a broadcast audience, and there is absolutely no reason that the corrected image would be sent back to the vehicle:

> The present disclosure thus advantageously provides systems and methods for ***selective capture of and presentation of native image portions, for broadcast production*** or other applications.

Ex. 1007 at [0056] (emphasis added).

87. Third, Dr. Darrell and Petitioner fail to explain which information is received by which component in Davies' system in satisfaction of the "receiving a modified line" claim element. Dr. Darrell relies on claim 24 of Davies as support for a supposed "computing device to receive the adjusted image," but he offers no explanation of what this "external computing device" actually is. Following the examples provided by Davies, a POSITA would not, in my opinion assume that the "external computing device" was the vehicle that originated the image, since Davies offers no examples of what the vehicle might do with such an adjusted image. Instead, a POSITA would have looked to Davies' description of providing the modified content for viewing by a user as described, for example, in connection with Figure 8 (reproduced below).

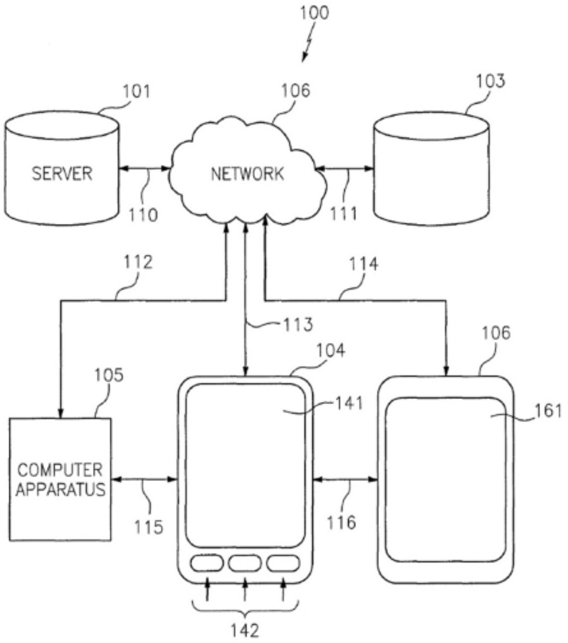

FIG. 8

Ex. 1007 at Fig. 8.

> The server 101 or source 103 may include a data service provider, for example, a cellular service provider, a business information provider, or any other suitable provider or repository. The server 101 or source 103 may also include an application server providing applications and/or computer executable code implementing any of the interfaces/methodologies described herein. The server 101 or source 103 may present a plurality of application defaults, choices, set-ups, and/or configurations such that a device may receive and process the application accordingly. ***The server 101 or source 103 may present any application on a viewer interface or web-browser of a device for relatively easy selection by a viewer of the device.***

Ex. 1007 at [0064] (emphasis added).

> Alternately, another server component or local computer apparatus, e.g., 104, 105 and/or 106, may produce the viewer interface and control connectivity to the server 101 or source 103. Also, the server 101 or one or more of the local computer apparatus 104, 105 and 106 may be configured to periodically access the source 103 and cache data relevant to data used in embodiments of the present invention.

Ex. 1007 at [0065]. These external devices are viewing and viewing control devices, not a device that would use any information for calibration.

IX. GROUNDS 3A/3B – ALLEGED OBVIOUSNESS OF CLAIMS 4, 11, AND 17 BASED ON CHOE IN VIEW OF KUEHNLE OR CHOE IN VIEW OF DAVIES AND FURTHER IN VIEW OF KUEHNLE

88. Claim 4, depends from claim 3, which in turn depends from independent claim 1. Claim 11 depends from claim 10, which in turn depends from independent claim 8. Claim 17 depends from claim 16, which in turn depends from independent claim 15. Each of claims 3, 4, 10, 11, 16, and 17 adds the same element to the respective independent claims 1, 8 and 15:

- "wherein receiving the image of the roadway comprises receiving an image of the roadway while the vehicle is moving" (claims 3, 10, and 16); and
- "wherein 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." (claims 4, 11, and 17).

89. As an initial matter, since all of these claims depend from claims 1, 8 or 15, and as discussed above, neither Choe alone nor Choe in view of Davies renders claims 1, 8 or 15 obvious. Moreover, Petitioner and Dr. Darrell do not assert that Kuehnle cures the deficiencies in Choe and Davies with respect to claims 1, 8 or 15. Thus, the addition of Kuehnle cannot render claims 4, 11, or 17 obvious. In addition, a POSITA would not have been motivated to combine Kuehnle with Choe and/or Davies.

90. Choe describes that in some cases the vehicle may be in motion while the calibration is taking place. Davies is silent on this point, although its descriptions of adjusting images of a racetrack while the vehicle is on the track at

least imply that the race car is in motion. Davies' other examples relating to videos of athletes on a playing field appear to be unrelated to any vehicle motion, because there is no vehicle. The key element here is thus detecting if the vehicle is traveling above a pre-defined speed or for a pre-defined duration. Neither of these situations have any relevance under Choe or Davies. For example, Davies describes capturing images of a racetrack in front of a (presumably moving) racecar, but none of the processes Davies describes depend on the speed of the vehicle. An image from a vehicle traveling on a banked track will be tilted in more or less the same manner regardless of the vehicle speed, and regardless of how long the vehicle has been driving. Similarly, while Choe describes that the calibration process may be carried out in real time while the vehicle is in motion, nothing in Choe depends on the actual speed of the vehicle or how long the vehicle has been in motion. Thus, these features are irrelevant to Choe and Davies.

91. As a result, there is no reason, outside of the teachings of the '276 patent, that a POSITA would have been motivated to even seek out a reference addressing speed and duration of travel. Neither Choe nor Davies offer any limitations or shortcomings that would be overcome by adding in speed or duration of travel thresholds as taught by Kuehnle. In my opinion, Dr. Darrell's opinion represents a classic case of hindsight bias. Armed with the teachings of the '276 patent, and seeking to find subject matter described by these claim elements, Dr.

Darrell has simply sought out a reference that teaches the target claim element, but this is unallowable in an invalidity analysis. In this sort of analysis, the expert must ask the question of whether a POSITA would have been inspired to seek out an improvement, and whether that improvement is then found to read on the claim in question. In this case, Choe and Davies' approaches would not benefit from the addition of speed or duration of travel thresholds, at least because neither Choe nor Davies makes use of speed or duration of travel information. In addition to this manifest shortcoming in his analysis, Dr. Darrell offers no compelling reasoning rooted in industry knowledge or experience that might otherwise motivate a POSITA to combine these references either. As a result, Dr. Darrell's opinion should be given no merit.

X. GROUND 4 – ALLEGED OBVIOUSNESS OF CLAIMS 1-20 BASED ON WESTMACOT IN VIEW OF TAL

92. In my opinion, Dr. Darrell and the Petitioner fail to show that Westmacot in view of Tal teaches or suggests claim elements 1[d], 1[e], or 1[g]. In addition, a POSITA would have had no reason to combine Westmacot and Tal, as explained in greater detail below.

A. Claim Element 1[d]: "transmitting the overlaid image to a computing device over a network"

93. Petitioner concedes that the claim element "transmitting the overlaid image to a computing device over a network" is not taught or suggested by

Westmacot. *See* Pet. at 65. Dr. Darrell simply reiterates that Westmacot creates annotated images, some of which have overlaid elements, but he does not offer any evidence that the overlaid images are transmitted anywhere, let alone to a computing device over a network. *See* Darrell Decl. at ¶ 339.

94. Dr. Darrell and Petitioner then introduce Tal, in an attempt to cure this deficiency. Tal describes a road survey system that uses a camera on a vehicle to detect road related "incidents" such as potholes, difficult to see lane markings, and roadside signage. The sort of "incidents" detected by Tal's system include:

> (a) The Neural Network(s) 905 may assess environmental conditions which may affect the system functionality, including some or all of the following conditions: heavy rain, heavy fog, heavy snowfall, occluded windshield, daytime lighting conditions, night time lighting conditions, reflections on the windshield, and/or sun glare.
>
> (b) The Neural Network(s) 905 may assess the road 14 type in order to know which type of models, workflows, algorithms or Neural Network(s)905 to apply. For example, the road 14 may be asphalt, concrete, gravel, dirt, trail or other types of roads.
>
> (c) The Neural Network(s) 905 may assess the road 14 conditions for the purpose of collecting road ratings for the roads which are travelled (such ratings may also be known as Pavement Condition Index).
>
> (d) The Neural Network(s) 905 may identify object(s) 12 of interest representing assets which are in a good state, whereby the absence of those objects 12 over time may be an incident. For example, street

> signage (which can be damaged or dislocated by high winds), traffic signals (which can be out of order), street lights (which may be burnt), lane markings (which can fade).
>
> (e) The Neural Network(s) 905 may identify object(s) 12 of interest representing object(s) which are to be redacted for privacy.

Ex. 1009 at [0130]-[0134].

95. Tal is thus not directed to determining any sort of road geometry or lines associated with road geometry. Nor does Tal describe using any of the collected road data to determine any sensor or camera calibration parameters. Instead, Tal merely describes capturing images using a camera, and either sending raw images to a server for further processing, or performing some object identification steps in the vehicle system and sending raw images and "object data" from the vehicle to the server. And, in all instances the server then performs additional object recognition processing. Dr. Darrell offers no evidence that Tal teaches or suggests transmitting any of the image data with overlaid lines. At best, Tal merely describes sending images together with descriptions of incidents (as described above) that may be present in the images.

B. Claim Element 1[e]: "receiving a modification of the line from the computing device, the modification comprising a new line at a second position"

96. Dr. Darrell opines that Westmacot teaches "receiving a modification of the line from the computing device, the modification comprising a new line at a

second position," citing to, or quoting from, portions of Westmacot that describe manual annotation of images, for example:

> [A]n annotation interface provides a human annotator with the ability to view the frames in a batch individually with the currently rendered lanes projected into the images. These lanes can be widened, narrowed and moved by the annotator . . . providing a clear advantage over annotation of all of the image[s] individually. Similarly, the disclosure explains that "the user can modify the annotation data A(n) for an individual image via the UI 412, in order to better align the assumed lane boundaries R1, R2 with the actual lane boundaries in that image," and that a "model adaptation component 410" allows efficient manual adaptation of annotation data across images. Figures 6 and 25 show specific examples where an annotator shifts an existing lane boundary to a new position or adds additional lanes, bus lanes, or cycle lanes."

Darrell Decl. at ¶¶ 348-349.

97. However, none of the cited disclosures relate to modifying any lines in the images, and Westmacot does not elsewhere include any such descriptions. Dr. Darrell attempts to link these descriptions of annotation to the "horizon line" described by Westmacot, but not only is this horizon line different from that described by the '276 patent, it is also not transmitted a server or other computing device over a network, and the description in Westmacot does not even suggest that this line is modified by anyone to create a new line. *See* Darrell Decl. at ¶ 350; Westmacot at 44.

98. Contrary to Dr. Darrell's opinion, Petitioner concedes that the claim element "receiving a modification of the line from the computing device . . ." is not taught or suggested by Westmacot. *See* Pet. at 67-68.

99. Tal does not cure this deficiency in Westmacot. Dr. Darrell opines that "Tal provides the how: 'over a network.'" Darrell Decl. at ¶ 351. But not only is there no requirement that the modification of the line be received over a network, simply providing a network for communication between two entities does not meet the requirements of the claim. What is communicated by Tal's network is unrelated to any sort of modifications of lines or object identifications, and, as described above, Westmacot also fails to teach receiving such modifications, with or without a network. Thus, Dr. Darrell points to Tal's network to provide an un-needed means for receiving modifications that neither Tal nor Westmacot teach or suggest.

C. Claim Element 1[g]: "transmitting data representing the camera parameter to the camera device"

100. Dr. Darrell and Petitioner concede that the claim element "transmitting the data representing the camera parameter to the camera device" is not taught or suggested by Westmacot. *See* Pet. at 71-72; Darrell Decl. at ¶ 369.

101. Dr. Darrell opines that Tal fills this gap because it teaches that images can be captured by a camera, and either sent to a server, or processed and sent to a server together with object data. *See* Darrell Decl. at ¶ 370. Dr. Darrell then opines

that "[t]hese disclosures establish two-way communication in which calibration data derived from imagery may be computed remotely and transmitted back for use by the originating camera device, thereby filling the gap left by Westmacot." *Id*.

102. However, nothing in Dr. Darrell's discussion with respect to this claim element describes or suggests how this "two-way communication" relates to "transmitting data representing the camera parameter to the camera device," so this opinion is unsupported.

103. In connection with claim element 1[d] (rather than 1[g]), Dr. Darrell cites Tal at [0138] as evidence of this "bidirectional communication":

> Referring to FIG. 12, shown is an example incident/ object 12 identification and reporting operation 1200. Depicted by example is Vehicle 102 equipped with a Device 101. The Device 101 identifies object(s) 12 of interest which are to be reported 1201. The Device 101 then transmits data 1202 to the Server(s) 107. The Server(s) 107 have files 1203, one or more database(s) 1204, and Software(s) 1205. ***The Server(s) 107 communicate with Client(s) 1208*** (which may be the devices 101 or separate computing devices with a browser or software that provides access to the system 1200) ***which allow users to handle the incidents 12 using a user interface 1209 which may present the incidents 12 in a variety of ways*** including a map view 1210, list view 1211, and gallery view 1212.

Ex. 1009 at [0138] (emphasis added).

104. This communication back to the client device is intended to provide information for the users to “handle the incident[].” *Id*. It is not related to transmitting data to a camera or calibrating anything at the client device. Further, not only is the data sent by Tal not the claimed “data representing a camera parameter,” it is sent to a human user, not a camera device.

D. Alleged Motivations to Combine Westmacot with Tal

105. Throughout his opinions related to claim elements 1[d], 1[e] and 1[g], Dr. Darrell proffers various alleged motivations to combine Westmacot and Tal. None of these opinions are persuasive.

106. As an initial matter, Westmacot describes a system for annotating images for use in machine learning. Tal, on the other hand, describes a system that is used to perform road surveys using image information to identify “incidents” such as potholes and road signage in need of repair. The only thing these two references have in common is that they both use images. But the images are used for entirely different purposes. Thus, in my opinion Westmacot and Tal are not analogous relative to one another, much less analogous to the ’276 patent. As such, a POSITA implementing the system of Westmacot would have had no reason to seek out, or even be aware of, a reference such as Tal.

107. In connection with claim element 1[d], Dr. Darrell first opines that, as with his discussion of Ground 3, Westmacot and Tal are “directly complimentary”

because Westmacot teaches the generation and storage of overlaid images, and Tal teaches transmitting "raw and overlaid images." Darrell Decl. at ¶ 344. However, notwithstanding the fact that neither Westmacot nor Tal describe overlaying *lines* on images, Westmacot has no need to transmit any annotated or overlaid images at all. Thus, even if Tal taught transmitting overlaid images (which it does not), Westmacot would have no use for this transmission.

108. Dr. Darrell next opines that "transmitting Westmacot's annotated images, as in Tal, was an obvious and predictable way to support large-scale training, validation, and remote access." Darrell Decl. at ¶ 344. But neither Westmacot nor Tal describe any need for, or problem solved by, "large-scale training, validation, and remote access." This rationale appears to have simply been fabricated by Dr. Darrell.

109. And finally, Dr. Darrell opines that "transmission across a network is nothing more than an obvious design choice." Yet, as noted above, Westmacot does not express any need for such transmission, and Dr. Darrell does not identify any improvement that such a transmission would bring to Westmacot. Dr. Darrell's opinion here is much like his opinion for the combination of Choe and Davies, that a POSITA seeking to enable transmission would have been motivated to use a method of transmission, which while painfully obvious, provides no explanation as to *why* a POSITA would have applied Tal's particular method of transmission to

Westmacot, especially when Westmacot's system does not require improvement, and Tal's method does not actually appear to improve anything in Westmacot.

110. In connection with claim element 1[e] specifically, Dr. Darrell opines that "[t]he combination of Westmacot and Tal therefore makes clear that receiving a modification comprising a new horizon line at a second position would have been obvious, since it merely combines Westmacot's disclosed line-adjustment framework and Tal's remote transmission/feedback." Darrell Decl. at ¶ 353. I disagree for several reasons.

111. First, Westmacot does not disclose any line overlay or line adjustment. Second, Tal does not actually disclose any remote transmission/feedback. Tal merely sends either raw images, or images together with object data, from the camera device to a server where they are further processed. There is no "feedback described," and any transmission from the server is, as is described above, simply information provided to the user to "handle the incident."

112. Dr. Darrell offers a variety of other alleged motivations, some of which are entirely untethered to either Westmacot or Tal. For example, Dr. Darrell asserts:

> A POSITA would recognize only a few routine ways to represent the modification (e.g., new line endpoints in image coords, delta from prior line, polynomial/spline coefficients, or a "replace-line" control message).

> Any of these is trivially packaged as Tal's "resultant processed data 20 / object data 21" or an instruction to update overlays and sent between device 101 and server 107 using the already-disclosed communications mechanism.

Darrell Decl. at ¶ 356.

113. But nowhere in Westmacot is there any description of such a representation of the modifications. In Westmacot, the modifications (if that's what Westmacot's annotations might be called), are simply applied to the images to be used for training. There is no need to communicate instructions for these "modifications" as speculated by Dr. Darrell. And contrary to Dr. Darrell's speculation about the desirability of "(1) Scalability and efficiency: offloading computationally intensive 3D reconstruction and line interpolation tasks to more powerful servers reduces the burden on the annotator's local system; (2) Collaboration and consistency: a networked implementation allows multiple annotators to contribute to the same dataset in real time, ensuring consistency and reducing duplication; and (3) Integration with cloud-based workflows," (Darrell Decl. at ¶ 357), neither Westmacot nor Tal ever suggest or imply that any of these features are needed or desired.

114. In short, Dr. Darrell has simply created a set of benefits that are untethered to either reference, in order to support his unnatural combination. Dr. Darrell even goes so far as the assert that "Tal makes clear that a POSITA would

have been motivated, with a reasonable expectation of success, to adapt Westmacot's system to receive modifications of lines at a remote computing device." But Tal does nothing of the sort. Tal never discusses lines at all, much less modifications to lines, and Westmacot expresses no need or desire for any annotations ("modifications," as Dr. Darrell refers to them) to be performed remotely.

115. In connection with claim element 1[g] specifically, Dr. Darrell asserts that in addition to the above rationales, a POSITA would have been motivated to combine Westmacot and Tal to improve "calibration and feedback," and inexplicably, to make use of "distributed processing." Darrell Decl. at ¶¶ 372, 373. Dr. Darrell opines that because Westmacot's camera provides images that the system subsequently annotates, and because it computes image parameters (used to rectify and annotate the images for use in training, not to calibrate the camera), that it would be obvious to transmit these parameters back to the camera for calibration. But this opinion appears to be entirely driven by hindsight. Neither Westmacot nor Tal are directed to camera calibration. So it appears that Dr. Darrell's opinion is driven by the need to identify a use of the systems of Westmacot and Tal to perform the claim elements, not because these uses and the benefit of these uses would become apparent by the natural combination of the two references (a combination which, in my opinion is un-natural and which makes no sense).

Because having been taught by the claims of the ’276 patent, Dr. Darrell knows what he is trying to achieve, which is an analysis based on impermissible hindsight.

116. As noted elsewhere in this declaration, I have focused my analysis on the elements of claim 1 of the ’276 patent. Independent claims 8 and 15 are drawn to different statutory claim constructs, but include the same basic claim element of claim 1: claim 8 is drawn to a non-transitory computer-readable storage medium for tangibly storing computer program that, when executed by a computer processor, performs operations of: the same elements as claim 1[a]-1[g], and claim 15 is drawn to a device, processor and storage medium for carrying out these same claim steps. Thus, my analysis of the elements of claim 1 applies equally to these independent claims. Further, because the dependent clams all require meeting each of the elements of the corresponding independent claims, none of these claims are rendered invalid, because Dr. Darrell and the Petitioner fail to show that the independent claims are rendered obvious by the prior art.

* * *

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

Dated: January 23, 2026

Scott Andrews

Scott Andrews

(650) 279-0242 scott@cogenia.com Petaluma, CA

Summary

Creative, energetic, and innovative internationally recognized technical executive experienced in general management, systems engineering, advanced product development, advanced technology, business development, strategic planning, and program management

- Location Based Technologies
- Vehicle Information Systems
- Vehicle Electrical/Electronics Systems
- ITS and Related Industries
- Communications Systems
- Mobile Information Technology
- Multimedia/Internet Computing
- Mobile Technology Test Instrumentation
- Vehicle Safety and Control Systems
- Enterprise Software

Experience

12/2001-Present Cogenia Partners, LLC

Systems engineering consulting supporting and mobile information, mobile electronics and automotive safety and entertainment systems development

<u>Current Engagements:</u>

- Expert witness for patent litigation, contracts and trade secrets:
    - Motive, related to vehicle monitoring systems
    - Toyota, related to vehicle user preferences
    - Evenflo, related to location alert devices (in child car seats)
    - Aptive, related to USB technology
    - Volvo, related to vehicle infotainment systems
    - USAA, Related to vehicle location systems

<u>Prior Engagements/Projects:</u>

- Technical consultant for connected vehicle security credential management system management concepts; Sponsored by Transport Canada
- Technical consultant for sensor supplemented message validation system for vehicle to vehicle communication based collision waring/avoidance systems. Sponsored by US DOT NHTSA
- Technical consultant for connected vehicle security credential management system deployment; Sponsored by US DOT NHTSA
- Subject matter expert and co-principle investigator on DSRC performance Measures development project for U.S.DOT NHTSA.
- Subject matter expert on communications data delivery system study to understand optimal roadside unit placements to support security credential management in connected vehicle systems; Sponsored by U.S. DOT RITA
- Developed systems engineering methodology for vehicle E/E systems; Applied methodology on project for Yazaki to reverse engineer the E/E architecture for a 2004 BMW 5 series vehicle.
- Co-Principal investigator for Integrated Advanced Transportation System; A 30+ year future technical feasibility assessment and strategy for U.S. DOT Federal Highway Admin. (FHWA).
- Technical consultant to American Association of State Highway Transportation Officials (AASHTO) for connected vehicle deployment analysis and strategy.

- Chief System Architect for the Vehicle Infrastructure Integration (VIIC) program (BMW, Chrysler, Daimler Benz, Ford, GM, Honda, Nissan, Toyota, VW); A connected vehicle research program funded by U.S. DOT FHWA.
- Technical consultant to Michigan State DOT (Enterprise Pooled Fund) to develop a system architecture and deployment strategy for Rural ITS.
- Telematics delivery architecture development for a Fortune 100 service provider
- Technical consultant to the Vehicle Safety Consortium developing Dedicated Short Range Communications (DSRC) standards for safety systems;
- Designed novel super capacitor based high performance hybrid vehicle as part of an early stage startup company; Developed performance requirements, conceptual designs and patented integrated electrical system architecture concept.
- Toyota Motor Sales – 10 year technology survey;
- Connected Vehicle Trade Association- Transferred AMI-C specifications to ISO TC 22, TC 204 AND OSGi. Developed OSGi Vehicle Interface Specification;
- Expert witness for:
  - Ford. related to vehicle camera systems
  - Honda, related to navigation systems,
  - Rideco, related to ridesharing systems
  - Verra Mobility, related to tolling systems
  - Volkswagen, related to navigation systems
  - Ford Motor Company, related to upfitter technology
  - Porsche, related to vehicle illumination systems
  - Toyota, related to driver authentication systems
  - Tesla, related to steering control systems
  - Apple Computer, related to indoor geolocation technologies
  - Google, related to cell phone location systems
  - General Motors, related to various automotive systems
  - Lordstown Motors, related to infotainment systems
  - Uber, related to location based systems
  - Cummins Diesel, related to cloud based vehicle data collection
  - Orbital Sciences, related to vehicle fleet management
  - Volkswagen, related to vehicle control technologies
  - Apple, related to mobile communications device control
  - Google, related to map displays
  - Platform Sciences, related to location based fleet management
  - Unified Patents, various location based technology cases
  - Uber, related to display of multiple terminals on navigation display
  - Directed Electronics, related to vehicle remote start systems
  - ZTE, related to cell phone location and orientation systems
  - Audi, America, related to vehicle control systems
  - Club Car, related to golf cart navigation systems
  - Unified Patents, various location based technology cases
  - Toyota, related to vehicle communications systems
  - American GNC vs. LG, related to MEMS sensors
  - Dale Progress, Ltd. vs. Toyota, related to vehicle information display systems
  - Blackberry vs. SNAP, related to display of multiple terminals on navigation display
  - Location Services vs. Google, related to augmented reality displays
  - Alert Signal vs. Apple, related to cell phone messaging systems

- AGIS vs. LG related to cell phone messaging systems
- Maxell vs. ASUS, related to cell phone navigation systems
- AGIS vs. HTC, related to cell phone location systems
- AGIS vs. Huawei, related to cell phone location systems
- AGIS vs. LG
- Michigan Motor Technologies vs. Hyundai, related to vehicle control systems
- Princeton Digital vs. Konami et al, related to video game display systems
- Delphi, related to automotive safety systems
- ATT vs. Vehicle IP relating to cell phone navigation systems
- VW/Audi vs. Beacon, relating to traffic information systems
- VW/Audi vs. Blitzsafe relating to mobile device integration and mobile audio systems
- T-Mobile vs. TracBeam relating to wireless location technologies
- VW/Audi vs. Joao relating to remote service architecturesApple Computer vs. Porto relating to cell phone navigation systems
- Mercedes vs. Adaptive Headlamp Technologies relating to adaptive headlamps
- Liberty Mutual, Geico and Hartford vs. Progressive Insurance relating to usage based insurance systems
- Toyota vs. American Vehicular Sciences (AVS) relating to occupant sensing systems
- Lenovo and Amazon vs. Pragmatus relating to device tracking
- Ford in a patent vs. Eagle Harbor Holdings relating to Bluetooth systems and mobile device integration in the vehicle
- Bentley vs. Cruise Control Technologies relating to adaptive cruise control
- Google vs. Walker Digital relating to 3D navigation displays
- Volkswagen/Sirius-XM vs. case relating to traffic information systems
- Volkswagen, Ford and GM in patent cases vs. Affinity Labs, relating to the iPod interface
- Honda vs. American Calcar, relating to telematics equipment and user interfaces
- Alpine, Denso and Pioneer Corporation in an International Trade Commission patent case vs. Honeywell, related to navigation systems
- BMW vs. American Calcar, relating to telematics equipment and user interfaces

4/2000 to 12/2001 Cogenia, Inc.
President and Chief Executive Officer, Founder
Founded company in 2000 to develop enterprise class data management software system. Responsibilities included development of business concept and plan, corporate administration including financial and legal management, leadership of executive team in product development, fundraising, business development, organizational development, and investor relations. Raised $2.2M between 8/00 and 5/01 from individuals and funds;

1996 to 4/2000 Toyota Motor Corporation, Japan
Project General Manager, R&D Management Division
Responsibilities included the conceptualization and development of multimedia and new technology products and services for Toyota's future generations of passenger vehicles in the United States and Europe, Heavy emphasis on strategy for information systems, and on development of technical concepts for computing and Internet oriented systems. Led

automated vehicle Development program leading up to 1997 Automated Highway Systems (AHS) demonstration in Sand Diego, CA; Supported technology acquisition for hybrid vehicle control systems; Working under direction of Toyota board members, established the Automotive Multimedia Interface Collaboration (AMI-C), a partnership of the world's car makers to develop a uniform computing architecture for vehicle multimedia systems, and led all early technical, planning and legal work. Provided technical management of technical contracts with Carnegie Mellon University Robotics Lab (Image based collision warning systems), and the development of Toyota's position on the US Intelligent Vehicle Initiative.

1983 to 1996 TRW, Inc.
Held a series of increasingly responsible positions in program management, technology development and business development.

1993 to 1996 TRW Automotive Electronics Group
Director, Advanced Product Planning/Development
Specific responsibilities included leadership and overall management of advanced development programs such as Automotive Radar, Adaptive Cruise Control, Occupant Sensing, In Vehicle Information Systems, and other emerging transportation products; Managed remotely located advanced development laboratory performing approximately $6M in annual development projects.

1983 to 1993 TRW Space & Electronics Group
Manager, MMIC Products Organization
Developed TRW's commercial GaAs MMIC business. Responsibilities included development of business strategy and business plan, and overall management of customer and R&D programs. Developed extensive international business base and took operation from start-up to $5M sales per year in under two years. Developed the first single chip 94 GHz Radar (Used for automotive cruise control and anti collision systems).

1979-1983 Teledyne Microwave
Developed high reliability microwave components. Developed CAD tools.

1977-1979 Ford Aerospace, Advanced Development Operation
Designed, tested and delivered microwave radar receiver systems

Education

MSEE Stanford University, 1982
BSEE University of CA, Irvine 1977
TRW Senior Leadership Program 1992

Publications

1. Two Dimensional Vehicle Control for Obstacle Avoidance in Multi-Lane Traffic Environments; Published in the proceedings of the 1998 IEEE International Conference on Intelligent Vehicles.
2. Automotive Multimedia Interface Collaboration; Briefing Presented to the 9th VERTIS Symposium, April 1999, Tokyo Japan.
3. Privacy and Authenticity in Telematics Systems; Published in the Proceedings of the Society of Automotive Engineers World Congress, 1999

4. Automated Highway Systems Acceptance and Liability; Briefing presented to the Automated Vehicle Guidance Demo 98 Conference, Rinjwoude, The Netherlands, June1998.
5. What is Telematics? Briefing presented at IIR Telematics Conference Scottsdale, AZ, December 2001
6. Advanced Telematics Services: A Hard Look at Reality; Briefing presented at IIR Telematics Conference Scottsdale, AZ, December 2001
7. Consumer Electronics and Telematics; Briefing presented at Eye For Auto Telematics Update Conference Las Vegas, NV, January 2003
8. The Automotive Multimedia Interface Collaboration Software and Network Architecture: Extending the Concept of Platform Independent Computing; Briefing Presented to the Future Generation Software Architectures in the Automotive Domain Conference, San Diego, CA, January 2004
9. Quality, Choice and Value: How New Architectures are Changing the Vehicle Lifecycle; Briefing presented at IEEE Convergence Conference, October 2004
10. Critical Standards for the Next Generation of Telematics Systems and Services; Briefing presented at the Telematics Update Conference, December 2004
11. VII System Overview; Briefing presented To Transportation Research Board, ITS and V-HA Committees 2007 Mid-Year Meeting; July 2007
12. Testing and Development of In-Vehicle Equipment and Private Applications (P08-1634); Briefing presented to the Transportation Research Board Annual Meeting, Washington, DC, January 2008
13. A Comparison of Communications Systems for VII; Presented at the ITS World Congress, New York, NY, October, 2008
14. Vehicle Infrastructure Integration Systems Overview; Presented at the ITS America Annual Meeting, June 1 2009, National Harbor, Maryland
15. Telematics Standards: Logical Next Steps; ITS International, August 2009
16. IntelliDrive^{SM} Overview; ITS International, May 2009
17. Time Synchronization and Positioning Accuracy in Cooperative IntelliDrive^{SM} Systems; Presented at the 2010 ITS America Annual Meeting, June 2010, Houston, Texas
18. Systematic Development of Positioning Requirements for Vehicle Applications; Presented at the 18th World Congress on Intelligent Transportation Systems , November, 2011, Orlando, Florida

19. The Interpretation of GPS Positioning Accuracy and Measurement Integrity in a Dynamic Mobile Environment; Presented at the 18th World Congress on Intelligent Transportation Systems, November, 2011, Orlando, Florida
20. Connected Vehicle Positioning Requirements and Possible Solutions; Presented at the 22nd World Congress on Intelligent Transportation Systems, October, 2015, Bordeaux, France
21. Connected Vehicle Performance Requirements; Presented at the 22nd World Congress on Intelligent Transportation Systems, October, 2015, Bordeaux, France

Patents

1. Mobile Body Reporting Device And Its System; Patent Number: JP11118902; 4/30/1999

2. Multiformat Auto-Handoff Communications Handset; Patent Number: US5,649,308; 07/15/1997

3. A Communications Terminal Device, A Communications System, And A Storing Medium For Storing A Program To Control Data Processing By The Communications Terminal Device; Patent Number: EP0867850, A3; 09/30/1998

4. Communication System For Controlling Data Processing According To A State Of A Communication Terminal Device; Patent Number: US 6,122,682 3/23/1998

5. Method And Apparatus For Controlling An Adjustable Device; Patent Number: US 5,864,105; 01/26/1999

6. Automatic Brake Device; Patent Number: JP2000108866; 4/18/2000

7. Visual Field Base Display System; Patent Number: JP2000029618; 01/28/2000

8. Intersection Warning System; Patent Number: US 5,926,114; 07/20/1999

9. Security For Anonymous Vehicular Broadcast Messages; Patent Number: US 7,742,603 3/27/2006

10. Digital Certificate Pool; Patent Number: US7,734,050 3/27/2006

11. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 7,802,263 9/21/2010

12. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 8,209,705 6/26/2012

13. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 8,566,843 10/22/2013

14. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 9,575,817 2/21/2017

15. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 9,705,765 7/11/2017

16. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 10,002,036 6/19/1028

17. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 10,031,790 7/24/1018

18. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 10,248,477 4/2/1019

19. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 11,188,400 11/30/2021

20. System, Method And Computer Program Product For Sharing Information In A Distributed Framework; Patent Number: US 11,354,179 6/7/2022

21. System for Location Based Triggers for Mobile Devices; Patent Number 9.973.899 5/15/2018

22. System for Location Based Triggers for Mobile Devices; Patent Number 10,194,291 1/29/2019

23. System for Location Based Triggers for Mobile Devices; Patent Number 10,194,292 1/29/2019

24. System for Location Based Triggers for Mobile Devices; Patent Number 10,349,243 7/9/2019

25. System for Location Based Triggers for Mobile Devices; Patent Number 10,499,215 12/3/2019

26. System for Location Based Triggers for Mobile Devices; Patent Number 10,631,146 4/21/2020

27. System for Location Based Triggers for Mobile Devices; Patent Number 10,735,922 8/4//2020

28. System for Location Based Triggers for Mobile Devices; Patent Number 11,252,543 2/15/2022

29. System for Location Based Triggers for Mobile Devices; Patent Number 11,792,613 10/17/2023