

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

VOLKSWAGEN GROUP OF AMERICA, INC.,
Petitioner,

v.

YECHEZKAL EVAN SPERO,
Patent Owner.

U.S. Patent No. 9,955,551 to Spero

Case No.: IPR2023-00318

DECLARATION OF MATTHEW A. TURK Ph.D.

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List of Exhibits

Exhibit No.	Description	Identifier
2001	Declaration of Matthew A. Turk, PhD	Turk Decl.
2002	Curriculum Vitae of Matthew A. Turk, PhD	Turk CV
2003	Best Practices and FAQs for Filing Requests for Reexamination Compliant with 37 CFR 1.510 and 1.915, PTAB, May 2010	Best Practices
2004	Intentionally left blank	
2005	Petition challenging U.S. Patent No. 9,955,551, Volkswagen Group of America, Inc. v. Yechezkal Evan Spero, IPR2023-00336, Paper 2, December 22, 2022	The '336 IPR Petition
2006	Petition challenging U.S. Patent No. 9,955,551, Volkswagen Group of America, Inc. v. Yechezkal Evan Spero, IPR2023-00315, Paper 2, December 9, 2022	The '315 IPR Petition

1. I, Matthew A. Turk, hereby declare as follows:
2. I am making this declaration at the request of Yechezkal Evan Spero in the matter of *Inter Partes* Review of U.S. Patent No. 9,955,551 (“the ‘551 Patent”) to Yechezkal Evan Spero.
3. I am being compensated for my work in this matter at a rate of \$490/hour for time spent reviewing materials and performing my analysis of the technical issues relevant to this matter. My compensation in no way depends on the outcome of this proceeding.
4. In preparation of this declaration, I have studied the exhibits as listed in the Exhibit List shown above in my report.
5. In forming the opinions expressed below, I have considered:
 - a. The documents listed above as well as additional patents and documents referenced herein;
 - b. The relevant legal standards, including the standard for obviousness provided in *KSR International Co. v. Teleflex, Inc.*, 550 U.S. 398 (2007), and any additional documents cited in the body of this declaration; and
 - c. My knowledge and experience based upon my work and study in this area as described below.

I. Qualifications and Professional Experience

6. I am a Professor and President of the Toyota Technological Institute at Chicago (TTIC) and an Emeritus Professor of the Department of Computer Science at the University of California, Santa Barbara. I have worked and studied in the field of computer vision since 1984, as well as related areas of image processing, pattern recognition, machine learning, and human-computer interaction. The field of computer vision is concerned with determining how computers can extract, analyze and understand information from images and video.

7. I received my doctorate degree in Media Arts and Sciences from the Massachusetts Institute of Technology (MIT) in 1991. My doctoral work was in the area of computer vision, specifically concerning automatic face recognition. I received my Master of Science degree in Electrical and Computer Engineering from Carnegie Mellon University in 1984. My Master's work was in the area of robot fine motion planning. I received my Bachelor of Science degree in Electrical Engineering from Virginia Tech (VPI&SU) in Blacksburg, Virginia in 1982, where my senior honors thesis was on image processing.

8. In 1991, I published the paper "Eigenfaces for Recognition," which I co-authored with my Ph.D. advisor, Dr. Alex Pentland. The research reported in this paper helped lead to practical automated face recognition systems that are used in today's security and surveillance systems, as well as in consumer applications.

My work on Eigenfaces has received several awards, including an IEEE Computer Society Outstanding Paper award at the IEEE Conference on Computer Vision and Pattern Recognition (CVPR) in 1991 and a “Most Influential Paper of the Decade” award from the International Association for Pattern Recognition (IAPR) Workshop on Machine Vision Applications (MVA 2000).

9. Along with my co-authors, I have received several other awards at professional conferences and workshops for my work in computer vision, image processing, and augmented reality, including several best paper awards and winning the ACM Multimedia Open Source Competition in 2015.

10. My industry experience includes working for Martin Marietta Denver Aerospace from 1984 to 1987, where I worked primarily on computer vision for autonomous vehicle navigation as part of the Defense Advanced Research Projects Agency’s Autonomous Land Vehicle program, the precursor to the later DARPA Grand Challenge events and subsequent advances in self-driving automobiles. In 1992, I was a visiting researcher at LIFIA/ENSIMAG in Grenoble, France and from 1993 to 1994, I worked for Teleos Research in Palo Alto, CA; in both of those positions, I worked on computer vision methods for recognizing human faces, gestures, and activity. From 1994 to 2000, I was a researcher for Microsoft Research, where I was a founding member of the Vision Technology Research Group and conducted research in vision-based human computer interaction and

other related areas.

11. In 2000, I joined the faculty of the University of California, Santa Barbara, as an Associate Professor. In 2005, I was promoted to Full Professor and served as the Chair of the Media Arts and Technology Graduate Program from 2005 to 2010. In 2017, I was appointed as Chair of the Department of Computer Science. At UCSB, I taught graduate and undergraduate courses related to computer vision, computer imaging, human computer interaction, probabilistic models and methods, artificial intelligence, computer graphics, machine learning, and other areas. My graduate Computer Imaging course covered the fundamentals of imaging systems, including the capture, storage, display, retrieval, and processing of images, as well as the nature of light, color, optics, human vision, non-visible (UV and IR) and multispectral imaging, sensors, cameras, and illumination.

12. I co-founded (in 2003) and co-directed the Four Eyes Lab at UCSB, where the research focus is on the “four I’s” of Imaging, Interaction, and Innovative Interfaces. The Four Eyes Lab researches a variety of topics, including computer vision, pattern recognition, virtual and augmented reality, and face processing technologies such as face recognition and facial expression analysis. I worked on and supervised many research projects in these areas, including (1) visual recognition of automobiles and (2) multi-flash imaging, which used multiple

image sources and special optics to infer 3D scene structure from images.

13. In 2014, I co-founded a startup company, Caugnate, to commercialize computer vision and augmented reality technology for remote collaboration. Caugnate was acquired by PTC Inc., in 2016, and now forms the core of the Vuforia Chalk augmented reality product.

14. In 2019, I became President of the Toyota Technological Institute at Chicago, an independent graduate research institute, where the research and education focus of the faculty and Ph.D. students is on computer science theory, machine learning, artificial intelligence, and related areas such as computer vision, speech and language processing, robotics, and computational biology.

15. As a result of my work and research, I am a named inventor of U.S. Patent Number 5,164,992 entitled “Face Recognition System,” U.S. Patent Number 6,674,877 entitled “System and Method for Visually Tracking Occluded Objects in Real-time,” and U.S. Patent Number 9,495,761 entitled “Environment mapping with automatic motion model selection.”

16. I was a founding member of the Advisory Board for the International Conference on Multimodal Interfaces (ICMI), which provides a venue for disseminating recent advances in multimodal interaction research, systems, and methods, which includes combining visual modalities with audio, haptic, or other modalities. I served as the Chair of the ICMI Advisory Board from 2006 to 2009. I

was also a founding member of the Advisory Board for the IEEE International Conference on Automatic Face and Gesture Recognition and served as the General Chair for the conference in 2011. I have been a primary organizer of several top research conferences, including serving as General Chair for the 2014 IEEE Conference on Computer Vision and Pattern Recognition, the primary annual conference in the field of computer vision, with over 2000 attendees, Program Chair for the 2017 IEEE Winter Conference on Applications of Computer Vision, and General Chair of the 2019 International Conference on Multimodal Interfaces (ICMI).

17. I am currently an Associate Editor of the *ACM Transactions on Intelligent and Interactive Systems* and the *International Journal of Computer Vision and Signal Processing*, and was formerly an Associate Editor of *Image and Vision Computing*. I have also served as a guest editor of several other journals related to computer vision, machine learning, and facial recognition.

18. In 2020, I was elected a Fellow of the Association for Computing Machinery (ACM), the main professional society in the field of computer science, for “contributions to face recognition, computer vision, and multimodal interaction.” In 2013, I was elected as a Fellow of the IEEE (the Institute of Electrical and Electronics Engineers), an award conferred by the Board of Directors of the IEEE upon a person with an extraordinary record of

accomplishments in any of the IEEE fields of interest. In 2014, I was elected as a Fellow of the International Association for Pattern Recognition (IAPR). In 2022, I was named as a Fellow of the Asia-Pacific Artificial Intelligence Association. I am also the recipient of the 2011-2012 Fulbright-Nokia Distinguished Chair in Information and Communications Technologies. I have given many keynote presentations at top conferences and workshops in my fields.

19. I have provided my full background in the curriculum vitae that is attached as Exhibit 2002.

II. Relevant Legal Standards

20. I have been asked to provide opinions on the claims of the ‘551 Patent in light of the prior art.

21. It is my understanding that a claimed invention is unpatentable under 35 USC § 102 if a prior art reference teaches every element of the claim. Further, it is my understanding that a claimed invention is unpatentable under 35 U.S.C. § 103 if the differences between the invention and the prior art are such that the subject matter as a whole would have been obvious at the time the alleged invention was made to a person having ordinary skill in the art to which the subject matter pertains. I also understand that an obviousness analysis takes into account factual inquiries including the level of ordinary skill in the art, the scope and content of the prior art, and the differences between the prior art and the claimed

subject matter.

22. It is my understanding that the Supreme Court has recognized several rationales for combining references or modifying a reference to show obviousness of the claimed subject matter. Some of these rationales include the following: combining prior art elements according to known methods to yield predictable results; simple substitution of one known element for another to obtain predictable results; a predictable use of prior art elements according to their established functions; applying a known technique to a known device to yield predictable results; choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success; and some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teachings to arrive at the claimed invention.

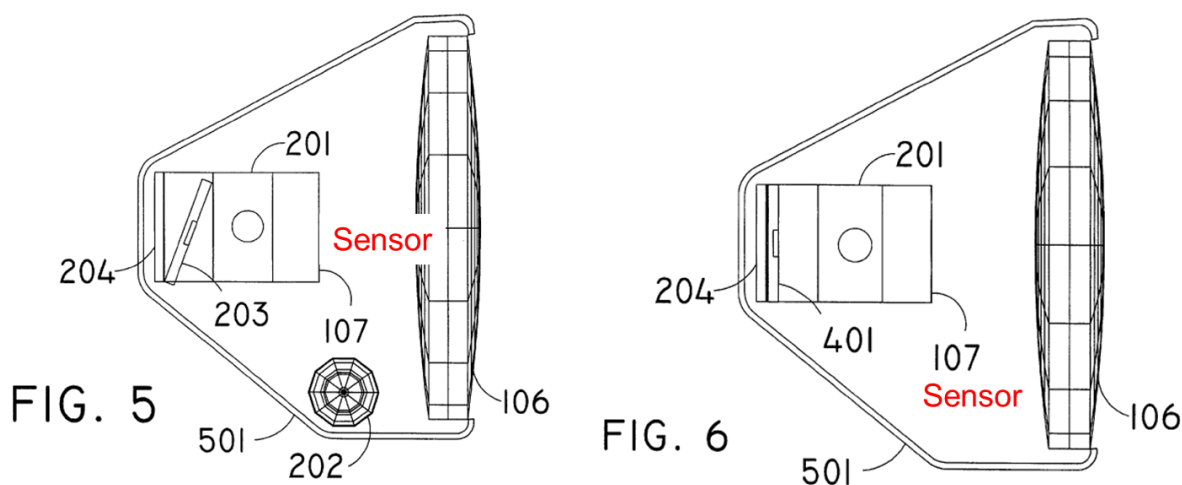
III. A Person of Ordinary Skill in the Art Would Not Have Been Motivated to Combine Beam and Satonaka or Karlsson and Nakamura

A. How a POSITA Would Have Combined the Prior Art

23. I understand that an obviousness determination is improper where the record lacks a clear, evidence-supported account of how the combination of references would work.

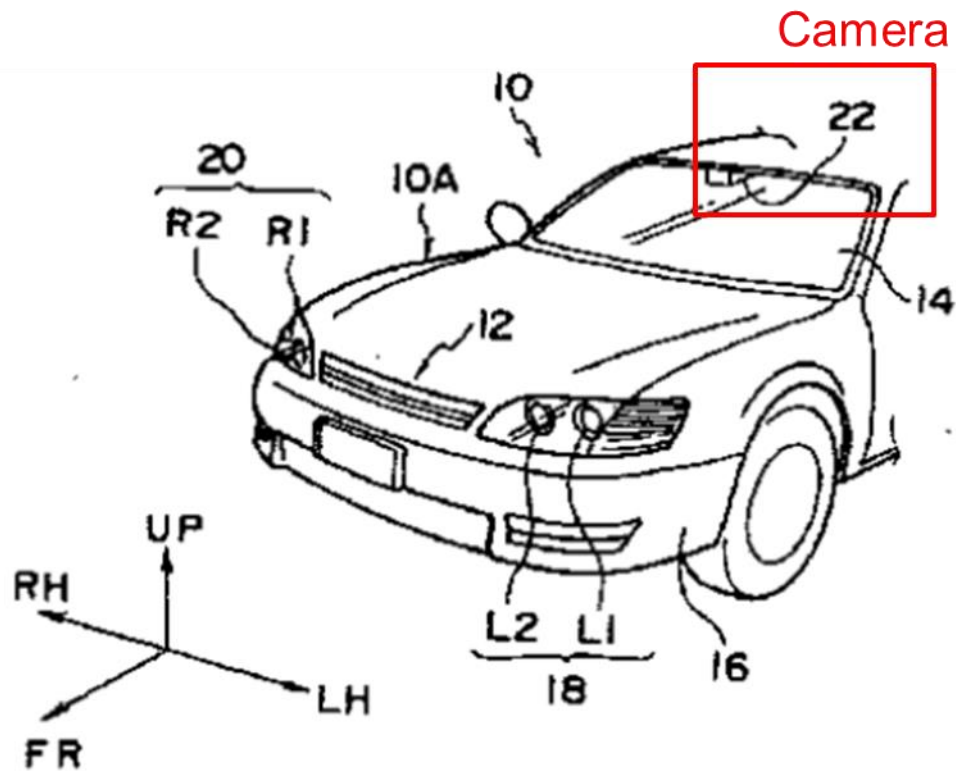
1. Ground 1: Petitioner Does Not Explain How a POSITA Would Have Combined Beam's Co-located Sensor with Satonaka's Remote Sensor Based Image Processing

24. Petitioner relies on Satonaka's image processing software for satisfying the "camera" limitations of claims [24.5]/[32.5]/[40.5]/[48.5]. (Petition at 29.) Beam discloses mounting the sensor within the headlamp assembly to ensure accuracy "[t]he sensor will be co-located with the light source so that errors in alignment are automatically compensated." (Ex. 1005, 2:63-65.)



(Ex. 1005, FIGs. 5, 6 Annotated)

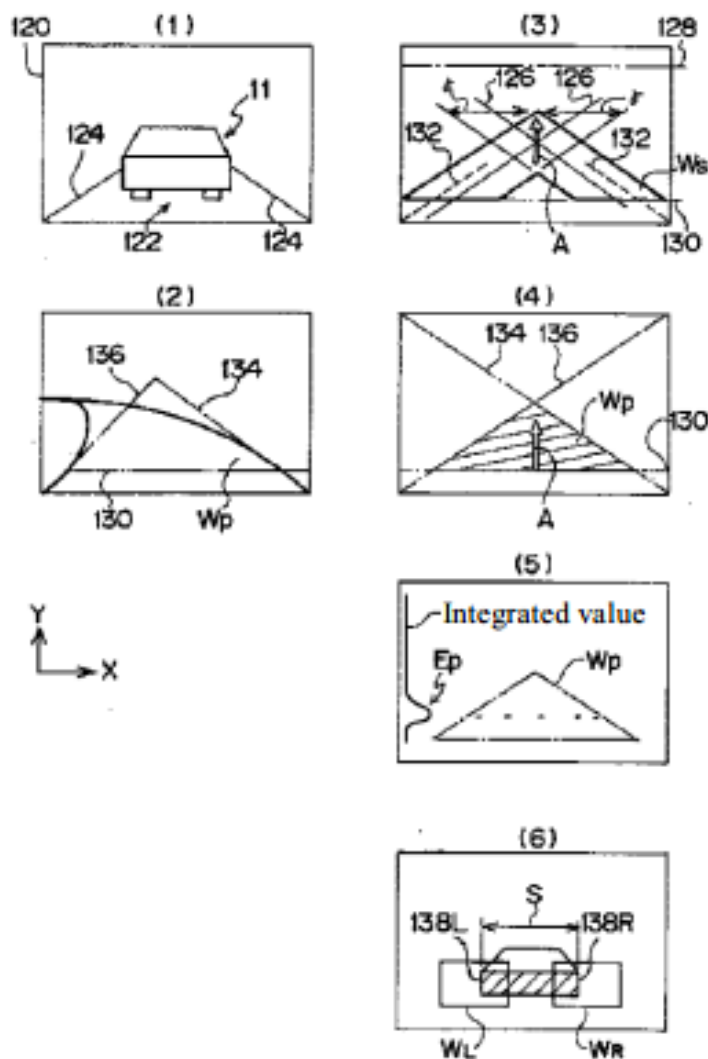
25. Satonaka discloses headlamps 18 and 20 that are provided on the top part of the front bumper 16 and a camera 22 that is mounted "[a]t the top of this windshield glass 14 and inside of vehicle 10 (at the driver's visual field position, or in other words, near the driver's eyepoint)." (Ex. 1014, [0017].)



(Ex. 1014, Fig. 1, Annotated)

26. With reference to Figure 4, Satonaka discloses a strategy for processing the image captured at the driver's eyeline. (Ex. 1014, [0026].)

(FIGURE 4)



(Ex. 1014, Fig. 4)

27. Even if one were to combine Satonaka's image processing software with Beam's lamp co-located sensor, Petitioner fails to explain how an image from Beam's co-located and boresighted camera would be used by Satonaka's vehicle recognition zone image processing strategy that is based on a remote camera

located at the top center of the windshield and that expressly defines subsequent processing from the visual perspective that provides.

28. Satonaka mounts a camera at the center of the windshield near the driver's eyeline. (Ex. 1014, [0016].) From this perspective, the camera generally sees the road as the driver does, with preceding traffic centered between lane markers, and lane markers largely visible on either side of a vehicle. (Id. at Fig. 4, 120.) If the viewpoint were shifted, for example, to a front left headlamp, a number of issues would occur. The perspective of lane markers would shift, the left side marker would appear more vertical, the right side marker would skew left, assuming it was even visible at all, as the vehicle 11 would obscure significantly more of the right side marker. Petitioner never recognizes, let alone provides a solution for, these issues.

29. Further, Satonaka does not include a mapping of coordinates to LEDs or lights in general. Nor does it even use its own coordinates directly to control lights. Importation of a new reference system of coordinates would require remapping the LEDs to the new coordinate system. Although Petitioner never actually alleges that the coordinates are even actually used for control of anything, merely that they are stored, were a POSITA to use them for control they would have to be correlated to lights in some manner. This represents another fact Petitioner does not address, other than stating that one could "simply modify

software instructions stored in the memory of Beam’s controller/processor (in view of Satonaka).” (Petition at 20.)

30. Instead of recognizing and addressing these engineering issues with the combination, Petitioner makes statements such as “this modification requires no physical changes,” and “Beam and Satonaka use the same basic architecture.” (*Id.*)

31. Petitioner states that “Satonaka provides details of how to implement the coordinate mapping of its pixels.” (Petition at 20.) But this is not a teaching of how to map coordinates to light sources (a minimal engineering step required to use coordinates in Beam). Rather, this is simply a statement that the image of Satonaka can be contemplated as coordinates.

32. Petitioner does not explain how the combination of Beam and Satonaka’s Software Implementation would work, i.e., how an image from Beam’s co-located and boresighted camera would be used by Satonaka’s vehicle recognition zone image processing strategy—a processing strategy that is based on a remote camera being located at the top center of the windshield and viewing and processing the scene from that perspective. Therefore the obviousness ground is improper.

a. Ground 3: Petitioner Does Not Explain How a POSITA Would Have Combined Karlsson's Internal Sensors with Nakamura's Remote Sensor Based Image Processing

33. Petitioner relies on Karlsson's collection of sensors combined with Nakamura's image processing software for satisfying the "*camera*" limitations of claims [24.5]/[32.5]/[40.5]/[48.5], for at least Ground 3B. (Petition at 63.) Karlsson discloses a collection of sensors, e.g., "a matrix of photo diodes or in the case of a light-sensitive sensor 23, a photo-sensitive plate as used in modern video cameras." (Ex. 1010, 12:22-24; 5:18-23.) However, Karlsson does not disclose that its sensors have the full capability of cameras, specifically with regards to capturing images. Petitioner fails to explain how Karlsson's system would determine vehicle coordinates using Nakamura's image processing strategy on the basis of incoming light, and without an image.

34. Even if one were to combine Nakamura's image processing software with Karlsson's internal sensor, Petitioner fails to explain how light sensed by Karlsson's lamp-located sensor would be used by Nakamura's vehicle recognition zone image processing strategy that is based on a remote camera located at the top center of the windshield.

35. Nakamura, like Satonaka, mounts a camera at the center of the windshield near the driver's eyeline. (Ex. 1014, [0016].) From this perspective, the

camera generally sees the road as the driver does, with preceding traffic centered between lane markers, and lane markers largely visible on either side of a vehicle. (*Id.*, Fig. 4, 1.) If the viewpoint were shifted, for example, to a front left headlamp, a number of issues would occur. The perspective of lane markers would shift, the left side marker would appear more vertical, the right side marker would skew left, assuming it was even visible at all, as the vehicle 11 would obscure significantly more of the right side marker. Petitioner never recognizes, let alone provides a solution for, these issues.

36. Petitioner also fails to explain how the coordinates of Nakamura would be mapped to the LEDs of Karlsson. Karlsson, unlike Beam, does not even disclose an alternative system for processing an image and choosing which lights to control. Instead, Karlsson discloses a system largely focused on improvements to a prior art system for adaptive control, without much detail, if any, on how such control is implemented, choosing instead to primarily discuss alternative light and sensor sources and assembly strategies. (Ex. 1010, 1:8-9, 2:2-9.) In fact, Karlsson's lack of an actual description of control was cited by Petitioner as a reason to modify Karlsson – "Karlsson does not expressly disclose how the direction of the target light sources is stored and processed to determine which LEDs to be dimmed to avoid glare." (Petition at 55.)

2. Hindsight Bias

37. I understand that a determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention. Instead, there must be a teaching or suggestion within the prior art, or within the field of the invention, to look to particular sources of information, to select particular elements, and to combine them in the way they are combined by the inventor.

a. Ground 3: Petitioner’s Combination of Karlsson and Nakamura is Based on Impermissible Hindsight By Adding Features Already Present in Karlsson

38. Petitioner notes that Karlsson discloses that its sensors are “preferably designed to be capable of precisely determining the direction and the intensity of the detected light.” (Petition at 55 quoting Ex. 1010 at 12:19-22.) Thus, Karlsson already contends that it has no issues in this regard and Petitioner admits as much. Further, Nakamura provides no teaching or statement that would suggest that Karlsson’s light detection would benefit from the inclusion of Nakamura’s coordinates, as those coordinates simply provide the direction (not even the intensity) of detected light – something Karlsson can already determine.

39. Petitioner does not explain any deficiency in Karlsson’s teaching of determining the direction and the intensity of the detected light, or improvements

by combining Karlsson with Nakamura. Instead, Petitioner merely states that the combination would further ensure Karlsson's system accurately identifies traffic ahead and dims its headlights appropriately, improving illumination quality and safety for drivers." (Petition at 57.)

40. Petitioner does not explain any new or different functionality provided by this combination; instead Petitioner quotes Karlsson's disclosure describing features that are already disclosed by Karlsson.

41. Karlsson teaches a simple control strategy in which a photosensor acts like a switch to control an adjacent light source. Karlsson states: "The spotlight sources and the spotlight sensors, ... may also be formed by LEDs and photosensitive transistors, respectively. Arrow 41 schematically indicates an electric connection between the spotlight sensors and spotlight sources D, I and D/I, which, for example, may consist of transistors or the like... Integration of LEDs and phototransistors on one carrier, for example, is also possible." (Ex. 1010, 19:34 - 20:5.). If the phototransistor is functioning as a switch for the LED(s) to which it is electrically connected, then light detected by the photodetector would cause a change to the electrical current to the LED and cause it to change state.

42. If a POSITA considered the above to be a control strategy, they would recognize that Karlsson, having both recitation of LED selection (via direct

electrical connection to phototransistors) and determination of directionality of detected incoming light, via the same phototransistors, represents a complete solution that not only does not require the addition of Nakamura's coordinates, but which has no use for them. In a system where the direct connection to a sensor is what controls the function of an LED, there is no reason to "store" coordinates in any manner; the mere incidence of light on the sensor achieves both selection (through electrical correlation of the LED and sensor) and control. That renders the addition of Nakamura, and its coordinate system, pure hindsight.

IV. Conclusion

43. In my opinion, the prior art references discussed above taken alone or in any permissible combination do not disclose or suggest each and every element of the challenged claims.

44. I reserve the right to supplement my opinions to address any information obtained, or positions taken, based on any new information that comes to light throughout this proceeding.

I declare under penalty of perjury that the foregoing is true and accurate to the best of my ability.

Executed on: 4/18/2023



Matthew A. Turk Ph.D.