

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

HESAI TECHNOLOGY CO., LTD.
Petitioner

v.

OUSTER, INC.
Patent Owner

U.S. Patent No. 11,175,405
Inter Partes Review No. 2023-01421

REPLY DECLARATION OF JAMES F. SHANLEY, PH.D.

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U.S. Patent No. 11,175,405
Reply Declaration in Support of Petition for *Inter Partes* Review

EXHIBIT LIST

No.	Short Name	Exhibit
1001	'405 Patent	U.S. Patent No. 11,175,405 to Pacala <i>et al.</i>
1002	'405 Prosecution History	Prosecution history for U.S. Patent No. 11,175,405
1003		Intentionally Left Blank
1004	Pacala	U.S. Patent Pub. No. 2014/0211194 to Pacala <i>et al.</i>
1005	Spector	U.S. Patent No. 10,473,766 to Spector
1006	Droz	U.S. Patent No. 10,605,984 to Droz <i>et al.</i>
1007	Villeneuve	U.S. Patent No. 10,520,602 to Villeneuve <i>et al.</i>
1008	Hall	U.S. Patent No. 9,983,297 to Hall <i>et al.</i>
1009	Borowski	U.S. Patent Pub. No. 2013/0300840 to Borowski
1010	Spector Provisional	U.S. Provisional Appl. No. 62/470,706 to Spector
1011	NIST	<i>Performance Analysis of Next-Generation LADAR for Manufacturing, Construction, and Mobility</i> , National Institute of Standards and Technology (2004)
1012	NOAA	Younkin <i>et al.</i> , <i>Velodyne VLP-16 Laser Scanner Acceptance</i> , NOAA Report, May 2016
1013	Pacala-2016	U.S. Patent Pub. No. 2016/0047901 to Pacala <i>et al.</i>
1014	Pacala-803	U.S. Patent No. 10,036,803 to Pacala <i>et al.</i>
1015	Hall-672	U.S. Patent No. RE46,672 to Hall

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No.	Short Name	Exhibit
1016	ITC Complaint	Complaint in ITC Inv. No. 337-TA-1363
1017	Delaware Complaint	Complaint in <i>Ouster, Inc. v. Hesai Group et al.</i> , No. 23-cv-00406 (D. Del.)
1018	Stay Order	Order Granting Stay in <i>Ouster, Inc. v. Hesai Group et al.</i> , No. 23-cv-00406 (D. Del.)
1019	Joint Claim Construction Chart	Joint Claim Construction Chart in ITC Inv. No. 337-TA-1363 (July 7, 2023)
1020	Termination Order	Order Granting Motion to Terminate in ITC Inv. No. 337-TA-1363
1021	Shanley CV	<i>Curriculum Vitae</i> of James F. Shanley
1022	Sensors 2020	Lee <i>et al.</i> , “Accuracy-Power Controllable LiDAR Sensor System with 3D Object Recognition for Autonomous Vehicle,” in <i>Sensors</i> , Vol. 20, Iss. 19 (Oct. 2020)
1023	Hipp-747	U.S. Patent No. 6,747,747 to Hipp
1024	Weimer	U.S. Patent No. 8,736,818 to Weimer <i>et al.</i>
1025	Borowski-838	U.S. Patent Pub. No. 2013/0300838 to Borowski
1026	DGC	<i>Report to Congress: DARPA Prize Authority</i> (2006)
1027	Team DAD	Hall <i>et al.</i> , <i>Team DAD Technical Paper</i> , DARPA Grand Challenge (2005)
1028	Marino	Marino <i>et al.</i> , <i>A compact 3D imaging laser radar system using Geiger-mode APD arrays: system and measurements</i> , MIT Lincoln Lab (2003)

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No.	Short Name	Exhibit
1029	Matsubara	Matsubara <i>et al.</i> , <i>Development of Next Generation LiDAR</i> , R&D Review of Toyota CRDL (2012)
1030	Hall-877	U.S. Patent No. 10,393,877 to Hall <i>et al.</i>
1031	Hagiz PHV Dec.	Declaration of Ron Hagiz in Support of Petitioner's Motion for <i>Pro Hac Vice</i> Admission
1032	Takai	Takai <i>et al.</i> , <i>Single-Photon Avalanche Diode with Enhanced NIR-Sensitivity for Automotive LIDAR Systems</i> , Sensors (2016)

I, Dr. James F. Shanley, declare as follows:

I. INTRODUCTION

1. I have been retained by Quinn Emanuel Urquhart & Sullivan LLP on behalf of Petitioner Hesai Technology Co., Ltd. (“Hesai”) as an independent expert in this *inter partes* review (this “IPR”) before the Patent Trial and Appeal Board (the “Board”).

2. I previously submitted a declaration setting forth my opinions regarding the invalidity of claims 21 and 23-34 (the “challenged claims”) of U.S. Patent No 11,175,405 (the “’405 patent”).

3. I understand that Patent Owner submitted a Response in this IPR, including a supporting declaration from Dr. Jason A. Janét. I have reviewed Patent Owner’s Response and Dr. Janét’s declaration.

4. Dr. Janét’s declaration raises several new issues and positions regarding that validity of the challenged claims that I understand Patent Owner did not previously raise, and that I did not have an opportunity to address in my initial declaration. These include a new proposed level of skill in the art for the ’405 patent, a new proposed claim construction for the term “stop region,” and alleged secondary considerations of non-obviousness.

5. I have been asked to provide my opinions in response to the new positions and arguments raised in Patent Owner's Response and Dr. Janét's declaration.

A. Qualifications

6. I provided an overview of my relevant experience and qualifications in Paragraphs 3 to 13 of my initial declaration. I incorporate that discussion by reference here.

B. Materials Considered

7. In addition to the materials identified in my initial declaration, in preparing this Declaration, I also considered Patent Owner's Response, Dr. Janét's declaration, the materials cited in Dr. Janét's declaration, and the additional materials cited in this Declaration.

II. LEGAL UNDERSTANDINGS

8. I provided my understanding of the applicable legal standards in Paragraphs 15 to 24 of my initial declaration. I incorporate that discussion by reference here.

III. LEVEL OF ORDINARY SKILL IN THE ART

9. In my initial declaration, I explained that a POSITA with respect to the '405 patent would have had an undergraduate degree in mechanical or electrical engineering or physics and two to three years of experience in the field of LiDAR

design. I also provided several reasons why this would have been the level of ordinary skill in the art and would have been typical for a POSITA with respect to the technology underlying the '405 patent.

10. I understand that Dr. Janét agrees with me that a POSITA would have work experience with LiDAR design. Janét Decl. ¶ 60. However, Dr. Janét believes that only one year of work experience is necessary, and need only be supplemented by two to three years of experience with “electro-optical and electro-mechanical devices or systems.” *Id.*, ¶ 62.

11. I disagree with Dr. Janét. The '405 patent is directed to LiDAR designs, and a POSITA would be familiar with the optical, electrical, and mechanical elements of a LiDAR system, specifically, including problems associated with the design and implementation of those components in the context of a LiDAR system and solutions for addressing those problems. Such knowledge would be gained through additional experience working with LiDAR systems, but not necessarily through experience with electro-optical and electro-mechanical systems more generally.

12. Regardless, because Dr. Janét agrees that a POSITA would have experience working with LiDAR systems, the opinions in my initial declaration and in this Declaration would be the same even if Dr. Janét's definition of the level of skill in the art is applied.

13. Dr. Janét also states that I opined that a POSITA would be a “team of engineers.” Janét Decl. ¶ 62. That is not correct. I merely explained at my deposition that in a real-world design process, a team of engineers would be involved so that multiple engineers can work on different aspects of the design in parallel. However, I also explained that there would be individual members of the team who possess all of the requisite experience.

IV. OPINIONS ON DROZ’S “STOP REGION”

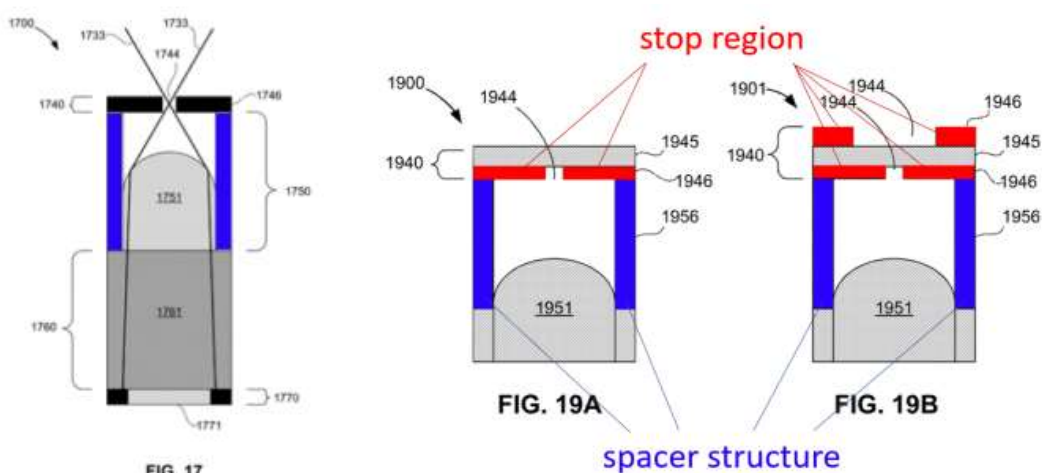
A. Claim Construction of “Stop Region”

14. Dr. Janét opines that the term “stop region” as used in the claims of the ’405 patent means “an optically non-transparent region that defines a field of view for a photosensor.” Janét Decl. ¶ 100. I disagree.

15. Dr. Janét’s proposed construction is based primarily one embodiment of the ’405 patent, which describes “[a]n input aperture layer **1740** including an optically transparent aperture **1744** and optically non-transparent stop region **1746** configured to define a narrow field of view when placed at the focal plane of an imaging optic.” Janét Decl. ¶ 102; ’405 patent (Ex. 1001) at 37:17-23. As an initial matter, a POSITA would not understand this description in an embodiment of the specification to define the term “stop region,” and I am informed that under the rules of claim construction it is not proper to import limitations from preferred embodiments into the claims. In addition, even in the context of this example, a

POSITA would understand that the ***aperture layer*** defines the field of view, not the ***stop region*** specifically, because it is the aperture layer (comprising both the optically non-transparent stop region ***and*** the optically transparent aperture) that is placed at the focal plane of the imaging optic.

16. Dr. Janét then cites to various examples where the specification uses the term “stop region” to refer to an optically non-transparent region in the aperture layer, and does not use the term “stop region” to refer to other optically non-transparent material that is outside of the aperture layer. For example, Dr. Janét annotates 17, 19A, and 19B of the ’405 patent (reproduced below) and states that the optically non-transparent material outside of the aperture layer (annotated in blue below) is not described as a “stop region.” Janét Decl. ¶¶ 103-104. But these examples do not support Dr. Janét’s construction of “stop region” to mean “an optically non-transparent region ***that defines a field of view for a photosensor.***” They merely show that the stop region is part of the aperture layer, and does not broadly refer to ***all*** optically non-transparent material. This is consistent with the claims, which recite that the stop region is part of the aperture layer. *See, e.g.*, ’405 patent (Ex. 1001), claim 21 (“***an aperture layer comprising*** a plurality of apertures ***separated by a stop region***”).



17. Other disclosures in the specification consistently describe the stop region as the optically non-transparent region of the aperture layer, but do not consistently describe the stop region as defining a field of view for a photosensor. For example, the embodiments of Figures 18A and 18B describe the aperture layer as including “[o]ptically transparent apertures **1844** and corresponding optically non-transparent optical stop regions **1846** ... supported on an optically transparent substrate **1845**,” but do not describe the stop region as defining a field of view. ’405 patent (Ex. 1001) at 38:44-47, 38:55-58. And in the embodiments of Figures 18C and 18D, the stop regions are described as “reduc[ing] stray light into the receiver channel,” not as defining a field of view. *Id.* at 38:66-39:2, 39:9-12. And in the embodiments of Figures 20C and 20D, the ’405 patent describes the *aperture* as defining “the maximal cylinder of light desired to be passed” (*e.g.*, a field of view), and the stop region merely “absorbs or reflects any incident stray light outside the diameter of [the] aperture.” *Id.* at 40:56-63, 41:13-25.

18. Dr. Janét also states that there is “no suggestion that the stop regions work to keep light from moving between the parallel optical channels.” Janet Decl. ¶ 105. I disagree. In the embodiment of Figure 20D, the ’405 specification describes using multiple aperture layers comprising apertures and their “corresponding optically non-transparent stop region,” and explains that the layers collectively “prevent stray light in one optical filter layer **2060** from *travelling into an optical filter region of an adjacent receiver channel*.” ’405 patent (Ex. 1001) at 41:7-29.

19. Dr. Janét also relies on definitions of an “aperture stop” from sources outside of the ’405 patent. Janét Decl. ¶¶ 107-108. However, these sources describe the term “aperture stop,” not the term “stop region” that appears in the claims of the ’405 patent. In addition, they explain that the light that passes through the system is determined by the *aperture*, not by the *stop region*.

B. Droz Discloses a “Stop Region” Under Dr. Janét’s Construction

20. Even under Dr. Janét’s proposed construction of a “stop region” to mean “an optically non-transparent region that defines a field of view for a photosensor,” it is my opinion that Droz discloses a stop region because the light-absorbing layers define the fields of view of the waveguides.

21. Droz expressly teaches that “the input ends of the waveguides” can be “limiting apertures.” Droz (Ex. 1006) at 15:35-43. And in one embodiment, “each respective input end of the waveguides in array **360** may correspond to a respective

aperture of system **300**. *Id.* at 16:17-21. A POSITA would have understood that in these examples, the input ends of the waveguides (as annotated below in Figure 3B) define the fields of view for their corresponding light detectors. But the sizes of the input ends of the waveguides (and their corresponding fields of view) depend at least in part on the light-absorbing layers (*e.g.*, 368 and 378), which separate the input ends from one another and limit their respective sizes (and fields of view).

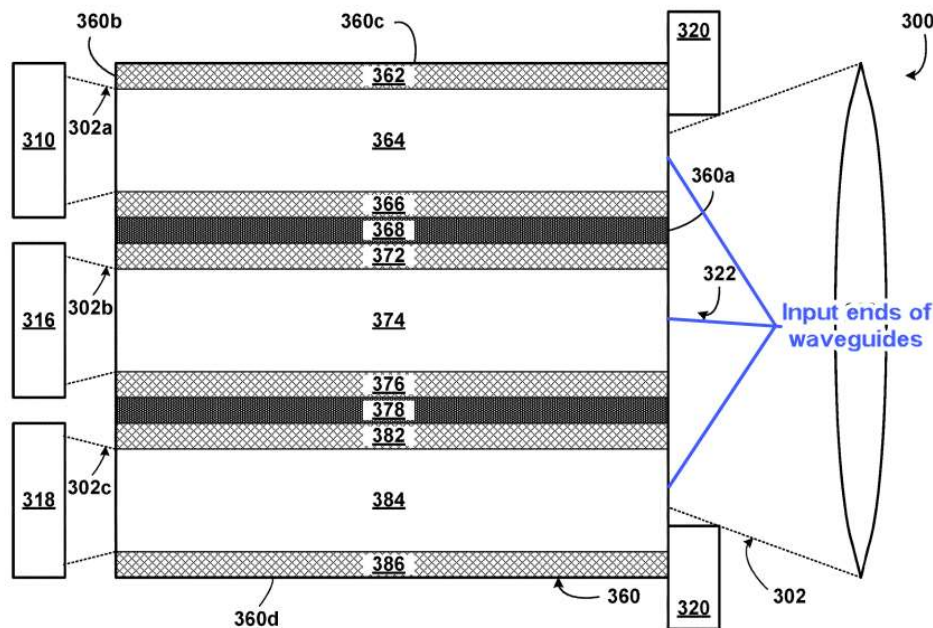
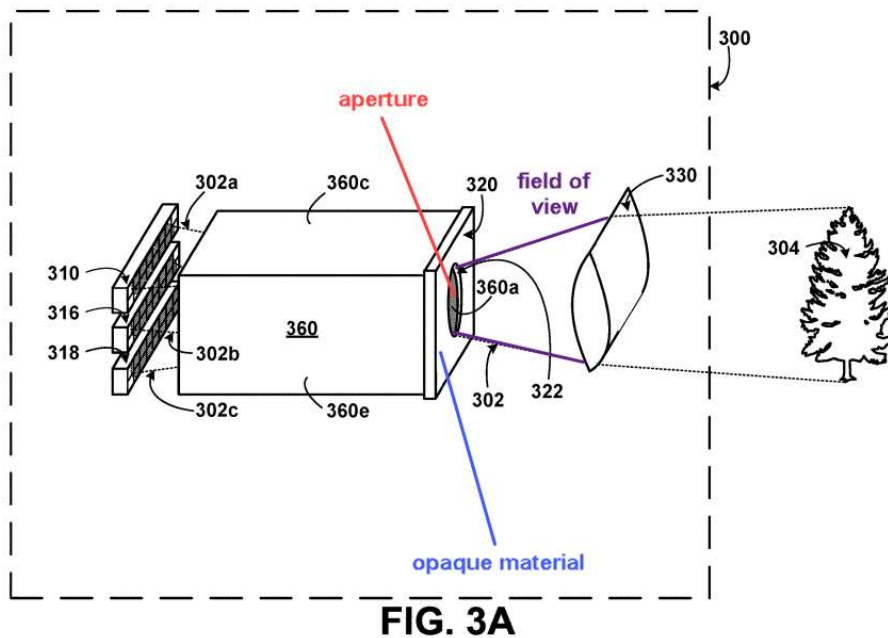


FIG. 3B

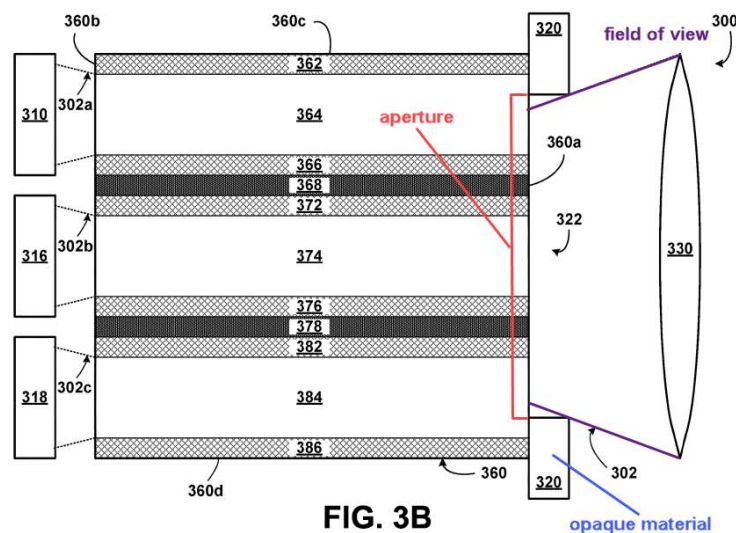
22. In addition, Droz explains that the “input end” of a waveguide is the portion that “extend[s] between cladding layers.” Droz (Ex. 1006) at 16:59-62. That is consistent with the apertures and stop regions of the aperture layer in the ’405 patent. Light that enters the waveguide array at the light-absorbing layers will be

absorbed, and thus will not be received at the detectors. Similarly, Droz explains that light that “propagat[es] inside a cladding layer of a waveguide ... rather than inside the a core of the waveguide” will be absorbed by the light-absorbing layer. Droz (Ex. 1006) at 4:43-48. Thus, the light-absorbing layers effectively limit the field of view of a waveguide to the size of its input end; other light will not enter the waveguide because it will be absorbed by the light-absorbing layers. In that respect, the input ends of Droz’s waveguides are similar to the definitions of “aperture stop” that Dr. Janét cites to, which describe an “aperture stop” as “*a diameter*” that “limits the size or diameter of the beam of rays which can pass through the system.” Janét Decl. ¶ 108.

23. Other teachings in Droz confirm that the light-absorbing layers define a field of view. For example, Droz describes embodiments where an “opaque material” defines an “aperture.” Droz (Ex. 1006) at 3:16-20. The opaque material and aperture “spatially filter light ... from the scene,” thus behaving “like an optical pinhole.” *Id.* at 6:6-9, 6:23-29. The aperture, whose size and field of view are determined by the surrounding opaque material, only allows only a “portion of the focused light to be transmitted to” the detectors. *Id.*, 6:25-28. This embodiment is illustrated in Figure 3A, annotated below. *Id.* at 13:14-17.

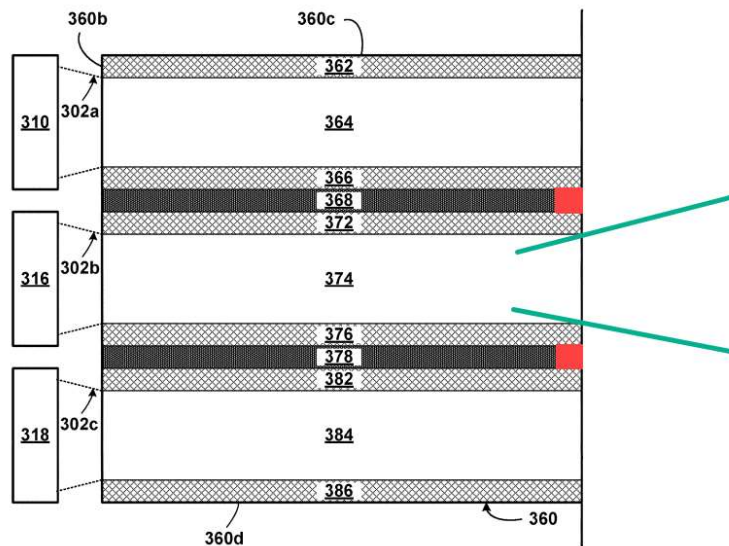


24. In Figure 3B, annotated below, the opaque material is shown as element 320, surrounding aperture 322. These collectively define a field of view illustrated as lines 302 (showing light entering the aperture). Droz (Ex. 1006) at 13:61-66.



25. Droz teaches that in one embodiment, the “opaque material 320 can be omitted,” and “each respective input end of the waveguides in array 360 may

correspond to a respective aperture.” Droz (Ex. 1006) at 16:18-21. In addition, Droz teaches that in Figure 3B, each waveguide “receive[s] a portion of light 302 projected on side 360a and extending between cladding layers 362 and 366 (i.e., input end of the first waveguide).” *Id.* at 14:4-7. The input end of the waveguide is thus an aperture in the aperture layer, and the light-absorbing layers are stop regions that define the field of view by absorbing light that arrives at the end of the light-absorbing layer aligned with the input end of the waveguide, as well as light that propagates in the adjacent cladding layers. This is illustrated in the annotated version of Figure 3B below, where one end of the light-absorbing region acts as a stop region, thus defining a field of view illustrated by the green lines.

**FIG. 3B**

26. Dr. Janét also opines that Droz’s light-absorbing layers do not define a field of view because no light-absorbing layer is shown at the outer perimeter of the

waveguide array in Figure 3B. Janét Decl. ¶ 101. I disagree. Even if the light absorbing layers are only provided between waveguides, they would nevertheless limit the fields of view of the outermost waveguides—the field of view may simply be very large. However, in the examples shown in Figures 3A and 3B, a POSITA would understand that other structures or devices are likely provided outside of the waveguide array, but not shown in Figure 3B specifically, that would prevent light from entering the waveguide along the sides.

V. SECONDARY CONSIDERATIONS OF NONOBVIOUSNESS

27. In his declaration, Dr. Janét opines that there are secondary considerations of nonobviousness relevant to the validity of the '405 patent. Dr. Janét only discusses two such purported secondary considerations: industry skepticism and failure by others. Janét Decl. ¶¶ 161-170. I disagree with Dr. Janét on both points.

A. Industry Skepticism

28. I disagree with Dr. Janét's opinion that there was "significant industry skepticism about the use of SPADs in a LIDAR device prior to the '405 patent." Janét Decl. ¶ 163.

29. Dr. Janét does not point to any publication or other material that demonstrates a widespread belief or opinion within the industry that SPADs could not be used in a LiDAR device, nor was there any such belief in the industry. To the

contrary, my initial declaration discusses several patents and papers that proposed the use of SPADs in LiDAR applications, including Droz (Ex. 1006), Borowski (Ex. 1009), Marino (Ex. 1028), and Matsubara (Ex. 1029). Marino, in particular, describes research performed by MIT Lincoln Labs, which performed extensive research on SPADs and LiDAR systems in the early 2000s.

30. Even in the year before the '405 patent (*i.e.*, in 2016), researchers were continuing to develop LiDAR systems using SPADs for detection. For example, in January 2016, a team of researchers at Toyota published a paper describing SPADs “for use in future automotive light detection and ranging (LIDAR) systems.” Ex. 1032 (Takai) at 1. The Toyota researchers reported that they “successfully and integrally designed” a “low-cost system-on-a-chip implementation” of SPADs and their associated circuitry. *Id.* at 1-2. The resulting system was able to achieve “a higher-performance, e.g., longer-range, higher-precision, and higher-measurement rate, LIDAR system.” *Id.* at 8.

31. The only basis Dr. Janét provides for his opinion about industry skepticism is the fact that I testified at my deposition that I did not use SPADs in LiDAR systems that I designed, and that I could not recall specific examples of commercial LiDAR systems that used SPADs. I do not agree that these reflect industry skepticism.

32. The project I was specifically asked about during my deposition took place in 2008, nearly a decade before the date of the '405 patent. At that time, SPAD technology was still being refined, SPADs were not readily available (e.g., as off-the-shelf components), and SPADs simply did not meet the design requirements for that particular project. Thus, for that particular project, I decided that SPADs were not the appropriate choice of detector. That does not mean I (or the industry) was skeptical that SPADs could be used in LiDAR systems. That was not at all the case.

33. Similarly, the fact that I could not recall specific examples of commercial SPAD-based LiDAR devices at my deposition is not because there was skepticism in the industry. As noted above, my initial declaration cited several patents and papers describing the use of SPADs in LiDAR systems. I could not recall at my deposition which of these, if any, were implemented in commercial products as of the date of the '405 patent. That does not change the fact that there was active research and development into LiDAR systems using SPADs for detection, as reflected in the patents and papers discussed in my initial declaration and above.

B. Failure of Others

34. I also disagree with Dr. Janét's opinion that "the literature is replete with discussion of failures to use SPADs in LIDAR systems." Janét Decl. ¶ 168.

35. The only “literature” Dr. Janét discusses is a single paper by a Russian research named Sergey Vinogradov. Ex. 2014. I have reviewed the Vinogradov paper, and I disagree that it shows repeated failures by others to develop SPAD arrays for use in LiDAR systems.

36. First, Sergey Vinogradov is not a prominent or well-known researcher in the field of LiDAR design. It is not clear from his paper or from Dr. Janét’s declaration whether Sergey Vinogradov even has sufficient experience with LiDAR systems to be considered a POSITA (under my definition or under Dr. Janét’s definition). And more generally, when the Vinogradov paper was published, Russia was not considered to be leading, or even active, in LiDAR design and related research. Thus, I would not consider the Vinogradov paper to reflect the state of the industry as of 2017. And Dr. Janét does not provide any reasons to do so.

37. Second, the Vinogradov paper does not claim to have performed a comprehensive survey of the literature or the field in order to determine whether or not the use of SPADs in LiDAR devices was successful. The paper only discusses two projects: the MiSPiA project, citing to papers published in the 2013-2015 time frame, and a project undertaken by Philips, citing to papers published in 2009 and 2012. Ex. 2014 (Vinogradov paper) at 3. Based on these two examples, the author concludes that “to the best of [his] knowledge, there are not attempts either to implement SPAD arrays or dSiPMs as a single photon number resolving LIDAR

receiver or to combine an array of SPAD arrays or dSiPMs as a focal plane array of photon number resolving detectors in 3D imaging LIDARs.” Ex. 2014 (Vinogradov Paper) at 4. The paper does not discuss any other research relating to SPADs and LiDAR systems, including the research and inventions discussed in Droz (Ex. 1006), Borowski (Ex. 1009), Marino (Ex. 1028), Matsubara (Ex. 1029), or Takai (Ex. 1032). Indeed, the paper acknowledges that a “detailed analysis of the SPAD-based receivers is *out of the scope of this paper*.” Ex. 2014 (Vinogradov Paper) at 4.

38. In addition, the Vinogradov paper does not claim that the MiSPiA and Philips projects *failed* to incorporate SPADs into a LiDAR system; it merely states that there were challenges or costs associated with doing so. Ex. 2014 (Vinogradov paper) at 3. However, as at least the Takai paper shows, researchers knew how to overcome these challenges to develop effective SPAD-based LiDAR systems at least by early 2016, over a year before the ’405 patent. *See* Ex. 1032.

39. Dr. Janét also notes that I testified that SPADs will fail without a quenching circuit. Janét Decl. ¶ 169. But as I explained in my initial declaration (at Paragraphs 48-49), this was well known about SPADs long before the ’405 patent, and it was well known in the field (and would have been well known to a POSITA) how to build a quenching circuit for a SPAD. The need for quenching circuits would not and did not render SPADs unusable in LiDAR systems—as patents and papers such as Droz, Borowski, Marino, Matsubara, and Takai confirm.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on the information and belief are believed to be true; I declare under penalty of perjury that the foregoing is true and correct, and understand that willful false statements and the like are punishable by fine or imprisonment, or both pursuant to 18 U.S.C. 1001.

Date: September 17, 2024

Respectfully Submitted,

James F. Shanley

Dr. James F. Shanley