

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MOBILEYE GLOBAL, INC. and
ZF ACTIVE SAFETY AND ELECTRONICS US LLC,
Petitioner,

v.

FACET TECHNOLOGY CORP.,
Patent Owner.

IPR2024-01111¹
Patent 9,671,328 B2

Before KEVIN F. TURNER, ROBERT J. SILVERMAN, and
SEAN P. O'HANLON, *Administrative Patent Judges*.

O'HANLON, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining Some Challenged Claims Unpatentable
35 U.S.C. § 318(a)

¹ ZF Active Safety and Electronics US LLC, which filed a petition in IPR2025-00749, has been joined as a petitioner in this proceeding.

I. INTRODUCTION

A. Background

Mobileye Global, Inc. (“Petitioner”) filed a Petition for *inter partes* review of claims 1–22 of U.S. Patent No. 9,671,328 B2 (Ex. 1001, “the ’328 patent”). Paper 1 (“Pet.”), 1. Facet Technology Corp (“Patent Owner”) filed a Preliminary Response. Paper 6 (“Prelim. Resp.”). With our authorization (*see* Paper 9; Ex. 3001), Petitioner filed a Preliminary Reply (Paper 7) and a Second Preliminary Reply (Paper 10) and Patent Owner filed a Preliminary Sur-reply (Paper 8) and a Second Preliminary Sur-reply (Paper 13).

In its Preliminary Response, Patent Owner informed us that it had disclaimed claims 17–22. Prelim. Resp. 1; *see also* Inst. Dec. 6–7 (addressing Patent Owner’s disclaimer); Ex. 2002 (Patent Owner’s disclaimer).

On March 5, 2025, we instituted an *inter partes* review of claims 1–16 (“the challenged claims”)² on all grounds raised in the Petition. Paper 14 (“Institution Decision” or “Inst. Dec.”).

Subsequent to institution, Patent Owner filed a Patent Owner Response (Paper 25, “PO Resp.”), Petitioner filed a Reply to the Patent Owner Response (Paper 28, “Pet. Reply”), and Patent Owner filed a Sur-reply to Petitioner’s Reply (Paper 34, “PO Sur-reply”). An oral hearing

² Because Patent Owner filed a statutory disclaimer of claims 17–22 of the ’328 patent (*see* Ex. 2002) prior to our Institution Decision, no *inter partes* review was instituted as to those claims. Inst. Dec. 6–7; *see also* 37 C.F.R. § 42.107(e) (“No *inter partes* review will be instituted based on disclaimed claims.”).

was held on December 5, 2025. A transcript of the hearing has been entered into the record. Paper 38 (“Tr.”).

For the reasons that follow, we conclude that Petitioner has proven by a preponderance of the evidence that claims 1–4 and 8–13 of the ’328 patent are unpatentable. However, Petitioner has failed to prove by a preponderance of the evidence that claims 5–7 and 14–16 of the ’328 patent are unpatentable.

B. Real Parties in Interest

Petitioner identifies itself as the sole real party in interest. Pet. 74.

Patent Owner identifies itself and Mandli Communications, Inc. as the real parties in interest. Paper 5, 3.

The parties are reminded of their continuing obligation to update their mandatory notice information “within 21 days of a change of the information.” 37 C.F.R. § 42.8(a)(3).

C. Related Matters

The parties indicate that the ’328 patent is the subject of the following district court proceedings:

Facet Technology Corp. v. General Motors LLC, No. 2:24-cv-00035 (E.D. Tex. filed January 22, 2024),

Facet Technology Corp. v. Mobileye Global, Inc., No. 2:24-cv-00058 (E.D. Tex. filed January 26, 2024),

Facet Technology Corp. v. HERE Global B.V., No. 2:24-cv-00269 (E.D. Tex. filed April 22, 2024),

Facet Technology Corp. v. TomTom International B.V., No. 1:24-cv-00111 (D.N.H. filed April 23, 2024), and

Mobileye Vision Technologies Ltd. v. Facet Technology Corp.,
No. 0:24-cv-04149 (D. Minn. filed November 7, 2024).

Pet. 75; Paper 5, 3–4.

The parties note that the '328 patent is the subject of *ex parte* reexamination 90/019,546. Pet. 75; Paper 5, 4. We note that this reexamination has been stayed. See Paper 16.

Petitioner notes another petition for *inter partes* review it filed challenging a related patent owned by Patent Owner, namely IPR2024-01110 challenging U.S. Patent No. 9,335,255 B2. Pet. 75.

D. The Challenged Patent

The '328 patent discloses “classifying different types of sheeting materials of road signs depicted in a videostream.” Ex. 1001, 1:33–35. The '328 patent recognizes that “[t]he goal of using an automated image identification system to recognize road signs and traffic signs is well known.” *Id.* at 1:39–41. Although there are “existing techniques for determining retroreflectivity,” these techniques “require an operator to target individual signs from a known distance.” *Id.* at 4:18–20.

The '328 patent purports to provide an improved “system for classifying different types of sheeting materials of road signs depicted in a videostream” that allows the user to “determine retroreflectivity without targeting individual signs” and to “automatically determine sheeting classification.” Ex. 1001, 3:51–53, 4:18–23. The system “employs several enhancements that are designed to improve the accuracy of evaluating intensity measurements made over a view where the reflective surfaces are not individually targeted” and “neither the distance to the reflective surface or the normal vector to the reflective surface are known.” *Id.* at 4:23–30.

Figure 4 illustrates a typical configuration of a sensor suite within a capture vehicle and is reproduced below. *Id.* at 4:39–43, 10:7–10.

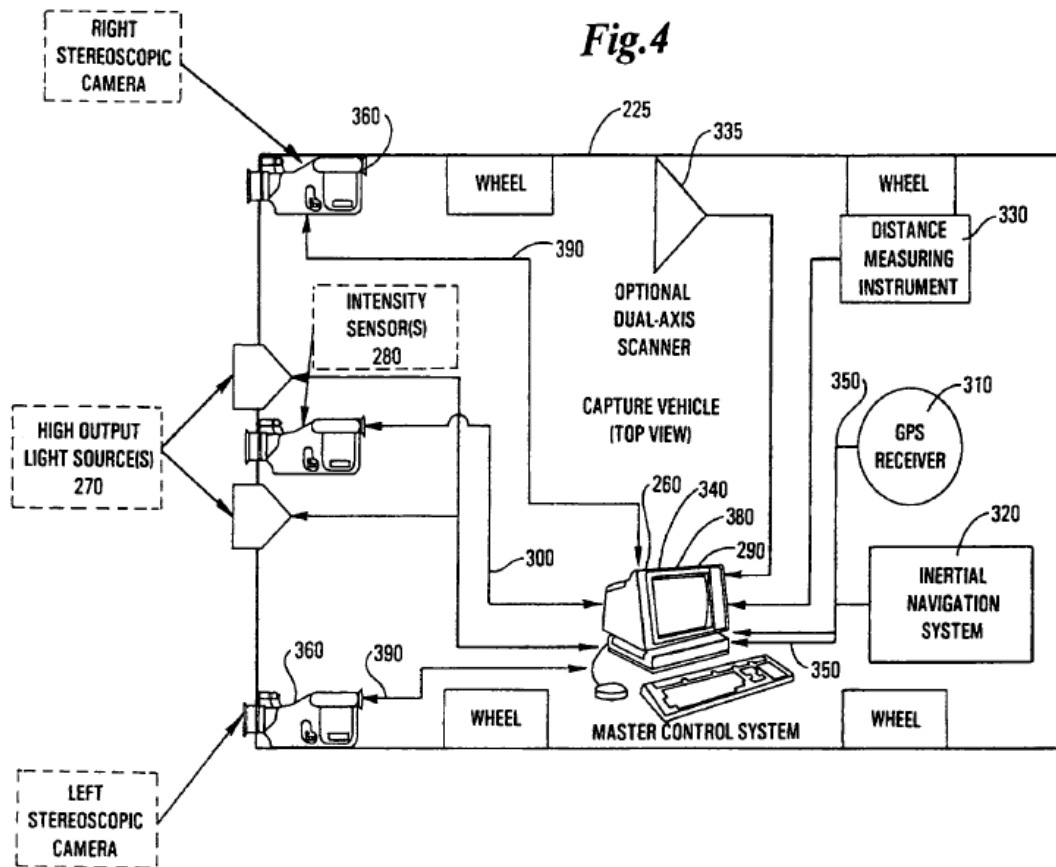


Figure 4 illustrates a preferred configuration of a sensor suite for use with a capture vehicle and the interconnections and couplings between the physical subcomponents of the system. *Id.* at 4:46–50. The system includes distance measuring instrument 330, GPS receiver 310, and inertial navigation system 320, which constitute the vehicle positioning subsystem. *Id.* at 10:21–24. The system includes high output light sources 270 and light intensity sensors 280, which constitute the light intensity measurement subsystem. *Id.* at 10:28–30. This subsystem “make[s] it possible to gather on-the-fly information for a desired highway 150 to allow the computation

of object of interest retroreflectivity.” *Id.* at 10:30–34. Figure 4 also illustrates stereoscopic cameras 360 and digital imagery system 390 “that allows for the creation of objects of interest 460 and their associated attributes 465 during post-processing.” *Id.* at 10:35–38.

In use, “[a] plurality of intensity measurements 300 are generated by the intensity measurement system 230 in response to the repeated strobing of the high output light source 270.” Ex. 1001, 8:6–9. “A computer processor 450 identifies an object of interest 460 in a portion of the intensity frame 420 and determines the object of interest attributes 465 associated with that object of interest.” *Id.* at 8:31–34. The processor uses “an intensity algorithm 490, a light intensity sensor characterization 275 and a look-up-table 475” to determine luminance values for the background and foreground of each object of interest. *Id.* at 8:46–49. The system compares the measured luminance values with the background and foreground colors and, based on a characterization of the light source wavelength, characterizes background retroreflectivity and foreground retroreflectivity. *Id.* at 8:50–56.

E. The Challenged Claims

Petitioner challenges claims 1–16 of the ’328 patent. Claims 1 and 9 are independent. Claim 9 is illustrative of the challenged claims and is reproduced below.

9. An automated system for assessing reflective surfaces disposed along a roadway comprising:
 - an active light sensor that is traversed along a roadway that includes at least one reflective surface on a road marker, the road marker having a reflective characteristic, the active light sensor including:

- a light source to illuminate an area that includes the at least one reflective surface; and
- a light sensor that measures a plurality of light intensity values within a field of view which includes at least a portion of the area illuminated by the light source; and
- a computer processing system operably connected to the active light sensor and configured to detect objects of interest within the field of view and for each object of interest:
 - determine whether the object of interest includes at least one light intensity value associated with a reflective surface of a road marker in the field of view; and
 - analyze the at least one light intensity value to determine an assessment of a discrete location of the road marker within the field of view.

Ex. 1001, 18:22–44.

F. Asserted Grounds of Unpatentability

The Petition relies on the following prior art references:

Name	Reference	Exhibit
Gallagher	US 2002/0063638 A1, published May 30, 2002	1005
Schofield	US 5,796,094, issued August 18, 1998	1006
Frank	US 5,202,742, issued April 13, 1993	1007
ASTM	<i>American Society for Testing and Materials, 1997 Annual Book of ASTM Standards, Vol. 04.03: Road and Paving Materials; Vehicle-Pavement Systems, Designation D 4383–96: Standard Specification for Plowable, Raised Retroreflective Pavement Markers</i>	1008
Leonard	US 5,313,262, issued May 17, 1994	1009
Popovich	WO 96/17258, published June 6, 1996	1010

Petitioner asserts the following grounds of unpatentability, based on an evaluation of the claims that may be challenged in this proceeding:

Claim(s) Challenged	35 U.S.C. §	Reference(s)/Basis
1–4, 8–13	103(a) ³	Gallagher, Schofield
15, 16	103(a)	Gallagher, Schofield, Frank
14	103(a)	Gallagher, Schofield, Frank, ASTM
5–7	103(a)	Gallagher, Schofield, Leonard, Popovich

Pet. 2. Petitioner submits two declarations of Charles E. Thorpe, Ph.D. (Ex. 1003, “Thorpe Declaration”; Ex. 1030) in support of its contentions. Patent Owner submits a declaration of Nikolaos Papanikolopoulos, Ph.D. (Ex. 2023) in support of its contentions.

II. ANALYSIS

A. Principles of Law

1. *Inter Partes Review*

“In an [*inter partes* review], the petitioner has the burden from the onset to show with particularity why the patent it challenges is unpatentable.” *Harmonic Inc. v. Avid Tech., Inc.*, 815 F.3d 1356, 1363 (Fed. Cir. 2016) (citing 35 U.S.C. § 312(a)(3) (requiring *inter partes* review petitions to identify “with particularity . . . the evidence that supports the grounds for the challenge to each claim”)). Petitioner bears the burden of

³ The application resulting in the ’328 patent claims priority to a date prior to the date when the Leahy-Smith America Invents Act (“AIA”), Pub. L. No. 112–29, 125 Stat. 284 (2011), took effect. Thus, we refer to the pre-AIA version of section 103.

persuasion to prove unpatentability of each challenged claim by a preponderance of the evidence. 35 U.S.C. § 316(e). This burden never shifts to Patent Owner. *Dynamic Drinkware, LLC v. Nat'l Graphics, Inc.*, 800 F.3d 1375, 1378 (Fed. Cir. 2015).

2. Obviousness

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter, as a whole, would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains. *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations including (1) the scope and content of the prior art, (2) any differences between the claimed subject matter and the prior art, (3) the level of skill in the art, and (4) when in evidence, any objective evidence of nonobviousness.⁴ *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

B. Level of Ordinary Skill in the Art

The level of ordinary skill in the art is “a prism or lens” through which we view the prior art and the claimed invention. *Okajima v. Bourdeau*, 261 F.3d 1350, 1355 (Fed. Cir. 2001). The person of ordinary skill in the art is a hypothetical person presumed to have known the relevant art at the time of the invention. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995). In

⁴ At this stage of the proceeding, the parties have not directed us to any such objective evidence.

determining the level of ordinary skill in the art, we may consider certain factors, including: “(1) the educational level of the inventor; (2) type of problems encountered in the art; (3) prior art solutions to those problems; (4) rapidity with which innovations are made; (5) sophistication of the technology; and (6) educational level of active workers in the field.” *Best Med. Int’l, Inc. v. Elekta Inc.*, 46 F.4th 1346, 1353 (Fed. Cir. 2022) (quoting *Daiichi Sankyo Co. v. Apotex, Inc.*, 501 F.3d 1254, 1256 (Fed. Cir. 2007)). “The patent’s purpose can also be informative.” *Id.*

Petitioner contends that a person having ordinary skill in the art at the time of the invention would have had “at least a bachelor’s degree in mechanical engineering, electrical engineering, computer science, physics, or related discipline, and four years of experience in research, design, or development in computer vision systems.” Pet. 6 (citing Ex. 1003 ¶ 31). Petitioner contends that “[h]igher levels of education may offset less experience and extensive experience can substitute for formal education.” *Id.* (citing Ex. 1003 ¶ 31).

Patent Owner offers a definition of the level of ordinary skill that is substantially identical to Petitioner’s, but requires only two years of experience rather than four. PO Resp. 13–14 (citing Ex. 2023 ¶ 57).

Petitioner replies that “four years of experience is proper for the level of ordinary skill, not two.” Pet. Reply 30 (citing Ex. 1030 ¶ 21). Petitioner’s witness, Dr. Thorpe, testifies that four years of experience is the proper definition because “a person of ordinary skill in the art would have derived much of his knowledge regarding computer vision systems through work experience or higher education because many undergraduate curricula

for the time did not include extensive coursework regarding computer vision systems.” Ex. 1030 ¶ 21.

The parties disagree only on the length of experience an ordinarily skilled artisan would have, with Petitioner contending four years and Patent Owner contending two years. Patent Owner’s witness, Dr. Papanikolopoulos, does not provide an explanation for his opinion or support his definition of the level of ordinary skill with citations to evidence. *See* Ex. 2023 ¶ 57 (“In my opinion, [Petitioner’s definition] is an excessive level of ordinary skill in the art, and I believe instead [an ordinarily skilled artisan] would more likely have two years of experience rather than four years.”). On the other hand, Petitioner’s witness, Dr. Thorpe, does provide an explanation for his opinion, explaining that his assertion that four years of experience is required is based on the state of the art, typical undergraduate curricula, and his supervision of doctoral students. Ex. 1030 ¶ 21.

Based on the arguments presented and the cited references, we find Petitioner’s definition of the level of ordinary skill reasonable and for purposes of this Decision, adopt it as our own. We note that we would reach the same conclusions under either proposed standard.

C. Claim Construction

In an *inter partes* review, claims are construed using the same claim construction standard that would be used to construe the claims in a civil action under 35 U.S.C. § 282(b), including construing the claims in accordance with the ordinary and customary meaning of such claims as understood by one of ordinary skill in the art and the prosecution history pertaining to the patent. 37 C.F.R. § 42.100(b). “[T]he ordinary and

customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention” and “after reading the entire patent.” *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313, 1321 (Fed. Cir. 2005) (en banc). In addition to the specification and prosecution history, we also consider use of the terms in other claims and extrinsic evidence including expert and inventor testimony, dictionaries, and learned treatises, although extrinsic evidence is less significant than the intrinsic record. *Id.* at 1312–17. Usually, the specification is dispositive, and it is the single best guide to the meaning of a disputed term. *Id.* at 1315.

“The Board is required to construe ‘only those terms . . . that are in controversy, and only to the extent necessary to resolve the controversy.’” *Realtime Data, LLC v. Iancu*, 912 F.3d 1368, 1375 (Fed. Cir. 2019) (alteration in original) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng’g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999)).

Patent Owner argues that independent claims 1 and 9 each require an order in which the steps are performed: first detecting objects of interest and then, subsequently, determining certain attributes of the detected objects of interest. PO Resp. 14–22. Patent Owner argues that the detect recitation provides antecedent basis for the determine recitations. *Id.* at 14–15. Patent Owner argues that the separate detect and determine recitations require separate steps that cannot be performed concurrently. *Id.* at 16–18. Patent Owner argues that this interpretation is consistent with the decision in *Cybersettle, Inc. v. Nat’l Arb. F., Inc.*, 243 F. App’x 603, 609 (Fed. Cir. 2007) (*id.* at 18–20) and the ’328 patent (*id.* at 20–22).

Petitioner contests Patent Owner’s interpretation as an improper attempt to rewrite the claims. Pet. Reply 2–10. Petitioner argues that neither the claims nor the specification of the ’328 patent requires the order of steps asserted by Petitioner “[b]ecause the objects of interest exist in physical space, the computer processing system need not wait for an object to be detected before starting the[] ‘determine’ functions” (*id.* at 3), and the specification discloses that the functions can happen concurrently (*id.* at 4–7). Petitioner argues that Patent Owner’s contentions improperly “ask[] the Board to construe ‘the object of interest’ as the *detected* object of interest.” *Id.* at 8.

“As a general rule, unless the steps of a method claim actually recite an order, the steps are not ordinarily construed to require one.” *Mformation Techs., Inc. v. Rsch. in Motion Ltd.*, 764 F.3d 1392, 1398 (Fed. Cir. 2014) (citation modified). “However, a claim requires an ordering of steps when the claim language, as a matter of logic or grammar, requires that the steps be performed in the order written, or the specification directly or implicitly requires an order of steps.” *Id.* (cleaned up).

“[O]rdinarily in process claims steps taken concurrently are the equivalent of steps taken successively.” *In re White*, 39 F.2d 974, 975 (CCPA 1930); *see also Cybersettle*, 243 F. App’x. at 609 (finding “the step of calculating the differences between demands and offers can occur concurrently with the [next enumerated step of] receipt of multiple demands and offers” and “the testing step of ‘determining whether any of the differences fall within the predetermined settlement range’ may occur concurrently with the receipt and comparison of the bids” (citation modified)). This is especially true here, given that the recitations at issue are

functional language in an apparatus (system) claim. We further agree with Petitioner that the '328 patent discloses such concurrent performance of these steps:

Either *concurrent with* or subsequent to the identification of road signs 30 and generation of asset management database 24, the computer processor 22 evaluates that portion 32 of each video frame or image that depicts a road sign 30 to determine a set of color values 40, 42 for each of a plurality of colors on the road sign 32. A retroreflectivity value is generated for each color portion 34, 36 on each frame of the tagged videostream 20 containing the road sign 30 that represents a different color value 40, 42.

Ex. 1001, 5:52–60. Thus, the '328 patent discloses concurrently detecting objects of interest (road signs) and determining whether the object of interest has a particular color value.

Moreover, Patent Owner's arguments appear to be duplicative of arguments Patent Owner made in its request for rehearing by the Director of the Institution Decision (*see* Paper 18), which was denied (*see* Paper 21).

Accordingly, for the foregoing reasons, we decline to adopt Patent Owner's interpretation that independent claims 1 and 9 each require an order in which the steps are performed.

We determine that no further construction of any term is necessary.

D. Overview of the Asserted Prior Art

1. Gallagher

Gallagher discloses “a method and apparatus for assessing the integrity of road markers and markings.” Ex. 1005 ¶ 1. Figure 1 illustrates the reflectivity measuring apparatus and is reproduced below.

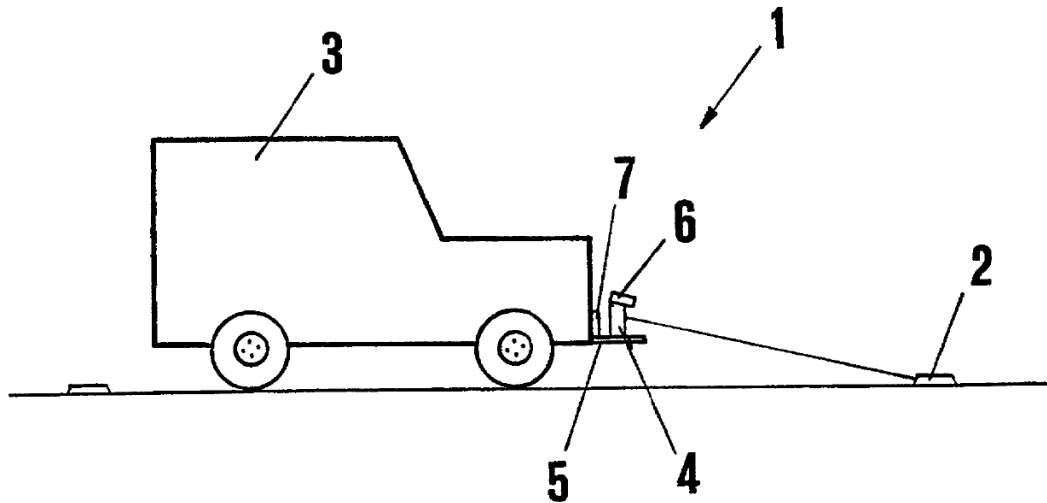


Figure 1

Figure 1 illustrates a side view of reflectivity measuring apparatus 1. *Id.* ¶¶ 26, 31. The apparatus is mounted on vehicle 3 and is designed to measure the reflectivity of road markings 2 when travelling at speeds of up to about 100 kph. *Id.* ¶ 32. The apparatus includes light source 4 mounted on platform 5, light sensor 6 (which may be provided as an array of sensors in module 6a), and computer 8. *Id.* ¶¶ 35, 38, 45–46; *see also id.* Fig. 3 (illustrating a block diagram of the apparatus components). The apparatus can be used to assess a variety of road marking types, such as raised pavement markers. *Id.* ¶¶ 2, 33.

In operation, an operator in the vehicle 3 initiates the measurement process by sending a signal via the computer 8 to activate the light control relay 10. . . . The relay 10 switches power from the power supply 12 to the light source 4. The light source 4 subsequently illuminates a reflective surface of a marker 2 and the reflected light is detected by one or a number of the light sensors 6 in the module 6a which has been aligned to detect light from a particular area of road.

Id. ¶ 46. The computer determines the reflectance level of each road marker and determines whether it meets a predetermined minimum acceptable reflectance level. *Id.* ¶¶ 67–68. Any road marker that does not meet this level is tagged to identify it for replacement. *Id.* ¶ 68.

2. Schofield

Schofield discloses a vehicle control system that controls the vehicle's headlamps in response to sensing the headlights of oncoming vehicles and taillights of leading vehicles. Ex. 1006, 1:12–17. Figure 3 is a block diagram of the system and is reproduced below.

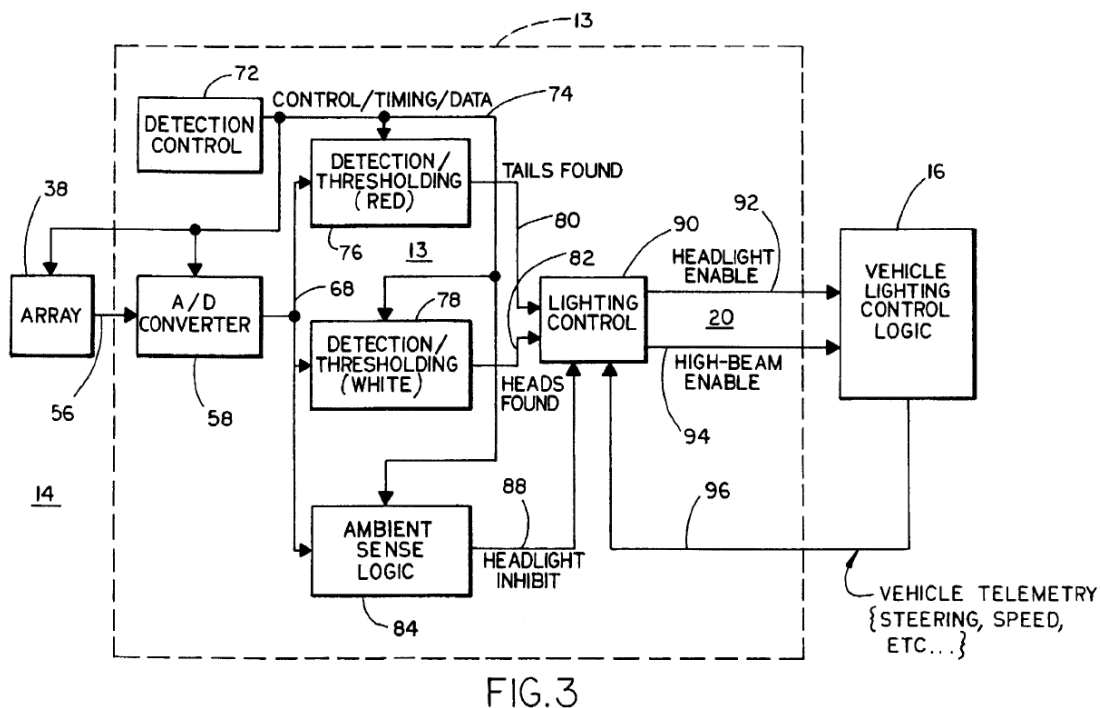


FIG. 3

Figure 3 illustrates a block diagram of control system 13. *Id.* at 3:15. An image sensing module (*see id.* at Fig. 2) includes an optical device, such as a lens, an array of light sensors, and a spectral separation device between the optical device and the light-sensing array. *Id.* at 4:16–21. The optical

device senses light from a scene forward of the vehicle, which light is filtered by the spectral separation device to expose adjacent pixels of the light-sensing array to one of the red, green, or blue bands of light. *Id.* at 3:39–40, 5:50–56. Output from the array is received by analog-to-digital converter 58, which converts the analog pixels to digital values. *Id.* at 4:47–49. The digital output is supplied to taillight detection circuit 76, headlight detection circuit 78, and ambient sense logic circuit 84. *Id.* at 4:49–52.

The taillight detection circuit compares red band values to neighboring green and blue band values and, if the red intensity value is a predetermined number of times greater than the green and blue intensity values, the system determines that the light source is red. Ex. 1006, 4:62–5:1. If the red intensity is above a threshold value, the light source is determined to be taillights. *Id.* at 5:1–3. The headlight detection circuit compares adjacent red, green, and blue values and, if the intensities of each color are all above threshold values and within a predetermined range, the system determines that the light is white and the source is headlights. *Id.* at 5:4–12. The ambient detection circuit samples a subset of photosensor elements over a long period of time. *Id.* at 5:15–18. Outputs from these three circuits are fed to lighting control circuit 90, which determines whether the vehicle headlights should be turned on and whether the headlights should be switched into or out of high-beam mode. *Id.* at 5:33–39.

3. Frank

Frank discloses “providing a laser radar apparatus for a vehicle which is capable of ‘looking ahead’ of the vehicle in order to anticipate changes in

roadway geometry.” Ex. 1007, 2:67–3:3. The apparatus uses “only one laser source and one receiver to accurately measure the distance and angle between the vehicle and a retroreflector mounted at or near the road surface.” *Id.* at 3:3–7. The apparatus “provide[s] distance and angel measurements between a vehicle and a retroreflector in order to improve reaction time of an automated steering control system.” *Id.* at 3:22–25.

4. *ASTM*

ASTM is a testing standard for “a type of plowable, retroreflective, raised pavement marker for lane marking and delineation.” Ex. 1008, 451.⁵ The retroreflective markers “are intended for nighttime visibility.” *Id.* The test methods include “[m]easur[ing] the coefficient of luminous intensity.” *Id.* at 454.

5. *Leonard*

Leonard discloses “detecting objects to control a vehicle” by “expanding the field of view with a light separating means to permit plural objects to be detected simultaneously.” Ex. 1009, 1:7–9, 2:8–11. The system uses “a diffracting grating . . . in the beam path of the generated light source” that “expands the beam’s field of view by distributing the transmitted radiation into plural sub-fields,” which are then “set to a greater intensity to ensure reflection of the sub-fields” when they are “associated with distant objects.” *Id.* at 2:11–17.

⁵ Petitioner cites to the original pagination rather than the added exhibit pagination. *See, e.g.*, Pet. 55. For consistency, we do likewise.

6. Popovich

Popovich discloses “an optical position sensing system operating in the infra-red spectrum to determine the position . . . of a target object in three dimensional space.” Ex. 1010, 1. Popovich provides “a simplified position sensing system based on optical triangulation” that may be used as a “simplified means to determine movement of an illuminated object.” *Id.*

E. Asserted Obviousness Based on Gallagher and Schofield

Petitioner argues that claims 1–4 and 8–13 would have been obvious in view of Gallagher and Schofield. Pet. 7–44. In support of its showing, Petitioner relies upon the Thorpe Declaration. *Id.* (citing Ex. 1003). We have reviewed the parties’ briefs and the evidence of record and determine that, for the reasons explained below, Petitioner has shown, by a preponderance of the evidence, that claims 1–4 and 8–13 would have been obvious in view of Gallagher and Schofield.

1. Independent Claim 9

Petitioner relies on Gallagher to disclose a system substantially as recited, and relies on Schofield to teach determining a light source’s location. Pet. 14–26.

a. The Preamble

Claim 9 recites “[a]n automated system for assessing reflective surfaces disposed along a roadway.” Ex. 1001, 18:22–23. Petitioner maps Gallagher’s apparatus 1 to the recited automated system and argues that the apparatus includes a light source, light sensors, and a computer that

automatically measure reflectivity in real time. Pet. 14–15 (citing Ex. 1005 ¶¶ 33–35, 46, 55–66, 71; Ex. 1003 ¶ 62).

Patent Owner does not contest this aspect of the Petition. *See generally* PO Resp.

Gallagher discloses apparatus 1 that is mounted on vehicle 3 and is designed to measure the reflectivity of road markings 2 when travelling at speeds of up to about 100 kph. Ex. 1005 ¶ 32. The apparatus includes light source 4 mounted on platform 5, light sensor 6 (which may be provided as an array of sensors in module 6a), and computer 8. *Id.* ¶¶ 35, 38, 45–46; *see also id.* Fig. 3 (illustrating a block diagram of the apparatus components). The apparatus can be used to assess a variety of road marking types. *Id.* ¶ 33. The apparatus determines the reflectance level of the road markings and presents the results to the user in real time. *Id.* ¶¶ 67, 71.

Accordingly, for the foregoing reasons, to the extent the preamble is limiting, Gallagher supports Petitioner’s contentions.

b. The Active Light Sensor Recitation

Claim 9 recites “an active light sensor that is traversed along a roadway that includes at least one reflective surface on a road marker, the road marker having a reflective characteristic.” Ex. 1001, 18:24–27. Petitioner maps the combination of Gallagher’s light source 4, light sensors 6, and module 6a to the recited active light sensor. Pet. 15–16 (citing Ex. 1005 ¶¶ 35–39, Fig. 3; Ex. 1003 ¶ 64). Petitioner notes that these components are mounted on a vehicle and are operable to measure reflectivity of road markers having two reflective surfaces when traveling

along a road at speeds up to about 100 kph. *Id.* at 16–17 (citing Ex. 1005 ¶¶ 5, 31–33, 34, 66–68, Fig. 2; Ex. 1003 ¶ 65).

Patent Owner does not contest this aspect of the Petition. *See generally* PO Resp.

For the reasons stated above regarding the Preamble, Gallagher supports Petitioner’s contentions.

c. The Light Source Recitation

Claim 9 recites that the active light sensor includes “a light source to illuminate an area that includes the at least one reflective surface.” Ex. 1001, 18:28–29. Petitioner maps Gallagher’s light source 4 to the recited light sensor and argues that it illuminates test area A in which a road marker is located. Pet. 17–18 (citing Ex. 1005 ¶¶ 35–37, 43, 46, Fig. 2; Ex. 1003 ¶ 66).

Patent Owner does not contest this aspect of the Petition. *See generally* PO Resp.

Gallagher discloses that its apparatus includes light source 4 that projects a beam to cover a 3 meter by 0.5 meter test area A in front of the vehicle and in which a road marker is located. Ex. 1005 ¶ 35, Fig. 2.

Accordingly, for the foregoing reasons, Gallagher supports Petitioner’s contentions.

d. The Light Sensor Recitation

Claim 9 recites that the active light sensor includes “a light sensor that measures a plurality of light intensity values within a field of view which includes at least a portion of the area illuminated by the light source.” Ex. 1001, 18:30–32. Petitioner maps Gallagher’s array of light sensors 6 in

module 6a to the recited light sensor and argues that the light sensors are directed at sections of test area A and arranged to detect reflected light from the road marker. Pet. 18–19 (citing Ex. 1005 ¶¶ 38, 40–41, 46, Figs. 2–3; Ex. 1003 ¶ 67). Petitioner argues that each of the sensors in the array measures a luminous intensity value and the computer determines which of the intensity values indicates light reflected from the road marker. *Id.* at 19–20 (citing Ex. 1005 ¶¶ 55–56, 66–67; Ex. 1003 ¶¶ 68–69).

Patent Owner does not contest this aspect of the Petition. *See generally* PO Resp.

Gallagher discloses that its apparatus includes an array of light sensors that detect reflected light from road markers. Ex. 1005 ¶ 38. “Each sensor is arranged to detect reflected light from a relatively small viewing angle,” covering respective sections of test area A. *Id.* ¶¶ 40, 60.

Accordingly, for the foregoing reasons, Gallagher supports Petitioner’s contentions.

e. The Computer Processing System Recitation

Claim 9 recites “a computer processing system operably connected to the active light sensor and configured to detect objects of interest within the field of view.” Ex. 1001, 18:34–36. Petitioner maps Gallagher’s computer 8 to the recited computer processing system and argues that it receives data from, and is therefore operably connected to, light sensors 6. Pet. 20–21 (citing Ex. 1005 ¶¶ 33, 45, 47, 55–66, Fig. 3; Ex. 1003 ¶ 71). Petitioner argues that the computer determines which of the measured reflectance levels indicates the presence of road markers. *Id.* at 21–22 (citing Ex. 1005 ¶¶ 33, 60–64, 66; Ex. 1003 ¶ 72).

Patent Owner asserts that “the Petition relies on steps (a)-(g)” of Gallagher’s algorithm for determining the integrity of road markings and argues that none of these steps detects objects of interest nor makes determinations on already-detected objects of interest. PO Resp. 23–27. Patent Owner argues that, in step d, Gallagher’s process merely provides the driver with an “indicator . . . derived from the raw output of the sensor with the current highest intensity reading” but does not “detect[] any objects of interest from the collected data.” *Id.* at 25–26 (citing Ex. 1005 ¶ 60; Ex. 2023 ¶ 102).

Petitioner replies that, in step d, Gallagher “detect[s] the presence of an object of interest and provid[es] a visual indicator of where in the field of view it was detected.” Pet. Reply 11 (citing Ex. 1005 ¶¶ 10, 60–62; Ex. 1030 ¶ 23); *see also id.* at 12–13 (“When Gallagher’s computer ‘detect[s] which light sensor 6 is reading the highest reflecting reading,’ it detects an object of interest because the computer distinguishes between ‘background reflectance levels on non[-]road marking sections of the road’ and reflectance levels indicating a road marking.” (first alteration in original)). Petitioner argues that, in step e, Gallagher’s system determines the location of each road marking. *Id.* at 13–14 (citing Ex. 1005 ¶¶ 60–64, 69).

Patent Owner replies that Gallagher’s “step (d) performs nothing that one of skill in the art would consider to be ‘detect[ing] objects of interest within the field of view’ because it is not ‘analyzing any recorded data.’” PO Sur-reply 4 (citing Ex. 2023 ¶ 102). Patent Owner argues that “step (d) merely ‘detects which light sensor 6 is reading the highest reflectance reading,’ which is not object detection.” *Id.* Patent Owner argues that

Gallagher’s “step (e) merely records the vehicle position from the vehicle gearbox revolution sensor.” *Id.* at 6 (citing Ex. 1005 ¶ 63).

Gallagher discloses that its computer receives measured reflectance data from the light sensors and determines which reflectance levels across test area A most likely indicate the presence of road markers. Ex. 1005 ¶¶ 46–47, 56, 60. We agree with Petitioner that the determination of which light sensor has the highest reading is detecting an object of interest. Ex. 1005 ¶ 60; Pet. 21–22; Ex. 1003 ¶ 72. Patent Owner’s and Dr. Papanikolopoulos’s conclusory assertions to the contrary are not availing.

Accordingly, for the foregoing reasons, Gallagher supports Petitioner’s contentions.

f. The Determine Recitation

Claim 9 recites that, for each object of interest, the computer processing system is configured to “determine whether the object of interest includes at least one light intensity value associated with a reflective surface of a road marker in the field of view.” Ex. 1001, 18:38–41. Petitioner argues that Gallagher’s computer selects which of the measured reflectance levels indicates the presence of road markers. Pet. 22–23 (citing Ex. 1005 ¶¶ 23, 33, 55–56, 65–66; Ex. 1003 ¶ 74).

Patent Owner asserts that “the Petition relies on steps (a)-(g)” of Gallagher’s algorithm for determining the integrity of road markings and argues that none of these steps detects objects of interest nor makes determinations on already-detected objects of interest. PO Resp. 23–27. Patent Owner argues that, in step g, Gallagher’s process “reflects a single

step approach” that identifies “[r]oad markers . . . as being road markers from the light sensor data based simply on the presence of peak responses in the collected light sensor data, without any prior detection of objects of interest.” *Id.* at 26 (citing Ex. 1005 ¶¶ 66–67; Ex. 2023 ¶ 103).

Petitioner replies that, in step f, Gallagher’s system determines and establishes background reflectance levels (Pet. Reply 15 (citing Ex. 1005 ¶ 65)), and, in step g, Gallagher’s system uses the established background reflectance levels to select the measured reflectance levels that indicate the reflective surface of a road marker (*id.* (citing Ex. 1005 ¶ 66; Ex. 1003 ¶ 113)). Petitioner argues that Figure 5 shows that “Gallagher’s computer detects road markers, determines their location, determines that they have front and rear reflective surfaces, determines the reflectance level in CIL of each reflective surface, and associates that information together in storage.” *Id.* at 14 (citing Ex. 1005 ¶¶ 60–71, 74, 79, Fig. 5; Ex. 1030 ¶ 32).

Patent Owner replies that Petitioner’s reliance on Gallagher’s Figure 5 is improper because Figure 5 is not mentioned in the Petition. PO Sur-reply 7.

Gallagher discloses that its computer analyzes the measured data to select “which reflectance levels indicate a road marker.” Ex. 1005 ¶ 66. Gallagher further discloses that its computer determines the reflectance level of each road marker and determines whether it meets a predetermined minimum acceptable reflectance level. Ex. 1005 ¶¶ 67–68.

Accordingly, for the foregoing reasons, Gallagher supports Petitioner’s contentions.

g. The Analyze Recitation

Claim 9 recites that, for each object of interest, the computer processing system is configured to “analyze the at least one light intensity value to determine an assessment of a discrete location of the road marker within the field of view.” Ex. 1001, 18:42–44. Petitioner argues that Schofield teaches dividing a light sensor’s field of view into spatially separated regions and identifying light sources, at least in part, according to their spatial distribution. Pet. 23 (citing Ex. 1006, 2:36–41, 9:26–32; Ex. 1003 ¶ 76). Petitioner argues that it would have been obvious to an ordinarily skilled artisan “to implement Schofield’s determination of a light source’s location within a field of view to distinguish between different types of road markers.” *Id.* Petitioner argues that this modification would have improved Gallagher’s system by allowing more specificity through spatial filtering and pattern recognition, allowing the system to improve identification of road markers arranged side by side on either side of the road centerline. *Id.* at 23–25 (citing Ex. 1005 ¶¶ 40, 43, 68; Ex. 1006, 10:51–11:12; Ex. 1003 ¶¶ 77–78).

Patent Owner argues that neither Schofield nor Gallagher determines the location of road markers. PO Resp. 28–29. Patent Owner argues that Schofield merely separates its field of view into separate regions “to eliminate some erroneous headlight/taillight detections by limiting detections of the point sources to only certain regions of the camera image.” *Id.* at 28 (citing Ex. 1006, 9:26–38; Ex. 2023 ¶¶ 70–71, 105). Patent Owner argues that Gallagher determines the location of the vehicle, not the road markers. *Id.* at 29 (citing Ex. 2023 ¶ 107).

Petitioner replies that Gallagher “disclos[es] that its GPS ‘can be used to pinpoint the position of the vehicle’ *and* the ‘markers 2 as measurements are being taken.’” Pet. Reply 19 (citing Ex. 1005 ¶¶ 48, 63, 74, 79, Fig. 5; Ex. 1030 ¶¶ 43–44). Petitioner argues that Patent Owner improperly attacks the references individually and mischaracterizes Schofield, which, Petitioner asserts, “uses the light source’s location within the scene to help *confirm* its identification.” *Id.* at 20 (citing Ex. 1006, 2:26–41, 9:24–29; *Palo Alto Networks, Inc. v. Centripetal Networks, LLC*, 122 F.4th 1378, 1386 (Fed. Cir. 2024)).

Patent Owner replies that the Petition and Dr. Thorpe’s first declaration admitted that Gallagher’s GPS system corresponds to the location of the active sensor and “additional steps would have been necessary to also determine the location of the markers,” but the Reply and Dr. Thorpe’s second declaration argue that Gallagher’s GPS system determines the location of the markers. PO Sur-reply 9–10 (citing Ex. 1003 ¶ 176; Ex. 1030 ¶¶ 43–44). Patent Owner argues that we should therefore disregard all of Dr. Thorpe’s testimony. *Id.* at 10.

We disagree with Patent Owner’s assertion that Petitioner and Dr. Thorpe contradicted their earlier positions. *See* PO Sur-reply 9–11. Notably, Patent Owner includes only part of Dr. Thorpe’s testimony from his first declaration, which is directed to dependent claim 5. *See id.* at 10. The full statement reads:

Gallagher discloses that its computer processing system is configured to determine the location of each road marker tested. *Supra* Section VIII.A.11.g (Ground 1, [1H]). Gallagher discloses that this location determination uses “a GPS interface 15 ... to pinpoint the position of the vehicle and/or markers 2 as measurements are being taken.” Gallagher [0048]. Because the

light source is in a fixed location on Gallagher's vehicle, a POSITA would have understood that this GPS position of the vehicle corresponds to the location of the active sensor. Accordingly, a POSITA would have recognized that additional steps would have been necessary to also determine the location of the markers. Gallagher [0048].

Ex. 1003 ¶ 176 (alteration in original). Thus, contrary to Patent Owner's assertion, in his original declaration, Dr. Thorpe interprets Gallagher as disclosing using its GPS system to pinpoint the location of the markers. Dr. Thorpe further recognizes that additional steps would be needed to determine the location of the markers based on the vehicle's GPS system. However, Dr. Thorpe does not testify or "admit" that Gallagher's system does not perform these additional steps. Rather, in paragraph 177 of his original declaration, Dr. Thorpe relies on Leonard and Popovich to teach one particular manner of doing so.

Furthermore, Gallagher discloses that its gearbox revolution sensor and its GPS interface can be used as "[l]ocation means for determining the location of the markers." Ex. 1005 ¶ 48. And Schofield teaches "taking into account the relative location of the source of light within the scene" to distinguish headlights and taillights (that is, objects of interest) from other light sources, such as streetlights and building lights. Ex. 1006, 9:26–29, 9:53–57.

Additionally, Schofield discloses a vehicle control system that detects the headlights of oncoming vehicles and taillights of leading vehicles. Ex. 1006, 1:12–17. The determination that the monitored area in front of the controlled vehicle contains headlights or taillights is based in part on the determination of the color of light (*id.* at 4:62–5:12) and the relative location of the light source (*id.* at 9:26–35). Schofield further discloses that its

system “may be utilized to identify particular traffic signs by their spectral signature as well as their geometric organization” and that its system “consider[s] the spatial, as well as the spectral, characteristics of light sources.” *Id.* at 12:1–11. We are persuaded by Dr. Thorpe’s testimony that applying this teaching to Gallagher’s system would beneficially allow the user to distinguish between road markers arranged side-by-side on either side of the centerline. *See* Ex. 1003 ¶ 77.

Accordingly, for the foregoing reasons, Gallagher and Schofield support Petitioner’s contentions.

Patent Owner also argues that Petitioner has not set forth adequate reasoning explaining why an ordinarily skilled artisan would combine the teachings of Gallagher and Schofield. PO Resp. 33–36. Patent Owner interprets the Petition as “combin[ing] Schofield’s camera-based approach with Gallagher to improve object detection or recognition.” *Id.* at 33–34 (citing Pet. 24, 36; Ex. 2023 ¶ 91). Patent Owner argues that the Petition does not provide adequate detail on how the “disparate structures and functionalities” of the two systems would be combined, asserting that “there are many potential ways of combining Gallagher and Schofield.” *Id.* (citing Ex. 2023 ¶¶ 92–93; Ex. 2026, 105:2–7, 106:22–25, 107:12–21, 110:13–14, 111:4–5). Patent Owner argues that combining the systems of Gallagher and Schofield would require “sensor fusion,” which would have been “especially difficult here because the sensors provide very different type[s] of information,” the “two systems’ sensors have different fields of view,” and the systems “operate at highway speeds.” *Id.* at 34–36 (citing Ex. 2023 ¶¶ 93–95).

Petitioner replies that it “need not explain precisely how parts from Schofield would be integrated into Gallagher to show obviousness.” Pet. Reply 18 (citing *Allied Erecting & Dismantling Co., Inc. v. Genesis Attachments, LLC*, 825 F.3d 1373, 1381 (Fed. Cir. 2016)). Petitioner argues that the combination would not require sensor fusion and the combination would be “straightforward based on disclosures like Schofield’s pattern recognition” even at highway speeds. *Id.* at 18–19 (citing Ex. 1005 ¶ 32; Ex. 1006, 10:66–11:12; Ex. 1030 ¶¶ 38–42). Petitioner argues that, rather than relying on Schofield’s camera, “for claim 9, the Petition proposes implementing Schofield’s disclosure of pattern recognition to help with precisely identifying the location of side-by-side road markers.” *Id.* at 21 (citing Pet. 23–25).

Patent Owner argues that Petitioner’s Reply and Dr. Thorpe’s second declaration improperly provide new arguments, not included in the Petition, asserting why it would have been obvious to combine the teachings of Gallagher and Schofield. PO Sur-reply 13–16. Patent Owner reiterates that the proposed combination would require sensor fusion, rendering the combination unpredictable. *Id.* at 16–18.

Petitioner is correct to the extent that it need not show that “the features of [Schofield] may be bodily incorporated into the structure of [Gallagher],” but Petitioner must prove that “a skilled artisan would have been motivated to combine the teachings of the prior art references to achieve the claimed invention.” *Allied Erecting*, 825 F.3d at 1381. For claim 9, Petitioner proposes to modify Gallagher’s system to use “Schofield’s determination of a light source’s location within a field of view” in Gallagher’s system. Pet. 23. Thus, Petitioner’s combination does

not require the combination of Gallagher's and Schofield's sensors into a single system, and Patent Owner's "sensor fusion" argument is inapposite. *See* Tr. 48:8–49:6 (Patent Owner's counsel confirming that the problem of "sensor fusion" stems from combining disparate sensors in a single system).

As noted above, Schofield teaches considering the relative location of the light source in determining whether the light source is from headlights or taillights (that is, an object of interest). *See* Ex. 1006, 9:26–35. We are persuaded that an ordinarily skilled artisan would be motivated to use this teaching in Gallagher's device to help distinguish between road markers that are arranged side-by-side and have a reasonable expectation of success in doing so. *See* Ex. 1005 ¶ 40; Ex. 1003 ¶¶ 77 (“[An ordinarily skilled artisan] would have seen Schofield's determination of a light source's location within the field of view as advantageous because it would have allowed Gallagher's computer to associate the measured reflectance level with the appropriate road marker.”), 79 (“[I]mplementing this determination would have required [an ordinarily skilled artisan] to implement only conventional techniques of image processing (identifying a location of a particular pixel within an array), which was well known by [an ordinarily skilled artisan], to predictably yield the result of the location within a field of view indicating an intensity value associated with a road marker. Given that Schofield and Gallagher disclose similar types of arrays, this combination would have merely required the use of Schofield's known technique to improve Gallagher's similar device in the same way.”).

h. Conclusion

For the foregoing reasons, we are persuaded that Petitioner has shown, by a preponderance of the evidence, that claim 9 would have been obvious in view of the combination of Gallagher and Schofield.

2. *Claims 10–13*

Claim 10–13 depend directly from claim 9. Ex. 1001, 18:45–60. Petitioner contends that Gallagher and Schofield teach or suggest the recitations of these claims and supports these contentions with declaration testimony. Pet. 26–30 (citing Ex. 1003). Patent Owner does not contest Petitioner’s challenges to these claims apart from its contentions regarding parent claim 9. PO Resp. 37.

We determine that Petitioner’s contentions regarding these dependent claims are fully supported by the record. Accordingly, we are persuaded that Petitioner has shown, by a preponderance of the evidence, that claims 10–13 would have been obvious in view of the combination of Gallagher and Schofield. *See In re NuVasive*, 841 F.3d 966, 974 (Fed. Cir. 2016) (“The Board, having found the only disputed limitations together in one reference, was not required to address undisputed matters.”); Paper 15, 10 (emphasizing that “any arguments not raised and fully briefed in the response will be deemed waived”).

3. *Independent Claim 1*

Petitioner relies on Gallagher to disclose a system substantially as recited, and relies on Schofield to teach an image capture system. Pet. 33–41.

a. The Preamble

Claim 1 recites “[a]n automated system that detects and determines reflective surfaces of interest in a scene of non-retroreflective surfaces along a roadway that is being traversed by a vehicle.” Ex. 1001, 17:32–35. Petitioner relies on substantially the same arguments it advanced for the Preamble of claim 9. Pet. 33–34 (citing Ex. 1005 ¶¶ 32–35, 46, 55–60; Ex. 1003 ¶ 100).

Patent Owner does not contest this aspect of the Petition. *See generally* PO Resp.

For the reasons set forth in § II.E.1.a above regarding the Preamble of claim 9, to the extent the preamble is limiting, Gallagher supports Petitioner’s contentions.

b. The Image Capture System Recitation

Claim 1 recites “an image capture system that captures images within a field of view along the roadway.” Ex. 1001, 17:36–37. Petitioner maps Schofield’s imaging sensor module 14 to the recited image capture system and argues that the module captures frames forward of the vehicle. Pet. 34–35 (citing Ex. 1006, 3:29–30, 3:36–44, 3:64–66, 4:16–21, 8:38–40, 11:8–12, 11:44–47, 12:8–11, Fig. 11a; Ex. 1003 ¶ 102). Petitioner argues that it would have been obvious to an ordinarily skilled artisan “to incorporate Schofield’s imaging sensor module 14 into Gallagher’s apparatus to improve the apparatus’[s] ability to identify objects of interest along the roadway.” *Id.* at 35 (citing Ex. 1006, 9:24–26, 10:18–11:12, 11:58–12:46; Ex. 1003 ¶ 103).

Petitioner contends that it would have been obvious “to incorporate Schofield’s imaging sensor module 14 into Gallagher’s apparatus to improve the apparatus’ ability to identify objects of interest along the roadway.” Pet. 35. Petitioner argues that it would have been obvious to an ordinarily skilled artisan “to incorporate the data from Schofield’s imaging sensor module into the processing performed by Gallagher’s ‘powerful’ computer to improve road-marker identification.” *Id.* at 36 (citing Ex. 1005 ¶¶ 50–72; Ex. 1003 ¶ 103). Petitioner asserts that “[an ordinarily skilled artisan] would have seen Gallagher’s reflectivity measuring apparatus and Schofield’s system as complementary because both are used to identify road markings like traffic signs and lane markers in real time from a moving vehicle.” *Id.* at 37 (citing Ex. 1005 ¶¶ 31–33, 72; Ex. 1006, 12:1–4, 12:40–42; Ex. 1003 ¶ 106).

Patent Owner relies on substantially the same arguments presented for claim 9 in contending that Petitioner has not adequately set forth why an ordinarily skilled artisan would combine the teachings of Gallagher and Schofield. PO Resp. 33–36; PO Sur-reply 13–18.

Unlike the argument for claim 9, Petitioner’s argument for claim 1 proposes to combine Gallagher’s and Schofield’s sensors into a single system: “[An ordinarily skilled artisan] would have been motivated to incorporate Schofield’s imaging sensor module 14 into Gallagher’s apparatus to improve the apparatus’ ability to identify objects of interest along the roadway.” Pet. 35. Petitioner proposes to “perform[] Schofield’s pattern recognition using Gallagher’s computer, based on data from Gallagher’s light sensor module and Schofield’s imaging sensor module.” *Id.* at 36. Petitioner purports that the modification “would further improve

the road-sign and road-marker identification” by “identify[ing] road signs and road markers using different characteristics.” *Id.* (citing Ex. 1005 ¶¶ 31–33; Ex. 1006, 10:66–11:12, 12:1–4, 12:40–42). The portions of Gallagher cited by Petitioner disclose detecting objects of interest, such as lane markers and traffic signs, based upon their shape, reflectivity, luminance, and spectral characteristics. Ex. 1006, 10:66–11:12, 12:1–4, 12:40–42. Thus, rather than fusing the data from Gallagher’s and Schofield’s system and performing calculations using both data sets, Petitioner proposes to perform Gallagher’s processes and Schofield’s processes separately in the same system. We agree that an ordinarily skilled artisan would have a reasonable expectation of success with this arrangement, given Gallagher’s instruction to use a computer with sufficient processing power. *See* Ex. 1005 ¶ 50; Ex. 1003 ¶ 107.

Additionally, as noted in § II.E.1.g above regarding the Analyze Recitation of claim 9, Schofield discloses a vehicle control system that monitors an area in front of a vehicle to determine the presence and location of lights, and may be used to identify traffic signs. Ex. 1006, 1:12–17, 4:62–5:3, 5:4–12, 9:26–35, 12:1–3. Imaging sensor module 14 senses light from a scene forward of the vehicle via an array of light sensors. *Id.* at 3:36–44, 4:16–21. Accordingly, for the foregoing reasons, Schofield supports Petitioner’s contentions.

Additionally, we determine, that Petitioner sets forth reasoning with rational underpinning to support its contentions that it would have been obvious to combine the teachings of Gallagher and Schofield. For example, Petitioner argues that implementing Schofield’s imaging sensor module in Gallagher’s system would beneficially “enable[] the identification of objects

through things like their shape and spectral characteristics . . . to improve object identification.” Pet. 35 (citing Ex. 1005 ¶¶ 55–67; Ex. 1006, 9:24–26, 10:18–11:12, 11:58–12:46; Ex. 1003 ¶ 103); *see also* Ex. 1006, 10:66–11:12, 12:1–11 (discussing pattern recognition, spectral signature, and the use of Schofield’s system with traffic signs). Petitioner’s assertions are supported by the declaration testimony of Dr. Thorpe. *See, e.g.*, Ex. 1003 ¶¶ 103–107.

c. The Active Light Sensor Recitation

Claim 1 recites “an active light sensor including: a light source that illuminates an area along the roadway; and a light sensor that measures light intensity values within at least a portion of the area illuminated by the light source.” Ex. 1001, 17:38–43. Petitioner relies on its arguments advanced for the Active Light Sensor, Light Source, and Light Sensor Recitations of claim 9. Pet. 38.

Patent Owner does not contest this aspect of the Petition. *See generally* PO Resp.

For the reasons set forth in §§ II.E.1.b, II.E.1.c, and II.E.1.d above regarding the cited recitations of claim 9, Gallagher supports Petitioner’s contentions.

d. The Computer Processing System Recitation

Claim 1 recites “a computer processing system operably connected to the image capture system, and the active light sensor and configured to detect objects of interest within the field of view.” Ex. 1001, 17:44–47. Petitioner relies on its arguments advanced for the Computer Processing System Recitation of claim 9 and argues that it would have been obvious to

an ordinarily skilled artisan to connect Schofield’s imaging sensor module to Gallagher’s computer system. Pet. 39 (citing Ex. 1005 ¶¶ 33, 50; Ex. 1003 ¶ 110).

Patent Owner does not contest this aspect of the Petition. *See generally* PO Resp.

For the reasons set forth in § II.E.1.e above regarding the Computer Processing System Recitation of claim 9, Gallagher supports Petitioner’s contentions. For the reasons set forth in § II.E.3.b above regarding the Image Capture System Recitation of claim 1, we determine that Petitioner sets forth reasoning with rational underpinning to support its contentions that it would have been obvious to combine the teachings of Gallagher and Schofield.

e. The Determine Recitation

Claim 1 recites that, for each object of interest, the computer processing system is configured to “determine whether the object of interest includes a reflective surface based on the light intensity values.” Ex. 1001, 17:48–49. Petitioner argues that “Gallagher’s apparatus ‘can test the reflectivity’ of various lane markers, including ‘painted lines’ and ‘raised pavement markers 2’ ‘fastened or secured along lanes.’” Pet. 40 (citing Ex. 1005 ¶¶ 33–34; Ex. 1003 ¶ 113). Petitioner argues that “Gallagher uses the light intensity values from the light sensors 6 to determine whether lane markers, including the painted lines of the lane and raised pavement markers fastened along the lane, include a reflective surface by distinguishing their reflectance levels from the ‘non-marker reflectance levels.’” *Id.* (citing Ex. 1005 ¶¶ 33, 65–66; Ex. 1003 ¶ 113).

Patent Owner relies on substantially the same arguments presented for claim 9 in contending that Gallagher does not disclose detecting objects of interest then making determinations on the already-detected objects of interest. PO Resp. 30–32.

For the reasons set forth in § II.E.1.f above regarding the Determine Recitation of claim 9 and in § II.E.1.e above regarding the Computer Processing System Recitation of claim 9, we find Patent Owner’s arguments unavailing and that Gallagher supports Petitioner’s contentions.

f. The Road Marker Recitation

Claim 1 recites that, for each object of interest, the computer processing system is configured to “determine whether the reflective surface is a road marker based on an assessment of the reflective surface.”

Ex. 1001, 17:50–52. Petitioner argues that Gallagher’s computer determines the presence of a road marker based on peak responses in the measured reflectance data. Pet. 40–41 (citing Ex. 1005 ¶ 66; Ex. 1003 ¶ 115).

Patent Owner argues that Petitioner relies on Gallagher’s step g to satisfy each of detecting an object of interest, determining whether the object of interest includes a reflective surface, and determining whether the reflective surface is a road marker. PO Resp. 32 (citing Pet. 40–41; Ex. 1003 ¶ 115; Ex. 2023 ¶ 115).

Petitioner replies that Gallagher’s step g includes multiple parts, including determining which markers include a reflective surface and determining which of those reflective surfaces are road markers. Pet. Reply at 21–22 (citing Ex. 1005 ¶¶ 65–66; Ex. 1003 ¶ 115; Pet. 40). Petitioner argues that this second step “involves determining whether each reflective

surface corresponds to a painted line or a raised pavement marker.” *Id.* at 22 (citing ex. 1005 ¶¶ 33, 66, Fig. 2; Ex. 1003 ¶ 115; Ex. 1030 ¶ 49).

Patent Owner replies that Petitioner’s contention that Gallagher’s step g includes multiple steps “is plainly an improper new reply argument” because “the Petition does not mention Gallagher distinguishing between painted lines or raised pavement markers in its discussion of step 1G.” PO Sur-reply 12–13 (citing Pet. 40–41; Ex. 1003 ¶¶ 114–115). Patent Owner argues that Petitioner’s contention “is inconsistent with Gallagher itself—all of the enumerated steps in Gallagher’s algorithm are expressly limited to the example of ‘raised pavement markers.’” *Id.* (citing Ex. 1005 ¶ 33).

As noted above, Petitioner relies on Gallagher’s disclosure that its apparatus can be used to “test the reflectivity of a wide variety of reflective road markings and road markers such as, for example, road signs and posts, reflective painted lines whether continuous or broken, and more particularly raised pavement markers.” Ex. 1005 ¶ 33; *see also* Pet. 40 (citing same). Although Gallagher does state that “[f]or simplicity the description of the preferred embodiment of the invention will be limited to raised pavement markers 2 (referred to herein as ‘markers’),” Gallagher further states that “it will be appreciated by those skilled in the art that the apparatus 1 can be adapted to measure other types of reflective markings on or adjacent the road.” Ex. 1005 ¶ 33. Thus, we understand Gallagher to disclose its system being used for a variety of types of reflective road markings, including painted lines and raised pavement markers, but the discussion in the specification to be limited to how the reflectivity of raised pavement markers are tested. We agree with Petitioner’s interpretation that, by stating that

“[i]n the case of road markers the peak responses sensed are determined as the highly reflective surfaces of a road marker” (*id.* ¶ 66), Gallagher distinguishes the processing of road marker responses from that of other types of markings, and the “peak response” is used to determine the presence of a road marker. *See* Pet. 40–41; Pet. Reply 21–22; Ex. 1003 ¶ 115; Ex. 1030 ¶ 49.

Accordingly, for the foregoing reasons, Gallagher supports Petitioner’s contentions.

g. The Location Recitation

Claim 1 recites that, for each object of interest, the computer processing system is configured to “determine a location of the road marker.” Ex. 1001, 17:53. Petitioner argues that Gallagher’s system uses data from its GPS interface or gearbox revolution sensor to determine the location of road markers. Pet. 41 (citing Ex. 1005 ¶¶ 8, 12, 20, 22, 48; Ex. 1003 ¶ 117).

Patent Owner relies on substantially the same arguments presented for claim 9 in contending that Gallagher does not disclose determining a location of a road marker. PO Resp. 33.

Petitioner replies that Gallagher “disclos[es] that its GPS ‘can be used to pinpoint the position of the vehicle’ and the ‘markers 2 as measurements are being taken.’” Pet. Reply 19 (citing Ex. 1005 ¶¶ 48, 63, 74, 79, Fig. 5; Ex. 1030 ¶¶ 43–44).

Patent Owner replies by relying on the same arguments advanced for the Analyze Recitation of claim 9. PO Sur-reply 9–11.

For the reasons set forth in § II.E.1.g above regarding the Analyze Recitation of claim 9, we find Patent Owner's arguments unavailing and that Gallagher supports Petitioner's contentions

Accordingly, for the foregoing reasons, Gallagher supports Petitioner's contentions.

h. Conclusion

For the foregoing reasons, we are persuaded that Petitioner has shown, by a preponderance of the evidence, that claim 1 would have been obvious in view of the combination of Gallagher and Schofield.

4. Claims 2–4 and 8

Claim 2–4 and 8 depend directly from claim 1. Ex. 1001, 17:54–62, 18:15–21. Petitioner contends that Gallagher and Schofield teach or suggest the recitations of these claims and supports these contentions with declaration testimony. Pet. 41–44 (citing Ex. 1003). Patent Owner does not contest Petitioner's challenges to these claims apart from its contentions regarding parent claim 9. PO Resp. 37.

We determine that Petitioner's contentions regarding these dependent claims are fully supported by the record. Accordingly, we are persuaded that Petitioner has shown, by a preponderance of the evidence, that claims 10–13 would have been obvious in view of the combination of Gallagher and Schofield. *See In re NuVasive*, 841 F.3d at 974; Paper 15, 10.

F. Asserted Obviousness Based on Gallagher, Schofield, and Frank

Petitioner argues that claims 15 and 16 would have been obvious in view of Gallagher, Schofield, and Frank. Pet. 44–55. In support of its

showing, Petitioner relies upon the Thorpe Declaration. *Id.* (citing Ex. 1003). We have reviewed the parties’ briefs and the evidence of record and determine that, for the reasons explained below, Petitioner has failed to show, by a preponderance of the evidence, that claims 15 and 16 would have been obvious in view of Gallagher, Schofield, and Frank.

Claim 15 depends directly from claim 9 and further recites “wherein the computer processing system is further configured to determine exemplary angular displacements of incident light for each light intensity measurement from a reference position relative to the field of view as part of the assessment of the discrete location of the road marker within the field of view.” Ex. 1001, 18:66–19:4. Petitioner relies on Frank to teach using a laser diode as the light source and determining the distance to each identified retroreflector to improve Gallagher’s determination of the observation angle (which is the angle between the incident and reflected light). Pet. 47–51 (citing Ex. 1005 ¶¶ 37, 41, 47, 57, 68; Ex. 1007, 4:10–51, 6:4–11, 10:54–58, 10:61–11:4, 13:64–14:15; Ex. 1003 ¶¶ 132–137; Ex. 1014, 15, 21, 24; Ex. 1015, 67).

Patent Owner argues that Petitioner fails to explain adequately why an ordinarily skilled artisan would incorporate Frank’s teachings into Gallagher’s apparatus for several reasons. PO Resp. 37–43. Below, we discuss one such reason that we find dispositive.

Patent Owner argues that Petitioner has not explained adequately how Frank teaches determining multiple exemplary angular displacements for a single light intensity measurement, as recited. PO Resp. 40–41 (citing Ex. 2023 ¶ 130). Patent Owner argues that Frank does not disclose that its system uses “a sufficiently fast laser radar system to take multiple angular

displacement measurements for a single road marker from a single reference location.” *Id.* (citing Ex. 2023 ¶ 130).

Petitioner replies that, “[b]ecause the Petition’s claim 15 analysis complies with the narrower definition of ‘exemplary angular displacements’ in claim 16 by showing the obviousness of determining an observation angle ‘for each reference position relative to the field of view,’ it complies with the broader definition in claim 15.” Pet. Reply 23 (citing Pet. 47–51; *Littelfuse, Inc. v. Mersen USA EP Corp.*, 29 F.4th 1376, 1380 (Fed. Cir. 2022)).

Patent Owner replies that “claim 16 narrows what kind of exemplary angles are required, but it in no way rebuts Patent Owner’s argument that claim 15 requires multiple ‘exemplary angular displacements’—plural—‘for each light intensity measurement from a reference location.’” PO Sur-reply 20.

We agree with Patent Owner. Claim 15 requires the computer processing system to be “configured to determine exemplary angular displacements of incident light for each light intensity measurement,” and claim 16 requires that “each of the exemplary angular displacements of incident light comprises an observation angle corresponding to one of a plurality of distances of the light source from the road marker.” Ex. 1001, 18:66–19:9. We agree with the parties’ interpretation that claim 15 requires a plurality of exemplary angular measurements of incident light be determined for each light intensity measurement. *See* PO Resp. 39; Pet. Reply 23. However, the Petition does not address making multiple distance measurements for each light intensity measurement, as recited in claim 15. *See* Pet. 47–51. Petitioner fails to define or explain its asserted

“narrower definition” of claim 15, and likewise fails to explain adequately its implicit assertion that claim 16 changes the requirement of claim 15 that the computer processing system be configured to determine a plurality of exemplary angular displacements of incident light for each light intensity measurement. *See* Pet. Reply 23.

For at least the foregoing reasons, Petitioner has failed to show, by a preponderance of the evidence, that claim 15 and its dependent claim 16 would have been obvious in view of the combination of Gallagher, Schofield, and Frank.

G. Asserted Obviousness Based on Gallagher, Schofield, Frank, and ASTM

Petitioner argues that claim 14 would have been obvious in view of Gallagher, Schofield, Frank, and ASTM. Pet. 55–60. In support of its showing, Petitioner relies upon the Thorpe Declaration. *Id.* (citing Ex. 1003). We have reviewed the parties’ briefs and the evidence of record and determine that, for the reasons explained below, Petitioner has failed to show, by a preponderance of the evidence, that claim 14 would have been obvious in view of Gallagher, Schofield, Frank, and ASTM.

Claim 14 depends directly from claim 9 and further recites “wherein the computer processing system is further configured to determine an entrance angle and an observation angle of the road marker as part of the assessment of the discrete location of the road marker within the field of view.” Ex. 1001, 18:61–65. Petitioner relies on Frank to teach the use of a laser diode as the light source and determining the distance to each identified retroreflector as in the challenged based on Gallagher, Schofield, and Frank. Pet. 57–58. Petitioner relies on ASTM to teach that the minimum

reflectance level for a road marker depends on both the observation angle (the angle between the incident and reflected light) and the entrance angle (the angle in the horizontal plane between the direction of incident light and the normal to the leading edge of the marker). *Id.* at 58–60; *see also* Ex. 1001, 7:43–64 (discussing observation and entrance angles). Petitioner argues that it would have been obvious to factor in both the observation angle and the entrance angle when using Frank’s laser diode to improve Gallagher’s determination of a road marker’s reflectivity. Pet. 58–60 (citing Ex. 1003 ¶¶ 153–154).

Patent Owner argues that Petitioner fails to explain adequately the combination of references teaches all of the recitations of claim 14 for several reasons. PO Resp. 43–48. Below, we discuss one such reason that we find dispositive.

Patent Owner argues that Petitioner has not shown adequately how the proposed combination determines an entrance angle. PO Resp. 44–47. Patent Owner notes that the Petition asserts that Frank’s angle α is the scanning angle of its laser and argues that “angle α is not an angle ‘determined’ by Frank’s system—angle α has nothing to do with an entrance angle.” *Id.* at 44 (citing Pet. 59; Ex. 1003 ¶ 154; Ex. 2023 ¶ 136; Ex. 2026, 140:14–17). Patent Owner argues that, during his deposition, Petitioner’s witness, Dr. Thorpe, identified Frank’s angle θ as the entrance angle. *Id.* at 44–45 (citing Ex. 2026, 140:14–17). Patent Owner argues that this angle is not an entrance angle because “Frank’s angle θ is the angle between the *vehicle’s normal vector* and the incident light on the sign,” which only coincides with an entrance angle “when the vehicle and the sign *happen[]* to be pointing in specific orientations, such as when the sign is perfectly

perpendicular to the road and the vehicle is driving straight down a straight road.” *Id.* at 45–47 (citing Ex. 1001, 7:55–64, 15:16–17, Fig. 2; Ex. 1007, Fig. 12; Ex. 2023 ¶¶ 137–140). Patent Owner argues that this does not constitute “*determining* the entrance angle, as recited in claim 14.” *Id.* at 47 (citing Ex. 1023 ¶ 104).

Petitioner replies that there is “a typo in the Petition,” asserting that, rather than referring to Frank’s angle α , the intent was to refer to Frank’s angle θ . Pet. Reply 25 (citing Pet. 59–60). Petitioner asserts that the citations in the Petition refer to Frank’s angle θ . *Id.* (citing Pet. 44–47, 59–60). Petitioner argues that, “when the road marker is properly mounted” and the vehicle is “traveling parallel to the lanes of the road,” Frank’s angle θ is equivalent to the entrance angle. *Id.* at 26 (citing Ex. 1003 ¶ 155).

Patent Owner replies that “the Petition’s and Petitioner’s expert’s *detailed explanation* of angle α and the *repeated* statements identifying only angle α as the purported entrance angle of claim 14” refute Petitioner’s assertion that its reference to angle α in the Petition was a mere typographical error. PO Sur-reply 22 (citing Pet. 45, 59, 60; Ex. 1003 ¶¶ 128, 154–156). Patent Owner reiterates that Frank’s “angle θ is not an entrance angle” and using it as asserted by Petitioner “is not ‘determin[ing] an entrance angle,’ it is merely *assuming* an entrance angle.” *Id.* at 23 (alteration in original).

We agree that Petitioner has not shown adequately how the combination of references teaches determining an entrance angle, as recited in claim 14. The ’328 patent defines entrance angle as follows: “Entrance angle 160 (See FIG. 12) is defined as the angular displacement of the incident light 170 relative to the normal vector 180 from the object face

surface 130.” Ex. 1001, 7:55–57. ASTM provides the same definition. Ex. 1008, 452. Petitioner asserts that “Frank’s determination of its angle α . . . is one common way to estimate the entrance angle.” Pet. 59 (citing Ex. 1007, 10:67–11:4, Fig. 2A; Ex. 1003 ¶ 154). Petitioner reproduces Frank Figure 2A, which illustrates its angle α . *Id.* Dr. Thorpe’s testimony is virtually identical to the Petition. Ex. 1003 ¶ 154. We agree with Patent Owner—as does Petitioner (*see* Pet. Reply 25)—that Frank’s angle α is not an entrance angle, as it is the laser scanning angle. Ex. 1007, 6:32–38.

We are not persuaded that Petitioner’s reference to Frank’s angle α was a typographical mistake, with the intention having been to refer to Frank’s angle θ (*see* Pet. Reply 25) for the reasons set forth by Patent Owner. *See* PO Sur-reply 22. Even considering Petitioner’s arguments, Petitioner fails to persuade us that Frank teaches determining an entrance angle. Frank’s angle θ is the angle “formed between axis 104 and an imaginary line drawn between vehicle 101 and a retroreflector,” where “[a]xis 104 is an imaginary line formed parallel to the centerline axis of vehicle 101 and passing through the center of laser radar apparatus 103.” Ex. 1007, 4:37–44. Thus, angle θ is not an entrance angle. The fact that angle θ may, under certain circumstances the likelihood of which has not been made of record, happen to be equivalent to the entrance angle does not establish that Frank teaches a computer processing system that is configured to determine an entrance angle, as recited in claim 14.

For at least the foregoing reasons, Petitioner has failed to show, by a preponderance of the evidence, that claim 14 would have been obvious in view of the combination of Gallagher, Schofield, Frank, and ASTM.

H. Asserted Obviousness Based on Gallagher, Schofield, Leonard, and Popovich

Petitioner argues that claims 5–7 would have been obvious in view of Gallagher, Schofield, Leonard, and Popovich. Pet. 61–73. In support of its showing, Petitioner relies upon the Thorpe Declaration. *Id.* (citing Ex. 1003). We have reviewed the parties’ briefs and the evidence of record and determine that, for the reasons explained below, Petitioner has failed to show, by a preponderance of the evidence, that claims 5–7 would have been obvious in view of Gallagher, Schofield, Leonard, and Popovich.

Claim 5 depends directly from claim 1 and further recites, wherein the computer processing system is configured to determine the location of the road marker using the light intensity values for the reflective surface by using a location and heading of the active sensor and a location of the object of interest to determine a light vector emanating from the light source responsible for one of the light intensity values and comparing the light vector to one of a plurality of predetermined vectors based on a light source angle characterization.

Ex. 1001, 17:63–18:4. Petitioner relies on Gallagher’s GPS interface to determine the location of Gallagher’s vehicle, which Petitioner equates to the location of the array of light sensors. Pet. 69–70 (citing Ex. 1005 ¶ 48; Ex. 1003 ¶ 176). Petitioner relies on Leonard to teach using an expanded sensor field of view to avoid the need to adjust the beam angle between measurements and to allow simultaneous reflectivity measurements for multiple road markers. *Id.* at 64–66 (citing Ex. 1003 ¶¶ 165–169), 70 (citing Ex. 1009, 4:62–5:62; Ex. 1003 ¶ 177). Petitioner relies on Popovich to teach defining a ray vector that passes through the center of the targeted retroreflector and determining the retroreflector’s location via triangulation

of two such ray vectors generated from two light beams. *Id.* at 66–68 (citing Ex. 1003 ¶¶ 170–172). Petitioner further relies on Popovich to teach “compar[ing] the determined light vector to one of a plurality of predetermined vectors based on a light source angle characterization.” 70–71 (citing Ex. 1010, 2–3, 6–7, 10; Ex. 1003 ¶¶ 177–178).

Patent Owner argues that Petitioner fails to explain adequately why an ordinarily skilled artisan would combine the teachings of the asserted references for several reasons. PO Resp. 48–57. Below, we discuss three such reasons that we find dispositive.

1. Popovich as Analogous Art

Patent Owner argues that the Petition’s reliance on Popovich is improper because the reference is not analogous to the invention claimed in the ’328 patent. PO Resp. 48–50.

A reference qualifies as prior art for a determination under § 103 when it is analogous to the claimed invention. *In re Clay*, 966 F.2d 656, 658 (Fed. Cir. 1992).

Two separate tests define the scope of analogous prior art: (1) whether the art is from the same field of endeavor, regardless of the problem addressed, and (2) if the reference is not within the field of the inventor’s endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved.

In re Bigio, 381 F.3d 1320, 1325 (Fed. Cir. 2004) (citing *In re Deminski*, 796 F.2d 436, 442 (Fed. Cir. 1986)).

The Supreme Court’s decision in [*KSR*] directs us to construe the scope of analogous art broadly, stating that “*familiar items may have obvious uses beyond their primary purposes*, and a person of ordinary skill often will be able to fit the teachings of

multiple patents together like pieces of a puzzle.” [KSR, 550 U.S.] at 402 (emphasis added).

Wyers v. Master Lock Co., 616 F.3d 1231, 1238 (Fed. Cir. 2010).

a. Field of Endeavor

Petitioner argues that “Popovich [is] analogous art to the ’328 patent because they are in the same field of endeavor, namely, automated object recognition.” Pet. 64 (citing Ex. 1001, 1:31–32; Ex. 1007, 5–7; Ex. 1003 ¶ 164); Pet. Reply 28.

Patent Owner argues that Petitioner presents “an unduly broad identification of a field of endeavor.” PO Resp. 48. Patent Owner argues that “the ’328 [p]atent is in the ‘field of automated object recognition’ and more specifically, identifying, measuring, and classifying road markers from a vehicle,” whereas “Popovich is in the field of ‘optical position sensing,’ and in particular, head-position measurement for interactive television or software applications.” *Id.* at 48–49 (citing Ex. 2023 ¶ 144).

“We determine the field of endeavor ‘by reference to explanations of the invention’s subject matter in the patent application, including the embodiments, function, and structure of the claimed invention.’” *Netflix, Inc. v. DIVX, LLC*, 80 F.4th 1352, 1359 (Fed. Cir. 2023) (quoting *In re Bigio*, 381 F.3d at 1325)). We agree with the parties that the ’328 patent is in the field of automated object recognition. *See* Pet. 64; PO Resp. 48–49; *see also* Ex. 1001, 1:31–32 (“The present invention relates generally to the field of automated object recognition.”), 3:51–53 (“The present invention is a system for classifying different types of sheeting materials of road signs depicted in a videostream.”). We agree with Patent Owner that Popovich is in the field of optical position sensing. PO Resp. 49; *see also* Ex. 1010, 1

(“This invention relates to optical position sensing systems generally”; “In accordance with the present invention there is provided an optical triangulation tracking system”), 5 (“A first embodiment of the present invention, in the form of a head tracking system shown in Figure 1, is based on the use of optical triangulation to determine the spatial position of a viewer.”).

Accordingly, we agree with Patent Owner that the ’328 patent and Popovich are in different fields of endeavor.

b. Reasonable Pertinence to Inventors’ Problem

Petitioner argues that “Popovich [is] also analogous art to the ’328 patent because [it is] reasonably pertinent to problems addressed by the ’328 patent, including automatically identifying objects of interest without relying solely on ‘template matching of shape and color.’” Pet. 64 (citing Ex. 1001, 1:39–47; Ex. 1010, 5–7; Ex. 1003 ¶ 164); Pet. Reply 28.

Petitioner contends that Popovich’s system “identif[ies] the position of a ‘retroreflective target’ by determining the position of the sensor in the sensor array that received the reflected light’s ‘spot intensity.’” *Id.*

Patent Owner argues “the ’328 [p]atent is designed to be an ‘automated system’ that operates ‘along a roadway that is being traversed by a vehicle,’” whereas “Popovich is trying to detect a target on a human head—at much shorter distances—in a relatively static environment.” PO Resp. 49 (citing Ex. 1001, claim 1; Ex. 2023 ¶ 145). Patent Owner argues that Popovich’s system requires two angled light beams to illuminate the two sides of the user’s face, which “would not be applicable to a vehicle on a roadway.” *Id.* at 49–50 (citing Ex. 2023 ¶ 145).

In the embodiment relied upon by Petitioner, Popovich discloses using either an array of photodetectors to determine the location of a single spot moving against a black background or a raster scanning sensor that determines the spot intensity of the reflected beam. Ex. 1010, 6–7. It is not clear upon which sensor Petitioner relies, as Petitioner references aspects of each. *See* Pet. 64 (referencing “sensor array” and “spot intensity”). Regardless of which sensor on which Petitioner intends to rely, Petitioner fails to persuade us that Popovich is reasonably pertinent to the problem of “automatically identifying objects of interest without relying solely on ‘template matching of shape and color,’” as Popovich merely determines the location of a reflector by triangulating two rays of reflected light. *See* Ex. 1010, 5–7, Fig. 1. Petitioner does not identify within Popovich the intention of avoiding reliance on “template matching of shape and color.” Dr. Thorpe’s testimony is substantially identical to the Petition, and, thus, likewise fails to apprise us that Popovich is reasonably pertinent to the problem identified by Petitioner. *See* Ex. 1003 ¶ 164.

c. Conclusion

Because we determine that Popovich is neither in the same field as the ’328 patent or reasonably pertinent to a particular problem faced by the inventors of the ’328 patent, we find that Popovich is not analogous art.

2. Reliance on Multiple Embodiments

Patent Owner argues that “Petitioner cites and combines distinct embodiments of Popovich without explanation nor an identified motivation to combine.” PO Resp. 51 (citing Ex. 2023 ¶ 153). Patent Owner argues that, in a first embodiment, Popovich’s sensors measure the position of the

intensity profile peak to define a ray vector (*id.* (citing Ex. 1010, 6–7; Ex. 2023 ¶ 153)) and, in a third embodiment, Popovich “uses light sources of different wavelengths and angular intensity distribution profiles” (*id.* (citing Ex. 1010, 9–11; Ex. 2023 ¶ 153)). Patent Owner argues that “Popovich expressly states that this third embodiment *does not use* the disclosure on pages 6-7 from the first embodiment.” *Id.* (citing Ex. 1010, 10; Ex. 2023 ¶ 153).

Petitioner replies that the Petition explains why it would have been obvious to incorporate teachings from different embodiments in Popovich in the combination. Pet. Reply 28 (citing Pet. 64–69).

We agree that Petitioner relies on two incompatible embodiments of Popovich’s system without explaining how they would be combinable. Petitioner first relies on Popovich’s first embodiment, which discloses a raster scanning sensor that determines the trajectory of the reflected light ray based on the position of its “spot” on the sensor, to teach measuring the intensity peak of reflected light. Pet. 70 (citing Ex. 1010, 6–7). Then Petitioner relies on Popovich’s third embodiment, which discloses measuring the intensity of reflected light having a varying angular intensity distribution profile, to teach using the angular bearing of the reflected light in determining light intensity. *Id.* at 71 (citing Ex. 1010, 10). Thus, the two embodiments use different sensors, impart light have differing characteristics to the retroreflector, and determine the position of the retroreflector in different manners. Indeed, as correctly noted by Patent Owner, Popovich expressly distinguishes the operation of these two embodiments. Ex. 1010, 10. However, neither Petitioner nor Dr. Thorpe

explains adequately how these incompatible systems would be combined. *See* Pet. 70–71; Ex. 1003 ¶¶ 177–178.

3. Predetermined Vectors

Patent Owner argues that Petitioner does not cite to any disclosure or teaching for the recited “comparing the light vector to one of a plurality of predetermined vectors based on a light source angle characterization,” instead relying solely on conclusory assertions. PO Resp. 52–54.

Petitioner replies that “Patent Owner improperly attacks Popovich individually.” Pet. Reply 29.

Petitioner relies on Gallagher to disclose selecting reflectance levels that indicate a road marker. Pet. 71 (citing Ex. 1005 ¶ 66). Petitioner relies on Popovich to teach using the angular bearing of reflected light in the determination of light intensity (which, as disclosed above, requires imparting light having a varying angular intensity distribution profile onto the reflective surface). *Id.* (citing Ex. 1010, 10). Petitioner does not rely on either reference to disclose or teach the use of predetermined vectors, nor do we see such disclosure in the relied-upon portions of the references. Instead, Petitioner merely asserts that, “[b]ecause the light-source intensity varies relative to its heading, [an ordinarily skilled artisan] would have found it obvious to compare the determined light vector to one of a plurality of predetermined vectors based on a light source angle characterization.” *Id.* (citing Ex. 1003 ¶ 178). Dr. Thorpe similarly fails to identify any teaching of using a plurality of predetermined vectors. *See* Ex. 1003 ¶ 178. Such conclusory assertions fail to meet Petitioner’s burden to “specify where each

element of the claim is found in the prior art patents or printed publications relied upon.” 37 C.F.R. § 42.104(b)(4).

4. Conclusion

For at least the foregoing reasons, Petitioner has failed to show, by a preponderance of the evidence, that claim 5 and its dependent claims 6 and 7 would have been obvious in view of the combination of Gallagher, Schofield, Leonard, and Popovich.

III. CONCLUSION⁶

Based on the evidence presented with the Petition, the evidence introduced during the trial, and the parties’ respective arguments, Petitioner has shown, by a preponderance of the evidence, that claims 1–4 and 8–13 of the ’328 patent are unpatentable. However, Petitioner has failed to show that claims 5–7 and 14–16 of the ’328 patent are unpatentable. In summary,⁷

⁶ Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner’s attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. See 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. See 37 C.F.R. §§ 42.8(a)(3), (b)(2).

⁷ Claims 17–22 have been disclaimed and thus not designated as “Shown Unpatentable” or “Not Shown Unpatentable” in this table.

Claim(s)	35 U.S.C. §	Reference(s)/ Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1–4, 8–13	103(a)	Gallagher, Schofield	1–4, 8–13	
15, 16	103(a)	Gallagher, Schofield, Frank		15, 16
14	103(a)	Gallagher, Schofield, Frank, ASTM		14
5–7	103(a)	Gallagher, Schofield, Leonard, Popovich		5–7
Overall Outcome			1–4, 8–13	5–7, 14–16

IV. ORDER

Accordingly, it is:

ORDERED that claims 1–4 and 8–13 of the '328 patent have been shown to be unpatentable;

FURTHER ORDERED that claims 5–7 and 14–16 of the '328 patent have not been shown to be unpatentable; and

FURTHER ORDERED that, because this is a final written decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

IPR2024-01111
Patent 9,671,328 B2

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