

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

ZF ACTIVE SAFETY AND ELECTRONICS US LLC,
Petitioner,

v.

FACET TECHNOLOGY CORP.,
Patent Owner.

Patent No. 9,335,255

Filing Date: October 13, 2014

Issue Date: May 10, 2016

Title: SYSTEM AND ASSESSMENT OF REFLECTIVE OBJECTS ALONG A
ROADWAY

Inter Partes Review No.: IPR2025-00748

**PETITION FOR *INTER PARTES* REVIEW
UNDER 35 U.S.C. §§ 311-319 AND 37 C.F.R. § 42.100 *et seq.***

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EXHIBITS

- Ex. 1001: U.S. Patent No. 9,335,255 (“the ’255 patent”)
- Ex. 1002: Prosecution History of the ’255 patent
- Ex. 1003: Declaration of Charles E. Thorpe, Ph.D. (“Thorpe”)
- Ex. 1004: Curriculum Vitae of Charles E. Thorpe, Ph.D.
- Ex. 1005: U.S. Patent Application Publication No. 2002/0063638 to Gallagher (“Gallagher”)
- Ex. 1006: U.S. Patent No. 5,796,094 to Schofield et al. (“Schofield”)
- Ex. 1007: U.S. Patent No. 5,202,742 to Frank et al. (“Frank”)
- Ex. 1008: American Society for Testing and Materials D4383–96, Standard Specification for Plowable, Raised Retroreflective Pavement Markers (July 1996) (“ASTM”)
- Ex. 1009: RESERVED
- Ex. 1010: International Patent Application Publication No. WO 96/17258 to Popovich (“Popovich”)
- Ex. 1011: RESERVED
- Ex. 1012: K.L. Black et al., *NCHRP Report No. 346: Implementation Strategies for Sign Retroreflectivity Standards*, Transportation Research Board (Apr. 1992) (“Black”)
- Ex. 1013: U.S. Patent No. 6,359,274 to Nixon et al. (“Nixon”)
- Ex. 1014: John J. Lumia, *A Mobile System for Measuring Retroreflectance of Traffic Signs*, Optics, Illumination, and Image Sensing for Machine Vision V, Donald J. Svetkoff, Editor, Proc. SPIE 1385, pp. 15-26 (1991) (“Lumia”)
- Ex. 1015: RESERVED
- Ex. 1016: V.J. Pezoldt et al., *Raised Pavement Marker Reflectivity*, Report No. TX-90/1151-1F (Nov. 1990) (“Pezoldt”)

- Ex. 1017: Joseph T. Fitzpatrick, *Unified Reflective Sign, Pavement and Delineation Treatments for Night Traffic Guidance*, Highway Research Board, Bulletin 255 (1960) (“Fitzpatrick”)
- Ex. 1018: U.S. Patent No. 5,162,643 to Currie (“Currie”)
- Ex. 1019: Hugh W. McGee et al., *An Implementation Guide for Minimum Retroreflectivity Requirements for Traffic Signs*, Report No. FHWARD-97-052 (Apr. 1998) (“McGee”)
- Ex. 1020: U.S. Patent No. 4,721,389 to Dejaiffe (“Dejaiffe”)
- Ex. 1021: Declaration of Raymond Cruitt
- Ex. 1022: Declaration of Kelley M. Hayes Greenhill

MANDATORY NOTICES

Real Party in Interest (37 C.F.R. § 42.8(b)(1))

The real party-in-interest for this petition is ZF Active Safety and Electronics US LLC.

No unnamed entity is funding, controlling, or directing this Petition for *inter partes* review of the '255 Patent, or otherwise has an opportunity to control or direct this Petition or Petitioner's participation in any resulting IPR.

Related Matters (37 C.F.R. § 42.8(b)(2))

To the best knowledge of Petitioner, the '255 Patent is involved in the following district court litigations:

Name	Number	Court	Filed
<i>Mobileye Vision Technologies Ltd. et al v. Facet Technology Corp.</i>	0:24-cv-04149	D. Minn.	Nov. 7, 2024
<i>Facet Tech. Corp. v. Mobileye Glob., Inc.</i>	2:24-cv-00058	E.D. Tex.	Jan. 26, 2024
<i>Facet Tech. Corp. v. Gen. Motors LLC</i>	2:24-cv-00035	E.D. Tex.	Jan. 22, 2024
<i>Facet Tech. Corp. v. Here Glob. B.V.</i>	2:24-cv-00269	E.D. Tex.	Apr. 22, 2024
<i>Facet Tech. Corp. v. TomTom Int'l B.V. et al.</i>	1:24-cv-00111	D.N.H.	Apr. 23, 2024

The '255 Patent is the subject of instituted IPR2024-01110, filed by Mobileye Global, Inc., to which Petitioner seeks to join this IPR. Petitioner is also concurrently filing another petition for IPR (IPR2025-00749) challenging the claims of U.S. Patent No. 9,671,328, a patent related to the '255 patent. U.S. Patent No. 9,671,328 is also the subject of an *ex parte* reexamination request, which was filed as Application No. 90/019,546 by Unified Patents, LLC, on June 20, 2024 as well as IPR2024-01111.

Lead and Back-Up Counsel (37 C.F.R. § 42.8(b)(3))

Petitioner designates counsel listed below. A power of attorney for counsel is being concurrently filed.

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I. PRELIMINARY STATEMENT

ZF Active Safety and Electronics US LLC (“Petitioner”) requests review under 35 U.S.C. § 311 and cancellation of claims 12-15 and 17-23 (“challenged claims”) of U.S. Patent No. 9,335,255 (“the ’255 patent”) over the grounds set forth in Section II. The ’255 patent was filed about fourteen years after its priority claim and claims substantially different subject matter than was originally claimed. In the end, all that remains are claims that combine conventional elements for measuring reflectivity and detecting objects using known object-detection techniques. As shown in the grounds below, nothing in the claims recites anything novel or nonobvious. Therefore, this IPR should be instituted and the claims canceled.

II. PRECISE RELIEF REQUESTED

Prior Art:

Exhibit / Name	Number / Title	Effective Filing Date	Issue / Publication Date	Prior-Art Provision
1005 “Gallagher”	U.S. Patent Application Publication No. 2002/0063638	Mar. 5, 1998	May 30, 2002	AIA: 102(a)(2) Pre-AIA: 102(e)
1006 “Schofield”	U.S. Patent No. 5,796,094	Mar. 25, 1996	Aug. 18, 1998	AIA: 102(a)(1)-(2) Pre-AIA: 102(a), (b), (e)
1007 “Frank”	U.S. Patent No. 5,202,742	Oct. 3, 1990	Apr. 13, 1993	AIA: 102(a)(1)-(2) Pre-AIA: 102(a), (b), (e)

Exhibit / Name	Number / Title	Effective Filing Date	Issue / Publication Date	Prior-Art Provision
1014 “Lumia”	<i>A Mobile System for Measuring Retroreflectance of Traffic Signs</i>	N/A	1990	AIA: 102(a)(1) pre-AIA: 102(a), (b)
1018 “Currie”	U.S. Patent No. 5,162,643	Feb. 26, 1991	Nov. 10, 1992	AIA: 102(a)(1)-(2) Pre-AIA: 102(a), (b), (e)

Unpatentability Grounds:

1	Gallagher renders obvious claims 12-14, 17, 21, and 23
2	Gallagher and Lumia render obvious claims 13 and 15
3	Gallagher and Schofield render obvious claims 18-19
4	Gallagher and Frank render obvious claim 20
5	Gallagher and Currie render obvious claim 22

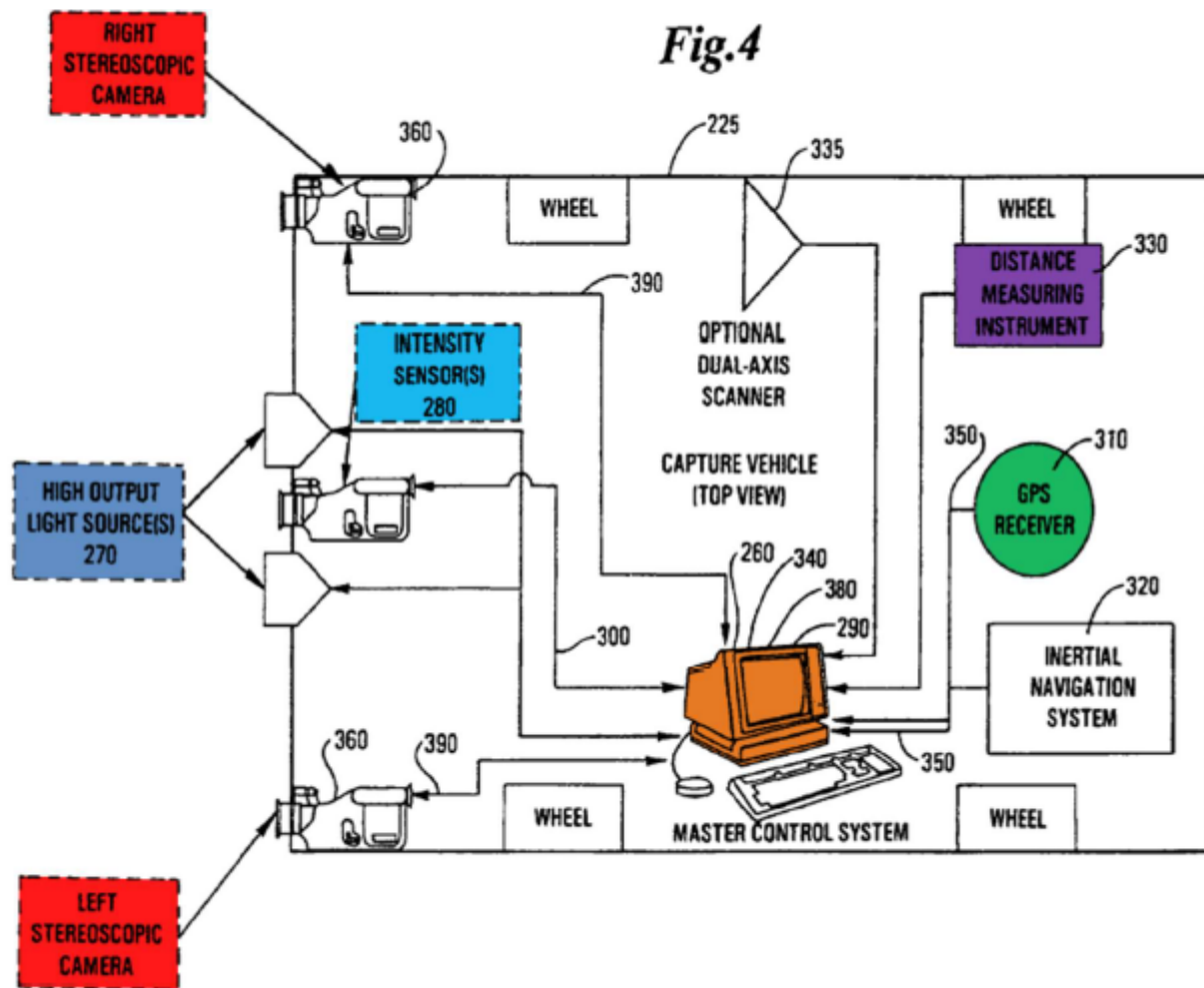
III. THE '255 PATENT

A. Specification

The '255 patent discloses a system for assessing reflective surfaces along a roadway. Ex. 1001, Abstract; Thorpe ¶¶43-50. The '255 patent admits that “using an automated image identification system to recognize road signs and traffic signs [was] well known,” but asserts that proposed systems used less accurate “template

matching of shape and color.” Ex. 1001, 1:36-42. The ’255 patent states that those inaccuracies are due to “the wide variations in lighting and conditions.” *Id.*, 1:42-44.

Like the known prior art, the ’255 patent’s system determines “retroreflectivity values for reflective surfaces disposed along a roadway” using “subsystems located on/in a capture vehicle 225.” *Id.*, 3:60-65, 7:57-8:8. (Retroreflectivity is the ability of an object to reflect light back to its source. Ex. 1014, 15-16; Thorpe ¶44.) Figure 4, annotated below, depicts “a typical configuration within a capture vehicle” that can produce “data and imagery to create digital representations of objects of interest” and their retroreflectivity. Ex. 1001, 10:7-10 (emphasis added).



Id., Fig. 4 (annotated).

A distance measuring instrument 330 and GPS receiver 310 form part of a vehicle positioning system 240 (shown in Figure 3) that generates position measurements (e.g., position of the vehicle and distance from the vehicle to a road marker). *Id.*, 8:1-5, 10:10-16, Fig. 3. Stereoscopic cameras 360 constitute a digital imagery system 390 used in “the creation of objects of interest 460 and their associated attributes 465.” *Id.*, 10:24-27.

“The high output light source(s) 270 and light intensity sensor(s) 280 constitute the light intensity measurement system 230.” *Id.*, 7:62-65, 10:17-23. Light intensity measurement system 230 (shown in Figure 3) generates intensity measurements “in response to the repeated strobing of the high output light source 270,” allowing the collection of data for computing retroreflectivity. *Id.*, 7:65-8:1, 10:17-23. The number of intensity values in each intensity measurement can correspond to “the number of pixels in the light intensity sensor’s 280 array.” *Id.*, 11:27-33.

The master control system (unlabeled) monitors the other onboard systems and records the data for post-processing by “desktop systems” to identify objects of interest and their retroreflectivity. *Id.*, 8:5-48, 9:4-10:6, Fig. 3.

The ’255 patent discloses that intensity is “determined from the gray value of the corresponding pixels” in the image of the light intensity sensor 280. *Id.*, 11:24-27. “Intensity values will vary according to the color of the reflected light, since not all colors of incoming light excite the light intensity sensor 280 pixels in the same way.” *Id.*, 11:41-43. “By knowing the background or foreground color of the object of interest” and the intensity sensor’s profile for a particular color, “the intensity value 300 for a particular color can be converted into a luminance value.” *Id.*, 11:43-48. With a “uniform light source,” knowing the luminance and the distance to the object of interest allows the retroreflectivity to be approximated. *Id.*, 11:61-12:8.

The '255 patent discloses using its system for determining retroreflectivity “to detect and determine a retroreflective surface of interest disposed in a scene of non-retroreflective surfaces.” *Id.*, 8:60-9:3. The '255 patent discloses that “road sign[s]” and “pavement markings” include reflective surfaces whose retroreflectivity may be measured. *Id.*, 3:60-65, 17:26-18:30.

Notably, none of the '255 patent's techniques for determining reflectivity laid out in its “Summary of the Invention” are recited in the challenged claims.

B. Prosecution History

The '255 patent was filed as Application No. 14/512,735. Following a preliminary amendment, the Examiner rejected claims 20 and 31 (which correspond to claims 1 and 12 of the '255 patent) for obviousness-type double patenting over claim 19 of U.S. Patent No. 8,660,311, and claim 20 of U.S. Patent No. 8,860,944, respectively. Ex. 1002, 211-214. Applicant filed terminal disclaimers for each patent. *Id.*, 229-232, 236. The Examiner then issued a notice of allowance, stating that “the prior art fails to disclose or make obvious” the claimed combination of features in each independent claim. *Id.*, 290-293.

C. Level of Ordinary Skill in the Art

A person of ordinary skill in the art (“POSITA”) of the '255 patent 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. Thorpe ¶33. Higher levels of education may offset less experience and extensive experience can substitute for formal education. Thorpe ¶33.

D. Claim Construction

The '255 patent recites one means-plus-function term. Petitioner proposes a construction for this term below. For all other terms, the plain meaning should apply for the purpose of this IPR. *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) (“[O]nly those [claim] terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.”).¹

1. “means for determining a plurality of light intensity values directed to cover a field of view which includes at least a portion of the area illuminated by the light source”

This term recites the word “means” and should be construed as a means-plus-function term under pre-AIA § 112, ¶ 6, with the following function and corresponding structure:

¹ Petitioner reserves the right to argue that certain limitations in the challenged claims are indefinite and/or require construction to resolve controversies in other forums.

- Function: “determining a plurality of light intensity values directed to cover a field of view which includes at least a portion of the area illuminated by the light source”;
- Structure: a light sensor, or equivalents. Ex. 1001, 20:53-55.

The structure of “light sensor” is supported, for example, by dependent claim 23, which states that “the means for determining a plurality of light intensity values comprises a light sensor.” *Id.* Accordingly, the ’255 patent “clearly associate[s]” a “light sensor” with the recited function. *Cardiac Pacemakers, Inc. v. St. Jude Med., Inc.*, 296 F.3d 1106, 1113 (Fed. Cir. 2002). This structure is also consistent with the specification, which repeatedly refers to a “light intensity sensor 280.” *E.g.*, Ex. 1001, 7:62-65, 10:17-19, 11:21-60. For example, the “light intensity sensor 280” is part of a “light intensity measurement system 230,” where each intensity measurement includes “intensity values for N discrete points within the scene, where N corresponds to the number of pixels in the light intensity sensor’s 280 array.” *Id.*, 7:62-65, 11:27-33.

IV. OVERVIEW OF THE PRIOR ART

A. Gallagher

Gallagher, like the ’255 patent, discloses a “reflectivity measuring apparatus” used on a moving vehicle. Gallagher, [0001], [0031]-[0033]; Thorpe ¶¶55-59. Gallagher discloses that “[l]ight reflective road markings and markers are

extensively used to demarcate vehicle lanes and supply vital information to drivers about sections of road” and “function by reflecting or retroreflecting light rays entering the reflective material of the road marking back to a driver.” Gallagher, [0002]. Gallagher’s apparatus tests “road markings and road markers such as, for example, road signs and posts, reflective painted lines whether continuous or broken, and ... raised pavement markers” “to ensure they continue to meet minimum standards of reflectivity/retroreflectivity.” Gallagher, [0003], [0006], [0031]-[0033]. It overcomes the disadvantages of then-conventional test methods that relied on subjective “night time drivebys using headlights” or a labor-intensive “portable hand held measuring instrument.” Gallagher, [0003]-[0006].

Gallagher’s apparatus “is mounted on ... a vehicle 3” and “can obtain reflectivity measurements, inter alia, with the vehicle 3 travelling at speeds of up to about 100 kph.” Gallagher, [0032]. “For simplicity,” Gallagher describes an embodiment that measures “raised pavement markers 2,” referred to as “markers,” but it can also “be adapted to measure other types of reflective markings on or adjacent [to] the road.” Gallagher, [0033]. Gallagher’s apparatus includes “a light source 4 in the form of a standard vehicle headlight” with a “relatively constant and even intensity.” Gallagher, [0035]. “A reflected light results from the beam illuminating” a surface of marker 2, and “[a] light sensor 6 detects the reflected light.” Gallagher, [0036], [0038], [0046]. Sensor arrays containing multiple sensors,

each “arranged to detect reflected light from a relatively small viewing angle,” “are advantageously aligned in an encased module 6a to increase the field of view of the apparatus 1.” Gallagher, [0038], [0040]. The sensors may be “photodiodes mounted precisely on the module 6a at a height and angle to properly detect reflected light” and may be configured to “indicate the [color] of a road marking being tested.” Gallagher, [0039]. The light source 4 and light sensor module 6a are mounted in close proximity “to reduce the observation angle to almost zero.” Gallagher, [0041]. This apparatus is depicted in Figure 1, below.

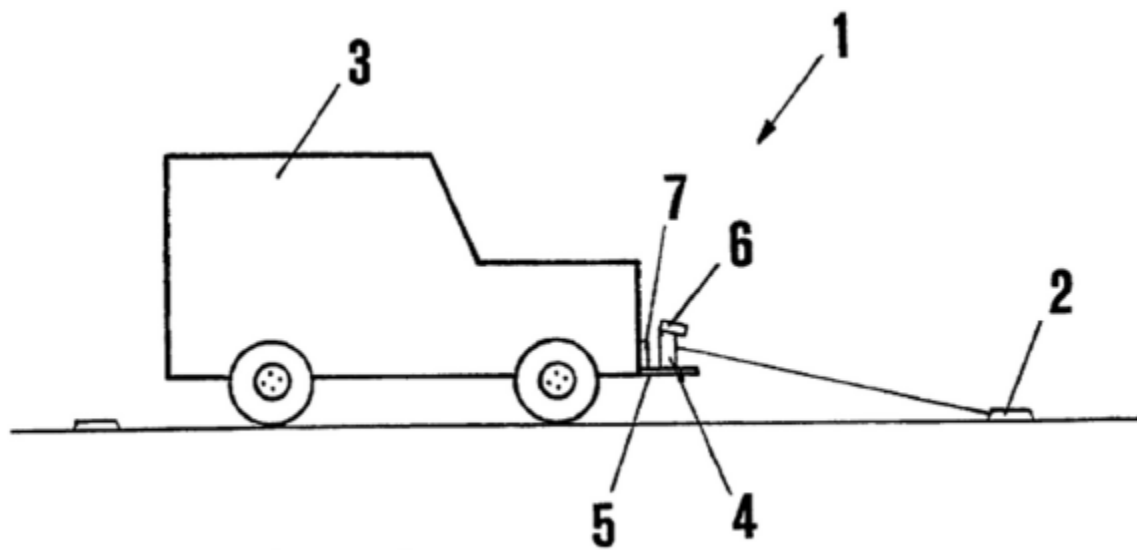


Figure 1

Gallagher, Fig. 1.

The apparatus also includes “a computer 8 ... to carry out a method of testing the integrity of road markings.” Gallagher, [0045]. Computer 8’s processing includes “getting the data ... on the reflected light detected by the light sensors 6,”

“calculating the average reflectance level from a set of sampled data from each sensor,” “calibrating the data by multiplying the data with a predetermined calibration factor to calibrate for different positions in the light sensor module 6a,” “determining the distance travelled from the start position of the road marking test so as to determine the location of each road marking,” “determining the background reflectance level on the road and establishing non-marker reflectance levels,” “selecting ... which reflectance levels indicate a road marker,” “determining the reflectance level of the road marker in a value of millicandela per Lux (CIL),” and “tagging ... a road marker if it is determined as measuring a reflectivity less than the predetermined minimum acceptable reflectance level.” Gallagher, [0055]-[0068].

“The data obtained on the reflectance level and location of each road marking tested can be stored and later used in a rerun of a stretch of road tested earlier.” Gallagher, [0073]. Gallagher’s apparatus also provides “an audio and/or visual indicator” of the vehicle’s position on the road to the driver to help the driver “maintain the vehicle 3 in a proper position on the road to allow the apparatus 1 to obtain reflectivity measurements.” Gallagher, [0060]-[0062].

Figure 3, below, highlights the reflectivity measuring apparatus’ light source 4, its array 6a of light sensors 6, and its computer 8. Gallagher, [0035]-[0050], Fig. 3.

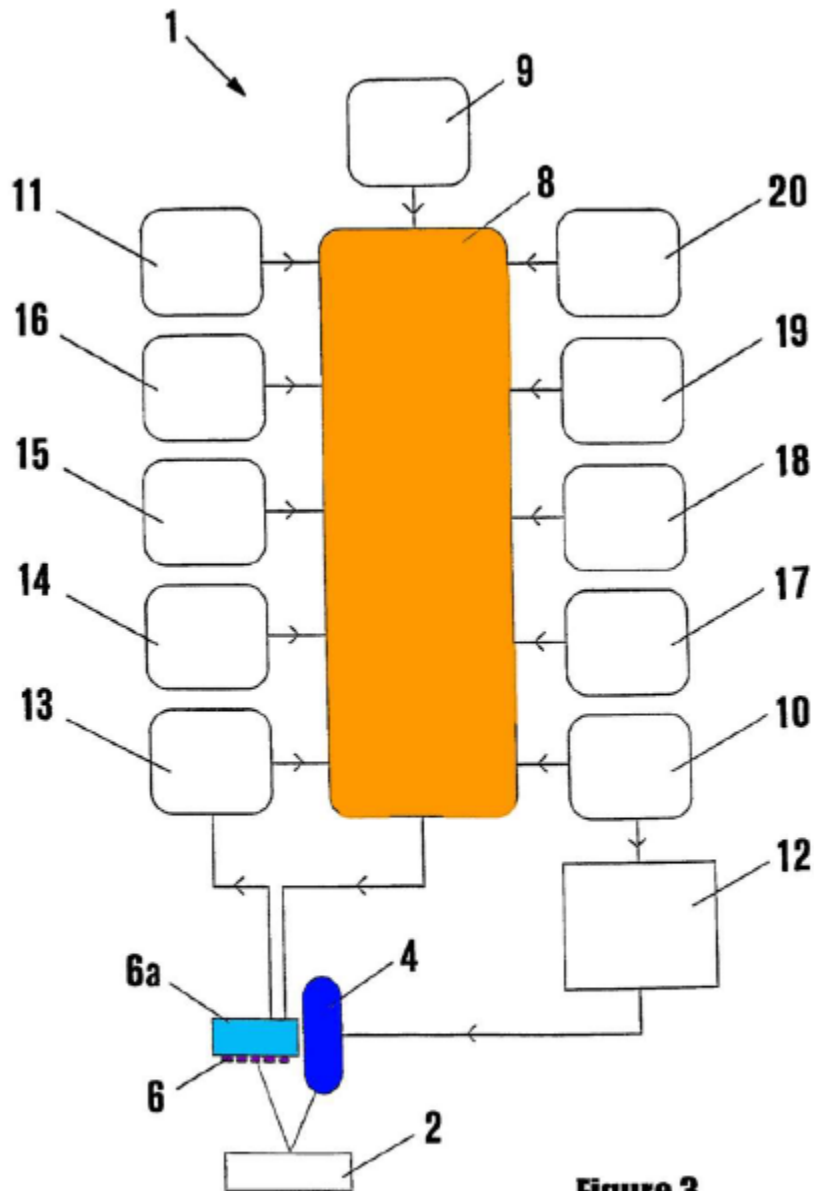


Figure 3

Computer
Light Source
Light Sensor Array / Sensors

Gallagher, Fig. 3 (annotated).

Gallagher is analogous art to the '255 patent because it is in the same field of endeavor, namely, automated object recognition. Ex. 1001, 1:29-30; Gallagher, [0007], [0066], [0078]; Thorpe ¶59. Gallagher is also analogous art to the '255 patent

because it is reasonably pertinent to problems addressed by the '255 patent, including automatically identifying road markers without relying solely on “template matching of shape and color.” Ex. 1001, 1:36-44; Gallagher, [0066] (identifying road markers based on “peak responses sensed” by light sensors); Thorpe ¶59.

B. Lumia

Lumia was published and publicly accessible to persons interested and ordinarily skilled in the art no later than a few days after June 26, 1990, the date

that it was received at a library for cataloging and indexing. Ex. 1021, ¶18; Ex. 1012, 44 (citing Lumia as reference 3). Lumia therefore qualifies as prior art to the '255 patent under AIA § 102(a)(1)/pre-AIA § 102(a)-(b).

Lumia discloses a mobile system that “can measure the average retroreflectance of sign legend and background from a moving vehicle during daylight hours.” Lumia, 15; Thorpe ¶¶60-65. “This system uses a video camera to acquire sign images, a xenon flash as a source of light, a personal computer to analyze the sign images, and a laser rangefinder to measure the distance to the sign.” Lumia, 15.

Lumia’s system was design was designed to measure the retroreflectance of traffic signs formed from “retroreflective sheeting.” Lumia, 15. Lumia explains that

retroreflectance (R) can be calculated from the “the luminance of the reflected light” (L) and “the normal illumination incident on the retroreflector,” which is estimated using the intensity of the light source (I) and “the distance from the source to the detector” (d). Lumia, 15-16. This retroreflectance calculation results in the following equation:

$$R = \frac{L \cdot d^2}{I}$$

Id.; Thorpe ¶61.

To carry out retroreflectance measurements on both the legend and background of traffic signs, Lumia’s system uses “a video camera to record the sign,” “an electronic flash source to provide a short burst of light sufficiently bright enough to overcome the sign luminance due to ambient daylight illumination,” “a laser rangefinder” to measure the distance from the vehicle to the sign, and a computer to process images from the video camera and calculate the retroreflectance of a sign’s legend and background. Lumia, 15. Figures 4 and 5, below, illustrate Lumia’s system. Lumia, 17.

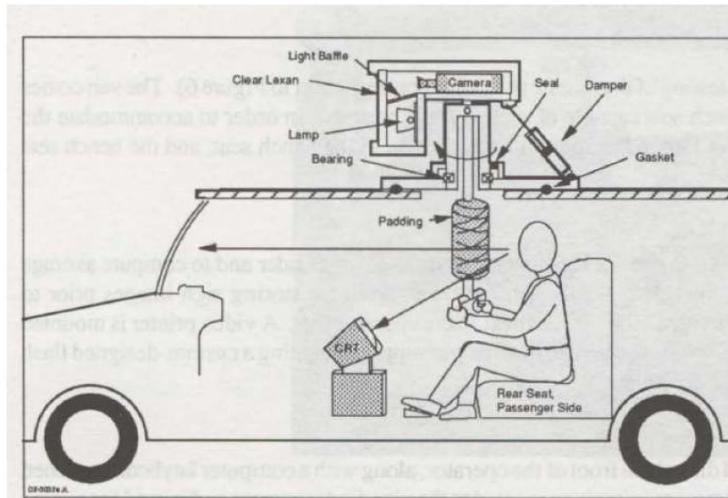


Figure 4. Conceptual design of MSMRTS mobile prototype.

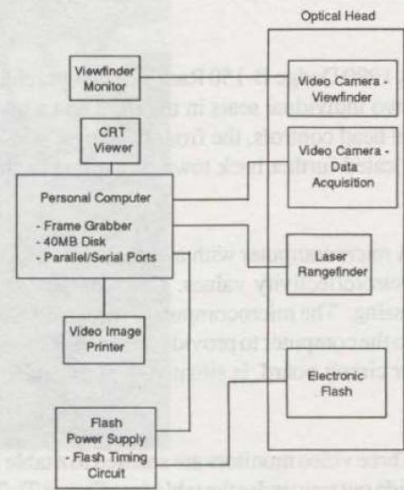
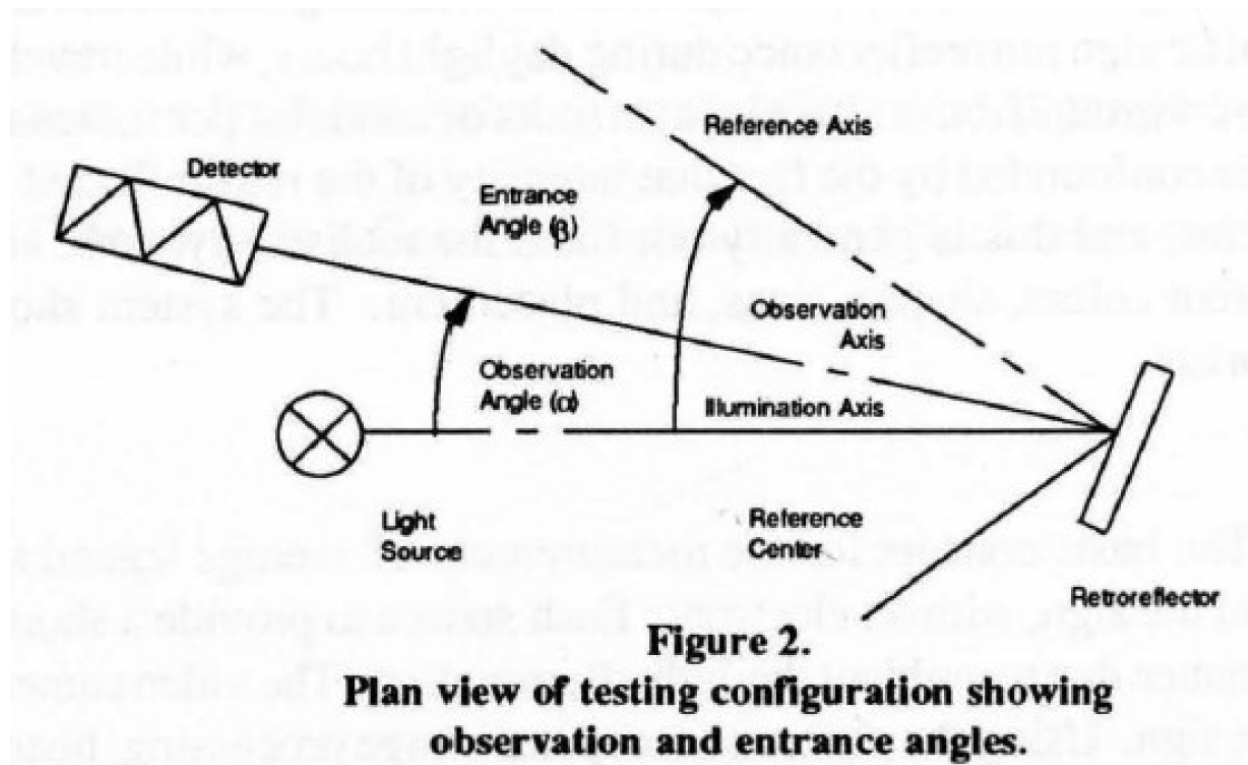


Figure 5. Block diagram of MSMRTS mobile prototype.

Lumia, Figs. 4-5.

Lumia recognized that the retroreflectance values change, depending on the “observation angle” and “entrance angle,” making attention to these angles “important since, in general, all retroreflective devices do not behave the same as the geometry is changed.” Lumia, 21; Thorpe ¶63. These angles are depicted in Figure 2, which shows “the commonly accepted geometry and definitions ... for evaluating retroreflective materials.” Lumia, 16.



Lumia, Fig. 2. For example, Figure 9, below, depicts the relative retroreflectance of different materials as a function of observation angle. Lumia, 21. “The effect of entrance angle (the angle between the axis of the light source and the normal to the sign) is far less severe.” Lumia, 21.

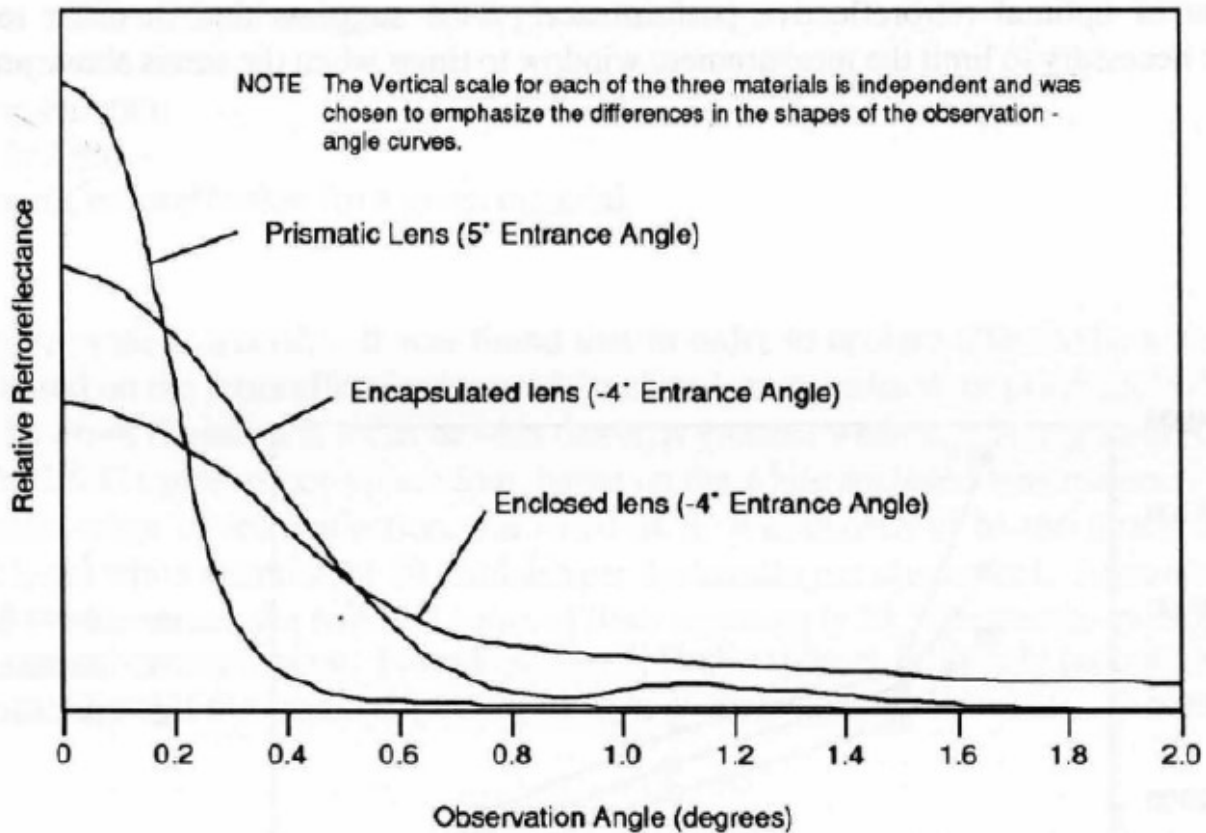


Figure 9. Relative retroreflectance versus observation angle.⁴

Lumia, Fig. 9.

When the distance between the light source and light detector is fixed, “the observation angle increases with decreasing distance to the sign.” Lumia, 21; Thorpe ¶64. Because “the material of the sign being measured will most likely not be known, ... it will be nearly impossible to relate the measured [retroreflectance] value to a commonly measured observation angle (such as 0.2°).” Lumia, 21. As a result, Lumia recognizes a “‘distance window’ in which the measurements need to be taken” to be sufficiently accurate. Lumia, 21; Thrope ¶64. “The use of a laser rangefinder in a moving system provides an accurate measure of monitoring the

distance from the vehicle to the sign and triggering image acquisition when a predetermined sign distance is reached.” Lumia, 15.

Lumia is analogous art to the ’255 patent because it is in the same field of endeavor, namely, an automated determination of retroreflectivity values for reflective surfaces disposed along a roadway. Ex. 1001, 3:60-65; Lumia, 15-16; Thorpe ¶65. Lumia is also analogous art to the ’255 patent because it is reasonably pertinent to problems addressed by the ’255 patent, including providing a device that overcomes “sending personnel in the field to measure retroreflectivity with a handheld device.” Ex. 1001, 1:61-2:51; Lumia, 15-16 (measuring retroreflectivity of a sign from a moving vehicle); Thorpe ¶65.

C. Schofield

Schofield discloses a system that “identifies particular light sources” by “separating each light source” in a forward scene of a vehicle and “analyzing that source to determine its characteristics,” including its spectral characteristics and spatial layout. Schofield, 1:56-67, 2:6-14; Thorpe ¶¶66-70. Light sources include “[l]ane markers, signs, and other sources of reflected light.” Schofield, 10:43-45. Schofield discloses using its system to “identify particular traffic signs” and “detect lane markers,” among other light sources. Schofield, 12:1-4, 12:40-42.

Schofield’s system includes “an imaging sensor module 14 which senses light from a scene forward of vehicle 10” and “an imaging control circuit 13 which

receives data from sensor 14.” Schofield, 3:36-44. “Imaging sensor module 14 includes an optical device 36, such as a lens, an array 38 of photon-accumulating light sensors, and a [filter array 40] for separating light from the scene forward of vehicle 10 into a plurality of spectral bands.” Schofield, 4:16-21. The “array 38 may be a charge couple device (CCD) array of the type commonly utilized in video camcorders and the like” and may include an array of “light-sensing pixels, each made up of a photosensor element 42.” Schofield, 4:28-31, 8:38-40, Fig. 4.

The imaging control circuit 13 “responds to the plurality of sensors in order to determine if spatially adjacent regions of the field of view forward of the vehicle include light of a particular spectral signature above a particular intensity level.” Schofield, 2:28-32, 4:47-5:12, 7:64-8:12. Analyzing the intensity values of each of the red, green, and blue pixels in the array both relative to each other and relative to a particular intensity range “helps to reduce false detection of light sources.” Schofield, 7:64-8:8. Schofield’s control circuit also uses “spatial filtering” and “[p]attern recognition” to further assist in identifying objects of interest. Schofield, 10:51-11:3. Spatial filtering refers to considering “whether a particular pixel, or pixel group, is detecting a light source having a particular spectral signature” and “what adjacent, or closely related, pixels or pixel groups, are detecting.” Schofield, 10:53-57. “Pattern recognition identifies objects of interest based upon their shape, reflectivity, luminance, and spectral characteristics.” Schofield, 11:1-3.

Schofield's system is used to identify "point sources of light in any particular location within the scene viewed forward of the vehicle" and "at great distances." Schofield, 9:24-26, 10:22-26. For example, Schofield discloses using its system "to identify particular traffic signs by their spectral signature as well as their geometric organization" (e.g., identifying red octagons as stop signs or yellow triangles as caution signs). Schofield, 12:1-4. Schofield attributes this ability to the "significant reduction in the amount of data to be processed because the image forward of the vehicle is captured in a manner which preselects data" using the spatial and spectral light-source characteristics. Schofield, 12:5-11. Schofield also discloses using its system "to detect lane markers ... to either assist in steering the vehicle or provide a warning to the driver that a lane change is occurring." Schofield, 12:40-42.

Schofield is analogous art to the '255 patent because it is in the same field of endeavor, namely, automated object recognition. Ex. 1001, 1:29-30; Schofield, 1:56-2:15, 9:24-26; Thorpe ¶70. Schofield is also analogous art to the '255 patent because it is reasonably pertinent to problems addressed by the '255 patent, including automatically identifying road markers without relying solely on "template matching of shape and color." Ex. 1001, 1:36-44; Schofield, 10:66-11:12 (using various characteristics, including "reflectivity," for object identification); Thorpe ¶70.

D. Frank

Frank discloses “a laser radar system capable of accurately measuring the distance and angle between a vehicle and a retroreflector located ahead at or near the road surface at some distance ahead of the vehicle.” Frank, 3:8-12; Thorpe ¶¶71-74. Frank’s apparatus “may be mounted in any location on the vehicle where the apparatus can be provided with a view of at least one retroreflector ahead of the vehicle.” Frank, 4:45-51. Frank’s apparatus “calculates the distance D between vehicle 101 to the retroreflector and the angle θ formed between axis 104 and an imaginary line drawn between vehicle 101 and a retroreflector, for example[,] retroreflector 114,” as depicted below. Frank, 4:37-42. “[T]he retroreflectors may be standard roadway reflectors embedded in the roadway” or “may be mounted at another location near the roadway,” such as “on posts.” Frank, 6:53-55, 7:13-18.

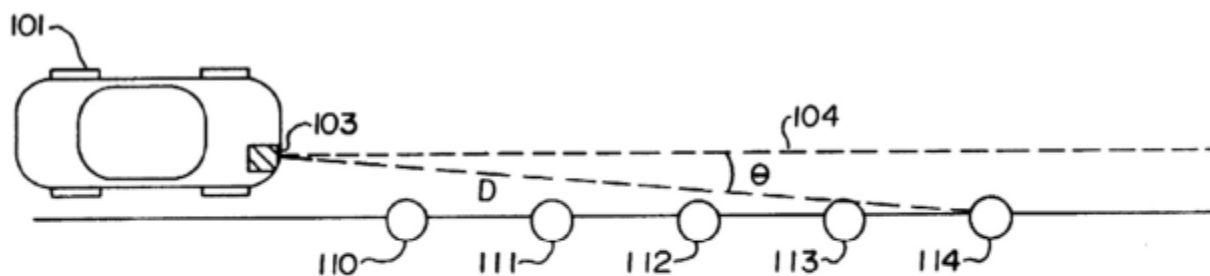


FIG. 2

Frank, Fig. 2.

Frank's apparatus includes a laser 332 producing a light beam 336 that "passes through cylindrical lens 331 to produce fan beam 339," which is "very thin but broadens at a predetermined angle forming a triangular or fan shaped beam." Frank, 4:52-5:7. "Fan beam 339 is reflected from mirror surface 330 and is directed towards roadway 102" Frank, 5:7-9. The angle of mirror surface 330 oscillates through a range, causing "fan beam 339 to scan a particular area." Frank, 5:12-21. Alternatively, Frank's apparatus may instead output a pulse-modulated "floodlight beam 946" covering all of a predetermined area that is similar in size to that covered by fan beam 339. Frank, 10:54-62. Figures 1A and 2A, below, depict the scanned area 447, with a beam angle ω and scanning range α producing "a beam that would scan the area from distance 121 in front of vehicle 101 (approximately 25 feet at the preferred two foot mounting height)" to an effective distance 122, approximately 130 feet, "due to the attenuation effects of the atmosphere" on the beam. Frank, 6:12-49.

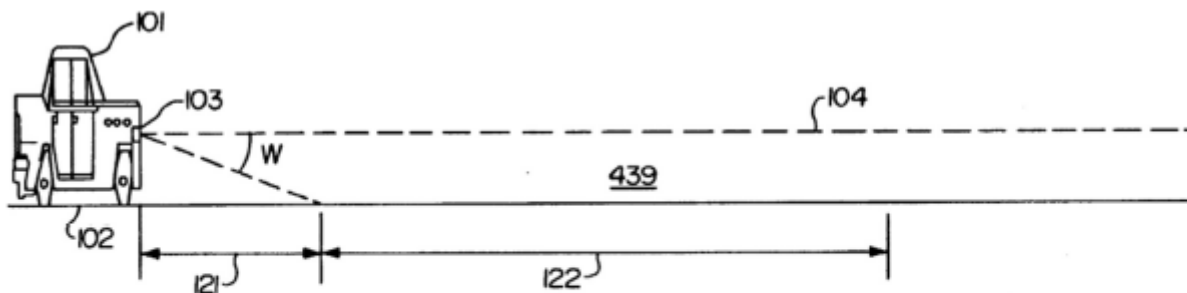


FIG. 1A

Frank, Fig. 1A.

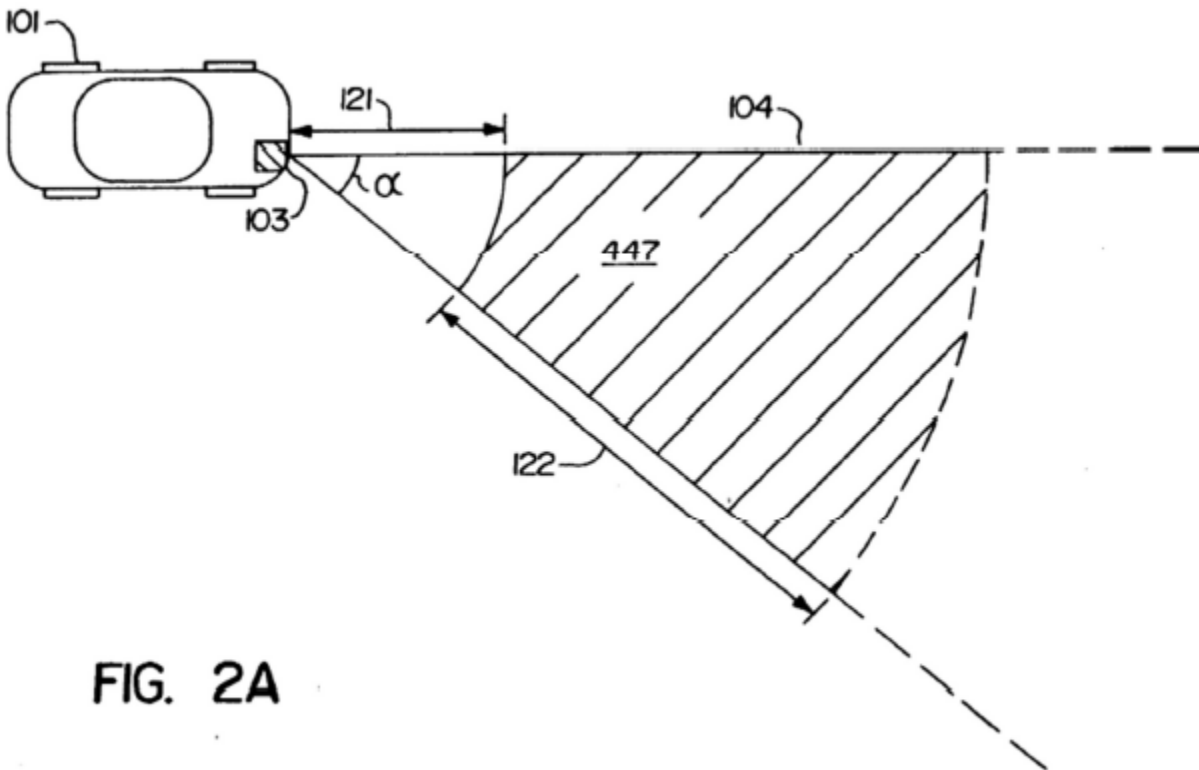


FIG. 2A

Frank, Fig. 2A.

Frank's apparatus includes a "receiving apparatus 465," including an optical receiver that "receives the reflected light beams from" all retroreflectors that "fall within a predetermined beam path" and "outputs a corresponding electrical signal to receiver electronics 443," which determines "distance D and angle θ for each retroreflector scanned." Frank, 6:4-7, 7:27-50. "If only reflectors located a certain distance or range from vehicle 103 are of interest, the controller may then subsequently sort such data and use only data of interest to the particular control algorithm." Frank, 6:7-11.

Frank is analogous art to the '255 patent because it is in the same field of endeavor, namely, automated object recognition. Ex. 1001, 1:29-30; Frank, 6:4-11; Thorpe ¶74. Frank is also analogous art to the '255 patent because it is reasonably pertinent to problems addressed by the '255 patent, including automatically identifying road markers without relying solely on “template matching of shape and color.” Ex. 1001, 1:36-44; Frank, 7:27-50 (identifying retroreflectors using “reflected light ... transmitted back to [a] laser radar apparatus”); Thorpe ¶74.

E. Currie

Currie discloses “a light detecting system for accurately determining the lateral position of a moving object, such as a vehicle, relative to a point or points in advance of the object’s current position along a desired path.” Currie, Abstract; Thorpe ¶¶75-78. Currie discloses a light source 30 that includes “a medium power infrared light source and an incandescent light source.” Currie, 4:20-34. “[T]he infrared light source is pulsed to permit accurate range detection in a range detection channel,” and “[t]he incandescent light source is used to provide enhanced reflection intensity from reflectors placed along the desired path of vehicle motion.” Currie, 4:34-39.

Light reflected from retroreflectors “along a side of the path which the vehicle is to be guided” is directed towards a lens in a “range detection channel” and a lens in an “angle detection channel.” Currie, 4:43-48. The lens in the angle detection

channel focuses the light on a “charge-coupled device (CCD) array 56,” and each output value from the array is compared to a threshold intensity “above that of typical ambient light or light reflected from surfaces other than the retroreflectors placed along the roadside.” Currie, 5:50-61, 7:1-29. “When the light intensity detected in a particular location (i.e., set of 3 detectors) of the CCD array is determined to exceed the experimentally determined threshold, the angular location of a reflector relative to a reference point on the moving vehicle can be readily determined.” Currie, 7:23-29, 7:38-46.

Light received by the lens “in the range detection channel is focused onto a single detector 46,” such as a photosensitive diode. Currie, 5:8-14. Currie’s system “stores a count proportional to the time required for a light pulse to travel from the light source 30 to one of the reflectors and back to the range detection channel.” Currie, 5:39-49, 4:34-37. This count is used to determine a distance to the retroreflector. Currie, 8:1-32, 9:44-46.

Currie is analogous art to the ’255 patent because it is in the same field of endeavor, namely, automated object recognition. Ex. 1001, 1:29-30; Currie, 1:7-15, 6:3-20, 6:57-63; Thorpe ¶78. Currie is also analogous art to the ’255 patent because it is reasonably pertinent to problems addressed by the ’255 patent, including automatically identifying road markers without relying solely on “template matching of shape and color.” Ex. 1001, 1:36-44; Currie, 8:50-56 (using reflected light to

identify reflectors “located on the ground along the roadside” or “on posts next to the roadside”), 9:39-49; Thorpe ¶78.

V. THE CHALLENGED CLAIMS ARE UNPATENTABLE

A. Ground 1: Gallagher Renders Obvious Claims 12-14, 17, 21, and 23

1. Independent Claim 12

a. [12P]: “An automated method of assessing reflective surfaces disposed along a roadway comprising:”

If limiting, Gallagher discloses [12P]. Thorpe ¶¶80-81.

Gallagher discloses an automated system of assessing reflective surfaces disposed along a roadway using its reflectivity measuring apparatus. Gallagher, [0033]-[0035]; Thorpe ¶81. Gallagher’s reflectivity measuring apparatus assesses reflective surfaces of road markers because it includes a light source that “illuminates a reflective surface of a” road marker disposed along a roadway, light sensors 6 that detect “the reflected light,” and a computer 8 that obtains data “on the reflected light detected by” light sensors 6 and selects “which reflectance levels indicate a road marker.” Gallagher, [0046], [0055]-[0066]; Thorpe ¶81. This system then tags any road markers determined to have “a reflectivity less than the predetermined minimum acceptable reflectance level.” Gallagher, [0068]. This system is automated because, once a measurement process is initiated, measurements automatically are “made in real time” by the computer. Gallagher, [0046], [0071]-[0072]; Thorpe ¶81.

- b. [12A]: “activating a light source as the light source is traversed along a roadway to illuminate an area that includes at least one reflective surface on a road marker, the road marker having a reflective characteristic;”**

Gallagher discloses or suggests [12A]. Thorpe ¶¶82-85.

Gallagher’s reflectivity measuring apparatus is “mounted on a vehicle” and includes “a light source 4.” Gallagher, [0007], [0035]-[0039]; Thorpe ¶83.

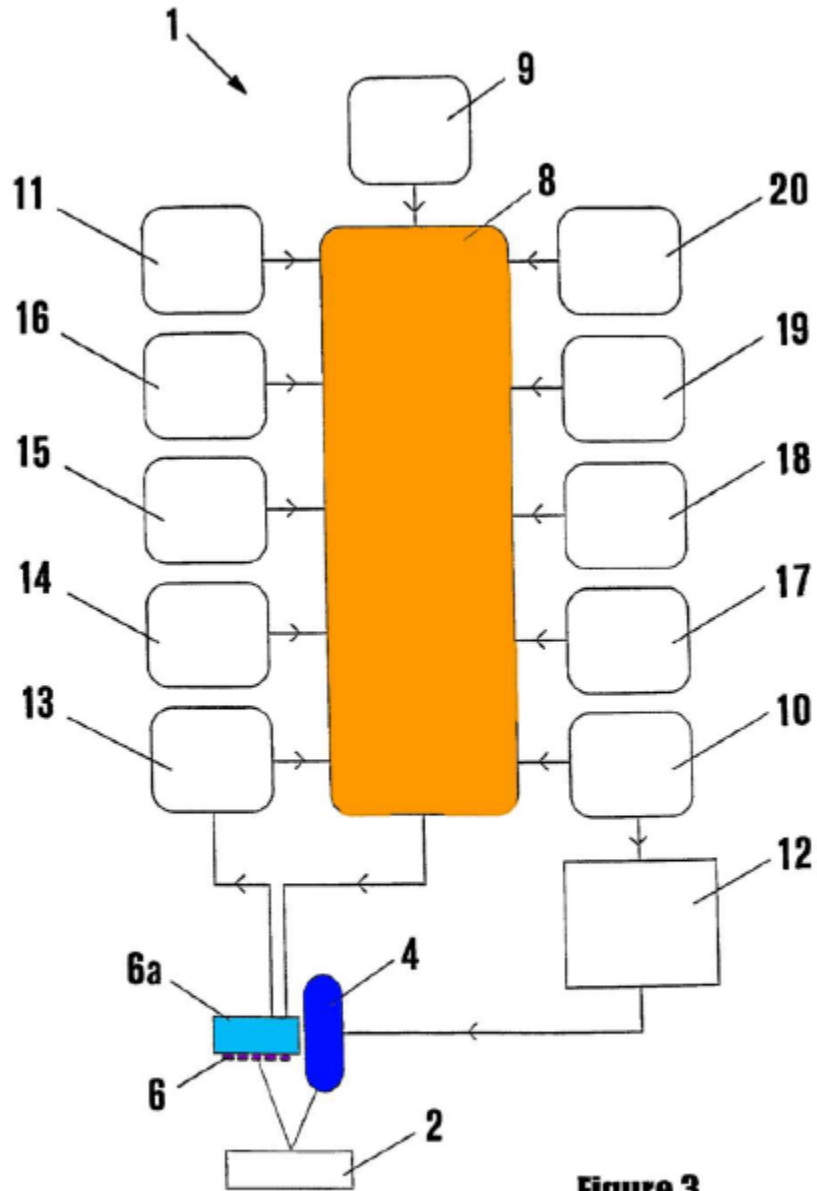


Figure 3

Computer
Light Source
Light Sensor Array / Sensors

Gallagher, Fig. 3 (annotated).

Gallagher's light source 4 is traversed along a roadway because it is "mounted on ... a vehicle 3" and measures reflectivity while the vehicle travels "at speeds of up to about 100 kph" (traverses) "on a road" (along a roadway). Gallagher, [0031]-

[0032], Fig. 2 (below); Thorpe ¶84. The roadway includes raised pavement markings, for example, that “have two highly reflective surfaces” (at least one reflective surface on a road marker). Gallagher, [0005], [0034]; Thorpe ¶84. The apparatus measures the level of reflectivity (a reflective characteristic) of the “road markers.” Gallagher, [0032]-[0033], [0066]-[0068]. Gallagher’s active light sensor can also “be adapted to measure other types of reflective markings on or adjacent [to] the road.” Gallagher, [0033]; Thorpe ¶84.

Gallagher discloses that, as the vehicle—and thus the light source—traverses along a roadway, an operator in the vehicle activates the light source “by sending a signal via the computer 8 to activate the light control relay 10,” which “switches power from the power supply 12 to the light source 4.” Gallagher, [0032], [0046]; Thorpe ¶85. This causes light source 4 to “illuminate[]” a “test area A,” highlighted below, that includes “a reflective surface of a marker 2.” Gallagher, [0035]-[0037], [0043], [0046]; Thorpe ¶85. The apparatus measures the level of reflectivity (a reflective characteristic) of the “road markers.” Gallagher, [0032]-[0033], [0066]-[0068]; Thorpe ¶85.

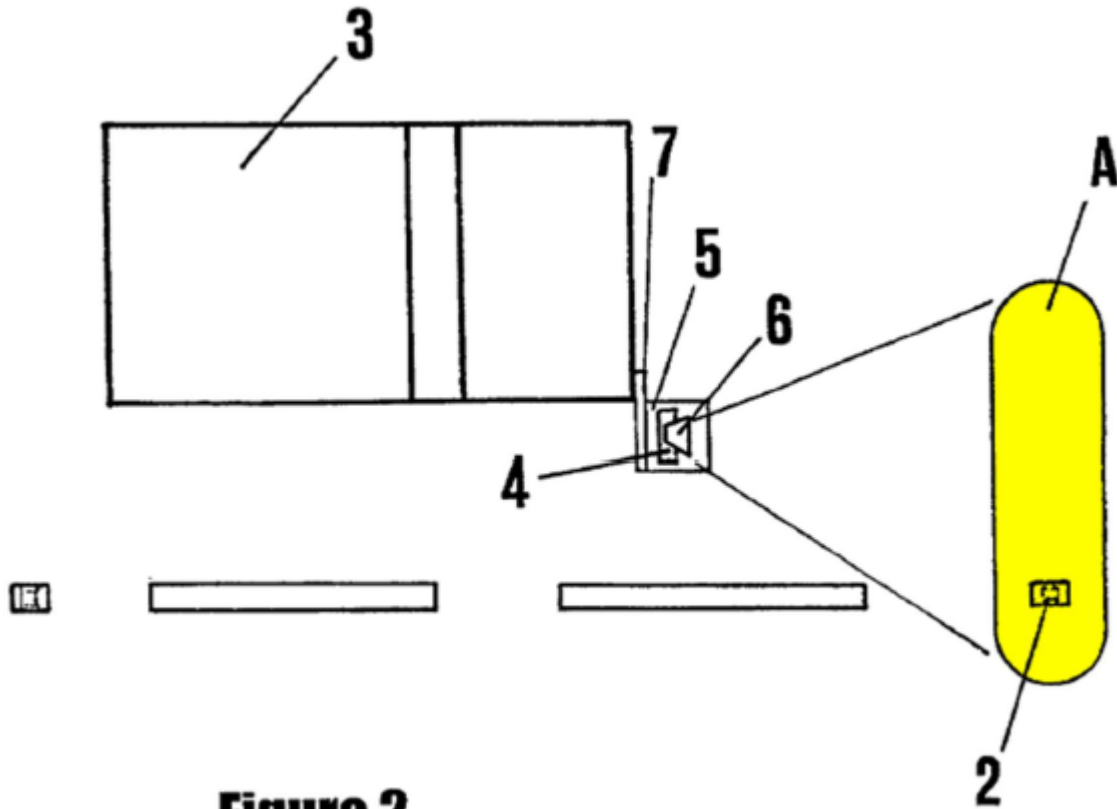


Figure 2

Gallagher, Fig. 2 (annotated).

- c. [12B]: “determining a plurality of light intensity values with at least one intensity sensor directed to cover a field of view which includes at least a portion of the area illuminated by the light source; and”

Gallagher discloses or suggests [12B]. Thorpe ¶¶86-89.

Gallagher’s apparatus includes or at least suggests “at least one intensity sensor directed to cover a field of view which includes at least a portion of the area illuminated by the light source” because it includes a “light sensor module 6a” (intensity sensor) with an array of “light sensors 6,” one or more of which detects “reflected light” from “a reflective surface of a marker 2.” Gallagher, [0038], [0040]-

[0041], [0046]; Thorpe ¶87. The array of light sensors “cover[s] a wide field of view,” with each light sensor covering “a section of the area A” that is illuminated by light source 4 (a field of view which includes at least a portion of the area illuminated by the light source) and “arranged to detect reflected light from a relatively small viewing angle.” Gallagher, [0009], [0035]-[0037], [0040], [0060]; Thorpe ¶87. The cropped and annotated version of Figure 3, below, depicts an array of light sensors 6 aligned in a light sensor module 6a. Gallagher, [0038], [0040], Fig. 3; Thorpe ¶87.

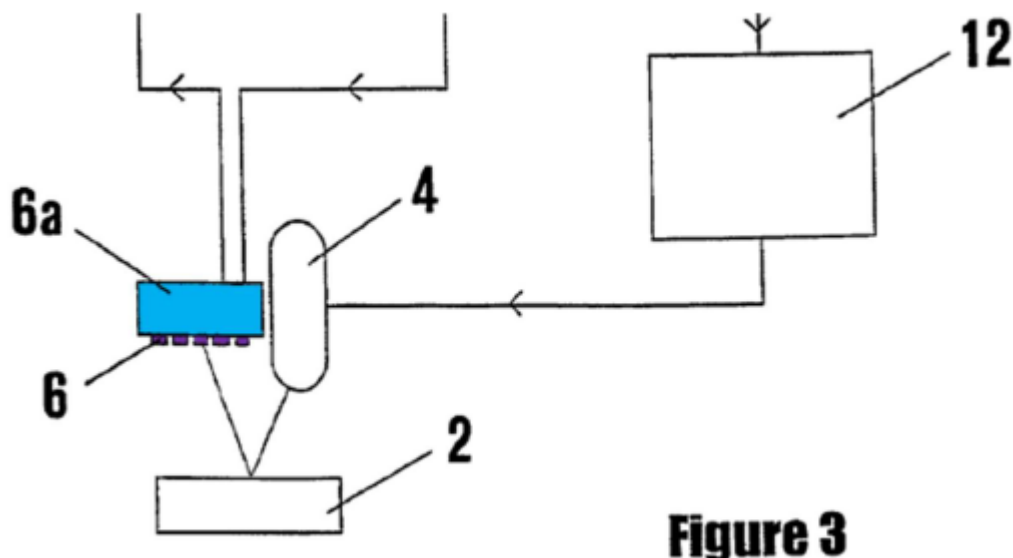


Figure 3

Gallagher, Fig. 3 (cropped, annotated).

A POSITA would have understood that Gallagher’s light sensor module 6a determines a plurality of light intensity values within the area A (its field of view) via its light sensors 6. Thorpe ¶88. For example, Gallagher discloses that its computer selects, from the data “on the reflected light detected by the light sensors

6,” “which reflectance levels indicate a road marker” and then “determin[es] the reflectance level of the road marker in a value of millicandela per Lux (CIL).” Gallagher, [0055]-[0056], [0066]-[0067]. CIL, also known as the “coefficient of luminous intensity,” was a well-known way to express “the ratio of luminous intensity of [the] reflector in the direction of the observation to the illumination at the retroreflector on a plane perpendicular to the light.” Ex. 1012, 4; Thorpe ¶89. A POSITA would have understood that data output by each of the light sensors 6 is indicative of the measured luminous intensity values (a plurality of light intensity values) within the area A. Thorpe ¶89; *see* Ex. 1013, 1:18-19 (“A light sensor generates an output signal indicating the intensity of light incident upon the light sensor.”).

- d. **[12C]: “using a computer processing system configured to: [12D] identify a portion of at least one light intensity value of the plurality of light intensity values associated with one of the at least one reflective surface of the road marker; and [12E] analyze the portion of the at least one light intensity value of the plurality of light intensity values to determine an assessment for the reflective characteristic of the road marker.”**

Gallagher discloses or suggests [12C] and its sub-elements [12D] and [12E]. Thorpe ¶¶90-93.

Gallagher’s apparatus includes “a computer 8” (computer processing system) configured to perform various tasks. Gallagher, [0045], [0047], [0049]-[0070];

Thorpe ¶91. As discussed below, Gallagher's computer processing system is configured to perform each of the corresponding elements for [12D], the "identify" function, and [12E], the "analyze" function. Thorpe ¶91.

For [12D], Gallagher's computer processing system is configured to "identify a portion of at least one light intensity value of the plurality of light intensity values associated with one of the at least one reflective surface of the road marker" because it discloses that computer 8 obtains "the data ... on the reflected light detected by the light sensors 6" (light intensity values of the plurality of light intensity values), "determin[es] the background reflectance level on the road and establish[es] non-marker reflectance levels," and "select[s], from data obtained ..., which reflectance levels indicate" a reflective surface of a road marker (e.g., painted lines and/or raised pavement marker) (identifying a portion of the light intensity values associated with one of the at least one reflective surface of the road marker). Gallagher, [0033], [0055]-[0056], [0065]-[0066]; Thorpe ¶92. Gallagher discloses that "the peak responses sensed are determined as the highly reflective surfaces of a road marker." Gallagher, [0066]. Accordingly, Gallagher uses the light intensity values from the light sensors to identify a reflective surface of a road marker by distinguishing their reflectance levels from the "non-marker reflectance levels." Gallagher, [0033], [0065]-[0066]; Thorpe ¶92. If the light intensity values do not indicate a reflective

surface where one should be, Gallagher's apparatus notes "the location of [the] missing road marker[]." Gallagher, [0023].

For [12E], Gallagher's computer processing system is configured to "analyze the portion of the at least one light intensity value of the plurality of light intensity values to determine an assessment for the reflective characteristic of the road marker" because, after the computer 8 selects which portion of the light intensity values "indicate[s] a road marker," the computer 8 "determin[es] the reflectance level of the road marker in a value of millicandela per Lux (CIL)" and determines whether the determined reflectance level is "less than the predetermined minimum acceptable reflectance level" (an assessment for the reflective characteristic of the road marker). Gallagher, [0066]-[0068]; Thorpe ¶¶93. If so, Gallagher's computer 8 tags the road marker so that "it can later be identified and replaced as required." Gallagher, [0068].

2. Claim 13: "The automated method of claim 12, wherein activating a light source comprises synchronizing activation of a plurality of light sources to optimize light intensity reflected from the road marker."

Gallagher discloses or suggests the additional limitations of claim 13. Thorpe ¶¶94-96.

Gallagher discloses that "dual sets of light sources and light sensors can be mounted in opposite directions in one unit 5," which "is generally the side adjacent [to] the cent[er]line where bi[-]directional markers are operating." Gallagher,

[0074]. By activating both light sources mounted in opposite directions, Gallagher discloses that “both faces of a marker 2 can be tested in one pass by the apparatus 1.” *Id.*; Thorpe ¶95. Gallagher’s computer performs “an additional processing step ... to match the reflectance levels measured from the bi[-]directional faces of a road marker to be analy[z]ed, stored[,] and displayed.” Gallagher, [0054]-[0055], [0074].

A POSITA would have understood that Gallagher’s embodiment where two light sources are mounted in opposite directions to measure reflectance levels of the same road marker discloses that “activating a light source comprises synchronizing activation of a plurality of light sources to optimize light intensity reflected from the road marker.” Thorpe ¶96. For example, Gallagher discloses that an operator “initiates the measurement process by sending a signal via the computer 8 to activate the light control relay 10,” which “switches power from the power supply 12 to the light source 4.” Gallagher, [0046]; Thorpe ¶96. “The light source 4 subsequently illuminates a reflective surface of a marker 2” Gallagher, [0046]; Thorpe ¶96. In the two-light-source embodiment, a POSITA would have understood that initiating the measurement process would synchronize the activation of both light sources. Thorpe ¶96. This optimizes light intensity reflected from the road marker because Gallagher discloses that each individual light source is a “standard vehicle headlight” selected “to achieve a real life response from the markers 2,” thereby

providing a realistic representation of the light intensity that drivers perceive when driving along the roadway. Gallagher, [0035]; Thorpe ¶96.

3. Claim 14: “The automated method of claim 12, wherein activating a light source comprises activating a single light source.”

Gallagher discloses or suggests the additional limitations of claim 14 because Gallagher’s “activating a light source,” *supra* Section V.A.1.b ([12A]), comprises activating a single “light source 4 in the form of a standard vehicle headlight.” Gallagher, [0035]; Thorpe ¶97.

4. Independent Claim 17

a. [17P]: “An automated system for assessing reflective surfaces disposed along a roadway comprising:”

If limiting, Gallagher discloses or suggests [17P] for the reasons discussed in connection with [12P]. *Supra* Section V.A.1.a; Thorpe ¶98.

b. [17A]: “a light source that is traversed along a roadway to illuminate an area that includes at least one reflective surface on a road marker, the road marker having a reflective characteristic;

Gallagher discloses or suggests [17A] for the reasons discussed in connection with [12A]. *Supra* Section V.A.1.b; Thorpe ¶99.

- c. **[17B]: “means for determining a plurality of light intensity values directed to cover a field of view which includes at least a portion of the area illuminated by the light source; and**

As discussed in Section III.D.1, [17B] is a means-plus-function term that should be construed as follows:

- Function: “determining a plurality of light intensity values directed to cover a field of view which includes at least a portion of the area illuminated by the light source”;
- Structure: a light sensor, or equivalents. Thorpe ¶¶53-54, 100.

For the reasons discussed in connection with [12B], Gallagher’s light sensor array 6a discloses or suggests the requisite structure for “determining a plurality of light intensity values directed to cover a field of view which includes at least a portion of the area illuminated by the light source.” *Supra* Section V.A.1.c; Thorpe ¶101.

- d. **[17C]: “a computer processing system configured to: [17D] identify a portion of at least one light intensity value of the plurality of light intensity values associated with one of the at least one reflective surface of the road marker; and [17E] analyze the portion of the at least one light intensity value of the plurality of light intensity values to determine an assessment for the reflective characteristic of the road marker.”**

Gallagher discloses or suggests [17C] and its sub-elements [17D] and [17E] for the reasons discussed in connection with [12C] and its sub-elements [12D] and [12E]. *Supra* Section V.A.1.d; Thorpe ¶102.

5. **Claim 21: “The automated system of claim 17, wherein the light source comprises a vehicle headlight lamp.”**

Gallagher discloses or suggests the additional limitations of claim 21 because Gallagher discloses that the light source 4, *supra* Section V.A.4.b ([17A]) (referencing *supra* Section V.A.1.b ([12A])), is “a standard vehicle headlight.” Gallagher, [0035]-[0037]; Thorpe ¶103.

6. **Claim 23: “The automated system of claim 17, wherein the means for determining a plurality of light intensity values comprises a light sensor.”**

Gallagher discloses or suggests “a light sensor” “for determining a plurality of light intensity values” for the reasons discussed in connection with [17B]. *Supra* Section V.A.4.c; Thorpe ¶104.

B. Ground 2: Gallagher and Lumia Render Obvious Claims 13 and 15

- 1. Claim 13: “The automated method of claim 12, wherein activating a light source comprises synchronizing activation of a plurality of light sources to optimize light intensity reflected from the road marker.”**

As discussed for Ground 1, claim 13, Gallagher discloses or suggests the additional limitations of claim 13. *Supra* Section V.A.2; Thorpe ¶105. To the extent Patent Owner argues or the Board finds that “synchronizing activation of a plurality of light sources” requires alternating the activation of a plurality of light sources, Gallagher and Lumia render obvious the additional limitations of claim 13. Thorpe ¶¶105-112.

Gallagher’s light source is “a standard vehicle headlight,” such as a “continuous 12 V, 100 W sealed beam unit.” Gallagher, [0035]. A POSITA would have understood that the light intensity produced by this light source is well suited for measuring reflectance of road markings at night, when ambient light is minimum, but would lack the intensity to run tests during the day with dependable accuracy. Gallagher, [0073] (“test runs can be conducted at night”); Lumia, 16, 22-24; Thorpe ¶106. A POSITA would have found it obvious to modify Gallagher’s design to optimize it for daytime measurements and would have looked to Lumia for implementation details of how to do so.

Lumia, similar to Gallagher, discloses a vehicle that measures “traffic sign retroreflectance,” but Lumia’s vehicle can do so “during daylight hours.” Lumia, 15; Thorpe ¶107. Lumia does so by activating “a xenon flash as a source of light,” which provides “a short burst of light sufficiently bright enough to overcome the sign luminance due to ambient daylight illumination.” Lumia, 15; Thorpe ¶107. Lumia discloses that such a high-intensity light source is necessary for daytime measurements because “the light source must provide an adequate amount of additional exposure above the ambient signal so that the retroreflection due to the illumination system may be appropriately detected and isolated.” Lumia, 23; Thorpe ¶107.

A POSITA would have been motivated to implement multiple xenon flashes as a source of light and synchronize their activation to optimize the reflected light intensity for daytime hours based on the teachings of Gallagher and Lumia. Thorpe ¶108. A POSITA would have been motivated to implement Lumia’s xenon flash as the light source because Lumia discloses that it provides sufficient light intensity to overcome “ambient daylight illumination.” Lumia, 15; Thorpe ¶108. Measuring retroreflectivity during the day would have been advantageous to allow greater flexibility in testing schedules and the replacement of any markers determined to be faulty as quickly as possible to improve the safety of the roadway. Gallagher, [0003]

(disclosing “being restricted to night-time testing” as a disadvantage), [0073] (disclosing testing at night and replacing “during the day”); Thorpe ¶108.

A POSITA would have been motivated to implement a plurality of Lumia’s xenon flashes and synchronize their activation to provide sufficient samples for Gallagher’s computer to accurately calculate reflectance levels. Gallagher, [0019], [0047], [0056]-[0057]; Thorpe ¶109. Gallagher discloses preferably “filtering the data” collected by the light sensors “by calculating an average reflectance level from a set of sampled data” “to smooth out fluctuations caused by mechanical vibrations, road imperfections, electrical interference[,] and noise and the like.” Gallagher, [0019], [0056]-[0057]; Thorpe ¶109. To accomplish this, Gallagher discloses “sampling road marking reflectance level data at frequent intervals.” Gallagher, [0047]; Thorpe ¶109.

To ensure multiple samples at a sufficient frequency for Gallagher’s “average reflectance level from a set of sampled data,” a POSITA would have been motivated to provide multiple xenon flashes and synchronize their activation because Lumia estimates that the flash duration for each flash should be, for example, 0.1 msec, and xenon flashes were known to have a recharge time in between flashes. Lumia, 23-24; Thorpe ¶110. A POSITA would have recognized that providing multiple xenon flashes would allow synchronizing their activation to increase the number of measurement samples and would have been motivated to do so because Gallagher

discloses that increasing the number of samples desirably helps “smooth out fluctuations.” Gallagher, [0019], [0057]; Thorpe ¶110.

A POSITA would have reasonably expected success in such a design, as synchronizing the activation of multiple light sources to detect reflected light from a retroreflector was a well-known concept. International Patent Application Publication No. WO 96/17258 (“Popovich”; Ex. 1010), 12-13 (disclosing the sequential” activation of multiple “light emitting elements” “one after another” to illuminate retroreflective objects); Thorpe ¶111. Moreover, Gallagher discloses that “a wide variety of light sources can be suitable” for its testing, leading a POSITA to believe that Lumia’s xenon flash would work as a light source. Gallagher, [0037]; Thorpe ¶111. Gallagher also discloses that, even with “three sets of light sources and sensors,” its “computer 8 is capable of simultaneously processing data obtained by the light sensors,” leading a POSITA to believe that Gallagher’s computer could support the synchronization of multiple light sources. Gallagher, [0075]; Thorpe ¶111.

Accordingly, combining Gallagher and Lumia to activate the synchronizing of multiple xenon light flashes to optimize the reflected light intensities for daytime measurements would have required a POSITA to apply only conventional techniques for timing the activation of each light source and the sampling of data to measure the reflected light after each activation, which was well known at the time.

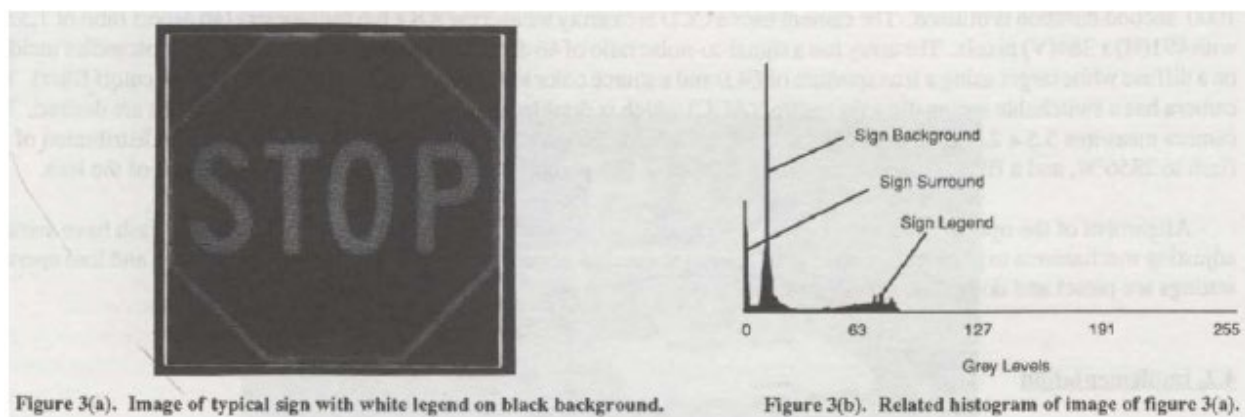
Lumia, 15 (disclosing using “an electronic flash source to provide a short burst of light” and “a video camera to record the sign,” whose signal “is then converted to a digitally sampled representation of the sign”); Thorpe ¶112. And a POSITA would have understood that positioning each xenon flash to maintain essentially the same distance between the light source and Gallagher’s light sensor array 6a would allow each measurement to maintain essentially the same observation angle, further providing a POSITA with the reasonable expectation that such a design could successfully provide Gallagher’s computer with a useful “set of sampled data” for averaging the reflectance levels. Gallagher, [0019], [0056]-[0057]; Thorpe ¶112.

2. Claim 15: “The automated method of claim 12, further comprising determining a luminance value utilizing the plurality of light intensity values and a characterization profile of the at least one light intensity sensor.”

Gallagher and Lumia render obvious the additional limitations of claim 15. Thorpe ¶¶113-117.

Lumia discloses “determining a luminance value utilizing the plurality of light intensity values and a characterization profile of the at least one light intensity sensor” because it discloses that using “a video camera” as a light sensor “effectively divides the [field of view (FOV)] defined by the system magnification into smaller FOVs, thereby creating individual luminance meters at each sensing element site.” Lumia, 16; Thorpe ¶114. When the system is “properly calibrated,” the average intensity value of each area in the FOV of similar intensity “corresponds to the

average luminance.” Lumia, 16; Thorpe ¶114. For example, Lumia discloses producing a histogram of “the retroreflected intensity distribution” in gray levels (below right) of “an actual sign” extracted using software (below left). Lumia, 15-17; Thorpe ¶114. This histogram can be used to identify and average legend and background values, which “correspond[] to the average luminance” of the legend and background, respectively. Lumia, 15-17; Thorpe ¶114.



Lumia, Figs. 3(a)-3(b).

Because Lumia discloses that an intensity value determined from the image captured by the video camera corresponds to a luminance value when properly calibrated, a POSITA would have understood Lumia’s calibration to disclose a characterization profile that relates the light intensity values of the video camera (light intensity sensor) to corresponding luminance values. Thorpe ¶115. Because retroreflectance can be calculated by dividing “the luminance of the reflected light” by “the normal illumination incident on the retroreflector,” determining the

luminance and knowing the illumination allows the retroreflectance to “be readily obtained.” Lumia, 15-16; Thorpe ¶115.

A POSITA would have found it obvious to implement Lumia’s determining a luminance value utilizing the plurality of light intensity values and a characterization profile of the at least one light intensity sensor to allow Gallagher’s apparatus to calculate the retroreflectivity of road markers. Thorpe ¶116. A POSITA would have been motivated to do so because, as was well known at the time, several road authorities specified minimum retroreflectivity values for road markings along a roadway. *E.g.*, Ex. 1019, 6, 8-11; Thorpe ¶116. Because Gallagher recognizes that “road[] authorities worldwide invariably advocate different standards for road markings” and expressed a desire to analyze the data “in a way and to an extent that meets the criteria of each country,” a POSITA would have been motivated to implement Lumia’s determining a luminance value to allow its apparatus to identify and tag any markers “that do not meet the predetermined minimum acceptable reflectance level” for countries that require a minimum retroreflectivity level for road markers. Gallagher, [0049], [0077]; Thorpe ¶116.

A POSITA would have had a reasonable expectation of success because both Gallagher and Lumia relate to apparatuses that measure reflective characteristics of retroreflective surfaces from a moving vehicle using a light intensity sensor, giving a POSITA the expectation that Lumia’s determining a luminance value could be

readily implemented in Gallagher's apparatus. Gallagher, [0031]-[0039]; Lumia, 15-171; Thorpe ¶117. Additionally, Gallagher discloses that "[a] variety of light sensors are envisaged as being suitable in the apparatus 1," further giving a POSITA the expectation that a light sensor could be selected and calibrated to associate the light intensity value to a corresponding luminance value. Gallagher, [0037], [0039]; Thorpe ¶117. Indeed, similar to Lumia's "properly calibrated" light sensor array, Gallagher discloses determining "calibration factors for each individual sensor in the array" based on "static tests in a laboratory," meaning a POSITA would have had to apply only conventional techniques to similarly provide Gallagher's light sensor array with a characterization profile based on calibration factors that relate each measured light intensity value to a luminance value. Lumia, 16; Gallagher, [0058]-[0059]; Thorpe ¶117.

C. Ground 3: Gallagher and Schofield Render Obvious Claims 18-19

- 1. Claim 18: "The automated system of claim 17, wherein the computer processing system further comprises a color identification subsystem, the color identification subsystem configured to associate at least one color with the reflective characteristic of the road marker."**

Gallagher and Schofield render obvious the additional limitations of claim 18. Thorpe ¶¶118-123.

Gallagher discloses one embodiment where the light sensors in the light sensor module are "photodiodes mounted precisely ... at a height and angle to

properly detect reflected light.” Gallagher, [0039]. But Gallagher also discloses that “[a] variety of light sensors” are “suitable” in its apparatus. *Id.* In particular, when “sensing [colored] markers, light sensors with different spectral responses or similar light sensors with different filters can be used” such that “[t]he data signals detected by the sensors ... indicate the [color] of a road marking being tested.” *Id.*; Thorpe ¶119. When using Gallagher’s reflectivity measuring apparatus “to test different [colored] road markings simultaneously,” a POSITA would have found it obvious to implement Schofield’s use of color to associate at least one color (e.g., yellow, red, and/or white) with the reflective characteristic of the road marker (e.g., its reflectance levels) to confirm the assessment as to whether the road marker’s reflective characteristic meets the predetermined minimum reflectance levels. Gallagher, [0039]; Thorpe ¶119.

Schofield discloses using color to assist in identifying objects of interest because it discloses identifying the “spectral signature” of a light source—its color—to “warn the driver that a light has changed from green to yellow to red,” to identify “red octagons ... as stop signs,” or to identify “yellow triangles as caution signs,” for example. Schofield, 11:60-64, 12:1-4; Thorpe ¶120. Schofield also teaches that “[l]ane markers ... may be readily identified by spectral signature.” Schofield, 10:43-45.

A POSITA would have been motivated to implement Schofield's use of color to confirm the color of the measured road marker because Gallagher suggests such a combination, as Gallagher discloses using its reflectivity measuring apparatus to sense "[colored] markers" and "to test different [colored] road markings simultaneously." Gallagher, [0039]; Thorpe ¶121. This would have suggested to a POSITA to use Schofield's identification of objects of interest using spectral signature to assist in assessing the type of road marker with which an identified reflective surface is associated. Thorpe ¶121.

Road markers were well known to be a variety of colors, including yellow, white, and red, each of which indicates different information to the driver. American Society for Testing and Materials D4383–96, Standard Specification for Plowable, Raised Retroreflective Pavement Markers (July 1996) ("ASTM"; Ex. 1008), 451-453 (disclosing white, yellow, red, blue, and green raised retroreflective pavement markers); Raised Pavement Marker Reflectivity, Report No. TX-90/1151-1F (Nov. 1990) ("Pezoldt"; Ex. 1016), 29-30, 55 (disclosing "retroreflective raised pavement marker products" "in a variety of reflective colors and color combinations," including yellow, white, and red); Thorpe ¶122. As was known, each color of road marker required a different reflectance level. Pezoldt, 29-30; Thorpe ¶122. A POSITA would have been motivated to associate at least yellow, white, or red with the reflective characteristic (e.g., its reflectance level) of the road marker to confirm

the assessment of whether the reflective characteristic satisfied the “minimum acceptable reflectance level” for the particular color of road marker. Gallagher, [0068]; Thorpe ¶122.

A POSITA would have had a reasonable expectation of success because Schofield teaches different techniques for associating yellow, white, and red with other characteristics of a particular object of interest (e.g., associating pairs of white light sources with oncoming headlights, yellow triangles with caution signs, and red octagons with stop signs) that a POSITA would have reasonably expected to work with Gallagher’s array of “light sensors with different spectral responses or similar light sensors with different filters.” Schofield, 10:35-50, 11:1-6, 12:1-8; Gallagher, [0039]; Thorpe ¶123. Schofield also discloses that “reflectivity” and “spectral characteristics” may be used together to identify objects of interest. Schofield, 11:1-3; Thorpe ¶123. Accordingly, combining Gallagher and Schofield to associate yellow, white, or red with a reflective characteristic of the road marker to confirm the assessment of whether the reflective characteristic satisfied the minimum acceptable reflectance level for the particular color of road marker would have required a POSITA to apply only conventional techniques of associating a color with reflectivity to yield the predictable result of confirming the assessment of the reflective surface. Thorpe ¶123.

2. Claim 19: “The automated system of claim 18, wherein the at least one color is selected from a set of colors consisting of yellow, green, red and white.”

As discussed in connection with claim 18, Gallagher and Schofield render obvious associating at least yellow, red, and white with the reflective characteristic of the road marker, so Gallagher and Schofield render obvious the additional limitations of claim 19. *Supra* Section V.C.1; Thorpe ¶124.

D. Ground 4: Gallagher and Frank Render Obvious Claim 20

1. Claim 20: “The automated system of claim 17, wherein the light source comprises a laser scanning device.”

Gallagher and Frank render obvious the additional limitation of claim 20. Thorpe ¶¶125-129.

Frank, similar to Gallagher, discloses an apparatus that “may be mounted in any location on the vehicle where the apparatus can be provided with a view of at least one retroreflector ahead of the vehicle” and identifies the retroreflectors along a roadway. Frank, 4:10-51, 6:4-11; Thorpe ¶126. Frank discloses a light source that comprises a laser scanning device because its apparatus is a “laser radar apparatus” that includes a laser diode 332, whose light beam 336 passes through a lens “to produce [a] fan beam 339” that is “reflected from mirror surface 330 and is directed towards roadway 102.” Frank, 1:13-29, 4:52-5:9; Thorpe ¶126. The mirror surface 330 “is controlled by servo motor 333” that “oscillates through a particular range of

motion at a particular frequency to produce a regular scanning motion of fan beam 339” over “a particular area.” Frank, 4:52-5:17; Thorpe ¶126.

Frank’s apparatus also includes an optical receiver that receives the reflected light back from the retroreflectors. Frank, 7:27-31, 10:61-67; Thorpe ¶127. A distance from the light source to the retroreflector can be determined “by measuring a phase difference between transmitted and received carrier waves modulated on the light beam” or by measuring “[t]he time delay between the transmitted and received pulses.” Frank, 7:34-42, 10:61-67; Thorpe ¶127. An angle of the reflected light relative to the vehicle’s heading “can be determined from the position on the array in which the signal is received.” Frank, 7:47-50, 10:67-11:4; Thorpe ¶127. Frank’s optical receiver is a “photodiode array” or any “other type of photosensitive array.” Frank, 10:67-11:4, 13:64-14:15; Thorpe ¶127.

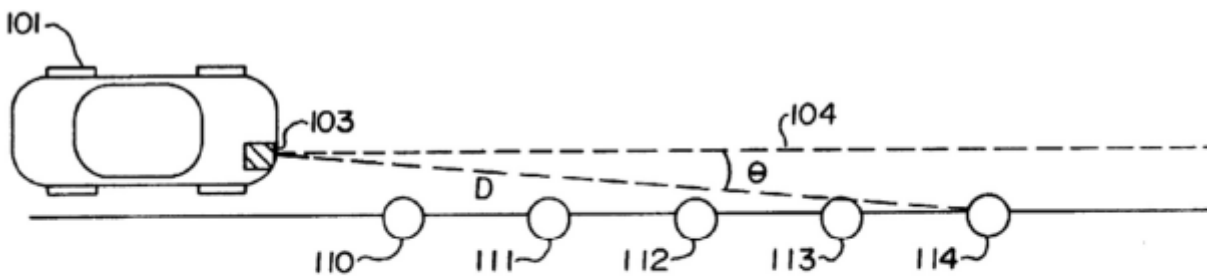


FIG. 2

Frank, Fig. 2.

A POSITA would have found it obvious to implement Frank's laser scanning device as Gallagher's light source 4 to improve the accuracy of Gallagher's reflectivity measurements by obtaining improved estimates of the distance and angle to the retroreflector. Thorpe ¶128. A POSITA would have been motivated to do so because providing Gallagher's apparatus with a light source like Frank's laser scanning device would have allowed Gallagher's computer to determine the precise distance from the light source to each road marker, which would have improved Gallagher's determination of "the reflectance level of the road marker in a value of millicandela per Lux" by allowing Gallagher's computer processing system to factor in a precise distance to the road marker for each measurement in its determination. Gallagher, [0067]-[0068]; Thorpe ¶128.

A POSITA would have reasonably expected success in such a combination because Gallagher discloses that "a wide variety of light sources can be suitable" for its testing, leading a POSITA to expect success implementing Frank's light source. Gallagher, [0037]; Thorpe ¶129. Additionally, Frank discloses that its determination can be carried out using a "photodiode array," like the one disclosed in Gallagher, or any "other type of photosensitive array," like Schofield's array. Frank, 10:67-11:4, 13:64-14:15. Accordingly, a POSITA would have only needed to apply conventional data processing techniques to implement Frank's laser scanning device and obtain accurate distance measurements from the light source to each

retroreflector using Gallagher’s light sensor apparatus, for example, by “measuring a phase difference between transmitted and received carrier waves modulated on the light beam.” Frank, 7:27-42; Thorpe ¶129.

E. Ground 5: Gallagher and Currie Render Obvious Claim 22

- 1. Claim 22: “The automated system of claim 21, wherein the vehicle headlight lamp is selected from a group consisting of a light emitting diode, a xenon lamp, a halogen lamp, a fluorescent lamp, and an incandescent lamp.”**

Gallagher and Currie render obvious the additional limitations of claim 22. Thorpe ¶¶130-133.

As discussed in connection with claim 21, Gallagher discloses that the light source 4 is “a standard vehicle headlight.” Gallagher, [0035]-[0037]; *supra* Section V.A.5; Thorpe ¶131.

A POSITA would have found it obvious to use an incandescent lamp for the “standard vehicle headlight.” Gallagher, [0035]; Thorpe ¶132. Gallagher does not provide any examples of a standard vehicle headlight, but a POSITA would have known that incandescent lamps were ubiquitous as vehicle headlights at the time. Ex. 1020, 7:14-18 (disclosing “a tungsten incandescent lamp” as an example of “an automotive headlamp”); Gallagher, [0035]; Thorpe ¶132. A POSITA would have been motivated to use an incandescent lamp for the standard vehicle headlight because Currie discloses that, compared to other light sources, an incandescent light source provides “enhanced reflection intensity” from the same type of road markers

that Gallagher desires to measure, suggesting to a POSITA that an incandescent lamp would have been a suitable type of vehicle headlight for use in Gallagher's apparatus. Currie, 4:31-42; Thorpe ¶132.

A POSITA would have had a reasonable expectation of success because Currie discloses that incandescent light sources are suitable light sources for illuminating retroreflectors along a roadway, leading a POSITA to expect success in implementing Gallagher's standard vehicle headlight as an incandescent lamp. Currie, 4:31-42; Thorpe ¶133. Moreover, incandescent lamps were well-known types of standard vehicle headlights, and Gallagher discloses that standard vehicle headlights, as well as "a wide variety of light sources," are suitable for use in its apparatus. Gallagher, [0035]-[0037]; Thorpe ¶133.

VI. DISCRETIONARY DENIAL IS NOT WARRANTED

A. Discretionary Denial Is Inappropriate Under 35 U.S.C. § 314(a) and *Fintiv*

At this time, no factors articulated in *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 at 5-6 (PTAB Mar. 20, 2020), weigh in favor of noninstitution under 35 U.S.C. § 314(a).

Factor one favors institution. The '255 Patent is being asserted in District Court against Petitioner's customer and a company related to Petitioner's supplier in Case Nos. 2:24-cv-00035 and 2:24-cv-00058, identified in the related matters

above. Those cases have been stayed by the District Court pending the results of IPR2024-01110 (which this IPR copies and moves to join) and IPR2024-01111.

Factor two favors institution. Trial in the District Court cases referenced above is stayed.

Factor three favors institution. The District Court cases referenced above are in their early stages, and have been stayed.

Factor four favors institution. The petition challenges additional claims of the '255 patent beyond those that are being asserted by the Patent Owner in the District Court cases referenced above, and those cases are stayed pending the outcome of IPR2024-01110, which this IPR copies.

Factor five favors institution. The '255 Patent is not being asserted against Petitioner.

Factor six favors institution. Petitioner presents compelling unpatentability challenges that merit institution that have already been instituted in IPR2024-01110.

B. Discretionary Denial Is Inappropriate Under 35 U.S.C. § 325(d)

Where, as here, a petitioner files a “copycat” petition in conjunction with a timely motion for joinder and agrees to assume a “passive understudy role,” the *General Plastic* factors are “effectively neutraliz[ed].” *Apple Inc. v. Uniloc*, 2017 LLC, IPR2018-00580, Paper 13 at 10-11 (Aug. 21, 2018). The current Petition asserts the same grounds and argument as presented in instituted IPR2024-01110,

and is accompanied by a timely motion for joinder, and should not be denied institution under Section 325(d). Further, the following discussion on the inapplicability of discretionary denial is excerpted from IPR2024-01110, which has already been instituted.

Noninstitution under § 325(d) would also be improper based on the factors set forth in *Becton, Dickinson & Co. v. B. Braun Melsungen AG*, IPR2017-01586, Paper 8 at 17-18 (PTAB Dec. 15, 2017). Currie, Frank, and Schofield were never considered during the prosecution of the '255 patent. While Gallagher and Lumia are cited on the face of the '255 patent, they were never applied in any rejection by the Examiner for the '255 patent and were merely two references of well over one hundred cited during prosecution. See Ex. 1001, Item (56) (References Cited); see generally Ex. 1002. Indeed, the Examiner did not apply any art during the prosecution of the '255 patent, and the challenged claims differ from those found in earlier patents in the family.

VII. GROUNDS FOR STANDING

Petitioner certifies that the '255 patent is available for IPR and that Petitioner is not barred or estopped from requesting review.

Pursuant to 37 C.F.R. § 42.103, the undersigned authorizes the charge of any required fees to Deposit Account No. 19-0733.

VIII. CONCLUSION

For the foregoing reasons, claims 12-15 and 17-23 should be canceled.

Dated: April 4, 2025

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CERTIFICATION UNDER 37 CFR § 42.24(d)

Pursuant to 37 C.F.R. § 42.24(a)(1)(i), the undersigned hereby certifies that the foregoing Petition for Inter Partes Review contains 10,145 words, excluding the parts of this Petition that are exempted under 37 C.F.R. § 42.24(a), as measured by the word-processing system used to prepare this paper.

Dated: April 4, 2025

By: /John R. Hutchins/

John R. Hutchins
Reg. No. 43,686

CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. § 42.105, I hereby certify that I caused a true and correct copy of this Petition for *Inter Partes* Review in connection with U.S. Patent No. 9,335,255 and supporting evidence to be served via FedEx Priority Overnight on April 4, 2025, on the following:

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