

Patent Owner's Demonstratives for Oral Hearing

Mobileye v. Facet, IPR2024-01111

U.S. Patent No. 9,671,328

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US009671328B2

(12) **United States Patent**
Retterath et al.

(10) **Patent No.:** US 9,671,328 B2
(45) **Date of Patent:** Jun. 6, 2017

(54) **SYSTEM AND ASSESSMENT OF
REFLECTIVE OBJECTS ALONG A
ROADWAY**

(71) Applicant: **Facet Technology Corp.**, Eden Prairie,
MN (US)

(72) Inventors: **James E. Retterath**, Excelsior, MN
(US); **Robert A. Laumeier**, Eden
Prairie, MN (US)

(73) Assignee: **Facet Technology Corp.**, Eden Prairie,
MN (US)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/148,722**

(22) Filed: **May 6, 2016**

(65) **Prior Publication Data**
US 2016/0377529 A1 Dec. 29, 2016

Related U.S. Application Data
(60) Continuation of application No. 14/512,735, filed on
Oct. 13, 2014, now Pat. No. 9,334,255, which is a
(Continued)

(51) **Int. Cl.**
G01N 21/00 (2006.01)
G01N 21/25 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **G01N 21/251** (2013.01); **G01N 21/55**
(2013.01); **G01N 21/84** (2013.01); **G01S 17/06**
(2013.01);
(Continued)

(58) **Field of Classification Search**
CPC G02B 27/0172; G02B 2027/0178; G02B
2027/014; G02B 2027/0138;
(Continued)

(56) **References Cited**
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Sign Detection and Recognition, Jung Hak and Tae Young Choi,
IEICE Transaction Fundamentals, vol. E81-A, No. 6, pp. 1128-
1135, Jun. 1998.

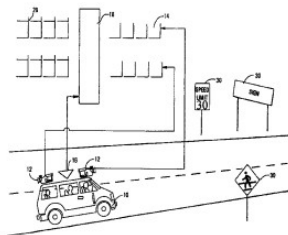
(Continued)

Primary Examiner—Michael P Stafira
(74) **Attorney, Agent, or Firm**—Patterson Thuenle
Pedersen, P.A.

(57) **ABSTRACT**

A system for classifying different types of sheeting materials
of road signs depicted in a videostream compares estimated
retroreflectivity values against known minimum retroreflectivity
values for each of a plurality of colors. Once a road
sign has been identified in the videostream, the frames
associated with that road sign are analyzed to determine
each of a plurality of colors present on the road sign. An
estimated retroreflectivity for each of the plurality of colors
present on the road sign is then determined. By comparing
the estimated retroreflectivity for each of the plurality of
colors against known minimum retroreflectivity values for
the corresponding color for different types of sheeting
materials, an accurate determination of the classification of
the sheeting material of the road sign is established. Prefer-
ably, certain conditions of gross failure of the sheeting
material are filtered out before classification of the sheeting
material is determined.

22 Claims, 18 Drawing Sheets



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MOBILEYE EXHIBIT 1001

ing type of each sign. Measurements of retroreflectivity and identification of sheeting type are helpful in evaluating the visibility of a sign and whether it has deteriorated due to a breakdown in the pigments or reflective material in the sheeting material of the sign. The retroreflectivity and sheeting type can also be used to produce a predictive model of how the sign will perform into the future based on the as-measured characteristics.

Generally, highway and street maintenance departments do not systematically evaluate the deterioration of the reflective materials used on road signs and markers. If inspections of road signs or markers are performed, they are typically accomplished by having inspectors manually position a handheld retroreflectometer directly on the surface of a sign in order to determine a retroreflectivity value for that sign. When there are a large number of road signs or markers (sometimes referred to as traffic control devices or TCDs) in a given jurisdiction, the task of manually inspecting all of these road signs and markers can be time consuming and expensive.

'328 Patent, 2:8-27 (cited by POR at 4)

U.S. Patent No. 9,671,328



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2027/014; G02B 2027/0138;
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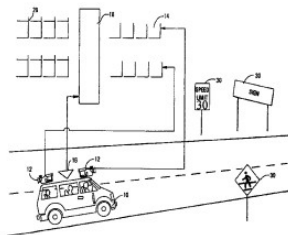
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A system for classifying different types of sheeting materials
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22 Claims, 18 Drawing Sheets



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MOBILEYE EXHIBIT 1001

In a preferred embodiment, a system for the automated determination of retroreflectivity values for reflective surfaces disposed along a roadway is utilized to establish the retroreflectivity values for both foreground and background colors of a road sign for the purpose of classifying the sheeting material of that sign. An area along the roadway that includes at least one reflective surface is repeatedly illuminated by a light source and multiple light intensity values are measured over a field of view which includes at least a portion of the area illuminated by the light source. A computer processing system is used to identify a portion of the light intensity values associated with a reflective surface and analyze the portion of the light intensity values to determine at least one retroreflectivity value for that reflective surface. Color images of the area and locational information are also generated by the system and are used together with a characterization profile of the light source to enhance the accuracy of the determination of retroreflectivity values.

'328 Patent, 3:66-4:17 (cited by POR at 4)

GROUND 1:

Gallagher & Schofield

vs. claims 1, 2-4, 8-13

Claim Construction of the “detect” and “determine” steps of ‘328, claims 1 and 9

- Petitioner Admits that “detect” and “determine” cannot be simultaneously satisfied by the same step in prior art:

2. Patent Owner’s argument about the prior art simultaneously performing both steps

Separate from Patent Owner’s argument about the claims requiring a sequence, Patent Owner also argues that “the ‘detect’ and ‘determine’ steps cannot be simultaneously satisfied by the same act being performed on the same particular object of interest.” POR 14, 16, 23. Neither Petitioner nor the Board have ever contended that both steps can be satisfied with a single step.¹ Indeed, the Board

Reply at 9 (cited by Surreply at 12)

Gallagher (Ex. 1005)

This invention relates to reflectivity measuring apparatus. This invention provides reflectivity measuring apparatus for assessing the integrity of road markings including a light

US 20020063638A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2002/0063638 A1
(43) Pub. Date: May 30, 2002

(54) REFLECTIVITY MEASURING APPARATUS AND METHOD

(76) Inventor: PHILIP ANTHONY GALLAGHER, HAMILTON (NZ)

Correspondence Address:
MARK D SIMPSON
SYNNESTVEDT & LECHNER
1101 MARKET STREET
2600 ARAMARK TOWER
PHILADELPHIA, PA 191072950

(*) Notice: This is a publication of a continued prosecution application (CPA) filed under 37 CFR 1.536(d).

(21) Appl. No.: 09/380,680
(22) PCT Filed: Mar. 5, 1998
(86) PCT No.: PCT/NZ98/00028
(30) Foreign Application Priority Data
Mar. 5, 1997 (NZ) 314352

Publication Classification
(51) Int. Cl. 7 B60Q 1/00
(52) U.S. Cl. 340/905; 340/901

(57) ABSTRACT

This invention relates to reflectivity measuring apparatus. This invention provides reflectivity measuring apparatus for assessing the integrity of road markings including a light source, a light sensor and a processing means, the apparatus being mounted on a vehicle such that, in use, the light source illuminates a reflective surface on a road marking, and wherein the light sensor detects any reflected light and the data signal is received by the processing means, the processing means processes the data to provide information on the reflectivity of a said reflective surface. In another aspect of the invention there is provided a computer controlled process for determining the integrity of light reflective road markings, the computer being programmed to carry out the steps of getting data on the reflectance levels of road markings, calibrating the data by multiplying the data with a predetermined calibration factor, and determining whether the road marking

Page 1 of 10 MOBILEYE EXHIBIT 1005

[0035] The apparatus requires a light source 4 in the form of a standard vehicle headlight such as to achieve a real life response from the markers 2. A continuous 12 V, 100 W sealed beam unit is suitable and is powered by a stable power supply 12. The light source 4 is of relatively constant and even intensity when a wide beam is projected about 2.3 meters from a platform or unit 5 located at the front of the vehicle 3 to cover a 3 metre by 0.5 metre area. Area A defines the test area for the apparatus 1.

[0039] The sensors are photodiodes mounted precisely on the module 6a at a height and angle to properly detect reflected light. A variety of light sensors are envisaged as being suitable in the apparatus 1. In the case of sensing coloured markers, light sensors with different spectral responses or similar light sensors with different filters can be used. The data signals detected by the sensors will indicate the colour of a road marking being tested. This feature is useful in situations where the apparatus 1 is being used to test different coloured road markings simultaneously.

Ex. 1005, Abstract, [0035], [0039] (cited by POR at 5)

Gallagher – Does Not “detect” and “determine” (cls. 1, 9)

Patent Application Publication May 30, 2002 Sheet 3 of 4 US 2002/0063638 A1

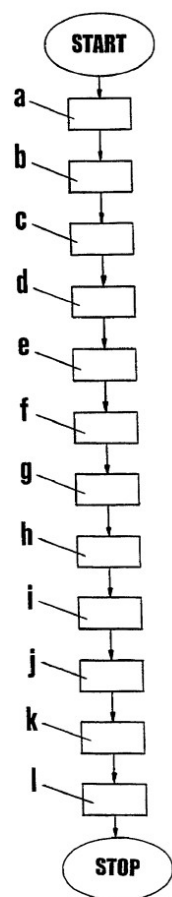


Figure 4

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Steps a-c: no detect or determine

[0056] The first process step a. includes getting the data from the output of the ADC 13 on the reflected light detected by the light sensors 6. As multiple sensors are desirably used, each light sensor 6 requires a separate data channel.

[0057] Process step b. includes filtering the data by calculating the average reflectance level from a set of sampled data from each sensor to smooth out fluctuations caused by mechanical vibrations, road imperfections, electrical interference and noise and the like.

[0058] Process step c. involves calibrating the data by multiplying the data with a predetermined calibration factor to calibrate for different positions in the light sensor module 6a.

Ex. 1005, [0056]-[0058] (cited by POR at 23-24)

Ex. 1005, Fig. 4 (cited by POR at 30; Surreply at 5)

Gallagher – Does Not “detect” and “determine” (cls. 1, 9)

Patent Application Publication May 30, 2002 Sheet 3 of 4 US 2002/0063638 A1

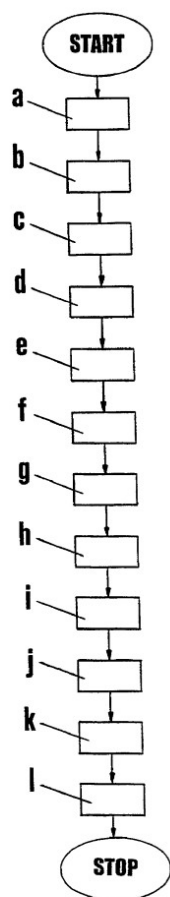


Figure 4

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Step d: no detection of objects, or determinations—just outputting data

[0060] Process step d. involves determining the vehicle position on the road and providing an audio and/or visual indicator means for the operator of the vehicle 3. This enables the operator to maintain the vehicle 3 in a proper position on the road to allow the apparatus 1 to obtain reflectivity measurements. As each of the five light sensors 6 covers a section of the area A and data from each light sensor is received showing the reflectance levels across area A of the road, then given that background reflectance levels on non road marking sections of the road are low and road markers 2 are relatively high, the computer program can detect which light sensor 6 is reading the highest reflectance reading and to provide the operator with that information.

Ex. 1005, [0050] (cited by POR at 25-26)

Ex. 1005, Fig. 4 (cited by POR at 30; Surreply at 5)

Gallagher – Does Not “detect” and “determine” (cls. 1, 9)

Patent Application Publication May 30, 2002 Sheet 3 of 4 US 2002/0063638 A1

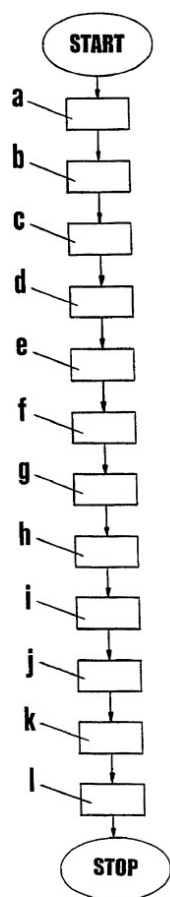


Figure 4

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Step g: one-step determination that reflective surface is present

[0065] Process step f. involves determining the background reflectance level on the road and establishing non-marker reflectance levels.

[0066] Process step g. involves selecting, from data obtained in step a., which reflectance levels indicate a road marker. In the case of road markers the peak responses sensed are determined as the highly reflective surfaces of a road marker.

[0067] Process step h. involves determining the reflectance level of the road marker in a value of millicandela per Lux (CIL) or as a percentage of the predetermined standard reflectance level.

Ex. 1005, [0065]-[0067] (cited by POR at 26-27)

No connection to any data from step d

Ex. 1005, Fig. 4 (cited by POR at 30; Surreply at 5)

Schofield (Ex. 1006)

US005796094A

United States Patent [19]

[11] Patent Number: 5,796,094

Schofield et al.

[45] Date of Patent: Aug. 18, 1998

[54] **VEHICLE HEADLIGHT CONTROL USING IMAGING SENSOR**

[75] Inventors: **Kenneth Schofield**, Holland; **Mark L. Larson**, Grand Haven; **Keith J. Vadas**, Coopersville, all of Mich.

[73] Assignee: **Donnelly Corporation**, Holland, Mich.

[21] Appl. No: 621,863

[22] Filed: Mar. 25, 1996

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 23,918, Feb. 26, 1993, Pat. No. 5,550,677.

[51] Int. Cl.⁶ B60Q 1/02; H05B 37/02

[52] U.S. Cl. 250/208.1; 250/214 AL; 250/226; 362/61; 315/82

[58] Field of Search 250/226, 205, 250/208.1, 208.2, 214 D, 214 AL, 216; 356/218, 221, 222, 225; 315/82, 83; 362/61, 64, 65, 71

[56] **References Cited**

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 Article entitled "On-Chip CMOS Sensors for VLSI Imaging Systems" published by VLSI Vision Limited, 1991, (no month).

Commonly assigned United States patent application Serial No. 08/023,918 filed on Feb. 26, 1993, by Kenneth (NMI) Schofield and Mark L. Larson for an Automatic Rearview Mirror System Using a Photosensor Array.

Commonly assigned United States patent application Serial No. 08/478,093 filed Jan. 7, 1995, by Kenneth (NMI) Schofield and Mark L. Larson for an Automatic Rearview Mirror, Vehicle Lighting Control and Vehicle Interior Mirror System Using Photosensor Array.

Primary Examiner—Edward P. Westin
 Assistant Examiner—John R. Lee
 Attorney, Agent, or Firm—Van Dyke, Gardner, Linn & Burkhardt, LLP

[57] **ABSTRACT**

A vehicle headlamp control method and apparatus includes providing an imaging sensor that senses light in spatially separated regions of a field of view forward of the vehicle. Light levels sensed in individual regions of the field of view are evaluated in order to identify light sources of interest, such as oncoming headlights and leading tailights. The vehicle's headlights are controlled in response to identifying such particular light sources or absence of such light sources. Spectral signatures of light sources may be examined in order to determine if the spectral signature matches that of particular light sources such as the spectral signatures of headlights or tailights. Sensed light levels may also be evaluated for their spectral distribution in order to identify light sources of interest.

53 Claims, 11 Drawing Sheets

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MOBILEYE EXHIBIT 1006

A vehicle headlamp control method and apparatus includes providing an imaging sensor that senses light in spatially separated regions of a field of view forward of the vehicle. Light levels sensed in individual regions of the field of view are evaluated in order to identify light sources of interest, such as oncoming headlights and leading taillights. The vehicle's headlights are controlled in response to identifying such particular light sources or absence of such light sources. Spectral signatures of light sources may be examined in order to determine if the spectral signature matches that of particular light sources such as the spectral signatures of headlights or taillights. Sensed light levels may also be evaluated for their spatial distribution in order to identify light sources of interest.

Ex. 1006, Abstract, (cited by POR at 8)

Petition's Use of Schofield for Claim 9: limitation 9F

- **Claim 9: Schofield not used for “detect” or “determine” limitations** (Pet. at 20-21)

- e. **[9F]: “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.”**

A POSITA would have found it obvious to implement Schofield's determination of a light source's location within a field of view to distinguish between different types of road markers. Schofield, 9:26-32; Thorpe ¶76. Schofield discloses that the sensors in its light-imaging array “divide the scene forward of the vehicle into spatially separated regions, and light sources are identified, at least in part, according to their spatial distribution across the regions.” Schofield, 2:36-41, 9:26-32; Thorpe ¶76.

Pet. at 23 (cited by POR at 28-29)

Schofield's Subdivision of a Scene into "spatially separated regions" is Irrelevant

- Schofield subdivides scene for different detection thresholds

In order to take into account this spatial differentiation, the present invention comprehends detecting light sources at a lower threshold centrally of the scene and at a higher threshold at the periphery of the scene. This may be accom-

Ex. 1006, 9:58-61,
(cited by POR at 28)

- Schofield also subdivides scene to reduce pixel-density

plastic. Electronically, such spatial differentiation may be accomplished by establishing a higher threshold level for pixel intensity detection for pixels located at the periphery of the scene than for pixels located centrally of the scene. This would cause centrally positioned light sources to be detected at a lower intensity level than sources detected at the periphery of the scene. Such spatial differentiation could

Ex. 1006, 10:6-12
(cited by POR at 28)

- Both are irrelevant to determining the location of a detected object

Gallagher Likewise Does Not Teach Limitations 9F or 1H

- **Gallagher's GPS & gearbox sensor only provide the location of the vehicle:**

[0048] Location means for determining the location of the markers 2 is also obtained to allow identification of each marker 2 being tested. A gearbox revolution sensor 14 is used to obtain a measurement of the speed of the vehicle 3 and the distance travelled from a reference point. Alternatively a GPS interface 15 can be used to pinpoint the position of the vehicle and/or markers 2 as measurements are being taken.

Ex. 1005, [0048]
(cited by POR at 29)

- **Petitioner admits that Gallagher's GPS only provides the location of the vehicle's sensor, not the road marker:**

Because the light source is in a fixed location on Gallagher's vehicle, this GPS position of the vehicle corresponds to the location of the active sensor.

Thorpe ¶176. Accordingly, a POSITA would have recognized that additional steps would have been necessary to also determine the location of the markers. *Id.*

Pet. at 70 (cited by POR at 29, 33)

The Petition Improperly Uses Single Step in Gallagher— step (g)—for both “determine” steps of claim 1 ([1F] & [1G])

e. [1F]: “determine whether the object of interest includes a reflective surface based on the light intensity values;”

Thorpe ¶113. Accordingly, 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.” Gallagher, [0033], [0065]-[0066]; Thorpe ¶113. If the light intensity values do not

Pet. at 39-40

f. [1G]: “determine whether the reflective surface is a road marker based on an assessment of the reflective surface; and”

...
Gallagher discloses that, “[i]n the case of road markers[,] the peak responses sensed are determined as the highly reflective surfaces of a road marker.” Gallagher, [0066]. Accordingly, Gallagher discloses determining that a reflective surface is a raised pavement marker (road marker) based on assessing whether the reflectivity of the reflective surface indicates a “peak response[].” *Id.*; Thorpe ¶115.

Pet. at 40-41

[0065] Process step f. involves determining the background reflectance level on the road and establishing non-marker reflectance levels.

[0066] Process step g. involves selecting, from data obtained in step a., which reflectance levels indicate a road marker. In the case of road markers the peak responses sensed are determined as the highly reflective surfaces of a road marker.

Ex. 1005, [0066]
(cited by POR at 32,
Surreply at 12-13)

Petition's Use of Schofield – Claim 1

b. [1A]: “an image capture system that captures images within a field of view along the roadway;”

A POSITA 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. Schofield, 9:24-26, 10:18-11:12, 11:58-12:46; Thorpe ¶103. Schofield discloses applying “[p]attern recognition” to “assist in the detection of ... objects of interest,” where this pattern recognition

Pet. at 34-35

d. [1E]: “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 and for each object of interest:”

view for the reasons discussed for [9D]. *Supra* Section IV.A.4.c; Thorpe ¶110. For the reasons discussed regarding [1A], a POSITA would have found it obvious to

Pet. at 38-39

Flaws With Proposed Gallagher-Schofield Combination

- Inadequate details regarding *how* they are proposed to be combined:

Q. So you'd have to track the object as it's getting closer to the vehicle and passing from one sensor to another?

A. A person of ordinary skill in the art would have five different ways of doing that, tracking it from image to image to image, localizing it in 3D and then watching the vehicle motion, et cetera, et cetera, et cetera. Strike that. Not five different ways of doing it. Would have **multiple ways of doing it**.

Ex. 2026, 107:12-21 (cited by POR at 34) (emphasis added)

Q. I'm just trying to understand exactly what you're proposing in your declaration for combining Gallagher and Schofield. So is there something that says we're using this object-based sensor fusion approach?

A. I'm saying there's **multiple ways to combine them**

Ex. 2026, 110:24-111:5 (cited by POR at 34) (emphasis added)

“[T]he Board nowhere clearly explained, or cited evidence showing, *how* the combination of the two references was supposed to work. At least in this case, such a **clear, evidence-supported account of the contemplated workings of the combination is a prerequisite** to adequately explaining and supporting a conclusion that a relevant skilled artisan would have been motivated to make the combination and reasonably expect success in doing so.”

Personal Web Techs., LLC v. Apple, Inc., 848 F. 3d 987, 994 (Fed. Cir. 2017) (emphasis added) (cited by POR at 34)

Sensor fusion of Gallagher and Schofield's Disparate Sensor Types in an Automated, Highway-speed System Was Not Predictable

■ Patent Owner's Expert:

Schofield's camera-based approach is using a different kind of sensor than Gallagher (i.e. a camera versus a photodiode array), pointed at a different area (i.e. pointed ahead out the windshield, as opposed to at the ground 2.3m in front of the vehicle). Cameras synchronize the capture process across all pixels simultaneously or in coordinated sequences. Creating an image represents a coherent snapshot of a scene at a specific moment. By contrast, a photodiode array (without modifications for coordination) would produce disconnected light measurements rather than spatially and temporally coherent images.

... fusion even more difficult. In my opinion, as of earliest priority date of the '328 Patent in 2001, performing sensor fusion of a computer based vision system (such as Schofield) with a photodiode based system pointed down at the road way (such as Gallagher) would have not had a reasonable expectation of success at the highway speeds that both such systems operate using the hardware available or foreseeable at the time. Indeed, as Dr. Thorpe himself said in a publication in 2001 "working

Ex. 2023 ¶¶ 94-95
(cited by POR at 34-36)

Sensor fusion of Gallagher and Schofield's Disparate Sensor Types in an Automated, Highway-speed System Was Not Predictable

▪ Petitioner's Expert, Dr. Thorpe's Contemporaneous Statements in 2001:

Dependable Perception for Robots

Chuck Thorpe, Olivier Clatz, Dave Duggins, Jay Gowdy, Miller, Christoph Mertz, Mel Siegel, Chieh-Chih Y
Robotics Institute, Carnegie Mellon Un
<firstname.lastname>@ri.cmu.edu

Abstract

The weakest link in many mobile robots is perception. In order to build robots that are reliable and dependable and safe, we need to build robots that can see. Perception is becoming a solved problem for certain constrained environments. But for robots working outdoors, and at high speeds, and in close proximity to people, perception is still incomplete. Our robots need to see objects; to detect motion; and to detect which of those objects are people. In the current state of the art, this requires multiple sensors and multiple means of interpretation. This paper illustrates those principles in the context of the CMU Navlab Group's work on vehicle safety for busses and passenger cars.

1 Introduction

Mobile robots can be unreliable and undependable for a number of reasons: sensor failures, actuation failures, planning failures, computing crashes, etc. These weaknesses have been addressed for certain environments by using multiple sensors. AGVs operate in factories, robots deliver mail in offices and hospitals, the ConneXXion system shuttles people from a bus stop to their offices, experimental robots run in museums and train stations. These machines are now taken for granted: nobody worries about mechanical failure or runaway actuators. People are comfortable working in close proximity to them, or even riding on the ConneXXion robot sounds a disappointed tone: riders of a driverless vehicle or a conventional bus apparently picked up. While this may be bad news for companies that want to make autonomous vehicles, it's good news for robotics as a field: the public truly has stopped even noticing.

These successful applications tend to share two characteristics:

1. The environment is "clean". It is often instrumented (with navigation aids) or at least mapped (by leading the vehicle to collect observations). Obstacles are relatively easy to sense and segmented from the flat floor or plane.
2. The vehicles move slowly. If an obstacle is detected, in some cases, the robot stays put until its preloaded map is updated. In other cases, the robot is allowed certain simple obstacle avoidance.

Abstract

The weakest link in many mobile robots is perception. In order to build robots that are reliable and dependable and safe, we need to build robots that can see. Perception is becoming a solved problem for certain constrained environments. But for robots working outdoors, and at high speeds, and in close proximity to people, perception is still incomplete. Our robots need to see objects; to detect motion; and to detect which of those objects are people. In the current state of the art, this requires multiple sensors and multiple means of interpretation. This paper illustrates those principles in the context of the CMU Navlab Group's work on vehicle safety for busses and passenger cars.

3 See Everything Again

While the individual sensors are good, none of them can see all the features that we need to detect; and no one sensor is reliable in all circumstances. Thus, a dominant theme of our work is sensor fusion. It is our thesis that:

- 1) no single sensor will provide complete and affordable coverage, therefore sensor fusion will be required;
- 2) no single sensor fusion methodology will be suitable for all combinations of sensors.

Object Detection at Highway Speeds Continues to be Unpredictable Today



U.S. Department of Transportation
**National Highway Traffic Safety
Administration**



November 5, 2024

Eddie Gates
Director, Field Quality
Tesla, Inc.
45500 Fremont Blvd.
Fremont, CA 94538

Subject: Information Request ID PE24031-01

Dear Mr. Gates,

This letter is to inform you that the Office of Defects Investigation (ODI) of the National Highway Traffic Safety Administration (NHTSA) has opened a Preliminary Evaluation (PE24031) to examine FSD-equipped vehicles manufactured by Tesla, Inc. (Tesla) and FSD's potential failure to perform, including detecting and responding appropriately in specific situations where there is reduced roadway visibility that may limit FSD's ability to safely operate.

This investigation will focus on the adequacy of FSD's ability to perform in reduced visibility conditions stemming from relatively common traffic occurrences such as sun glare, fog, and airborne dust in the wake of four crashes reported under the Standing General Order 2021-01 (SGO), one of which resulted in a fatality. It appears in these instances that the driver may not be aware that he or she is responsible for selection of the operational design domain or fully understand the capabilities and nuances of the system. This investigation will consider the adequacy of feedback or information the system provides to drivers to enable them to make a decision in real time when the capability of the system has been exceeded.

This letter lists the reference numbers corresponding to the four SGO reports and requests certain information from Tesla.

Unless otherwise stated in the text, the following definitions apply to these information requests:

- **OEDR:** Object and event detection and response or the subtasks of the dynamic driving task (DDT)¹ that include monitoring the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an

Ex. 2032 (cited by
POR at 36, Ex. 2023 ¶ 96)

GROUND 2:

Gallagher, Schofield & Frank

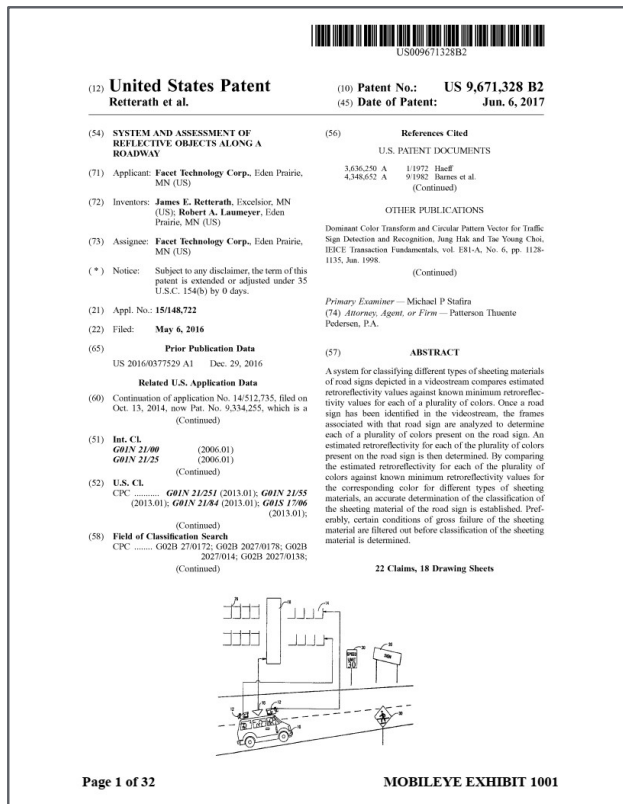
vs. claims 15-16

Additional Problems of Gallagher-Schofield-Frank Combination

- **Petition provides no description for how Frank's data is combined with Schofield (POR at 38-39)**
- **Petition fails to explain how Frank's purported "determining exemplary angular displacements" occurs in the combination "as part of the assessment of the discrete location of the road marker within the field of view" of Schofield or Gallagher (POR at 37-39)**
- **Adding Frank exacerbates problems with sensor fusion and contradicts Gallagher's method of operation (POR at 41-43)**

Frank Fails to Disclose or Suggest “determine” multiple “exemplary angular displacements” “for each light intensity measurement from a reference location” (’328 Patent, claim 15)

'328 Patent:



'328 Patent at
14:32-45
(cited by POR
at 40)

'328 Patent at
15:23-28
(cited by POR
at 40)

Of the methods listed above, the highest precision measuring systems for determining the normal vector **180** consists of a scanned laser and associated optical sensor. This combination yields relative distance measurements between the capture vehicle **225** and the object's face surface **130** that are more precise than optical measurements with cameras. A laser scanner attached to the capture vehicle **225** and directed toward a roadside scene populated with retroreflective signs **130** generates a series of reflection points to the optical sensor that appear as a horizontal segment of points. The optical sensor must be fast enough (i.e., have adequate data acquisition rates) to capture at least several individual discrete measurements across the object's face surface **130** (or of any other reflective asset). In general, two types of

locations with the object's face surface 130. Once the lateral series of discrete locations for a sign 190 is determined, simple triangulation methods are used to combine: (i) the vehicle location, (ii) vehicle heading vector, and (iii) scanned sign point to ultimately determine the normal vector 180 for the object's face surface 130.

Frank Fails to Disclose or Suggest “determine” multiple “exemplary angular displacements” “for each light intensity measurement from a reference location” (‘328 Patent, claim 15)

Patent Owner’s Expert:

vector. *Id.* at 15:19-28. However, the Frank reference contains no analogous disclosure of using a sufficiently fast laser radar system to take multiple angular displacement measurements for a single road marker from a single reference location—it does not even disclose if its laser radar is fast enough to do so. Nor does Petitioner nor Dr. Thorpe articulate any reason to combine the references so as to determine multiple exemplary angular displacements for a single light intensity measurement at a single reference location, as claimed. Instead, they articulate a

Ex. 2023 ¶ 130 (cited by POR at 40)

Claim Does Not Remove Claim 15's Requirement to “determine” multiple “exemplary angular displacements” “for each light intensity measurement from a reference location”

15. The automated system of claim 9, 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.

16. The automated system of claim 15, wherein 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.

'328 Patent, cls. 15-16 (cited by Surreply at 20)

GROUND 3: Gallagher, Schofield, Frank & ASTM vs. claim 14

Frank Fails to Disclose or Suggest “computer processing system is further configured to determine an *entrance angle*” (‘328 Patent, claim 14)

- **Petition’s Expert Admits the Theory in the Petition for Claim 14 Fails—Frank’s angle α is merely maximum angular sweep, not an entrance angle:**

A POSITA would have understood that Frank’s determination of its angle α , depicted below, is one common way to estimate the entrance angle. Frank, 10:67-11:4, Fig. 2A; Thorpe ¶154.

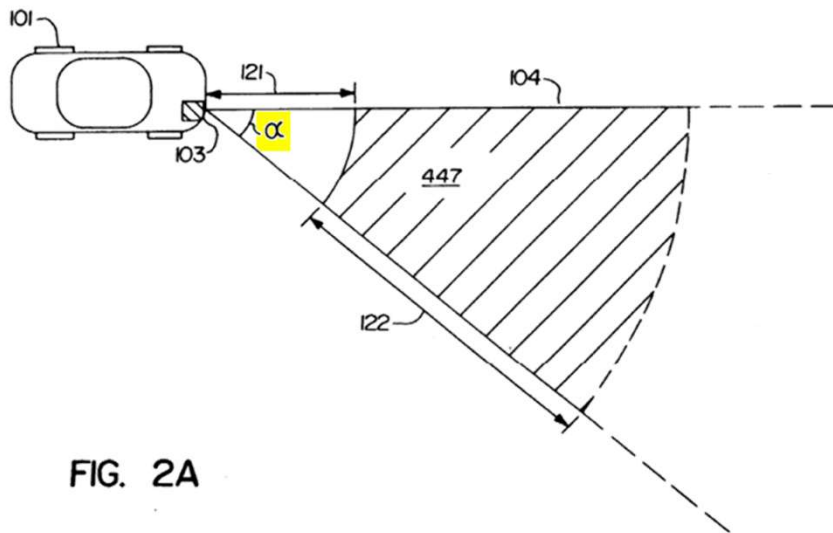


FIG. 2A

Petition at 59

Q. How does angle alpha in Frank relate to angle theta in Frank?

A. Let's go look at Figure 2A and see where Figure 2A gets described. I believe you may be correct that alpha may be the full sweep and I should, instead of using Figure 2A, should have used Figure 2 to indicate theta which is the angle to the retroreflector.

Ex. 2026, 140:10-17 (cited by POR at 44) (emphasis added).

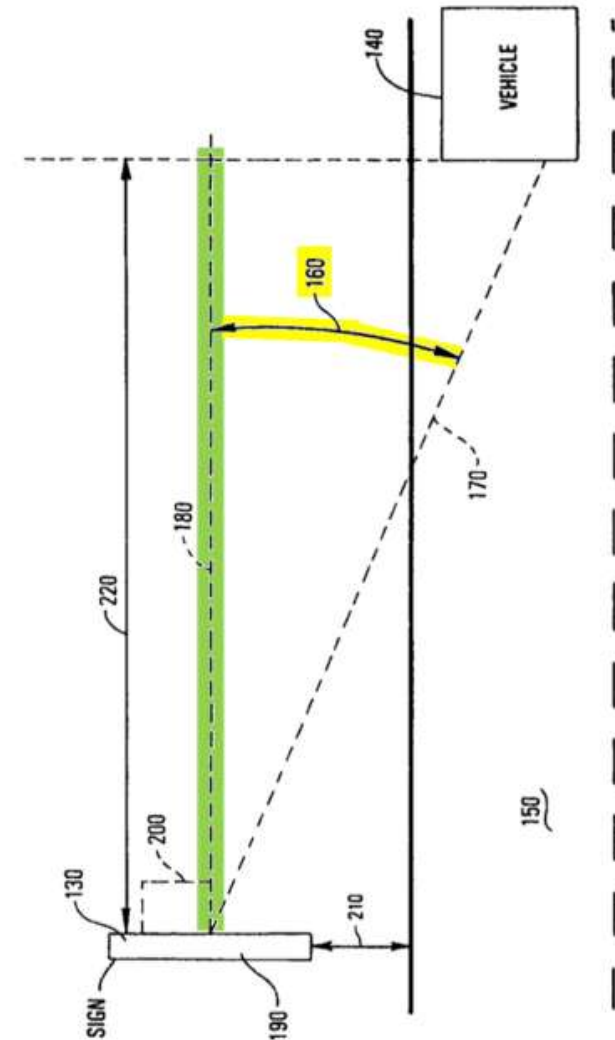
Ex. 2026, 140:14-17
(cited by POR at 44)

Petitioner's Improper New “angle θ ” Theory Also Fails

Entrance Angle in '328 Patent:

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**. Entrance angles are impacted by the angular position **200** of a sign **190** relative to the highway **150**, the sign **190** lateral distance **210** from the highway **150**, and the distance **220** of the vehicle **140** from the sign **190**. The inventors hereof are believed to

'328 Patent at 7:55-61 (cited by POR at 45)



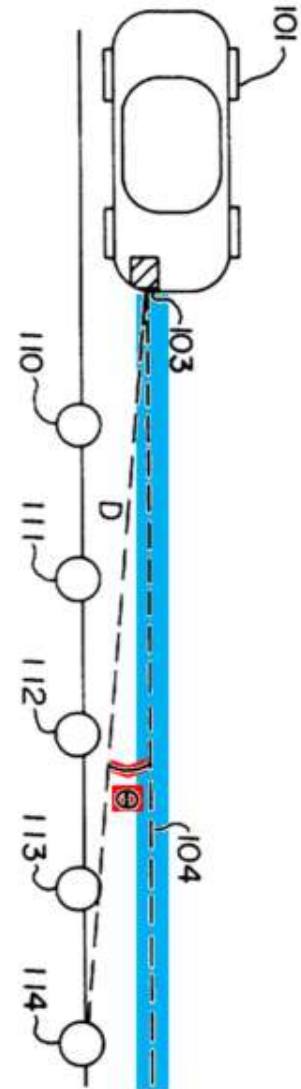
'328 Patent, Fig. 2 (annotated) (cited by POR at 46)

Petitioner's Improper New “angle θ ” Theory Also Fails

Frank's angle θ :

7:55-61 (emphasis added). By contrast, as shown in Frank's Figure 12, angle θ (red) is the angle “formed between axis 104 [blue] and an imaginary line drawn between vehicle 101 and a retroreflector,” i.e. the angle between the *vehicle's normal vector* and angle of incident light on the retroreflector. Ex. 1007, 4:37-42.

Ex. 2023 ¶ 138 (cited by POR at 45-46)



Ex. 1007, Fig. 12(cited by POR at 46)

GROUND 4:

Gallagher, Schofield, Leonard & Popovich vs. claims 5-7

Additional Problems of Gallagher-Schofield- Leonard-Popovich Combination

- **Popovich is not analogous art** (POR at 48-50)
- **The Petition selects from among various distinct embodiments of Popovich without a motivation to combine** (POR at 50-51)
- **Petitioner does not identify any benefits from adding Leonard and Popovich to the Gallagher-Schofield combination not already provided by Schofield** (POR at 55)
- **Adding Leonard Would Render Gallagher Inoperable** (POR at 55-56)
- **Popovich's Close-Distance Head-tracking Techniques Are Inapplicable to Gallagher** (POR at 56)

The Cited Prior Art Does Not Disclose or Suggest “comparing the light vector to one of a plurality of predetermined vectors based on a light source angle characterization” (claim 5)

- Popovich does not disclose or suggest any comparison using its angular intensity distribution profiles (POR at 52-53)

Light from sources 5B has an angular intensity distribution profile shown in the diagram of Figure 3a wherein the 'Y'-axis is intensity and the 'X'-axis is the angle theta with $x=0$ corresponding to the optical axis of the optical head 200 or 201. Similarly, the angular intensity distribution profile of light from sources 5A is shown in the diagram of Figure 3b. It will be apparent that the light sources 5A have a uniform angular intensity profile and correspond to the type of light sources 5 which may be used in the aforementioned first and second embodiments, whilst light sources 5B have the non-uniform symmetrical profile shown in Figure 3a. To provide the

Ex. 1010 at 10 (cited by POR at 52-53)

The Cited Prior Art Does Not Disclose or Suggest “comparing the light vector to one of a plurality of predetermined vectors based on a light source angle characterization” (claim 5)

- Popovich’s “peak of the spot’s intensity profile” is unrelated to the “angular intensity distribution profile” of light (POR at 53-54)

Each light ray portion 19,23 results in a corresponding sensor image within the respective imaging sensor 20. The following description relates to one such sensor image by describing components of one sensor 20 and is equally applicable to the other sensor image and sensor. Within the sensor 20 the sensor image is formed on a two-dimensional array of photodetectors whose responses are thresholded such that a binary image consisting of a single spot moving against a black background is formed. Alternatively, a raster scanning sensor typically comprising a CCD video camera could be used. By carrying out analogue-to-digital conversion of the signal, the spot intensity is characterised in terms of a number of grey levels - typically up to 256. By measuring the position in the matrix of the sensor(s) of the peak of the spot's intensity profile or, in the case of a spot having a flat topped profile, its centroid and using the known orientation in space of the sensor camera it is possible to define a ray vector that passes through the centre of the retroreflector 3.

Ex. 1010 at
6-7 (cited by
POR at 53-54)

