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Title: OPTICAL SYSTEM FOR COLLECTING DISTANCE
INFORMATION WITHIN A FIELD

DECLARATION OF JAMES F. SHANLEY, PH.D.

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used LiDAR construction that is overall compact in size and provided low-cost optical layout with the optoelectronic elements behind bulk optics. EX1013, [0010]-[0014], FIG.2. Based on my knowledge and experience and my review of Retterath, Borowski, and Pacala, a POSITA would have recognized that implementing the Retterath-Borowski combination with similar compact configuration as suggested by Pacala, in which the bulk optics are positioned immediately next to one another, would have provided such benefits without hindering operation of the device.

224. As a second reason, a POSITA would have been prompted implement the Retterath-Borowski combination with a rotational mechanism (as suggested by Pacala) to capture an overall wider field-of-view. For example, a POSITA would have recognized the benefits of an unobstructed 360-degree rotational field of view, which would have provided improved performance in autonomous-vehicle navigation at the time. Pacala's suggestion of a rotational design would have been recognized as beneficially achieve such an unobstructed 360-degree rotational field of view. EX1013, FIG.2, [0013]-[0014] ("spinning turret").

225. As a third reason, a POSITA would have been prompted to implement Pacala's conventional suggestions, as I discussed above, with the Retterath-Borowski combination because doing so was the application of known techniques to a known system (the primary Retterath LiDAR system) ready for improvement to yield predictable results. Indeed, Pacala suggested the compact solution for the bulk

optic positioning and further suggested the rotational mechanism in a LiDAR system, and the Retterath-Borowski combination provided a LiDAR system ready for improvement based on these particular features.

226. Based on my knowledge and experience in the field and my review of these references, a POSITA would have readily implemented this predictable combination, with a reasonable expectation of success. Here, all the references similarly describe conventional LiDAR configurations, including use of detector arrays that compute time-of-flight measurements. EX1005, FIGS. 6, 10, 11b; EX1013, [0013]-[0014], FIG.2. Moreover, a POSITA would have reasonably expected the emitter-detector arrangements of Retterath and Borowski to work in a rotating device like Pacala. As noted above, embodiments of Retterath describe a “solid state” device, and similar array designs were well known and implemented in rotating structures like Pacala.

227. For purposes of corroborating this fact, I note that Pennecot teaches a detector array mounted on a PCB in a housing that rotates about a fixed base. EX1024, FIGS. 2C, 5A. And Borowski teaches its multi-SPAD pixels mounted on rotating structure 33. EX1005, [0060]. Borowski further provides circuitry to correlate the rotational angle of the device with photon detection events to generate accurate 3D point clouds. *Id.*, [0060], [0106]. A POSITA would have had a reasonable expectation of success using the same traditional principle in a device

emitter of the plurality optical emitters on the LiDAR device of the Retterath/Borowski combination. *Supra*, §§XI.D.1-2;

E. Ground 1E: Retterath, Borowski, Weimer, and Pacala Render Obvious Claims 1-3, 5-8, and 10-13

250. As I discussed above in Ground 1D, Retterath, Borowski, and Weimer render obvious claims 1-3, 6-8, and 10-13. *See* Section XI.D. Moreover, even if the Retterath-Borowski-Weimer combination did not provide all elements of those claims, the predictable combination of Retterath in view of Borowski, Weimer, and Pacala would do so. This is especially the case in view of Pacala’s suggestions for positioning lenses “adjacent to” one another in a compact arrangement and for its suggestion of a rotational configuration and associated benefits. *Supra* Sections XI.C.1-3. Based on my knowledge and experience in the field, and my review of these references, a POSITA would have been motivated to combine the teachings of Retterath, Borowski, Weimer, and Pacala with a reasonable expectation of success, for the reasons and known benefits I detailed above in Sections XI.C.1-3 and XI.D.1-5.

F. Ground 1F: Retterath, Borowski, Weimer, and Hipp Render Obvious Claims 6-8, 17

251. As I discussed above in Ground 1D, Retterath, Borowski, and Weimer render obvious claims 6-8. *See* Section XI.D. Even if the Retterath-Borowski-Weimer combination did not provide all elements of claims 6-8, and 17 (which it

of a rotational design to achieve a 360-degree rotational field of view. As I discussed previously, an unobstructed rotational field of view would have been recognized as particularly beneficial to the performance in autonomous-vehicle navigation at the time. EX1013, FIG.2, [0014]. Implementing mechanical rotation of the Imai-Higashi optical system based on Pacala's suggestion configuration, either as an alternative, or in addition, to Imai's rotating mirror adjacent to stationary elements, would have facilitated an unobstructed field of view of 360 degrees, while promoting an optional more compact lateral size.

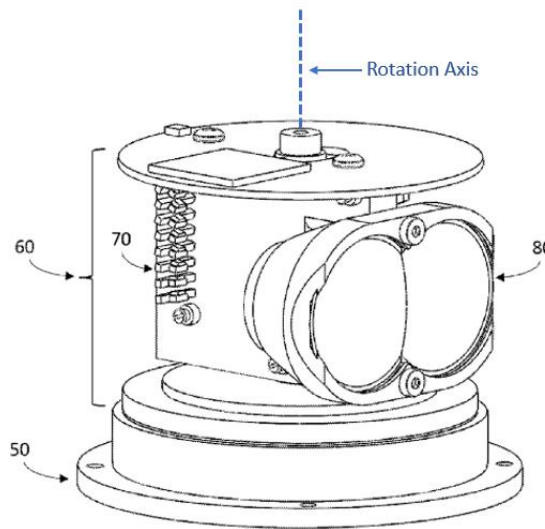
319. As a second reason, a POSITA would have been motivated to implement Pacala's suggestions for mechanical rotation of the optical system with the Imai-Higashi combination because doing so was the application of known techniques to a known system (the primary Imai LiDAR system) ready for improvement to yield predictable results. Pacala's suggested a rotational mechanism to rotate an optical system in a LiDAR device, and Imai-Higashi describe a LiDAR system ready for improvement. I note further that a POSITA would have had a reasonable expectation of success in making the combination, especially in view of the similar configurations of the references which all describe conventional LiDAR configurations that utilize detector arrays to compute time-of-flight measurements. EX1009, FIGS. 10, 11; EX1013, [0013]-[0014], FIG.2. Indeed, based on my knowledge and experience in the field, a POSITA would have reasonably expected

the emitter-detector arrangements of Imai and Higashi to work with a mechanically rotating component, as suggested by Pacala, given these similarities in system operation.

2. Claim 5: The optical system according to claim 1 further comprising a rotation mechanism configured to rotate the optical system about a rotational axis.

320. The Imai-Higashi-Pacala combination teaches the additional element of claim 5.

321. Pacala describes the base 50 that includes a motor to drive rotation of the turret section 60, which mounts the optical system of the device. EX1013, [0013], FIG.2.



EX10132, FIG.2 (annotated)

322. In the resulting system, the Imai-Higashi LDA and PDA (extending in the Z-axis and having multiple SPADs per pixel) would have been predictably

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

Date: September 25, 2023

Respectfully Submitted

James F. Shanley

Dr. James F. Shanley