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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

(88) Date of publication of the international search report:

28 September 2017

(54) Title: NEGATIVE OBSTACLE DETECTOR

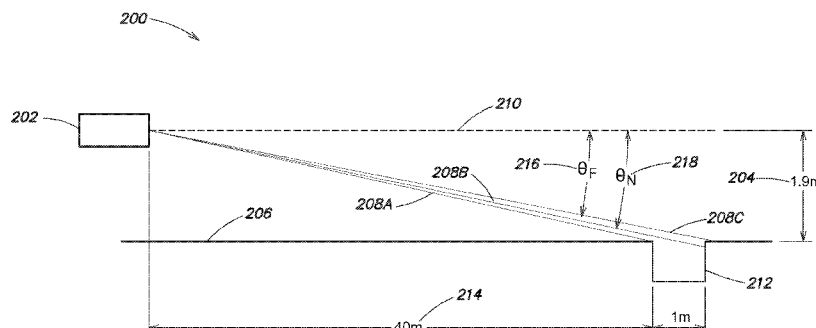


FIG. 2

(57) Abstract: An obstacle detector configured to identify negative obstacles in a vehicle's path responsive to steering a laser beam to scan high priority areas in the vehicle's path is provided. The high priority areas can be identified dynamically in response to the terrain, speed, and/or acceleration of the vehicle. In some examples, the high priority areas are identified based on a projected position of the vehicles tires. A scan path for the laser, scan rate, and/or a scan location can be dynamically generated to cover the high priority areas.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/057341

A. CLASSIFICATION OF SUBJECT MATTER

INV. G01S17/42 G01S17/93 G01S7/48 G01S7/481
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, INSPEC, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 101 55 488 A1 (CASPARY WILHELM [DE]; HEISTER HANS [DE]) 28 May 2003 (2003-05-28)	1,15
Y	paragraphs [0001], [0047], [0051], [0011], [0050], [0062], [0054], [0056], [0060], [0072] - [0073]; figures 1,2 ----- -/--	2



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

6 June 2017

Date of mailing of the international search report

14/08/2017

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/057341

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	KELLER SEAN D ET AL: "Emerging liquid crystal waveguide technology for low SWaP active short-wave infrared imagers", OPTOMECHATRONIC MICRO/NANO DEVICES AND COMPONENTS III : 8 - 10 OCTOBER 2007, LAUSANNE, SWITZERLAND; [PROCEEDINGS OF SPIE , ISSN 0277-786X], SPIE, BELLINGHAM, WASH, vol. 9384, 11 March 2015 (2015-03-11), pages 93840M-93840M, XP060050608, DOI: 10.1117/12.2076835 ISBN: 978-1-62841-730-2 paragraph [0003] abstract -----	2

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/057341

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 10155488	A1	28-05-2003	NONE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/057341

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1, 2, 15

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1, 2, 15

a solid-state liquid crystal waveguide steering device for an obstacle detector.

Solved technical problem underlying the claimed invention (see description, page 2, lines 23-24 and page 9, lines 16-18): Steering a laser beam from the range finder transmitter to target high priority areas at high-speed.

2. claims: 3, 4, 17

a solid-state liquid crystal waveguide steering device for an obstacle detector.

Solved technical problem underlying the claimed invention (see description, page 2, lines 23-24 and page 9, lines 16-18): Steering a laser beam from the range finder transmitter to target high priority areas at high-speed.

3. claims: 5, 16

wavelength multiplex operation of an obstacle detector.

Solved technical problem underlying the claimed invention (see description, page 22 lines 9-12): to improve detection of energy distribution changes resulting from obstacles in a travel path.

4. claims: 6-13, 18-22

providing negative obstacle detection and travel path estimation for an autonomous vehicle by means of a variable scan pattern.

Solved technical problem underlying the claimed invention (see description, page 9 lines 20-21): to identify obstacles which allow the autonomous vehicle to avoid any holes at high speed that create navigational barriers.

5. claims: 14, 23

an intensive mode of operation for an object detector.

Solved technical problem underlying the claimed invention (see description, page 15 lines 7-8): to increase sensitivity in measuring distance.
