PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	15/03/2019
Applicant's or agent's file reference 1115963	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2018/065039	11/12/2018	07/12/2018

International Patent Classification (IPC)
G02B 26/10 (2006.01) *G01S 17/93 (2006.01)* *G01S 7/481 (2006.01)*

Applicant
DIDI RESEARCH AMERICA, LLC

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☒ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examination Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/SG	Date of completion of this opinion	Authorized officer
Intellectual Property Office of Singapore 51 Bras Basah Road #01-01 Manulife Centre Singapore 189554 Email: pct@ipos.gov.sg	15/03/2019 *(day/month/year)*	Fang Zheng (Dr) IPOS Customer Service Tel. No.: (+65) 6339 8616

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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purpose of international search (Rules 12.3(a) and 23.1 (b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(b)).

3. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:

   a. ☐ forming part of the international application as filed:

      ☐ in the form of an Annex C/ST.25 text file.

      ☐ on paper or in the form of an image file.

   b. ☐ furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text tile.

   c. ☐ furnished subsequent to the international filing date for the purposes of international search only:

      ☐ in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).

      ☐ on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

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Box No. V Reasoned statement under Rule 43*bis*.(1)(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-20	YES
	Claims	NONE	NO
Inventive step (IS)	Claims	NONE	YES
	Claims	1-20	NO
Industrial applicability (IA)	Claims	1-20	YES
	Claims	NONE	NO

2. Citations and explanations:

The following citations are referred to in this written opinion. Full bibliographic details are provided in the International Search Report:

D1 – US 2013/0242363 A1
D2 – US 2016/0146939 A1
D3 – CN 106353891 A
(the original non-English language document was used for the purpose of establishing the written opinion)
D4 – US 2018/0275249 A1
D5 – US 2007/0053035 A1

D2-D5, each of which discloses an optical scanner system and method, relate to general background art and D2-D3 are mentioned for illustrative purpose.

1. Novelty

Claims 1-20

Claims 1-20 are novel and therefore comply with PCT Article 33(2), since none of the cited prior art documents individually discloses all the features of any of said claims.

2. Inventive step

Claims 1-20 do not involve an inventive step and therefore do not comply with PCT Article 33(3).

Claims 1, 14 and 18

D1 discloses the following features of independent claim 1 (references in parentheses refer to D1 and strikethrough wordings refer to features that are not disclosed in D1 and have been highlighted by the Examiner):

An apparatus comprising a Light Detection and Ranging (LiDAR) module (para. [0050], "serves as a component in a light detection and ranging system"), the LiDAR module comprising:

a light source (Fig. 3, ref. 38, "source");

a receiver (Fig. 3, ref. 34, "sensing mechanism"); and

a semiconductor integrated circuit comprising a microelectromechanical system (MEMS) and a controller (para. [0160], "MEMS formed on a substrate", Fig. 2-3, ref. 21, "silicon substrate", ref. 54, "data processor"),

wherein the MEMS comprises:

~~an array of first rotatable mirrors~~ to receive and reflect the light beam from the light source (Fig. 2-3, ref. 22, "first mirror");

a second rotatable mirror to receive the light beam reflected by ~~the array of first rotatable mirrors~~ (Fig. 2-3, ref. 24, "second mirror");

Box No. V Reasoned statement under Rule 43*bis*.(1)(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

~~an array of first actuators~~ configured to rotate each rotatable mirror ~~of the array of first rotatable mirrors~~ (para. [0162], [0166], Fig. 2, ref. 32, "rotor assembly"); and

a second actuator configured to rotate the second rotatable mirror (para. [0163], "driving force can be applied by any suitable mechanism"); and

wherein the controller is configured to control the ~~array of first actuators~~ and the second actuator to rotate, respectively, the ~~array of first rotatable mirrors~~ and the second rotatable mirror to set a first angle of light path with respect to a first dimension (para. [0177], "first mirror to rotate about an axis parallel to axis 28", Fig. 2, ref. 28) and to set a second angle of the light path with respect to a second dimension orthogonal to the first dimension (para. [0177], "second mirror to rotate about an axis parallel to axis 26", Fig. 2, ref. 26, orthogonal to ref. 28) to perform at least one of: reflecting light from the light source along the light path, or reflecting input light propagating along the light path to the receiver (para. [0182], Fig. 3, ref. 42, reflected by first and second mirrors).

Hence, claim 1 differs from D1 in that said claim defines an array of first mirrors and corresponding array of actuators instead of a single mirror and actuator in D1. However, D1 discloses that the shape of mirrors is preferably selected so as to minimize their moment-of-inertia so as to reduce actuation force (D1: para. [0166]). It is well known in the art that use of multiple synchronized mirrors is advantageous in maintaining the same effective aperture while lowering inertia of individual mirrors (see for examples, D2: para. [0025], Fig. 1, ref. 24, 26; D3: para. [0021], Fig. 1, ref. 1-5). The skilled person seeking to minimize inertia of the mirror would find it obvious to implement an array of mirrors and corresponding array of actuators and arrive at the present invention without practical difficulty. Therefore, an inventive step cannot be acknowledged for claim 1.

Claims 14 and 18 relate to a method and a non-transitory computer readable medium storing instructions that correspond to the subject matter of claim 1. The abovementioned objections to claim 1 hence apply, *mutatis mutandis*, to the subject matter of claims 14 and 18. Therefore, an inventive step cannot be acknowledged for claim 14 and 18.

Claims 2, 4-6, 13, 16-17 and 20

D1 further discloses the additional features of claim 2 (para. [0178], "laser diode"), claim 4 (Fig. 2-3, ref. 21, "silicon substrate"), claims 5-6 (Fig. 3, ref. 44, "optical element" as third mirror and respective arrangement), claims 13 and 17 (para. [0169], "motion of mirrors is sensed, processed and being used as a feedback to precisely control the position of mirrors"), claims 16 and 20 (para. [0014], "scanning in the vertical direction in low frequency region while scanning in the horizontal direction by a resonant mirror of high speed operation", para. [0150], "scanning along the second axis is a resonant scanning"). Therefore, an inventive step cannot be acknowledged for claims 2, 4-6, 13, 16-17 and 20.

Claims 3, 7-12, 15 and 19

The additional features defined in claims 3, 15 and 19, which are directed to transmitting and receiving a first light signal, relate to LiDAR operations that come within the scope of the customary practice followed by the skilled person.

Claims 7-12, which further define a collimator lens, relative mass of mirrors and actuators, represent straightforward implementation options which are well-known and commonly used in the technical field of optical scanning.

Therefore, an inventive step cannot be acknowledged for claims 3, 7-12, 15 and 19.

3. Industrial applicability

Claims 1-20 are industrially applicable and therefore comply with PCT Article 33(4).

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Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

1. Clarity and conciseness

Claims 1, 14 and 18 do not comply with PCT Article 6.

Claim 1

The term "the light beam" in pg. 27, ln. 9, lacks antecedent.

Claim 14

The term "an array of first rotatable micromirrors" in pg. 30, ln. 10-11, should presumably be "an array of first rotatable mirrors" in order to be consistent with subsequent definition in claims 14 and 16-17.

Claims 14 and 18

The term "an array of first rotatable mirrors" in pg. 30, ln. 15, lacks clarity, as it is not clear whether said term refers to the same or different from "an array of first rotatable mirrors" defined previously in claim 14.

Similar objection applies to the term "a second rotatable mirror" in pg. 30, ln. 15-16, "an array of first rotatable mirrors", in pg. 32, ln. 2, and "a second rotatable mirror" in pg. 32, ln. 2-3.