PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter I of the Patent Cooperation Treaty)

(PCT Rule 44*bis*)

Applicant's or agent's file reference DRX.P004.WO.01	**FOR FURTHER ACTION**	See item 4 below
International application No. PCT/US2015/036115	International filing date *(day/month/year)* 17 June 2015 (17.06.2015)	Priority date *(day/month/year)* 17 June 2014 (17.06.2014)
International Patent Classification (8th edition unless older edition indicated) See relevant information in Form PCT/ISA/237		
Applicant DREXEL UNIVERSITY		

1. This international preliminary report on patentability (Chapter I) is issued by the International Bureau on behalf of the International Searching Authority under Rule 44 *bis*.1(a).

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   In the attached sheets, any reference to the written opinion of the International Searching Authority should be read as a reference to the international preliminary report on patentability (Chapter I) instead.

3. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	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 Article 35(2) with regard to novelty, inventive step or 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

4. The International Bureau will communicate this report to designated Offices in accordance with Rules 44*bis*.3(c) and 93*bis*.1 but not, except where the applicant makes an express request under Article 23(2), before the expiration of 30 months from the priority date (Rule 44*bis* .2).

	Date of issuance of this report 20 December 2016 (20.12.2016)
The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No. +41 22 338 82 70	Authorized officer Agnès Wittmann-Regis e-mail: pt06.pct@wipo.int

Form PCT/IB/373 (January 2004)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: STEPHEN B. SCHOTT
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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	16 SEP 2015

Applicant's or agent's file reference	FOR FURTHER ACTION
DRX.P004.WO.01	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2015/036115	17 June 2015	17 June 2014

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G01M 7/08 (2015.01)
CPC - G01M 7/08 (2015.04)

Applicant DREXEL UNIVERSITY

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 Examining 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/	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	18 August 2015	Blaine Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

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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 purposes 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(a)).

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 file.

   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 forming part of 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	2-4, 10-12, 14-15	YES
	Claims	1, 5-9, 13	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-15	NO
Industrial applicability (IA)	Claims	1-15	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 5, and 8 lack novelty under PCT Article 33(2) as being anticipated by Hunan University (hereinafter Hunan).

Regarding claim 1, Hunan discloses a system for measuring structural integrity (Paragraphs 0002-0003, evaluation/ structural identification of bridges); comprising: a self-contained rapid modal testing trailer (Para. 0004, modal testing; Abstract; detection of bridge becomes rapid; Fig. 1, vehicle body 47 [wheeled apparatus capable of use as a trailer]) that delivers an impact load (via hammer means 43, Para. 0023) to a structure (Abstract, pulse hammer impacts bridge) being tested and records data resulting from the impact load in a data acquisition program (Paragraphs 0010-0011, data acquisition system/program), the testing unit comprising: an impact device that delivers the impact load (hammer 43); and a sensor assembly (sensor mounting arm 46) that extends from the testing unit to engage the structure (as depicted in Fig. 1).

Regarding claim 5, Hunan discloses the impact load is adjustable (Para. 0023, adjustable hammer mass).

Regarding claim 8, Hunan discloses the impact device is controlled using a controller (Para. 0010, controllable rebound hammer means).

Claims 1, 5-9, and 13 lack novelty under PCT Article 33(2) as being anticipated by Southeast University (hereinafter Southeast).

Regarding claim 1, Southeast discloses a system for measuring structural integrity (page 1, Description, Paragraphs 2-3, bridge structural safety indication; page 1, Advantageous Effects, integrated measure of bridge safety performance evaluation); comprising: a self-contained rapid (Abstract; rapid diagnosis of bridges) modal testing trailer (page 2, Brief Description, Fig. 1, apparatus; page 1, Background description, paragraph 2, the multi-mode of the bridge results in identification of the structural compliance matrix; Advantageous Effects, measure of the flexibility matrix of the bridge; [Fig. 1 apparatus is a wheeled apparatus and capable of being used as a trailer]) that delivers an impact load (page 1, Description, Para. 1, impact load device) to a structure (page 2, Detailed Description, loading hammer hits the [bridge] deck) being tested and records data (page 1, Summary, recording impact force over time) resulting from the impact load in a data acquisition program (page 2, Disclosure, signal analysis section to identify matrix requires the use of the impact data), the testing unit comprising: an impact device (hammer 9; page 1, Description of Drawings) that delivers the impact load (page 2, Detailed Description, loading hammer hits the deck); and a sensor assembly (force sensor 7; page 1, Description of Drawings) that extends from the testing unit to engage the structure (page 1, Summary, the force sensor is provided at the lower end of the loaded hammer [which hits the deck]).

Regarding claim 5, Southeast discloses the impact load is adjustable (page 2, Disclosure, load hammer of variable load weight, where an additional load weight can be provided to provide a larger impact load).

Regarding claim 6, Southeast discloses the sensor assembly engages the structure to be measured via a stabilizer foot ([as illustrated in Fig. 1, the apparatus makes contact with the deck via the unlabeled casters [interpreted as stabilizing feet for the assembly as a whole, and allowing for sensor engagement with the deck in a stabilized fashion]).

Regarding claim 7, Southeast discloses the sensor assembly extends from the unit via activation of an actuator (page 1, final paragraph, electric motor lifts the hammer, having sensor 7, to a certain height, and a control button to initiate free fall of the hammer).

Regarding claim 8, Southeast discloses the impact device is controlled using a controller (controller 6, page 1, Description of Drawings; page 2, Disclosure, controller signal controls hammer lifting loads).

Regarding claim 9, Southeast discloses the sensor assembly is controlled using a controller (controller 6, page 1, Description of Drawings; page 2, Disclosure, controller signal controls hammer lifting, [and, accordingly, height of the sensor attached to the hammer]).

Regarding claim 13, Southeast discloses the sensor assembly (force sensor 7) may be extended in multiple directions parallel to the structure before engaging the structure ["may be extended" is interpreted as optional language, and accordingly having no limiting effect].

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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:

Claim 3 is objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because claim 3 is indefinite for the following reason: Claim 3 recites "the impact plate" which lacks antecedent basis. For the purpose of the international opinion, claim 3 is interpreted as reciting "the strike plate", for which proper antecedent basis is given in claim 2.

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claims 2, 3, and 15 lack an inventive step under PCT Article 33(3) as being obvious over Southeast University (hereinafter Southeast) in view of Ratcliffe.

Regarding claim 2, Southeast discloses the impact device comprises a falling mass (page 2, Disclosure, load hammer of variable load weight) that impacts a deck to deliver the impact load (page 2, Detailed Description, loading hammer hits the [bridge] deck).
Southeast does not explicitly disclose impacting a strike plate.
Ratcliffe generally discloses a calibrated impact hammer (Title). Further, Ratcliffe discloses impacting (Fig. 1, via striking member 30; col. 2, lines 35-36, striker axially moves in positioner 20) a strike plate (strike plate 70; col. 3, lines 41-42).
It would have been obvious to one of ordinary skill in the art at the time of the invention that the impact load device of Southeast may be configured with a strike plate, as suggested by Ratcliffe, for the benefit of optionally modifying a single hammer to provide pulses of varying shapes, amplitudes, and durations (Ratcliffe, col. 3, lines 44-46).

Regarding claim 3, Southeast [as modified in claim 2 above] discloses when the falling mass strikes the impact plate [as modified by Ratcliffe], a rebound control assembly (including controller 6 and brakes 3, page 1, Description of Drawings) is activated to catch the falling mass from striking the strike plate [as modified by Ratcliffe] a second time on a rebound (page 2, Detailed Description, upon rebound detection by infrared sensor the controller applies brakes to the rails to avoid secondary impacts).

Regarding claim 15, Southeast discloses the impact device comprises a falling mass (page 2, Disclosure, load hammer of variable load weight) that falls along linear guide rails (page 2, Detailed Description, vertical rails), and upon detection of a rebound of the falling mass after impact, the impact device engages brakes that engage the linear guide rails and stop the falling mass from rebounding (page 2, Detailed Description, upon rebound detection by infrared sensor the controller applies brakes to the rails to avoid secondary impacts [subsequent rebounding]).
Southeast does not explicitly disclose impacting a strike plate.
Ratcliffe discloses impacting (Fig. 1, via striking member 30; col. 2, lines 35-36, striker axially moves in positioner 20) a strike plate (strike plate 70; col. 3, lines 41-42).
It would have been obvious to one of ordinary skill in the art at the time of the invention that the impact load device of Southeast may be configured with a strike plate, as suggested by Ratcliffe, for the benefit of optionally modifying a single hammer to provide pulses of varying shapes, amplitudes, and durations (Ratcliffe, col. 3, lines 44-46).

Claim 4 lacks an inventive step under PCT Article 33(3) as being obvious over Southeast University (hereinafter Southeast) in view of Ratcliffe and Meister.

Regarding claim 4, Southeast [as modified in claim 2 above] dislcoses the rebound control assembly comprises a rebound control actuator (electric brake 3) and a rebound control arm (page 1, Summary, electric brakes include guide rails and wedge block [arm] applied), and upon a sensor (infrared sensor 2; page 1, Description of Drawings) detecting the falling mass striking the strike plate [as modified by Ratcliffe], the sensor communicates this contact to a controller that activates the rebound control actuator, which extends the rebound control arm to catch the falling mass (page 2, Detailed Description, upon rebound detection by infrared sensor the controller applies brakes [including wedge block, arm] to the rails to avoid secondary impacts).
Southeast does not explicitly disclose a hall sensor [to detect the mass striking the strike plate].
Meister generally discloses an impact sensor for a vehicle safety restraint system (Title). Further, Meister discloses a hall sensor to detect an impact (Fig. 7, col. 6, lines 35-37, impact sensor as hall effect sensor).
It would have been obvious to one of ordinary skill in the art at the time of the invention that the infrared sensor of Southeast may alternatively be configured as a hall effect sensor for measuring impact, as suggested by Meister, for the benefit of providing an analog output signal in which the output voltage or current varies as a substantially continuous monotonic function of position (Meister, col. 6, lines 40-42).

Claim 10 lacks an inventive step under PCT Article 33(3) as being obvious over Southeast University (hereinafter Southeast) in view of Mahaffey et al. (hereinafter Mahaffey).

Regarding claim 10, Southeast discloses the sensor assembly (force sensor 7 [page 1, Description, shock vibration testing]).
Southeast does not explicitly disclose the sensor as a floating spring loaded accelerometer.
Mahaffey generally discloses the non-destructive testing of in-service wooden beams (Title). Further, Mahaffey discloses a sensor as a floating spring loaded accelerometer (Figures 9-10, Para. 0049, sensor pod 22 [of Fig. 1] has base 62 which holds accelerometer 43 [Fig. 2], wherein the accelerometer is spring mounted in base 62).
It would have been obvious to one of ordinary skill in the art at the time of the invention that the sensor of Southeast may be a floating spring loaded accelerometer, as suggested by Mahaffey, for the benefit sensing vibration in a cross arm (Mahaffey, Para. 0037).

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claims 11 and 12 lack an inventive step under PCT Article 33(3) as being obvious over Southeast University (hereinafter Southeast) in view of Mehta et al. (hereinafter Mehta).

Regarding claim 11, Southeast discloses data processing software (page 2, Disclosure, signal analysis section using impact data) and recorded data records (page 1, Summary, recording impact force data in time, and transmit to computer).
Southeast does not explicitly disclose an automated data quality check to check data.
Mehta generally discloses a method and apparatus for intelligent control and monitoring in a process control system (Title). Further, Mehta discloses an automated data quality check to check data (Fig. 5, block 256, "data good?", col. 17, lines 22-24, routine includes quality check on collected data).
It would have been obvious to one of ordinary skill in the art at the time of the invention that the bridge diagnostic data of Southeast be subject to a data quality check, as suggested by Mehta, for the benefit of invalidating bad data (Mehta, col. 17, lines 32-36).

Regarding claim 12, Southeast discloses the features of claim 11 as outlined above.
Southeast does not explicitly disclose the checking comprises checking for excessive erroneous noise, dropped channels, overloading of the load cells, and/or proper time synchronization of the independent data acquisitions.
Mehta discloses checking comprises checking for excessive erroneous noise, dropped channels (col. 17, lines 26-28, limited function block process variable indicative of no information on the process [dropped channel]), overloading of the load cells, and/or proper time synchronization of the independent data acquisitions.
It would have been obvious to one of ordinary skill in the art at the time of the invention that the bridge diagnostic data of Southeast may be subject to a data quality check checking for whether information exists, as suggested by Mehta, for the benefit of invalidating bad data (Mehta, col. 17, lines 32-36).

Claim 14 lacks an inventive step under PCT Article 33(3) as being obvious over Southeast University (hereinafter Southeast) in view of Korea Maintenance & Control (hereinafter Korea).

Regarding claim 14, Southeast discloses the sensor (sensor 7) and data acquisition program (page 2, Disclosure, signal analysis section using impact data; page 1, Summary, recording impact force data in time, and transmit to computer).
Southeast does not explicitly disclose reference sensors that are synchronized and located on the structure at a point of high modal amplitude relative to other locations on the structure.
Korea generally discloses a system for intelligent monitoring and safety evaluation of a bridge (Title). Further, Korea discloses reference sensors (sensor nodes 100, Drawing 1) that are synchronized and located on the structure (page 2, Description of Embodiments, sensor nodes 100 on slab of bridge establish schedule interval [synchronization] for communication to base node 200) at a point of high modal amplitude relative to other locations on the structure (page 2, Description of Embodiments, acceleration data of vehicle [associated with high modal amplitude of bridge] used to calculate modal matrix of mode of bridge).
It would have been obvious to one of ordinary skill in the art at the time of the invention that the impact load teachings of Southeast may additionally incorporate reference sensors, as suggested by Korea, for the benefit of calculating a mode parameter and characteristic frequency, modal matrix and mode coefficient of a bridge with an experimental modal analysis algorithm (Korea, page 2, Description of Embodiments).

Claims 1-15 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.