(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
18 July 2019 (18.07.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/138410 A1

(51) International Patent Classification:
A43B 3/00 (2006.01) *A61B 5/11* (2006.01)

(21) International Application Number:
PCT/IL2019/050052

(22) International Filing Date:
14 January 2019 (14.01.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
62/617,338 15 January 2018 (15.01.2018) US

(72) Inventors; and
(71) Applicants: **BLUSTAIN, Raphi** [IL/IL]; 29 HaMered Street, 6812511 Tel Aviv (IL). **HOLANDER, Shachar** [IL/IL]; 10 Adam HaCohen Street, 6458516 Tel Aviv (IL).

(74) Agent: **LUZZATTO, Kfir** et al.; LUZZATTO & LUZZATTO, P.O. Box 5352, 8415202 Beer Sheva (IL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,

WO 2019/138410 A1

(54) Title: STEP ANALYSIS DEVICE

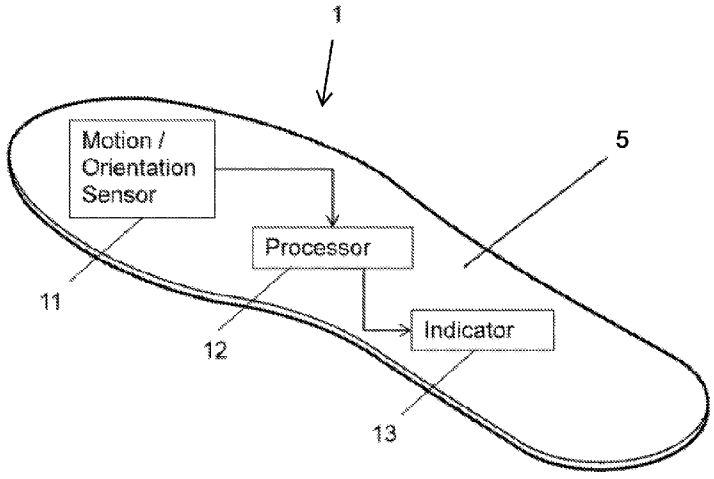

Fig. 1

(57) Abstract: A step analysis device comprises at least one motion sensor for measuring instantaneous direction- specific movement of a user made during an ambulatory activity; at least one deviation indicator for alerting the user during the ambulatory activity upon determination of deviative motion; and a processor for processing signals generated by the at least one motion sensor that are indicative of the instantaneous direction-specific movement, and for comparing the instantaneous direction-specific movement with a normative direction-specific movement. The processor is operable to command the at least one deviation indicator to generate a predetermined biofeedback alert upon determining a deviation greater than a predetermined threshold level between the instantaneous direction-specific movement and the normative direction- specific movement.

[Continued on next page]

EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

STEP ANALYSIS DEVICE

Field of the Invention

The present invention relates to the field of health care. More particularly, the invention relates to a step analysis device that is suitable for correcting bad walking such as in-toeing or out-toeing.

Background of the Invention

In a normal walking style, people walk with their toes pointing substantially forwardly. A deviation from the normal walking style, such as an in-toeing gait or an out-toeing gait, can cause damage to one's ankles, feet, knees, hips and back.

Often people who deviate from the normal walking style do so due to poor walking habits, imbalance of muscle strength or heredity. Many times, walking can be corrected by acquiring good and healthy walking habits.

It is an object of the present invention to provide a compact step analysis device which helps a user to correct bad walking habits.

It is an additional object of the present invention to provide a self-contained step analysis device that is capable of both monitoring a foot position during an ambulatory activity and independently indicating when the foot position needs to be corrected.

Other objects and advantages of this invention will become apparent as the description proceeds.

Summary of the Invention

A step analysis device comprises at least one motion sensor for measuring instantaneous direction-specific movement of a user made during an

ambulatory activity; at least one deviation indicator for alerting the user during the ambulatory activity upon determination of deviative motion; and a processor for processing signals generated by the at least one motion sensor that are indicative of the instantaneous direction-specific movement, and for comparing the instantaneous direction-specific movement with a normative direction-specific movement, wherein the processor is operable to command the at least one deviation indicator to generate a predetermined biofeedback alert upon determining a deviation greater than a predetermined threshold level between the instantaneous direction-specific movement and the normative direction-specific movement.

Even though generation of the biofeedback alert is foot-specific, a step analysis device may be mounted in each shoe of the user such that corresponding processors of first and second step analysis devices are synchronized in a master-slave arrangement to facilitate comparison of corresponding measured signals.

The invention is also directed to a shoe that comprises the step analysis device.

In one aspect, the at least one motion sensor, the at least one deviation indicator, and the processor are housed in a monolithic enclosure that is coupleable with a shoe part of a single shoe.

In one aspect, the processor is operable in inactive, measuring and calibrating modes, and is operable to generate the normative direction-specific movement in the calibrating mode.

In one aspect, the step analysis device is a walk correction device, and the processor is operable to command generation of the biofeedback alert upon

determining an angular difference greater than the predetermined threshold between an instantaneous foot orientation and a normative forward direction of movement.

In one aspect, the processor is operable to command generation of the biofeedback alert upon determining a deviation between an instantaneous running pattern and a reference running pattern.

Brief Description of the Drawings

In the drawings:

- Fig. 1 is a block diagram of an embodiment of a step analysis device, when schematically illustrated from above with respect to a shoe part within which it is mounted;
- Fig. 2 is a block diagram of an embodiment of a step analysis device;
- Fig. 3 is a flow chart for determining whether walk correction is necessary; and
- Fig. 4 is a partial block diagram of another embodiment of a step analysis device, together with other devices with which it is in wireless communication.

Detailed Description of the Invention

The step analysis device of the present invention is adapted to assist in correcting a deviative motion that is made while walking, jogging or running (hereinafter referred to as an "ambulatory activity"), for example caused by poor walking habits. Each placement of the foot on an underlying surface will be referred to a "step". The device is mounted within a single shoe of a user, or to any suitable part associated with the single shoe, and is capable of detecting the deviative motion and of alerting the user that a correction is needed. One implementation of the step analysis device is a walk correcting device that is configured to remind a user to walk in a normal walking style whereby the toes point

substantially forwardly. Since the step analysis device is mounted in a single shoe, the alert is foot-specific, and does not take into consideration the foot position of the other foot.

The device comprises at least one motion sensor, such as an accelerometer, for measuring the user's instantaneous foot position; at least one deviation indicator, such as an LED, a vibration element or an enunciator, for alerting the user when a deviative motion is detected; and a processor for processing measurements from each motion sensor to enable generation of an alert. The device can be mounted on an insole or on any other shoe part worn on a user's foot. In some embodiments, at least one orientation sensor, such as a digital compass, can be used for determining the direction in which the user's foot points.

Fig. 1 schematically illustrates an embodiment of a step analysis device 1, which is mounted on a shoe part 5 and configured to assist in walk correction. A motion / orientation sensor 11 measures the instantaneous foot orientation when walking. One or more are transmitted to a processor 12. Processor 12 processes one or more signals indicative of the measurements and compares this measured orientation to a normative forward direction of movement. If the difference between the instantaneous foot orientation and the normative forward direction of movement is greater than a predetermined threshold or a predetermined angular range (such as greater than a few degrees, e.g. 10-15 degrees, when a foot is pointing inwardly or outwardly instead of pointing straight ahead), processor 12 activates deviation indicator 13 to alert the user as to the deviation. The components of device 1 may be distributed, or alternatively may be mounted monolithically.

A user can personalize the device, for instance by determining the type and duration of alerts, and by determining the device sensitivity (i.e. the minimum difference between measurements made by the processor).

In some embodiments, the device may collect data regarding the walking habits and behavior of a user (e.g., level of a rotational variation of the lower extremity when the foot points toward the midline or away from the midline during gait, and intervals between alerts). The collected data can be used for several applications, e.g., to show the progress of the user for gaining healthy walking habits.

Although the description relates to forward movement, the step analysis device is likewise capable of determining deviative motion during rearward or lateral movement.

Fig. 2 schematically illustrates a walk correcting device 20, according to another embodiment. Walk correcting device 20 comprises a three-axis accelerometer 21 for determining the instantaneous foot orientation, a processor 22 in data communication with accelerometer 21, a deviation indicator 23 in data communication with processor 22, and a battery 26, or other suitable power source together with battery charging and power management circuitry, for powering accelerometer 21, processor 22 and deviation indicator 23. Processor 23 is generally configured with a selector 24, for selecting a mode of operation, whether an inactive mode, a measuring mode for measuring the instantaneous foot orientation, or a calibrating mode. Selector 24 may be activated by an input device, such as a small pressable switch that is accessible to the user, or by means of a remote control device such as one configured with a user interface that is in wireless data communication with a suitable communication device 28, such a short-range transceiver.

Accelerometer 21 is adapted to continuously, periodically or intermittently measure the instantaneous foot orientation of a user during an ambulatory activity. Generated voltage, generally resulting from stressed microscopic crystal structures, is indicative of a velocity vector and thus of the foot orientation. If the angular difference between the instantaneous foot orientation and the normative forward direction of movement is greater than the predetermined threshold, processor 22 activates deviation indicator 23, causing the alert to be provided to the user during the course of the ambulatory activity. Deviation indicator 23 may be embodied by various components such as a LED lamp that generates a perceptible beam, an enunciator that vocalizes a prerecorded message or a buzzing sound, or a vibration element.

A filter 27, usually a low-pass filter, which is in data communication with processor 22, or may be a module of the processor, may be used to improve the calculation output of the processor in the measuring mode and calibrating mode. In a normal walking style, each leg is involved in a different type of motion, such as rocking with the heel, lifting the foot from the floor, extending the knee and hip, flexing the knee and hip, and striking the floor with the foot. Each different type of motion is involved in helping to propel the body forwardly and is associated with varying magnitudes of force applied to the floor, and, through interaction with accelerometer 21, with varying levels of vibrations. Filter 27 is configured to filter out those measurements of the instantaneous foot orientation performed during leg motions which are associated with excessive noise, for example due to shock absorption of an extended knee or lowering the foot, with respect to the floor. Filter 27 may be operable to filter out the signals generated by accelerometer 21 before being transmitted to processor 22 when the corresponding foot displacement in the z-axis is greater than a predetermined threshold or when the corresponding signal to noise ratio is less than a predetermined threshold. For example, filter

27 may attenuate signals greater than 100 Hz. A typical filter may be one with a sample rate of 200 Hz and a cutoff frequency of 60 Hz.

Data measured by accelerometer 21 or processed by processor 22 may be stored in memory device 25, in order to be retrieved at a later time for future analysis.

All of these components may be housed in a monolithic enclosure 29, which is generally rigid, to minimize enclosure movement and to optimize measurement accuracy. The thin device enclosure 29, which generally has the size of a watch, is coupled to a suitable shoe part, such as an insole, outsole, tongue or heel. If so desired, enclosure 29 may be mounted within a dedicated cavity provided with an insole.

Fig. 3 illustrates a flow chart for determining whether walk correction is necessary. The description relates to forward motion of the user, but it is likewise applicable to rearward motion.

Whenever required, for example prior to first time use, the processor is set to calibrating mode in step 33 and the user then makes a few steps forward in step 35. The motion sensor detects the foot orientation for each step, and the processor, after processing the signals generated by the motion sensor that define a corresponding force vector , calculates the normative forward direction of movement in step 37 by combining the corresponding force vectors in accordance with predetermined instructions. Based on the calculated normative forward direction of movement, the processor generates an imaginary reference line in step 39 that corresponds to the calculated normative forward direction of movement, along which the user is expected to continue walking if correct walking habits are exhibited.

After the processor is subsequently set to the measuring mode in step 41, the user naturally and uninhibitedly walks in step 43 while the motion sensor detects the instantaneous foot orientation for each step. The processor processes the signals generated by the motion sensor that are indicative of the instantaneous foot orientation, and compares the instantaneous foot orientation with the normative forward direction of movement in step 45. If the angular difference between the instantaneous foot orientation and the normative forward direction of movement is greater than a predetermined threshold, the processor commands the deviation indicator to generate a predetermined alert signal in step 47. The alert urges the user to consciously or instinctively adjust the foot orientation in step 49. If the alert signal is repeatedly generated after each attempt to adjust the foot orientation, the user realizes that the device enclosure has moved and that calibration has to be performed once again.

Fig. 4 schematically illustrates step analysis device 50. Step analysis device 50 is configured similarly to device 20 of Fig. 2, but with the addition of a gyroscope 53, for measuring three-dimensional spatial motion during ambulatory activities, in addition to, or in place of, the accelerometer, such as in conjunction with a MEMS.

By virtue of the ability to accurately and reliably measure spatial motion, step analysis device 50 is capable of determining whether the user is deviating from the normative forward movement while running or jogging.

Since running motion is different than walking motion, a different calibration procedure is needed. In contrast to walking, both legs of a runner become separated from the ground and sequentially contact with the ground at the center of the foot in a landing stage. Also, the impact onto the ground while running is approximately three times the weight of the body, as opposed to being approximately 90% of body weight while

walking. Additionally, both legs of a runner follow a same line while running and have a relatively long stride.

Accordingly, after the calibrating mode is set, the user wearing step analysis device 50 is instructed to perform a running motion. During the running motion, the one or more motion sensors is able to detect the spatial orientation of various lower body parts such as the knee, ankle and foot for each step, and to distinguish between motions of a running cycle. The processor receives the signals generated by the one or more motion sensors that define a corresponding force vector and calculates the normative forward movement by combining the corresponding force vectors in accordance with predetermined instructions. The calculated normative forward movement is representative of a reference pattern to which is compared the running style of the user which is detected in the subsequent measuring mode. The processor generates a biofeedback alert by means of the deviation indicator upon detecting a deviation from the reference running pattern.

Step analysis device 50 is able to communicate wirelessly with a computerized device 58, such as mobile device, laptop computer and server, so that the acquired and analyzed data is able to be stored in an associated database 59 for later analysis.

A dedicated application may be running on the processor of step analysis device 50, and a user interface 55 may interface with the application by means of communication device 28. User interface 55 may be used for initiating one of the modes of operation, defining various settings, such as those of the deviation indicator and one or more motion sensors, adding an identifier to an analysis session, and uploading a desired reference running pattern from database 59 to the processor.

A reference running pattern may focus on a single motion of a running pattern that needs to be improved or is desired to be emulated, such as the height a foot is lifted from the ground during a take-off stage, the length of a running stride, or the way a foot contacts the ground and becomes separated from the ground, such that an alert will be generated only when the single motion is found to be deviative. Alternatively, all motions of the reference running pattern may be the basis of comparison with the instantaneous running pattern of the user. A score may be calculated from a comparison between corresponding motions of the reference and instantaneous running patterns, according to stored instructions, and an alert will be generated if the score is less than a predetermined threshold.

A reference running pattern may also be uploaded by a training specialist or physician in order to prevent injuries while running. Such a reference running pattern may define restrictions of the user, so that the biofeedback alert will be generated whenever a set user-specific maximum value is exceeded. Exemplary restrictions include a maximum running speed or acceleration.

Step analysis device 50 may also be used as a diagnostic tool, to analyze the performance of athletes during the course of an athletic activity, or to collect statistics or other pre-defined features related to a running session. The data received from step analysis device 50 can be used to compare the athlete's performance at a specific time or event of the athletic activity with stored data, so that the athlete's performance progress can be monitored.

It will be appreciated that any of the aforementioned features of step analysis device 50 are also applicable to a walk correction device.

In one embodiment, a step analysis device 50 is mounted in each shoe of the user. Even though each step analysis device 50 is foot-specific, the two identical step analysis devices may be in wireless communication with each other by the corresponding communication devices 28, allowing the corresponding processors to be synchronized in a master-slave arrangement to compare the corresponding measured signals. Thus one of the step analysis devices may generate a biofeedback alert if the corresponding foot is found to undergo deviative motion, such as being asymmetrical with respect to the other foot.

While some embodiments of the invention have been described by way of illustration, it will be apparent that the invention can be carried out with many modifications, variations and adaptations, and with the use of numerous equivalents or alternative solutions that are within the scope of persons skilled in the art, without exceeding the scope of the claims.

CLAIMS

1. A step analysis device, comprising:
   a) at least one motion sensor for measuring instantaneous direction-specific movement of a user made during an ambulatory activity;
   b) at least one deviation indicator for alerting the user during the ambulatory activity upon determination of deviative motion; and
   c) a processor for processing signals generated by the at least one motion sensor that are indicative of the instantaneous direction-specific movement, and for comparing the instantaneous direction-specific movement with a normative direction-specific movement,

   wherein the processor is operable to command the at least one deviation indicator to generate a predetermined biofeedback alert upon determining a deviation greater than a predetermined threshold level between the instantaneous direction-specific movement and the normative direction-specific movement.

2. The step analysis device according to claim 1, wherein the at least one motion sensor, the at least one deviation indicator, and the processor are housed in a monolithic enclosure that is coupleable with a shoe part of a single shoe.

3. The step analysis device according to claim 1, wherein the processor is operable in inactive, measuring and calibrating modes, and is operable to generate the normative direction-specific movement in the calibrating mode.

4. The step analysis device according to claim 1, which is a walk correction device, and the processor is operable to command generation of the biofeedback alert upon determining an angular difference greater than the predetermined threshold between an

instantaneous foot orientation and a normative forward direction of movement.

5. The step analysis device according to claim 1, wherein the processor is operable to command generation of the biofeedback alert upon determining a deviation between an instantaneous running pattern and a reference running pattern.

6. The step analysis device according to claim 1, wherein the processor is operable to command generation of the biofeedback alert which is foot-specific.

7. The step analysis device according to claim 6, which is mountable in each shoe of the user such that corresponding processors of first and second step analysis devices are synchronized in a master-slave arrangement to facilitate comparison of corresponding measured signals.

8. A shoe, comprising the step analysis device according to claim 1.

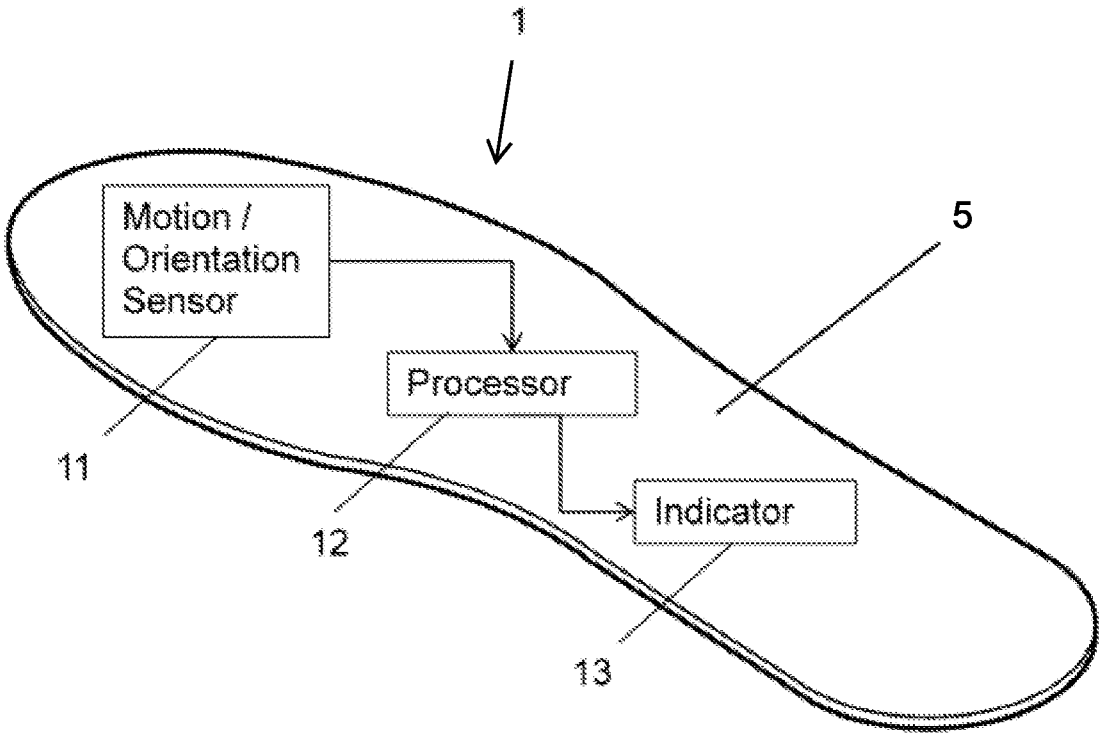

Fig. 1

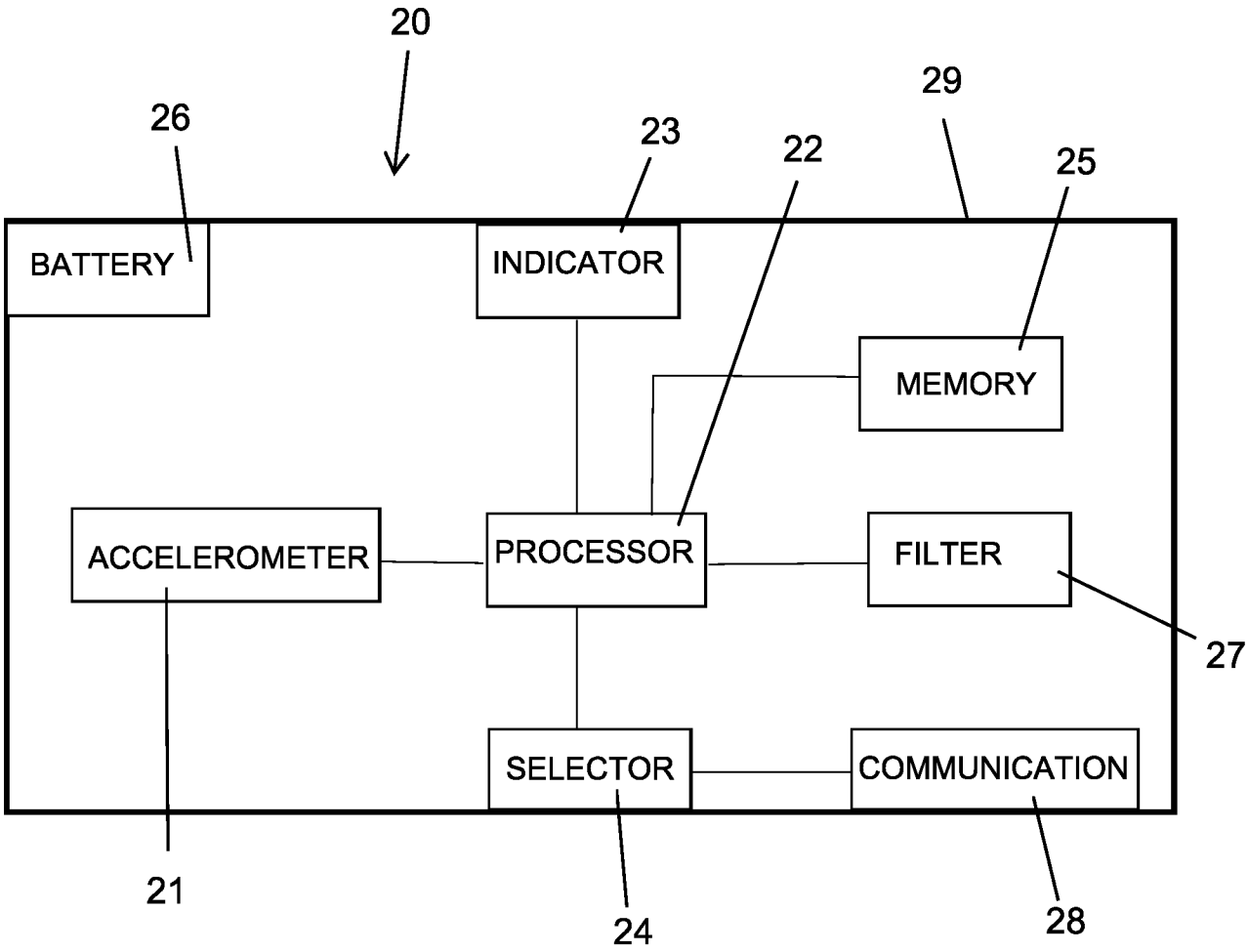
20
26
23
22
29
25
BATTERY
INDICATOR
MEMORY
ACCELEROMETER
PROCESSOR
FILTER
27
SELECTOR
COMMUNICATION
21
24
28

Fig. 2

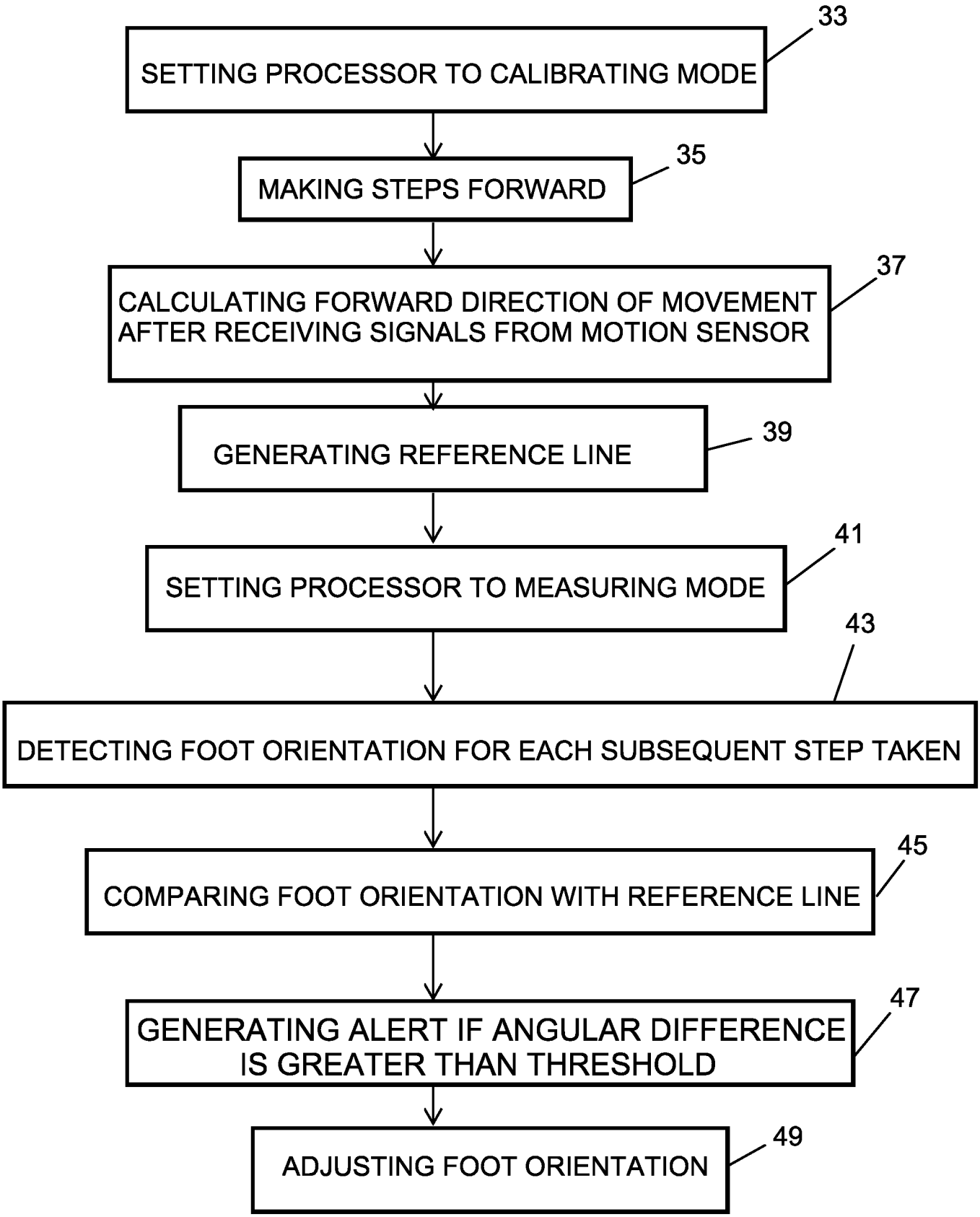
SETTING PROCESSOR TO CALIBRATING MODE
33
MAKING STEPS FORWARD
35
CALCULATING FORWARD DIRECTION OF MOVEMENT AFTER RECEIVING SIGNALS FROM MOTION SENSOR
37
GENERATING REFERENCE LINE
39
SETTING PROCESSOR TO MEASURING MODE
41
DETECTING FOOT ORIENTATION FOR EACH SUBSEQUENT STEP TAKEN
43
COMPARING FOOT ORIENTATION WITH REFERENCE LINE
45
GENERATING ALERT IF ANGULAR DIFFERENCE IS GREATER THAN THRESHOLD
47
ADJUSTING FOOT ORIENTATION
49

Fig. 3

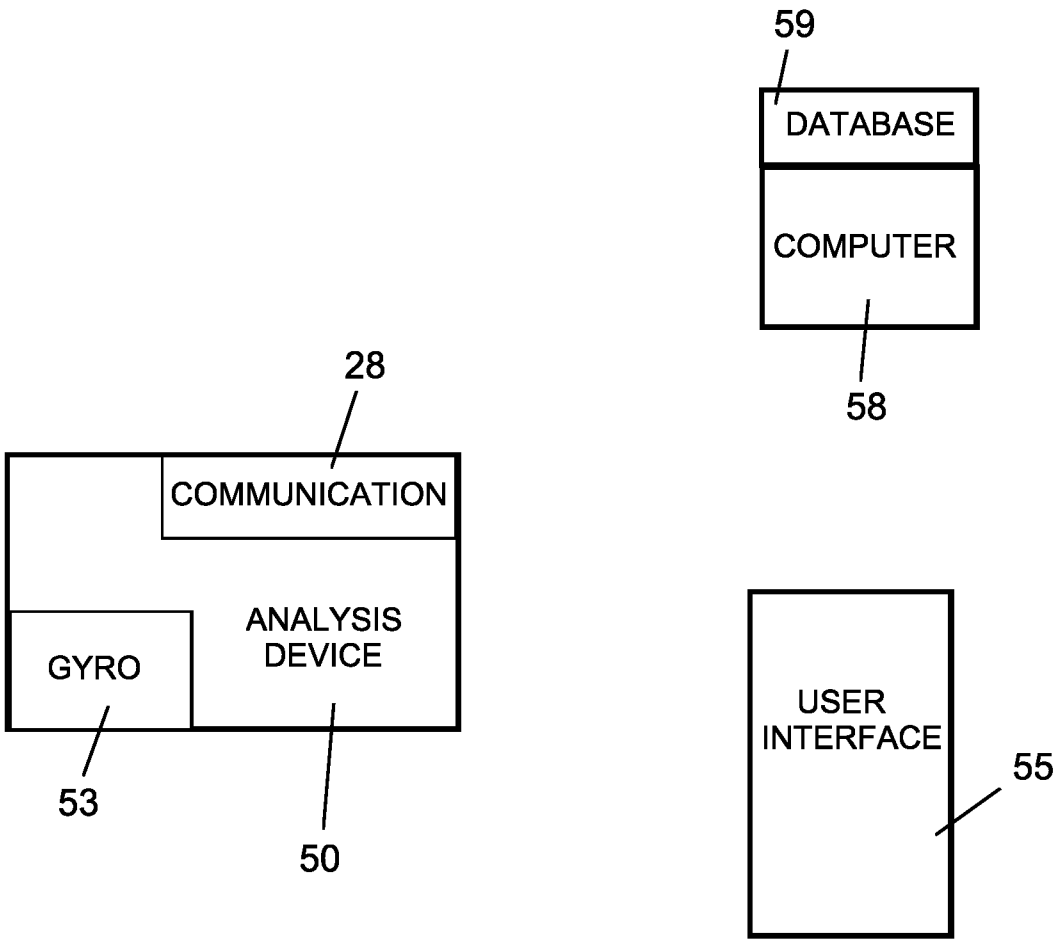
59
DATABASE
COMPUTER
58
28
COMMUNICATION
ANALYSIS DEVICE
GYRO
53
50
USER INTERFACE
55

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2019/050052

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2019.01) A43B 3/00, A61B 5/11

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)
IPC (2019.01) A43B 3/00, A61B 5/11

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)
Databases consulted: Google Patents, Orbit

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2016067584 A1 NIKE, INC. 10 Mar 2016 (2016/03/10) The whole document	1-8
A	US 2016302696 A1 Covenant Ministries of Benevolence Inc 20 Oct 2016 (2016/10/20) The whole document	1-8
A	US 2015257679 A1 MEDHAB, LLC. 17 Sep 2015 (2015/09/17) The whole document	1-8
A	US 2016341611 A1 NIKE INC. 24 Nov 2016 (2016/11/24) The whole document	1-8
A	US 2013324888 A1 SOLINSKY JAMES C 05 Dec 2013 (2013/12/05) The whole document	1-8

[X] Further documents are listed in the continuation of Box C. [X] 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	Date of mailing of the international search report
29 Apr 2019	29 Apr 2019

Name and mailing address of the ISA:	Authorized officer
Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	BITTON Oren Telephone No. 972-73-3927228

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2019/050052

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2014200834 A1 MEDHAB, LLC 17 Jul 2014 (2014/07/17) The whole document	1-8
A	US 2016367191 A1 Sensoria Inc. 22 Dec 2016 (2016/12/22) The whole document	1-8

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
US 2016067584 A1	10 Mar 2016	US 2016067584 A1	10 Mar 2016
		US 9743861 B2	29 Aug 2017
		CN 105453090 A	30 Mar 2016
		EP 2951740 A2	09 Dec 2015
		EP 3096256 A1	23 Nov 2016
		JP 2016508787 A	24 Mar 2016
		JP 6235616 B2	22 Nov 2017
		JP 2018033986 A	08 Mar 2018
		JP 2018033987 A	08 Mar 2018
		KR 20150115871 A	14 Oct 2015
		KR 101787221 B1	15 Nov 2017
		US 2014222173 A1	07 Aug 2014
		US 2016016041 A1	21 Jan 2016
		US 2017303827 A1	26 Oct 2017
		WO 2014121011 A2	07 Aug 2014
US 2016302696 A1	20 Oct 2016	US 2016302696 A1	20 Oct 2016
		US 9591998 B2	14 Mar 2017
		AU 2011285814 A1	28 Feb 2013
		AU 2011285814 B2	09 Jan 2014
		CA 2807590 A1	09 Feb 2012
		EP 2600765 A1	12 Jun 2013
		US 2012035509 A1	09 Feb 2012
		US 8628485 B2	14 Jan 2014
		US 2014094717 A1	03 Apr 2014
		US 9232911 B2	12 Jan 2016
		US 2016081590 A1	24 Mar 2016
		US 9408558 B2	09 Aug 2016
		WO 2012018846 A1	09 Feb 2012
US 2015257679 A1	17 Sep 2015	US 2015257679 A1	17 Sep 2015

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		US 9993181 B2	12 Jun 2018
		EP 2688472 A1	29 Jan 2014
		EP 2688472 A4	27 Aug 2014
		EP 2688472 B1	27 Apr 2016
		US 7969315 B1	28 Jun 2011
		US 2011214501 A1	08 Sep 2011
		US 8384551 B2	26 Feb 2013
		US 2014200834 A1	17 Jul 2014
		US 9453772 B2	27 Sep 2016
		US 2015025816 A1	22 Jan 2015
		US 10004946 B2	26 Jun 2018
		US 2013211281 A1	15 Aug 2013
		US 2015351664 A1	10 Dec 2015
		US 2015351665 A1	10 Dec 2015
		WO 2012128801 A1	27 Sep 2012
		WO 2015026744 A1	26 Feb 2015
		WO 2017030781 A1	23 Feb 2017
US 2016341611 A1	24 Nov 2016	US 2016341611 A1	24 Nov 2016
		US 9810591 B2	07 Nov 2017
		BR 112013021137 A2	04 Dec 2018
		BR 112013021140 A2	07 Aug 2018
		CA 2827683 A1	23 Aug 2012
		CA 2827683 C	09 Feb 2016
		CA 2827684 A1	23 Aug 2012
		CA 2827684 C	27 Sep 2016
		CA 2827685 A1	23 Aug 2012
		CA 2827685 C	03 Apr 2018
		CA 2934186 A1	23 Aug 2012
		CN 102143695 A	03 Aug 2011

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)		Publication Date
		CN 103476283	A	25 Dec 2013
		CN 103476283	B	20 Jan 2016
		CN 103476284	A	25 Dec 2013
		CN 103476284	B	25 Nov 2015
		CN 103476335	A	25 Dec 2013
		CN 103476335	B	09 Jun 2017
		CN 105208888	A	30 Dec 2015
		CN 105361330	A	02 Mar 2016
		CN 105361330	B	15 Feb 2019
		CN 105476158	A	13 Apr 2016
		CN 105476158	B	15 Jun 2018
		CN 105768322	A	20 Jul 2016
		CN 107224026	A	03 Oct 2017
		EP 2330937	A2	15 Jun 2011
		EP 2330937	B1	16 Nov 2016
		EP 2675310	A1	25 Dec 2013
		EP 2675310	B1	04 Jan 2017
		EP 2675312	A2	25 Dec 2013
		EP 2675312	B1	18 Jan 2017
		EP 2675355	A2	25 Dec 2013
		EP 2967187	A1	20 Jan 2016
		EP 3087858	A1	02 Nov 2016
		EP 3167738	A1	17 May 2017
		EP 3178338	A1	14 Jun 2017
		JP 2014505575	A	06 Mar 2014
		JP 5805218	B2	04 Nov 2015
		JP 2014505576	A	06 Mar 2014
		JP 5852141	B2	03 Feb 2016
		JP 2014505574	A	06 Mar 2014
		JP 5899247	B2	06 Apr 2016
		JP 2011524207	A	01 Sep 2011

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		JP 5925490 B2	25 May 2016
		JP 2016019751 A	04 Feb 2016
		JP 6140778 B2	31 May 2017
		JP 2016128023 A	14 Jul 2016
		JP 6194041 B2	06 Sep 2017
		JP 2016052582 A	14 Apr 2016
		JP 6280095 B2	14 Feb 2018
		JP 2016152973 A	25 Aug 2016
		JP 6290292 B2	07 Mar 2018
		JP 2017213419 A	07 Dec 2017
		JP 6463424 B2	06 Feb 2019
		JP 2016515873 A	02 Jun 2016
		JP 2018122098 A	09 Aug 2018
		JP 2018149377 A	27 Sep 2018
		KR 20130130051 A	29 Nov 2013
		KR 101608481 B1	01 Apr 2016
		KR 20140004206 A	10 Jan 2014
		KR 101609839 B1	07 Apr 2016
		KR 20140020275 A	18 Feb 2014
		KR 101618841 B1	10 May 2016
		KR 20160042166 A	18 Apr 2016
		KR 101734473 B1	12 May 2017
		KR 20160054626 A	16 May 2016
		KR 101754997 B1	06 Jul 2017
		KR 20160042142 A	18 Apr 2016
		KR 101780654 B1	25 Sep 2017
		KR 20170054556 A	17 May 2017
		KR 101819070 B1	16 Jan 2018
		KR 20150130475 A	23 Nov 2015
		KR 101879486 B1	17 Jul 2018
		KR 20170081284 A	11 Jul 2017

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)		Publication Date
		KR 101896204	B1	07 Sep 2018
		KR 20180081844	A	17 Jul 2018
		US 2010063778	A1	11 Mar 2010
		US 8676541	B2	18 Mar 2014
		US 2011199393	A1	18 Aug 2011
		US 9002680	B2	07 Apr 2015
		US 2012291563	A1	22 Nov 2012
		US 9089182	B2	28 Jul 2015
		US 2014260689	A1	18 Sep 2014
		US 9279734	B2	08 Mar 2016
		US 2014260677	A1	18 Sep 2014
		US 9297709	B2	29 Mar 2016
		US 2014277632	A1	18 Sep 2014
		US 9410857	B2	09 Aug 2016
		US 2010063779	A1	11 Mar 2010
		US 9462844	B2	11 Oct 2016
		US 2012291564	A1	22 Nov 2012
		US 9549585	B2	24 Jan 2017
		US 2016081418	A1	24 Mar 2016
		US 9622537	B2	18 Apr 2017
		US 2014277631	A1	18 Sep 2014
		US 10024740	B2	17 Jul 2018
		US 2012234111	A1	20 Sep 2012
		US 10070680	B2	11 Sep 2018
		US 2017215765	A1	03 Aug 2017
		US 10182744	B2	22 Jan 2019
		US 2016195440	A1	07 Jul 2016
		US 2017020224	A1	26 Jan 2017
		US 2017079368	A1	23 Mar 2017
		US 2018274996	A1	27 Sep 2018
		US 2018338560	A1	29 Nov 2018

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		US 2019117118 A1	25 Apr 2019
		WO 2009152456 A2	17 Dec 2009
		WO 2009152456 A3	04 Feb 2010
		WO 2012112930 A1	23 Aug 2012
		WO 2012112931 A2	23 Aug 2012
		WO 2012112931 A3	18 Apr 2013
		WO 2012112934 A2	23 Aug 2012
		WO 2012112934 A3	08 Nov 2012
		WO 2014151674 A1	25 Sep 2014
US 2013324888 A1	05 Dec 2013	US 2013324888 A1	05 Dec 2013
---	---	---	---
		US 9186096 B2	17 Nov 2015
		AU 2011219024 A1	18 Oct 2012
		AU 2011219024 B2	02 Jun 2016
		CA 2794245 A1	01 Sep 2011
		CA 2794245 C	17 Jul 2018
		EP 2538842 A2	02 Jan 2013
		EP 2538842 A4	23 Sep 2015
		US 7610166 B1	27 Oct 2009
		US 2010070193 A1	18 Mar 2010
		US 8209147 B2	26 Jun 2012
		US 2011208444 A1	25 Aug 2011
		US 8626472 B2	07 Jan 2014
		US 2015100251 A1	09 Apr 2015
		US 9470763 B2	18 Oct 2016
		US 2017203154 A1	20 Jul 2017
		US 10105571 B2	23 Oct 2018
		US 2013110456 A1	02 May 2013
		US 2013204545 A1	08 Aug 2013
		WO 2011084613 A2	14 Jul 2011
		WO 2011084613 A3	03 Nov 2011

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		WO 2011106099 A2	01 Sep 2011
		WO 2011106099 A3	05 Jan 2012
		WO 2013023004 A2	14 Feb 2013
		WO 2013023004 A3	11 Apr 2013
US 2014200834 A1	17 Jul 2014	US 2014200834 A1	17 Jul 2014
		US 9453772 B2	27 Sep 2016
		EP 2688472 A1	29 Jan 2014
		EP 2688472 A4	27 Aug 2014
		EP 2688472 B1	27 Apr 2016
		US 7969315 B1	28 Jun 2011
		US 2011214501 A1	08 Sep 2011
		US 8384551 B2	26 Feb 2013
		US 2015257679 A1	17 Sep 2015
		US 9993181 B2	12 Jun 2018
		US 2015025816 A1	22 Jan 2015
		US 10004946 B2	26 Jun 2018
		US 2013211281 A1	15 Aug 2013
		US 2015351664 A1	10 Dec 2015
		US 2015351665 A1	10 Dec 2015
		WO 2012128801 A1	27 Sep 2012
		WO 2015026744 A1	26 Feb 2015
		WO 2017030781 A1	23 Feb 2017
US 2016367191 A1	22 Dec 2016	US 2016367191 A1	22 Dec 2016
		AU 2013215287 A1	28 Aug 2014
		CA 2862732 A1	08 Aug 2013
		CN 104219999 A	17 Dec 2014
		EP 2809232 A2	10 Dec 2014
		EP 2809232 A4	01 Apr 2015
		EP 2809232 B1	12 Oct 2016

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2019/050052

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		ES 2618728 T3	22 Jun 2017
		HK 1204898 A1	11 Dec 2015
		JP 2015509028 A	26 Mar 2015
		JP 6272238 B2	31 Jan 2018
		KR 20140123977 A	23 Oct 2014
		US 2013192071 A1	01 Aug 2013
		US 8925392 B2	06 Jan 2015
		US 2015177080 A1	25 Jun 2015
		US 2015182843 A1	02 Jul 2015
		US 2016206242 A1	21 Jul 2016
		US 2017086519 A1	30 Mar 2017
		US 2018003579 A1	04 Jan 2018
		US 2019094088 A1	28 Mar 2019
		WO 2013116242 A2	08 Aug 2013
		WO 2013116242 A3	23 Oct 2014
		WO 2015017712 A1	05 Feb 2015
		WO 2015103442 A1	09 Jul 2015
		WO 2015175838 A1	19 Nov 2015
		WO 2016109744 A1	07 Jul 2016
		WO 2017120063 A1	13 Jul 2017
		WO 2017185050 A1	26 Oct 2017