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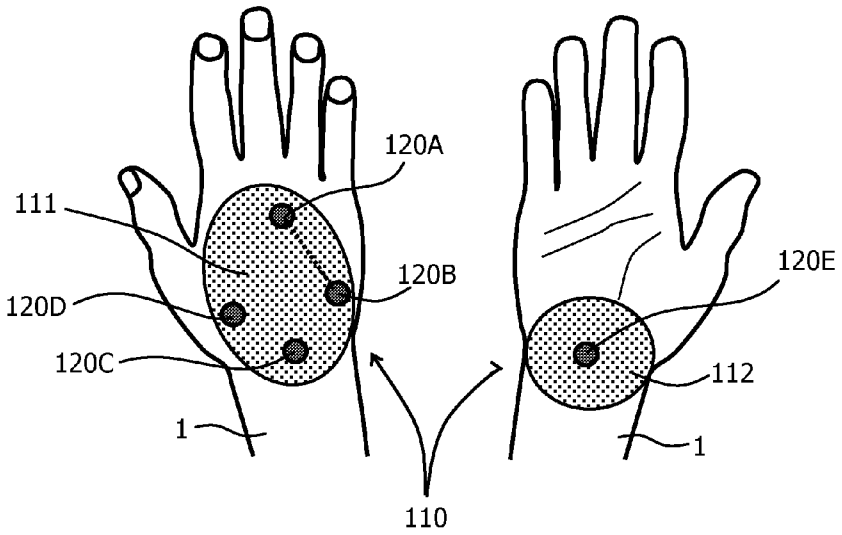

Fig. 1

(57) Abstract: The invention relates to means for detecting and recognizing gestures, particularly different hand gestures. A gesture detection device (110) according to the invention comprises at least one electrode (120A-120E) for measuring an electrical property of the skin of a user, for example the electrical conductance of the skin and/or its change. From these measurement data, different gestures assumed by the body can be recognized.

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Gesture recognition system

FIELD OF THEINVENTION

The invention relates to a gesture detection device and a method for detecting gestures of a user, i.e. to means for collecting data from which a gesture can be inferred. Moreover, it relates to a gesture recognition system and a method for recognizing gestures of a user, i.e. to means for collecting and evaluating data with respect to gestures.

BACKGROUND OF THE INVENTION

In the US 2002/0075232 A1, a system for the recognition of gestures made by a user is described that comprises a glove in which the electrical resistance of a conducting rubber layer is measured. Stretching or compressing of the glove can thus be detected and evaluated with respect to hand gestures made by the user.

SUMMARY OF THE INVENTION

In view of this background, it was an object of the present invention to provide means for reliably detecting and recognizing gestures with little effort of hardware to be worn by the user.

This object is achieved by a gesture detection device according to claim 1, a method according to claim 2, a gesture recognition system according to claim 8, a method according to claim 9, and a computer program product according to claim 14. Preferred embodiments are disclosed in the dependent claims.

According to its first aspect, the invention relates to a gesture detection device for detecting gestures of a user. In the context of the present invention, the term "gesture" shall be understood in a broad sense, comprising any configuration or posture a living body can assume. In particular, gestures shall comprise the postures a human body can voluntarily assume and that represent a symbol for some piece of information, e.g. for a command. The gesture detection device according to the present invention comprises at least one electrode for measuring an electrical property of the skin of the user of the device. In practice, two or more electrodes will typically be used to measure the desired electrical property of the skin.

According to its second aspect, the invention relates to a method for detecting gestures of a user, said method comprising the measurement of an electrical property of the skin of the user. The method comprises in general form the procedures that can be executed by the aforementioned gesture detection device. Remarks, explanations, and definitions made for the gesture detection device will therefore analogously apply for the method, too, and vice versa.

The gesture detection device and the method exploit the measurement of an electrical property of the skin for detecting gestures made by a user, i.e. for providing data from which gestures can be inferred. This approach has the advantage that it requires little hardware effort for data collection. All that is needed is one (or more) electrode(s) in contact to the skin of the user. Moreover, the approach is quite sensitive and reliable, because different gestures will always have some effect on the skin that covers the body parts making said gestures, wherein these effects usually comprise changes in electrical properties of the skin. As said changes are typically local, the electrode(s) is/are favorably attached to regions of the skin that are most affected by the gestures of interest (e.g. regions that are maximally stretched or compressed).

In the following, various embodiments of the invention will be described that relate both to the gesture detection device and the method defined above.

The electrical property of the skin that is measured may in general be any property or value which is affected by different gestures. Preferably, it is a passive electrical property, i.e. a property comprising no active generation of electrical voltages by or in the body of the user. Passive electrical properties comprise for example the capacitance of the skin and, which is a most preferred option, the electrical conductance of the skin. Electrical conductance (or, equivalently, electrical impedance) is a property that can readily be measured and that is at the same time quite sensitive to different gestures because gestures are usually accompanied by the stretching or compressing of different regions of the skin, which in turn affects the local conductance of the skin.

The measured electrical property of the skin may furthermore comprise the CHANGE of one of the aforementioned electrical properties, particularly the change of the electrical conductance of the skin. As an electrical property of the skin usually depends on a variety of influences besides gesture, a particular value of such a property will often not allow to unambiguously determine the corresponding gesture. For example, it is well known that electrical conductance of the skin is influenced by the emotional state of a person. For this reason, the change of an electrical property will often provide a more reliable indicator of

gestures. Changes in electrical properties may particularly occur when a gesture is assumed or stopped, i.e. during the transition from one gesture to another. During such a transition between gestures, other influences on the electrical properties of the skin (e.g. emotional state) usually remain constant. The change of the electrical property can therefore with high reliability be attributed to the change of gestures. It should be noted that the "change" of an electrical property may comprise single values representing a rate of change (i.e. a velocity) as well as a plurality of values representing a "trajectory" of the property.

It was already mentioned that gestures may comprise any configurations or postures the (human or animal) body can assume. In many practically important cases, gestures will comprise postures of the hand because hands are the most natural and versatile "instrument" of humans (after speech) for communicating information.

The at least one electrode that measures an electrical skin property is preferably attached to a hand or a wrist of a user. This allows for the aforementioned preferred detection of hand postures.

In another preferred embodiment of the invention, one or more electrodes are arranged on a flexible carrier, for example a textile mat, that can be attached to the skin and/or wrapped around a part of the body (e. g. the wrist). In this way the application of the usually small electrode(s) can be made more comfortable. Moreover, the carrier helps to guarantee a proper positioning of electrodes, particularly with respect to mutual distances between several electrodes.

The gesture detection device will typically comprise further assistant components that will not all be mentioned in detail, for example a communication device for transmitting (measurement-) data to another device, or a power supply (battery).

According to a third aspect, the invention relates to a gesture recognition system comprising the following two main components:

- A gesture detection device of the kind described above, i.e. a device with at least one electrode for measuring an electrical property of the skin of a user.
- A data processing device for recognizing gestures from the measurement data provided by the aforementioned gesture detection device. The data processing device may for example comprise a microprocessor or an FPGA.

According to a fourth aspect, the invention relates to a method for recognizing gestures of a user, said method comprising the recognition of gestures from measurement data of an electrical property of the skin of the user.

The gesture recognition system and the method according to the third and fourth aspect of the invention are related to the RECOGNITION of gestures, i.e. to the evaluation or interpretation of measurement data with the aim to assign a gesture from a set of possible gestures to these data. With the data processing device, the gesture recognition system comprises a component that allows to do such an evaluation automatically. The result of this automatic recognition procedure can then be further used by other components, for example to control CE devices like a VCR, a CD/DVD player or the like.

As far as the gesture recognition system and the method according to the third and fourth aspect of the invention make use of the measurement of an electrical property of the skin, the remarks, explanations and definitions made above for a gesture detection device and the associated method apply, too. Moreover, the system and the method can be realized with the particular embodiment described in the following.

According to one particular embodiment, a plurality of temporally consecutive measurement data is evaluated to recognize a gesture. The measurement data may belong to one gesture or several consecutive gestures. This approach provides a way to deal with a high variability of measurement data that is characteristic for electrical skin properties (as for biological parameters in general). The approach takes into account that a single measurement value often does not allow a reliable association to some gesture. For this reason, a plurality of measurement data belonging to an (initially unknown) gesture is collected, wherein these data are typically spread according to the variability of the electrical property. The whole set of data will however typically be distributed over a characteristic range or interval, which is more reliably associated to a certain gesture. Thus the measurement of electrical properties for some period, for example for several seconds, can in general help to increase the accuracy of gesture recognition.

According to a related embodiment, gestures are recognized from measurement data obtained during a transition between gestures. As was already explained above, measuring a change of electrical properties can often be used to more reliably infer the associated gesture. This is particularly true if the changes are due to a transition between gestures.

In a particular embodiment of the gesture recognition system, the gesture detection device and the data processing device are physically separate components that are (functionally) coupled via a wireless communication link. The gesture detection device, which has to be carried by a user, can thus be made as light as possible, while the necessary

computing power for gesture recognition and data evaluation can be accommodated in the (stationary) data processing device.

According to another embodiment of the gesture recognition system, the gesture detection device and the data processing device constitute an integrated apparatus. An advantage of this approach is that only a minimal amount of data, namely the recognized gesture, has to be communicated to the outside.

The recognition method according to the fourth aspect of the invention will typically be realized with the help of a computing device, e.g. with the data processing device of the gesture detection device. Accordingly, the present invention further includes a computer program product which provides the functionality of any of the methods according to the present invention when executed on a computing device.

Further, the present invention includes a data carrier, for example a floppy disk, a hard disk, an EPROM, or a compact disc (CD-ROM), which stores the computer product in a machine readable form and which executes at least one of the methods of the invention when the program stored on the data carrier is executed on a computing device. The data carrier may particularly be suited for storing the program of the computing device mentioned in the previous paragraph.

Nowadays, such software is often offered on the Internet or a company Intranet for download, hence the present invention also includes transmitting the computer product according to the present invention over a local or wide area network.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter. These embodiments will be described by way of example with the help of the accompanying drawings in which:

Figure 1 illustrates a top view (left) and a bottom view (right) of a gesture detection device attached to the hand of a user;

Figure 2 illustrates different gestures of the hand that can be recognized;

Figure 3 schematically shows components of a gesture recognition system realized by two distinct devices;

Figure 4 schematically shows components of a gesture recognition system realized by an integrated device.

Like reference numbers in the Figures refer to identical or similar components.

DESCRIPTION OF PREFERRED EMBODIMENTS

Gesture based interaction between a user and a controlled device is seen as a promising new interface design that may replace the use of classical buttons or a mouse. However, there are presently only few commercial applications of this approach (except touch screen "2D" gestures). This is due to the fact that a robust and simple recognition of gestures is challenging.

Many approaches to gesture recognition have significant disadvantages, for example the necessity to wear a particular (expensive and inconvenient) suit or glove. Video based gesture recognition usually does not require a user to wear or hold any additional devices, but it has a number of other disadvantages. For example, the hand of the user needs to be visible to the camera at all times, making this approach completely unusable in certain contexts (e.g. riding a bike, walking outside, etc.). Moreover, robustness depends very much on the illumination and contrast, which can change drastically depending on the environment or time of the day.

In view of this, a new approach for gesture detection and recognition is proposed here. An essential feature of this approach is the use of the skin and body conductance and/or its change in time to recognize postures or gestures.

Figure 1 schematically illustrates a gesture detection device 110 for detecting different hand gestures according to the aforementioned general principle. The gesture detection device 110 comprises a first flexible carrier or patch 111 in which four electrodes 120A, 120B, 120C, and 120D are integrated at fixed locations. The first flexible patch 111 is attached to the upper side of the hand 1 of a user as shown in the left part of Figure 1.

Additionally, the gesture detection device 110 comprises a second flexible patch 112 with a single electrode 120E, said patch 112 being attached to the palm/wrist as shown in the right part of Figure 1 (it should be noted that Figure 1 shows a top and a bottom view of the same hand 1).

The basic principle of the proposed method is the measurement of conductance (or resistance) between two points (connectors) located on the skin of a user. With the gesture detection device 110, for example the conductance between any two electrodes can be measured (e.g. the conductance S_{AB} between electrodes 120A and 120B). As the user changes the hand posture, the conductance is also changed, for example because of the skin stretching between two points. Different gestures – some examples are illustrated in Figure 2 – will thus have different effects on the conductance.

Figure 3 schematically shows a gesture recognition system 100 according to the present invention. The gesture recognition system 100 comprises two main components:

1. A gesture detection device 110 which provides the raw data needed for gesture recognition. The gesture detection device 110 comprises a conduction measuring unit, for example realized by the elastic patches 111 and 112 with electrodes 120A–120E of Figure 1. Moreover, it comprises a wireless communication unit 120 (not shown in Figure 1) for communicating measurement data provided by the conduction measuring unit to a data processing device 150. Furthermore, a battery is required for providing power for the communication unit and for measuring conductivity.

2. The aforementioned data processing device 150 (or "recognition engine"), which is programmed to evaluate the measurement data provided by the gesture detection device 110. Based on the result of the data processing device 150, various components and/or processes may be controlled in further modules 160. These modules 160 and the data processing device 150 may for example belong to a media layer 170.

Figure 4 shows a modified gesture recognition system 100', in which the data processing device 150' is integrated with the gesture detection device 110'. A wireless communication unit 120 can be used for communicating the results of the recognition process to a controlled device 170.

In the embodiment of Figure 4, the device worn by the user will require some processing power. However, the data transfer is significantly reduced as no raw data have to be transmitted.

The above embodiments of the invention can be modified in a variety of ways. For example, if conductance is measured only between two points, the set of gestures that can be recognized is rather limited since many gestures will have the same or only a very small effect on conductance. The proper location of the two measurement points (electrodes) also affects the set of recognizable hand postures. For this reason, it is preferred that conductance is measured between more than two points.

The conductance of the skin is affected by many factors, and therefore measuring an immediate conductance will usually not give a good estimate of the gesture (even immediately after a calibration). Instead a range of values over a short period of time can be measured. This "string" of values can then be used to recognize the gesture. The techniques that are used to recognize 2-dimensional gestures on a flat touch panel can be employed to recognize such a string of values. For example the SVM (Support Vector

Machine) method can be used for this. Details about this method may be found in literature (e.g. Corinna Cortes and V. Vapnik, "Support-Vector Networks", Machine Learning, 20, 1995).

Moreover, the change in conductance may be determined. This change may be measured either during a transition from one gesture to another (e.g. transition from fist to open palm), or when a gesture already made.

Figure 1 shows an embodiment in which a flexible thin device 110 is simply "stuck" to the skin (in the same fashion as a medical patch). Depending on the application at hand, a "wristband user interface" design might instead be preferred, which is made in the form of a wristband wrapped around the wrist.

In summary, the present invention discloses an unobtrusive method for supporting gesture based interaction. The method allows to identify for example finger and hand postures (e.g. fist, open palm, OK, etc). It is based on measuring the skin and body conductance at the few spots on the user's body. Based on differences in the skin and body conductance, the particular posture can be uniquely identified.

An essential feature of the invention is the scalability of the method, i.e. based on the required precision and the required set of gestures, the location and number of required contacts between which conductance is measured can be estimated. In the simplest case only two contact points are required. So for the light weight consumer applications a simple flat patch like device equipped with wireless communication can be created.

A user interface according to the invention can for example be used for supporting simple effortless gesture interaction with different appliances and systems including CL devices (kitchen appliance that will benefit from touch less interaction, portable devices such as mp3 player etc.), healthcare devices, and the like.

Finally it is pointed out that in the present application the term "comprising" does not exclude other elements or steps, that "a" or "an" does not exclude a plurality, and that a single processor or other unit may fulfill the functions of several means. The invention resides in each and every novel characteristic feature and each and every combination of characteristic features. Moreover, reference signs in the claims shall not be construed as limiting their scope.

CLAIMS:

1. A gesture detection device (110, 110') for detecting gestures of a user, comprising at least one electrode (120A–120E) for measuring an electrical property of the skin of the user.

2. A method for detecting gestures of a user, comprising the measurement of an electrical property of the skin of the user.

3. The gesture detection device (110, 110') according to claim 1 or the method according to claim 2,
characterized in that the electrical property of the skin comprises the electrical conductance of the skin.

4. The gesture detection device (110, 110') according to claim 1 or the method according to claim 2,
characterized in that the electrical property of the skin comprises the change of the electrical conductance of the skin.

5. The gesture detection device (110, 110') according to claim 1 or the method according to claim 2,
characterized in that the detected gestures comprise hand gestures.

6. The gesture detection device (110, 110') according to claim 1 or the method according to claim 2,
characterized in that the electrode (120A–120E) is attached to a hand (1) or a wrist of the user.

7. The gesture detection device (110, 110') according to claim 1 or the method according to claim 2,

characterized in that the electrode (120A–120E) is arranged on a flexible carrier (111, 112) that can be attached to the skin and/or wrapped around a body part.

8. A gesture recognition system (100, 100'), comprising

- a gesture detection device (110, 110'), particularly according to claim 1, with at least one electrode (120A–120E) for measuring an electrical property of the skin of a user;
- a data processing device (150, 150') for recognizing gestures from the measurement data provided by the gesture detection device (110, 110').

9. A method for recognizing gestures of a user, comprising the recognition of gestures from measurement data of an electrical property of the skin of the user.

10. The gesture recognition system (100) according to claim 8 or the method according to claim 9,

characterized in that gestures are recognized from a plurality of consecutive measurement data.

11. The gesture recognition system (100) according to claim 8 or the method according to claim 9,

characterized in that gestures are recognized from measurement data obtained during a transition between gestures.

12. The gesture recognition system (100') according to claim 8,

characterized in that the gesture detection device (110) and the data processing device (150) are coupled via a wireless communication link.

13. The gesture recognition system (100') according to claim 8,

characterized in that the gesture detection device (110') and the data processing device (150') constitute an integrated apparatus (100').

14. A computer program product for enabling carrying out a method according to claim 9.

15. A record carrier on which a computer program according to claim 14 is stored.

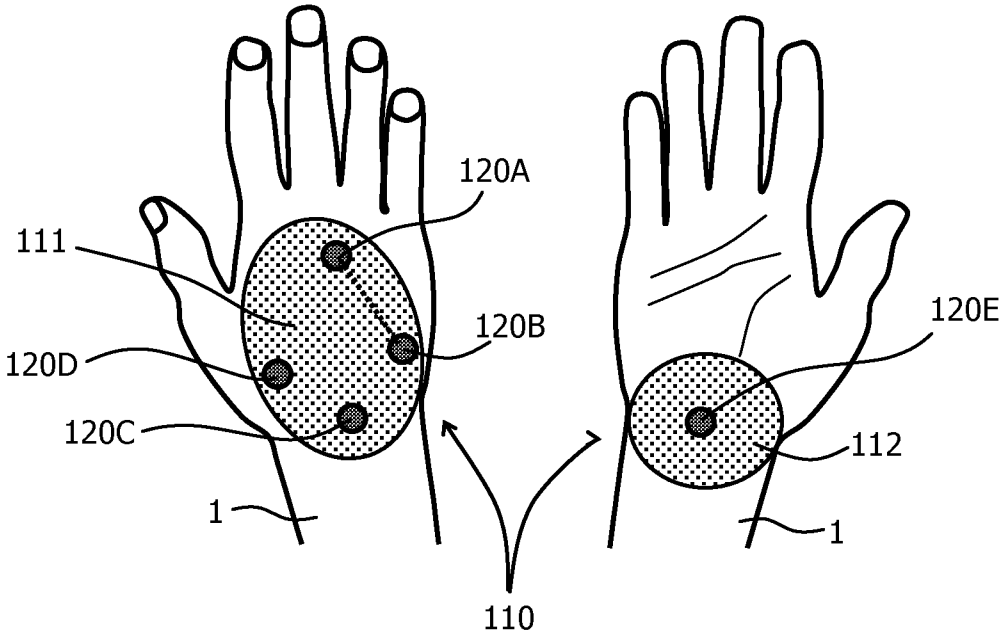

Fig. 1

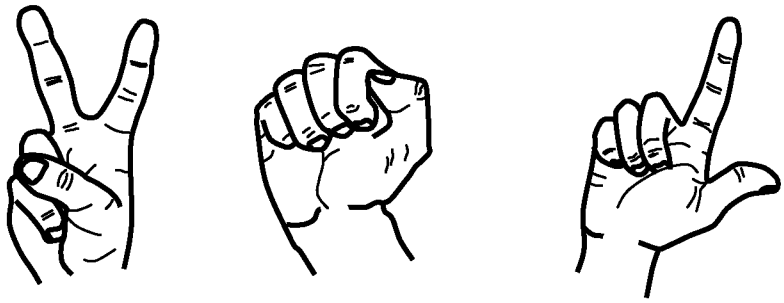

Fig. 2

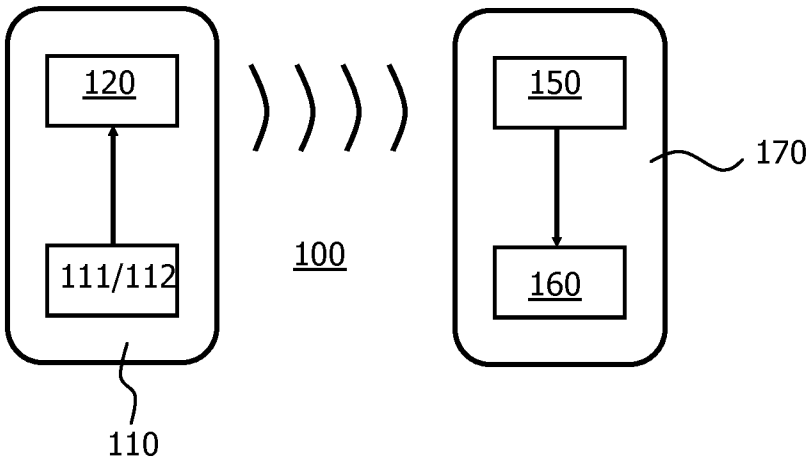

Fig. 3

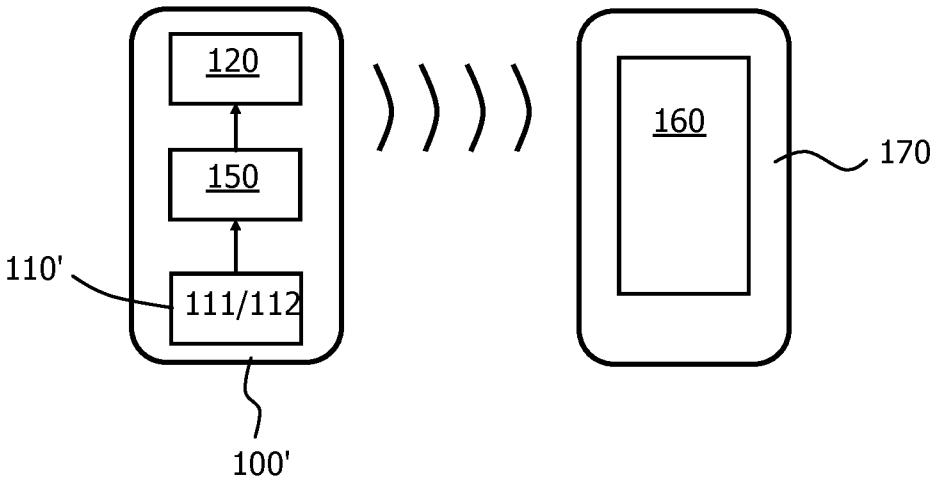

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/050523

A. CLASSIFICATION OF SUBJECT MATTER
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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)
G06F A61B

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, 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	WO 2005/121939 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]; GRUBER THOMAS [AT]) 22 December 2005 (2005-12-22) page 2, line 27 - page 3, line 18 page 4, line 12 - page 5, line 29 page 6, line 21 - page 10, line 14 figures 1-4 -----	1-15

☐ 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	Date of mailing of the international search report
27 April 2012	09/05/2012

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2012/050523

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2005121939 A2	22-12-2005	CN 1965286 A	16-05-2007
		EP 1759265 A2	07-03-2007
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		WO 2005121939 A2	22-12-2005