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(54) Title: AN APPARATUS FOR CONTROLLING AMBIENT STIMULI TO A PATIENT

(57) Abstract: The invention relates to an ambient stimuli control apparatus (100) for controlling an ambient stimuli system (120) capable of presenting ambient stimuli such as music or video for a patient. The apparatus is intended for use during uptake of FDG tracers for patients which have to undergo a PET brain scanning. In order to avoid excitation of inadvertent brain activity which could make the diagnosis of brain diseases more complicated, the apparatus determines different stimuli on the basis of different measured patient characteristics. The different stimuli are capable of reducing the patient's stress level and increasing the patient's awareness if the measured patient characteristics show either too high stress or too high tiredness, respectively.

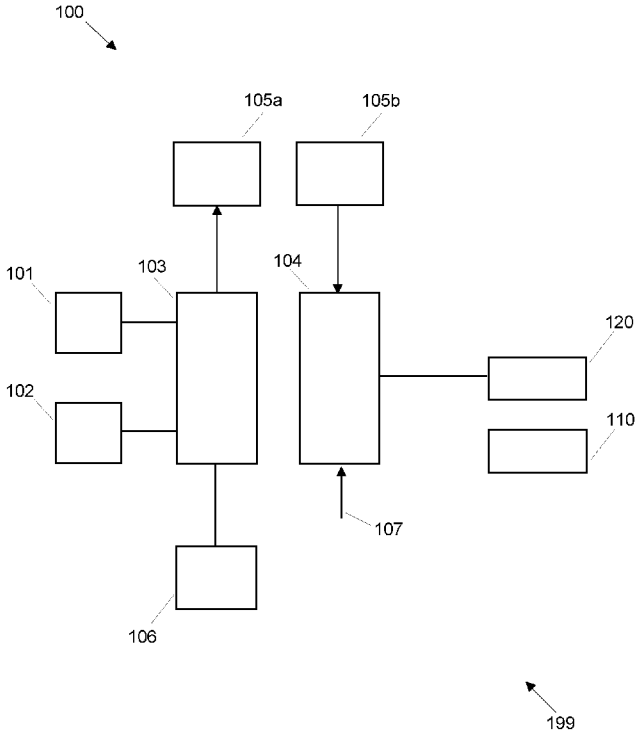


FIG. 1

WO 2014/016719 A1

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An apparatus for controlling ambient stimuli to a patient

FIELD OF THE INVENTION

The invention relates generally to the field of medical devices, specifically to a controller for controlling ambient stimuli to a patient.

BACKGROUND OF THE INVENTION

Position Emission Tomography (PET) may be used to detect various forms of brain diseases such as dementia, e.g. Alzheimer's disease since such diseases affect the metabolic brain activity in a distinctive way. In order to be able to detect the metabolic brain activity, the patient is given a radioactive glucose tracer such as FDG. Since the tracer and thereby the radioactivity is taken up in the brain depending upon the metabolic brain activity, specific patterns of radioactivity in the brain can be measured by a PET scanner. The measured patterns of radioactivity can be used for assisting a clinical diagnosis of brain diseases.

However, the uptake of the tracer may also depend on the patient's brain activity and thereby the patient's mental state and physical behavior. Such inadvertent uptake of radioactive glucose tracer may complicate diagnosis and compromise the specificity of the pattern of measured radioactivity in the brain. The inadvertent uptake of the tracer may even generate false positive results. For example, anxiety or stress but also sleep may affect the uptake of the glucose tracer and may therefore be sources of false positive brain activity compared the distinctive brain activity caused by brain diseases.

Accordingly, there is a need for making diagnosis of brain diseases using FDG-PET methods more reliable and more capable of detecting specific patterns of brain activity caused by brain diseases in spite of presence of noise from other brain activity which is not associated with brain diseases.

WO2008062384 discloses a patient carrier for use in a radiation imaging suite, the patient carrier comprising at least one sensor configured to detect one or more parameters in a group of environmental parameters in the radiation imaging suite and physiological parameters of a

patient positioned on the patient carrier, and an event initiator arranged to initiate an event in the radiation imaging suite based on the one or more detected parameters.

The inventor of the present invention has appreciated that improved methods for making diagnosis of brain diseases using FDG-PET is of benefit, and has in consequence devised the present invention.

SUMMARY OF THE INVENTION

It would be advantageous to achieve improvements within methods for making diagnosis of brain diseases using FDG-PET methods. In general, the invention preferably seeks to alleviate or eliminate problems with correct diagnosing caused by inadvertent uptake of FDG tracers in the brain due to the patient's brain activity. In particular, it may be seen as an object of the present invention to provide a method that solves the above mentioned problems wherein brain patterns caused by brain diseases may be distorted due to inadvertent uptake of FDG tracers, or other problems, of the prior art.

To better address one or more of these concerns, in a first aspect of the invention an ambient stimuli control apparatus for controlling an ambient stimuli system capable of presenting ambient stimuli for a patient is presented that comprises:

- a measurement unit for processing first and second measured patient characteristics, where the first and second measured patient characteristics are different characteristics,
- a stimuli unit configured to determine a first stimulus on the basis of the first measured patient characteristic for reducing a stress level of the patient and a second stimulus on the basis of the second measured characteristic for making the patient more aware, wherein the first and second stimuli can be generated by the ambient stimuli system.

The capability of the control apparatus to determine both a stimulus for reducing stress or a stimulus for making the patient more aware to avoid that the patient falls asleep enables stimulating the patient so that the patient can be calmed in case the patient characteristics indicates too high stress levels and enables stimulating the patient so that the patient can be entertained more in case the patient characteristics indicates that the patient is close to fall asleep.

Thereby, brain activity caused by stress or sleep may be avoided. Consequently, inadvertent uptake of a FDG tracer may be avoided so that brain disease patterns in PET images may be less distorted due to unwanted brain activity. Also the risk of generating false positive PET imaging results may be reduced since patterns in the PET image due to stress or sleep may be avoided.

In an embodiment the first measureable characteristic of the patient is indicative of a stress level and the second measureable characteristic of the patient is indicative of a sleep state level of the patient.

In an embodiment the first and second measured patient characteristics are obtainable from first and second detectors. Advantageously, different types of sensors may be used in order to obtain the most precise measurements of patient characteristics such as stress, sleep state or tiredness. Examples of sensors include stress and sleep sensors.

In an embodiment the measurement unit is configured to store the first and/or second measured characteristics in a storage. Advantageously, the storage of the measured patient characteristics may enable e.g. a doctor to better interpret the PET images since knowledge about specific patient characteristics measured during the uptake period may enable the trained doctor to compensate image results for possible special patient characteristics.

In an embodiment the stimuli unit is configured to determine the first and/or second stimuli also on the basis of patient data provided via an input to the stimuli control apparatus. Use of additional patient data may improve selection of stimuli or enable selection of stimuli which has best effect on the patient.

In a related embodiment the ambient stimuli control apparatus is configured to communicate the patient data to a database and, dependent on the patient data, to retrieve stimuli data relevant for determining the first and/or second stimuli from the database. Accordingly, by comparing patient data with similar patient data in the database it may be possible to determine stimuli which has shown good results for other patients with patient data similar to the current patient. The patient data in the database may have been obtained from previous patients which have been stimulated by stimuli determined by the stimuli control apparatus or other stimuli systems.

In an embodiment the ambient stimuli control apparatus is configured to communicate the first and/or second measured patient characteristics to a staff information device. Accordingly, the staff may be notified in case of abnormal patient characteristics enabling the staff to intervene, e.g. wake up the patient.

In an embodiment the ambient stimuli control apparatus further comprises a patient guiding function configured to guide to patient to perform particular acts.

A second aspect of the invention relates to an ambient stimuli control system comprising:
- an ambient stimuli control apparatus according to the first aspect, and
- an ambient stimuli system.

A third aspect of the invention relates to a method for controlling an ambient stimuli system capable of presenting ambient stimuli for a patient, the method comprises:
- processing first and second measured patient characteristics of the patient by use of a measurement unit, where the first and second measured patient characteristics are different characteristics,
- determining a first stimulus on the basis of the first measured patient characteristic for reducing a stress level of the patient or determining a second stimulus on the basis of the second measured characteristic for making the patient more aware by use of a stimuli unit,
- generating the determined first stimulus or the determined second stimulus by communicating the determined first stimulus or the determined second stimulus to the ambient stimuli system.

In general the various aspects of the invention may be combined and coupled in any way possible within the scope of the invention. These and other aspects, features and/or advantages of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

In summary the invention relates to an ambient stimuli control apparatus for controlling an ambient stimuli system capable of presenting ambient stimuli such as music or video for a patient. The apparatus is intended for use during uptake of FDG tracers for patients which have to undergo a PET brain scanning. In order to avoid excitation of inadvertent brain

activity which could make the diagnosis of brain diseases more complicated, the apparatus determines different stimuli on the basis of different measured patient characteristics. The different stimuli are capable of reducing the patient's stress level and increasing the patient's awareness if the measured patient characteristics show either too high stress or too high tiredness, respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be described, by way of example only, with reference to the drawings, in which

Fig. 1 shows an ambient stimuli control apparatus 100 and a stimuli control system 199.

DESCRIPTION OF EMBODIMENTS

Fig. 1 shows an ambient stimuli control apparatus 100 for controlling an ambient stimuli system 120. The ambient stimuli system may comprise an audio system capable of generating music or sounds for the patient, a video system capable of displaying video or images for the patient or other devices capable of presenting ambient stimuli for a patient. In general the ambient stimuli system may comprise one or more ambient stimuli devices or systems, e.g. an audio system combined with a video system.

The ambient stimuli control apparatus 100 comprises a measurement unit 103 for processing first and second measured patient characteristics. The first and second measured patient characteristics are different characteristics. For example, the first characteristic of the patient may be indicative of a stress level and the second measureable characteristic of the patient may indicative of a tiredness level of the patient.

The first and second patient characteristics may be obtained from a single detector, or they may be obtained from individual first and second detectors 101, 102 (respectively) which may be different detectors or similar detectors. The first and second detectors 101, 102 are normally different detectors suited for measuring different patient characteristics. However, the first and second detectors could also be the same physical detector capable of measuring different characteristics.

The first detector 101 may be a skin conductance detector such as a wristband detector capable of measuring the skin conductance. Skin conductance is indicative of the stress level of the patient, i.e. a low skin conductance indicates a relative high stress level. The first detector 101 could also be a heart rate detector since heart rate may also be indicative of the stress level. The first detector may also be embodied by a patient input means, e.g. a stress button, enabling the patient to indicate the current stress level by self-reporting.

The second detector 102 may be a camera configured to detect eye movement or eye-lid position which may be indicative of tiredness of the patient. E.g. if the eye-lid is almost closed, this may indicate that the patient is about to fall asleep. The camera detector may also be able to measure heart rate by measuring chest movements. Accordingly, the first and second detectors 101,102 could be embodied by the same detector, i.e. the same camera or two different cameras.

The second detector 102 could also be a brain detector capable of detecting brain signals such as alpha-waves. The level of alpha-waves is indicative of the tiredness or relaxation level of the patient and, therefore, the brain detector could embody the second detector 102 for detecting tiredness levels of the patient.

The second detector 103 may also be embodied by a patient input means, e.g. a tiredness button, enabling the patient to indicate if he or she feels tired.

Accordingly, examples of the first patient characteristic comprise stress level, skin conductance, respiration rate and heart rate. Examples of the second patient characteristic comprises tiredness level, relaxation level, eye-lid position, heart rate, respiration rate and alpha-wave level.

The processing capability of the measurement unit 103 may comprise receiving measurement signals from the first and second detectors 101, 102, scaling the detector signals or otherwise converting the signals into a form suitable for the stimuli unit 104. The processing capability may also comprise combining signals from the first and second detectors into a single signal, e.g. a signal wherein high signal levels indicate a high stress level and low levels indicate a high level of tiredness.

The ambient stimuli control apparatus 100 further comprises a stimuli unit 104 configured to determine a first stimulus on the basis of the first measured patient characteristic for reducing a stress level and a second stimulus on the basis of the second measured value for making the patient more aware or less relaxed.

The first or second stimulus determined by the stimuli unit 104 may be in the form of a stimulus descriptor containing an ID number or name of the stimulus or the determined stimulus may contain the content of the stimulus. For example, the determined stimulus may be data (e.g. mp3 coded data) containing a piece of music or the stimulus may an ID number defining the same piece of music. The stimuli unit 104 or the stimuli control apparatus 100 is configured to communicate the determined stimulus to the ambient stimuli system 120 which is able to generate the desired stimulus, e.g. by playing the music data containing the piece of music or by retrieving the piece of music from a music database based on the received ID number.

The first or second stimulus could also define a change of a stimulus, e.g. an increase or decrease in volume of an audio stimulus, an increase or decrease of room lighting intensity or room temperature, a change of the color setting of ambient room lighting or other changes of ambient stimuli.

Accordingly, by means of the stimuli unit 104 and the measured first and second patient characteristics it may be possible to affect or stimulate the patient by means of the first and second stimuli so that the patient at one hand is calmed by the first stimulus to avoid too high stress levels and at the other hand is entertained by the second stimulus to avoid that the patient falls asleep. In other words, it may be possible to stabilize the mental state and, thereby, the brain activity to a balanced mental state where the patient it neither too stressed/excited nor too relaxed/sleepy. It is understood the first and second stimuli are not generated at the same time.

Since the mental state - and thereby brain activity - of a patient can be controlled it may be avoided that the brain activity shows patterns corresponding to high stress levels and patterns corresponding to sleep. Thereby, it may be achieved that brain disease characteristics such as Alzheimer's disease characteristics in brain images obtained by a PET scanner after a FDG

tracer has been taken up by the patient's brain are not compromised or distorted by specific brain activities generated by stress or sleep.

Even though the patient should not sleep during the uptake of the FDG tracer, it may be desired that the patient keeps the eyes closed in order to avoid brain activity in the visual cortex. Therefore, the stimuli control apparatus may comprise a patient guiding function 110 configured to guide the patient to keep the eyes closed or to guide to patient to perform other particular acts. For example, the guiding function 110 may be an audio system containing a recorded voice that reminds the patient to keep the eyes closed during the uptake period.

When reference is made to a patient's stress level, e.g. in connection with use of the first stimulus for reducing a stress level, the term "stress" should be understood broadly to include similar mental states. For example, the first stimulus may be equally suited for reducing the patient's excitement, restlessness or anxiety. A stress state level may refer to how stressed, relaxed or anxious a patient is.

Similarly, when reference is made to a patient's awareness level or sleep state level, e.g. in connection with use of the second stimulus for increasing awareness or measurement of a patient characteristic, the term awareness should be understood broadly to include similar mental states. For example, the second stimulus may be equally suited for reducing tiredness, changing the sleep state level away from sleep, reducing tendency to fall asleep, or reducing the relaxation level of a patient. A sleep state level may refer to how tired, aware or relaxed a patient is.

The measured patient characteristics may advantageously be stored in a storage or database 105a. The stored measurement data may be used for interpretation of images obtained from the PET scan. For example, if the stored measurement data shows large levels of the first patient characteristics the patient may have been very stressed during the uptake period despite attempts to calm the patient by use of the ambient stimuli. Clinical experts may be able to determine a more precise diagnosis when it is known that the patient has been highly stressed. Similarly, the measured second patient characteristics may show that the patient had eyes open during a period in the PET uptake phase despite being instructed to keep eyes closed. Knowing that the patient had eyes open may explain high brain activity in the visual cortex area in the brain and, thereby, enable the clinical experts (e.g. a doctor) to correct the

images for these additional patterns of high brain activity. Thus, the stored patient characteristics may be presented to the clinical staff for manual correction of the PET images, or the patients characteristics may be made available for PET analysis software for computer assisted analysis of PET images or PET results. The storage of the first and/or second measured patient characteristics may be enabled by the measurement unit 103 being configured to store the patient characteristics in the storage 105a.

The first and/or second stimuli may be determined both on the basis of measured patient characteristics and other patient data such as age, gender, nationality, preferences for music/video genres and other non-measured patient characteristics. Thereby, it may be possible to determine a stimulus which has a higher chance of affecting the patient as desired. For example, if the patient is a female the stimuli unit 104 may be configured to not select soccer as a stimulation for making the patient more aware, since soccer may have the opposite effect on a female, i.e. making the female patient more tired. Accordingly, the stimuli unit 104 may be configured to determine the first and/or second stimuli also on the basis of patient data provided via an input 107 to the stimuli control apparatus 100. The input 107 may be a user interface enabling the patient of clinical staff to input such additional patient information.

The patient data provided via the input 107 may be communicated by the stimuli unit 104 to a database 105b in order to compare the patient data with stored patient data in the database. For example, the provided input data may identify the patient as a male with preferences for jazz music. The input data can be compared with data entries in the database 105b obtained from previous patients in order to find data entries with similar patient data characteristics (gender=male, preference=jazz). After having found the most similar data entry, information from the data entry about the effect of different stimuli (e.g. different pieces of music) on the patient may be utilized so that only the most effective stimuli are used for the new patient.

It may be advantageous to communicate the first and/or second measured patient characteristics to a staff so that the staff can react e.g. in case the measured patient characteristics shown that the patient has fallen asleep despite the attempt to make the patient more aware by use of suitable stimuli. For that purpose the ambient stimuli control apparatus 100 may be configured to communicate the first and/or second measured patient characteristics to a staff information device 106. The communication of the measured patient

characteristics may be made dependent measured characteristics, e.g. dependent on the size of measured values, so that data are only communicated if an intervention by the clinical staff is required.

Whereas the ambient stimuli control apparatus 100 may be an independent system which is connectable with different kinds of ambient stimuli systems or devices 120, the ambient stimuli control apparatus 100 could also be configured as an ambient stimuli control system 199 which contains both an ambient stimuli control apparatus 100 and an ambient stimuli system or device 120. For example, the ambient stimuli control apparatus 100 and an ambient stimuli device 120 may be integrated into a bed side unit.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single processor or other unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS

1. An ambient stimuli control apparatus (100) for controlling an ambient stimuli system (120) capable of presenting ambient stimuli for a patient, the apparatus comprises:
- a measurement unit (103) for processing first and second measured patient characteristics, where the first and second measured patient characteristics are different characteristics,
- a stimuli unit (104) configured to determine a first stimulus on the basis of the first measured patient characteristic for reducing a stress level of the patient and a second stimulus on the basis of the second measured characteristic for making the patient more aware, wherein the first and second stimuli can be generated by the ambient stimuli system (120).

2. An ambient stimuli control apparatus (100) according to claim 1, wherein the first measureable characteristic of the patient is indicative of a stress level and the second measureable characteristic of the patient is indicative sleep state level of the patient.

3. An ambient stimuli control apparatus (100) according to claim 1, where the first and second measured patient characteristics are obtainable from first and second detectors (101, 102).

4. An ambient stimuli control apparatus (100) according to claim 1, wherein the measurement unit is configured to store the first and/or second measured characteristics in a storage (105a).

5. An ambient stimuli control apparatus (100) according to claim 1, wherein the stimuli unit (104) is configured to determine the first and/or second stimuli also on the basis of patient data provided via an input (107) to the stimuli control apparatus (100).

6. An ambient stimuli control apparatus (100) according to claim 5, wherein the stimuli unit (104) is configured to determine the first and/or second stimuli on the basis of the patient data by communicating the patient data to a database (105b) and, dependent on the patient data, retrieving stimuli data relevant for determining the first and/or second stimuli from the database (105b).

7. An ambient stimuli control apparatus (100) according to claim 1, configured to communicate the first and/or second measured patient characteristics to a staff information device (106).

8. An ambient stimuli control apparatus (100) according to claim 1, further comprising a patient guiding function (110) configured to guide the patient to perform particular acts.

9. An ambient stimuli control system (199) comprising:
- an ambient stimuli control apparatus (100) according to claim 1, and
- an ambient stimuli system (120).

10. A method for controlling an ambient stimuli system (120) capable of presenting ambient stimuli for a patient, the method comprises:
- processing first and second measured patient characteristics of the patient by use of a measurement unit (103), where the first and second measured patient characteristics are different characteristics,
- determining a first stimulus on the basis of the first measured patient characteristic for reducing a stress level of the patient or determining a second stimulus on the basis of the second measured characteristic for making the patient more aware by use of a stimuli unit (104),
- generating the determined first stimulus or the determined second stimulus by communicating the determined first stimulus or the determined second stimulus to the ambient stimuli system (120).

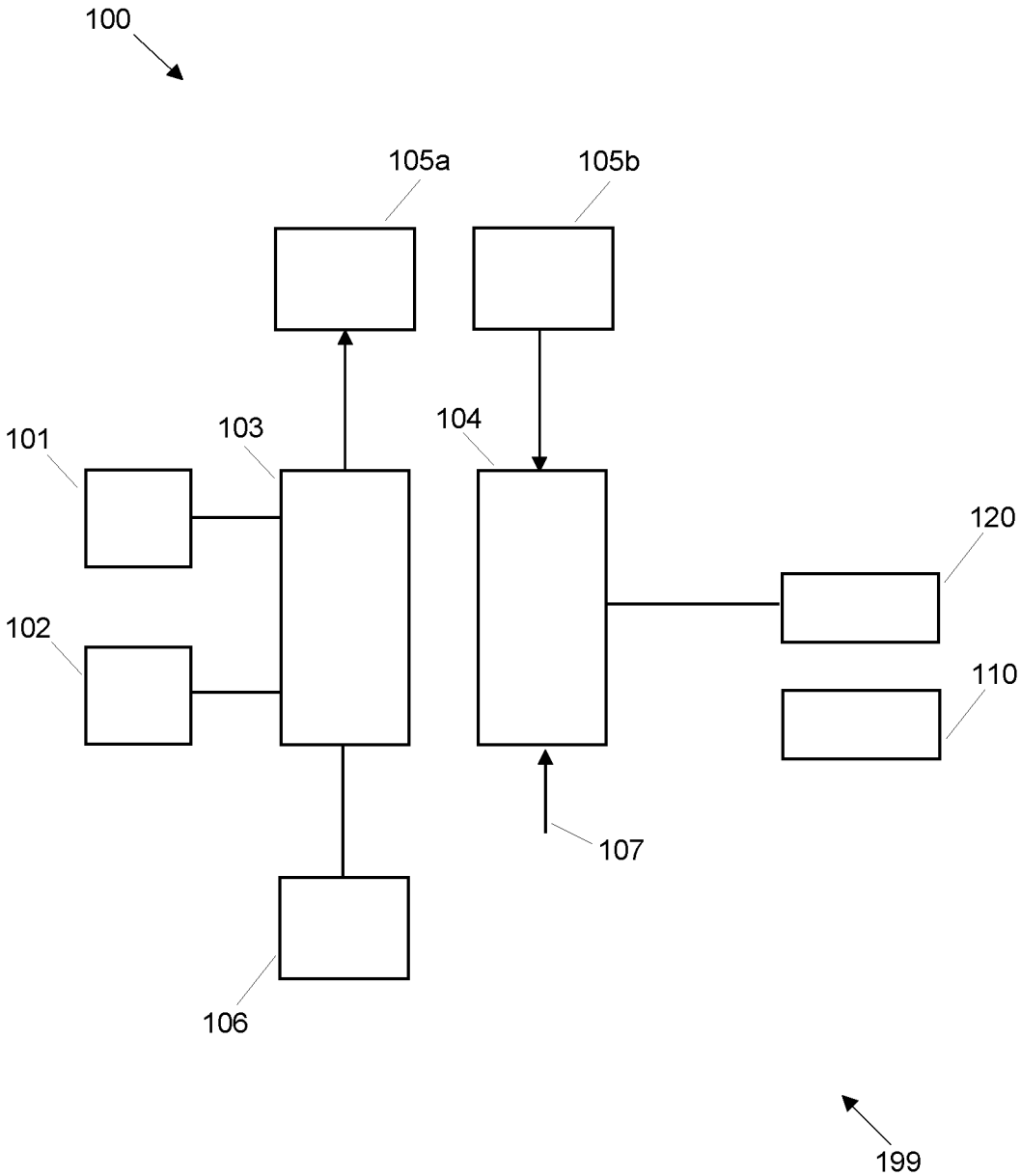


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. A61N5/06 A61B5/024 A61B5/0476 A61B5/053 A61B5/113
A61B5/16 A61M21/02
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)
A61N A61B A61M

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

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X	US 2010/080431 A1 (DATEMA CORNELIS PAUWEL [NL] ET AL) 1 April 2010 (2010-04-01) paragraphs [0002], [0005], [0009], [0019], [0020], [0024], [0025], [0029], [0034]; figure 4	1-3,7-10
X	US 2008/119994 A1 (KAMEYAMA SHOUGO [JP]) 22 May 2008 (2008-05-22) paragraph [0435] - paragraph [0445]	1-3,8-10

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
27 November 2013	05/12/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Koprinarov, Ivaylo

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
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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 2010/070299 A1 (DATEMA CORNELIS PAUWEL [NL] ET AL) 18 March 2010 (2010-03-18) the whole document	1-10

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Information on patent family members

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