Apparatus, software and method for processing images from a patient's heart

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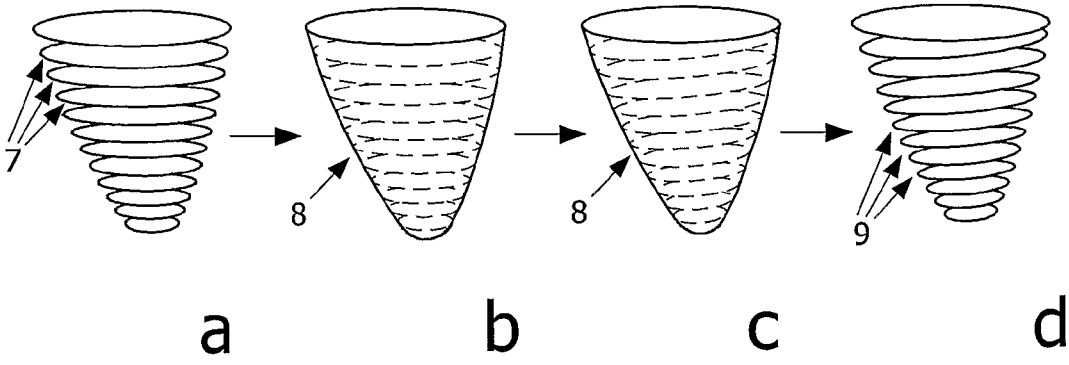
(54) Title: APPARATUS, SOFTWARE AND METHOD FOR PROCESSING IMAGES FROM A PATIENT'S HEART



(57) Abstract: The invention relates to an apparatus for processing images from a patient's heart comprising collecting means for collecting the images and processing means for processing said images in order to identify a necrotic area in the heart's myocardium, whereby the collecting means are arranged to collect functional images of the heart and late enhancement images of the heart, that registration means are provided to register the functional images in relation to the late-enhancement images and mapping means to map myocardial contours in the functional images in register with and onto the late-enhancement images.

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Apparatus, software and method for processing images from a patient's heart

The invention relates to an apparatus for processing images from a patient's heart comprising collecting means for collecting the images and processing means for processing said images in order to indicate a necrotic area in the heart's myocardium.

A cardiac examination usually consists of the acquisition of a number of image-sets:

- functional images: these images are used to visualize wall motion and to quantify parameters such as ejection fraction, stroke volume, cardiac output, wall thickness and wall thickening;

- first-pass perfusion images: these images are used to quantify the inflow of blood into the myocardium (reduced inflow may be an indicator of ischemia);

- late-enhancement images: these images are used to visualize and quantify myocardial necrotic (scar)tissue.

During acquisition of these three image-sets, the patient is situated at almost the same position on a scanner table and during each acquisition the patient is asked to hold his breath. This means that the position of the heart in each of the scans will not differ much.

The late-enhancement images are usually MR-images; the invention is however not restricted thereto but also concerns late-enhancement CT, or ultrasound images or any other suitable type of images. Preferably late-enhancement MR-images are used in view of its high sensitivity and specificity. In view thereof hereinafter the invention will be discussed mainly in relation to the processing of late-enhancement MR-images.

Late-enhancement MR-images are acquired as follows: a contrast agent is injected (usually Gadolineum based) and 15-25 minutes after this injection a set of ECG triggered MR-images is scanned at end diastole (the moment in the heart cycle at which the heart is in a relaxed state).

At present, automatic detection of the myocardial contours in late-enhancement MR-images is hampered by the fact that the pixels in the left ventricle and the pixels in the necrotic (scar)areas in the myocardium often have the same or almost the same grey value.

Consequently, also automatic identification of the necrotic area or areas is difficult. In the state of the art the myocardial contours are therefore manually drawn, which attracts certain disadvantages, i.e.:

- manual contour drawing is a tedious, time-consuming job;
- different persons usually draw different contours, i.e. manual contour drawing introduces inter-observer variability.

An object of the invention is to reduce this problem and to obtain advantages which will become apparent hereinafter.

The apparatus according to the invention is characterized in that the collecting means are arranged to collect functional images of the heart and late-enhancement images of the heart, that registration means are provided to register the functional images in relation to the late-enhancement images and mapping means to map myocardial contours in the functional images in register with and onto the late-enhancement MR-images. This provides the following advantages:

- manual drawing of the myocardial contours in late-enhancement images is no longer needed, which saves a significant amount of time;
- automatic contour detection eliminates inter-observer variability, i.e. it leads to better reproducible results;
- a position in the myocardium in the functional images can be geometrically linked to its corresponding position in the late-enhancement images, so that the results of the quantitative analysis of both types of images can be locally compared (e.g. wall motion from functional images versus scar volume from late-enhancement images).

The present invention provides a more accurate indication of areas that are suspect to be necrotic. Hence, the processed result allows the physician to focus onto such suspect region. Then, the present invention provides a technical aid for the physician to assess suspected regions.

Moreover, it is noted that the method of the present invention may be performed an image data, method actual presence of the patient being required.

It is remarked that the functional images may also be MR-images or any other type of suitable images such as CT-images or ultrasound images. It is preferred however that the functional images are also MR-images.

It is further remarked that the registration of the functional images with the late-enhancement images may be of any type. It can concern rigid, affine or non-rigid registration including as the case may be, translation, rotation and as far as necessary, scaling.

In a further aspect of the invention the apparatus is characterized in that the detection and mapping means include a contour model builder to derive a 3D-model from the detected myocardial contours in the functional images, and a slice-sampler to derive from said 3D-model myocardial contours in register with the late-enhancement images.

This provides a solution to the problem that the heart as monitored in the functional images will be slightly rotated, shifted or deformed with reference to the heart in the late-enhancement images which may be due to for instance different positioning of the lungs after expiration. This prevents direct mapping of contours from the functional images to the late-enhancement images. The just-mentioned feature of the apparatus according to the invention provides a solution for this.

The invention is also embodied in software for a computer to process images from a patient's heart arranged to identify a necrotic area in the heart's myocardium.

The software according to the invention is characterized in that it is arranged to register functional images of the heart in relation to late-enhancement images of said heart, and to select myocardial contours from said functional images and map said myocardial contours in register with and onto the late-enhancement images.

In a further advantageous embodiment the software is further arranged to derive a 3D-model from the detected myocardial contours selected from the functional images, and to derive from said 3D-model myocardial contours in register with the late-enhancement images.

In connection with the software exclusive rights are also requested for a data-carrier provided with such software.

Finally, it is remarked that the invention is also embodied in a method for processing images from a patient's heart, comprising the steps of collecting the images and processing the images to identify a necrotic area in the heart's myocardium.

The method according to the invention is characterized in that functional images of the heart and late-enhancement images of the heart are collected, that the functional images are registered with the late-enhancement images, and myocardial contours in the functional images are mapped in register with and onto the late-enhancement images.

Advantageously the method according to the invention is further characterized in that a 3D-model is built form the detected myocardial contours in the functional images, and samples are taken from said 3D-model to derive myocardial contours in register with the late-enhancement images and placed onto said late-enhancement images.

The invention will hereinafter be further elucidated with reference to an exemplary embodiment and with reference to the drawing.

Fig. 1 shows the apparatus according to the invention.

Fig. 2 shows schematically a preferred embodiment in the mapping of contours from functional MR-images to late-enhancement MR-images.

With reference first to Fig. 1 the apparatus according to the invention is indicated with reference numeral 3. The apparatus 3 comprises in a manner known per se (and therefore not shown) collecting means for collecting images such as a first series of functional images 1 of the heart and a second series of late-enhancement MR-images 2 of the heart. Collecting the functional images may be done before or after collecting the late-enhancement MR-images. The apparatus 3 further comprises processing means 4,5 for processing the images 1,2 with the purpose to identify a necrotic area in the heart's myocardium.

To this end the processing means 4,5 comprise registration means 4 to register the functional images 1 in relation to the late-enhancement MR-images 2 and detection and mapping means 5 to detect myocardial contours in the functional images 1 and to map said myocardial contours in register with and onto the late-enhancement MR-images 2. The result can be shown on a display 6.

The detection and mapping means 5 preferably include a contour model builder to derive a 3D-model from the detected myocardial contours in the functional images 1 and a slice-sampler to derive from said 3D-model myocardial contours 1 in register with the late-enhancement MR-images 2.

The operational functionality of the contour model builder and the slice-sampler is shown with reference to Fig. 2.

Fig. 2a shows a series of contours 7 that are identified in the functional MR-images 1.

Fig. 2b shows a 3D-model 8 which the earlier mentioned contour model builder has derived from the detected myocardial contours 7 detected in the functional images 1.

To compensate for the fact that the heart in the functional images 1 may be slightly rotated, shifted or deformed with reference to the heart in the late-enhancement

images 2, the earlier mentioned slice-sampler samples the 3D-model 8 to compensate same. This is shown in Fig. 2c. The resulting myocardial contours that are in register with the late-enhancement images 2 are referred to with number 9. Fig. 2d again shows these resulting late-enhancement myocardial contours 9.

CLAIMS:

1. Apparatus (3) for processing images from a patient's heart comprising collecting means for collecting the images (1,2) and processing means (4,5) for processing said images (1,2) in order to indicate a necrotic area in the heart's myocardium, characterized in that the collecting means are arranged to collect functional images (1) of the heart and late-enhancement images (2) of the heart, that registration means (4) are provided to register the functional images (1) in relation to the late-enhancement images (2) and mapping means (5) to map myocardial contours in the functional images (1) in register with and onto the late-enhancement images (2).

2. Apparatus according to claim 1, characterized in that the mapping means (5) include a contour model builder to derive a 3D-model (8) from the detected myocardial contours in the functional images (1), and a slice-sampler to derive from said 3D-model myocardial contours in register with the late-enhancement images (2).

3. Apparatus according to claim 1 or 2, characterized in that at least the late-enhancement images (2) are MR-images.

4. Software for a computer to process images (1,2) from a patient's heart arranged to indicate a necrotic area in the heart's myocardium, characterized in that it is arranged to register functional images (1) of the heart in relation to late-enhancement images (2) of said heart, and to map myocardial contours (7) from said functional images (1) in register with and onto the late-enhancement images (2).

5. Software according to claim 4, characterized in that it is further arranged to derive a 3D-model (8) from the detected myocardial contours selected from the functional images (1), and to derive from said 3D-model (8) myocardial contours in register with the late-enhancement images (2).

6. Software according to claim 4 or 5, characterized in that at least the late-enhancement images (2) are MR-images.

7. Data carrier provided with software according to anyone of claims 4-6.

8. Method for processing images from a patient's heart, comprising the steps of collecting the images (1,2) and processing the images (1,2) to indicate a necrotic area in the heart's myocardium, characterized in that functional images (1) of the heart and late-enhancement images (2) of the heart are collected, that the functional images (1) are registered with the late-enhancement images (2), and myocardial contours in the functional images (1) are mapped in register with and onto the late-enhancement images (2).

9. Method according to claim 8, characterized in that a 3D-model (8) is built form the detected myocardial contours in the functional images (1), and samples are taken from said 3D-model (8) to derive myocardial contours in register with the late-enhancement images (2) and placed onto said late-enhancement images (2).

10. Method according to claim 8 or 9, characterized in that at least the late-enhancement images (2) are MR-images.

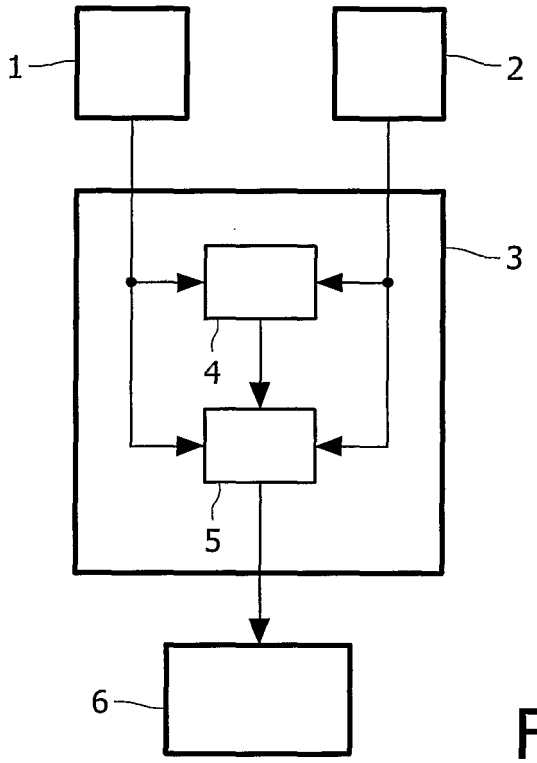

FIG. 1

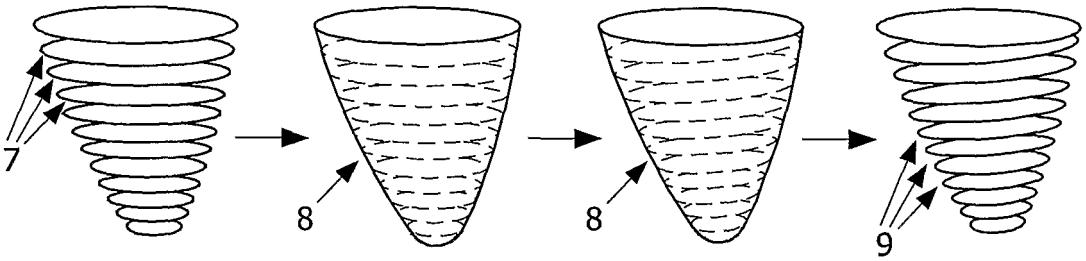

FIG. 2a FIG. 2b FIG. 2c FIG. 2d

INTERNATIONAL SEARCH REPORT

Interr al Application No
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A. CLASSIFICATION OF SUBJECT MATTER
A61B5/055 G01R33/28

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)
A61B G01R

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 practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2004/057607 A1 (BREEUWER MARCEL ET AL) 25 March 2004 (2004-03-25) the whole document	1,3,4, 6-8,10 2,5,9
Y	US 6 628 743 B1 (DRUMMOND DANIELLE ET AL) 30 September 2003 (2003-09-30) column 3, line 3 - column 11, line 17	2,5,9
A	EP 0 994 352 A (SIEMENS MEDICAL SYSTEMS, INC) 19 April 2000 (2000-04-19) paragraph '0001! - paragraph '0033!	1-10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2005	23/12/2005

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

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