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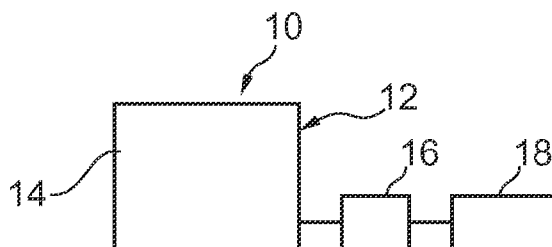


Fig. 1

(57) Abstract: The present invention relates to an image viewing device, such as a medical viewing device used in a medical imaging system. In order to improve the viewer's image perception, an image viewing device (10) with situational personalized parameter adjustment is provided that comprises a display arrangement (12) with at least one display unit (14), a data processor (16), and a user interface (18). The display arrangement is configured to display images and other visually perceivable content, and to display an interactive eye examination. The user interface is configured to enter feedback signals by interaction of a user. Further the data processor is configured to determine current eye-sight parameters of the user on behalf of the feedback signals, and to generate personal image display settings based on the determined eye-sight parameters.



PERSONALIZED OPTIMIZATION OF IMAGE VIEWING

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FIELD OF THE INVENTION

The present invention relates to image perception, and relates in particular to an image viewing device, a medical imaging system, and a method for situational personalized parameter adjustment of an imaging viewing device, as well to computer program element and
10 a computer readable medium.

BACKGROUND OF THE INVENTION

The recent developments in display technology lead to larger display units, allowing larger magnification, higher resolution or more content to be displayed compared to
15 small sized displays. For example, so-called “large screen displays” are used in interventional X-ray laboratories, e.g. in operation rooms in a hospital, where the large screen display is capable of displaying multiple windows, for example with real-time interventional data and preoperative data. These windows can be placed flexibly, such as in location and/or size. For example, US 2009/0213034 A1 describes a multi-modality medical image layout editor where
20 a layout of selected image data can be created or modified. Large screens are also used in a variety of other applications, such as for monitoring technical plants or for planning and strategic purposes, for example as used in military control and command rooms. However, it has been shown that the display of an increasing amount of images or data becomes an increasing challenge for the user’s viewing capacity. This may lead to a decreasing degree of
25 perception of the image content shown to the user.

SUMMARY OF THE INVENTION

There may thus be a need to improve the viewer’s image perception.

The object of the present invention is solved by the subject-matter of the
30 independent claims, wherein further embodiments are incorporated in the dependent claims.

It should be noted that the following described aspects of the invention apply also for the image viewing device, for the medical imaging system, for the method for situational personalized parameter adjustment of an image viewing device, for the computer

program element, and for the computer readable medium.

According to a first aspect of the present invention, an image viewing device with situational personalized parameter adjustment is provided, comprising a display arrangement with at least one display unit, a data processor, and a user interface. The display arrangement is configured to display images and other visually perceivable content, and to display an interactive eye examination. The user interface is configured to enter feedback signals by interaction of a user. The data processor is configured to determine current eye-sight parameters of the user on behalf of the feedback signals, and to generate personal image display settings based on the determined eye-sight parameters.

The interactive eye examination may be provided as an interactive eye examination test program. The interactive eye examination is provided as a personal onscreen eye examination, e.g. as personal pre-intervention display settings verification, for example in case of a medical intervention display arrangement. For example, the interactive eye examination is provided as a pre-interventional personal display adjustment. The interactive eye examination may be adapted to a specific type of a task, for example to a type of a planned intervention.

Interactive eye examination may also be adapted to the image type shown on a display arrangement. The interactive eye examination may focus on the maximum resolution of the image data provided by an image source, for example by an image detector in an X-ray imaging system. The interactive eye examination may also focus on the optimum brightness and contrast to provide optimized image content perception by the user. For example, the image data is provided by X-ray data, and the display arrangement is provided for showing X-ray images as attenuation images in grey scale.

For example, the image display settings are adjustable to the planned interventional procedure and may comprise at least one of the group of: brightness, contrast, colour, display layout, magnification factor, at least for images to be presented live during an intervention, and monitor location. The monitor location may be related to monitor-to-eye distance, tilt angle, and monitor height. The personalized image display settings may be applied during a further procedure, such as a planned interventional procedure.

According to an exemplary embodiment, the display arrangement is at least one of the group of: display of a personal computer, display arrangement of a camera-based security system or closed-circuit television, display arrangement of a weapons guidance system, display arrangement of a military control centre, display arrangement of a public safety

access point or technical plant monitoring, and display panel of a vehicle.

For example, the use with the personal computer can consider different viewing capacities of different users, for example when used by elderly people or people with changing eye-sight quality.

5 For example, in relation with a camera-based security system, different arrangements of the different image contents to be shown can be provided.

In a weapons guidance system, and in a military control centre, as well as in a public safety access point and the like, the display arrangement can be adapted to the responsible person or person in charge or command, or can be adapted to a person in a team
10 that has the weakest viewing capacity among a determined group of persons.

The display panel of a vehicle may be an infotainment and/or onboard function control panel or display, or may be a display of a navigation system, for example in a car, coach, or truck.

The display panel of a vehicle may be a control panel in a train or in an aircraft
15 cockpit.

According to an exemplary embodiment, the image viewing device is a medical image viewing device, and the display arrangement is provided for use in a planned interventional procedure to display medical images. The data processor is configured to generate the personal display settings for the planned interventional procedure and to adjust
20 the image display arrangement settings to the planned intervention. The display arrangement is configured to provide the interactive eye examination in an actual room setting of a planned spatial situation of an interventional room.

For example, the eye examination is displayed with a planned eye-to-monitor distance, and/or with a planned spatial lighting scenario.

25 The term “planned interventional procedure” refers to a particular intervention with predefined needs, for example in image content to be shown, scale, etc. For example, neural interventions have different requirements than cardiac interventions or orthopaedic interventions. For a planned interventional procedure, and also for a particular spatial situation, an eye examination program, or eye testing, is provided, testing the eye in the
30 objective sense, but also in terms of subjective testing for finding and optimally adjusting the display parameters.

For example, the display arrangement is configured to show an optotype relating to acuteness of vision, and/or an optotype relating to X-ray image grey scale

detectability. For example, the optotype comprises a Snellen chart or a Landolt chart.

According to a second aspect, a medical imaging system is provided, comprising an image acquisition device and an image viewing device. The image acquisition device is configured to acquire medical images of an object, and the image viewing device is configured to show the medical images. The image viewing device is an image viewing device according to one of the above mentioned examples.

The image acquisition device may be an X-ray imaging system with an X-ray source and an X-ray detector. The image acquisition device may be an ultrasound imaging system in a further example. The medical image viewing device is also provided for use in a picture archiving and communication system (PACS) used for medical purposes.

According to a third aspect, a method for situational personalized parameter adjustment of an image viewing device is provided, comprising the following steps:

- a) displaying an interactive eye examination on a display arrangement for displaying images and other visually perceivable content;
- b) entering feedback signals by interaction of a user with a user interface;
- c) determining current eye-sight parameters of the user on behalf of the feedback signals; and
- d) generating personal image display settings based on the determined eye-sight parameters.

According to an exemplary embodiment, in step d), a proposal is provided for at least one of the following, based on the determined current eye-sight parameters: i) an optimum monitor-to-user-distance; ii) magnification factor for the display arrangement; iii) arrangement of different windows within the display arrangement; iv) brightness and/or contrast; v) sharpness; and vi) filtering.

For example, the proposal iii) relates to an optimum direction layout. The proposal vi) may relate to filtering in the graphical sense, for example relating to different colours, or may relate to filtering certain content, such as identified anatomical structures or vessels, or a certain tissue type.

According to an exemplary embodiment, the actual monitor-to-use distance is adapted and the steps a) to d) are provided as the re-testing loop for a generation of refined display settings.

According to an exemplary embodiment, step a) comprises presenting an optotype relating to acuteness of vision, and/or an optotype relating to X-ray image grey scale

detectability.

For example, the current eye-sight parameters are stored for the application during the planned interventional procedure. In another example, current eye-sight parameters of a plurality of users are stored and retrieved per user. For example, the retrieved eye-sight parameters are used as a basis for a re-testing of the current eye-sight situation.

According to an exemplary embodiment, step b) comprises entering of preferred display characteristics, comprising at least one of the group of brightness, contrast, type and number of images and information to be displayed, minimum size of written information, magnification factor of medical images; step c) comprises determining a current user preference profile based on the preferred display characteristics; in step d), the image display settings for the planned interventional procedure are generated based also on the current user preference profile.

According to a further exemplary embodiment, the interactive eye examination is provided for different room settings that are planned to occur during the planned interventional procedure, wherein temporarily changing display settings are generated for the planned interventional procedure.

For example, different positions of the user may be provided or different lighting settings or scenarios.

According to an exemplary embodiment, a warning signal is provided when the parameters and settings of the display arrangement are changed such that, due to the current eye-sight parameters, a degree of image information perception would be below a predetermined limit.

In an example, the display settings are automatically adjusted when the parameters and settings of the display arrangement are changed; for example, when the user and the display arrangement are moved in relation to each other.

According to an aspect of the present invention, an image viewing device is provided, such as a large screen monitor, e.g. with display diameters of more than 100 cm, that is adjusted to the respective viewing capacity of a particular user. The viewing capacity is first determined by providing an interactive testing, and the result, i.e. the knowledge about the current viewing capacity, is then used for adjusting the display settings. For example, in the medical field, to safely perform an intervention, it is important that the clinician is actually able to see the full detail of the images, for example in the live image stream. The inability to perceive the anatomies, and/or devices used, in sufficient detail may lead to a decreased

quality of the interventional procedure itself. Further, display settings taking into account the current eye-sight quality leads to decreased physical and mental stress, and also to decreased back problems (since the user doesn't need to lean forward for a closer distance), and avoids unnecessary fatigue of the user. Thus, instead of providing a display arrangement with display settings that only take into account the preferred graphical layout options defined by the user, the present invention provides a display setting that is primarily based on the actual viewing capacity of the user in an objective sense. For example, large displays may provide a flexible screen layout, but the onscreen eye examination, for example an onscreen eye examination chart, according to the present invention helps to determine the quality of vision of the clinician, and may for example give direct feedback on the amount of magnification and monitor distance that is sufficient for the clinician to allow him or her to perceive all the details needed for a safe, accurate and minimally stressful intervention.

These and other aspects of the present invention will become apparent from and be elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the invention will be described in the following with reference to the following drawings:

Fig. 1 schematically shows an image viewing device in an exemplary embodiment;

Fig. 2 shows a medical image viewing device as an example of the image viewing device in a schematic setup as line-drawings in an overview in Fig. 2a and in a detailed view of the display arrangement in Fig. 2b and as respective photographic illustrations in Fig. 2c and Fig. 2d;

Fig. 3 shows an example of a medical imaging system;

Fig. 4 shows basic steps of an example of a method for situational personalized parameter adjustment of an image viewing device;

Fig. 5 shows a further example of a method; and

Fig. 6 shows a still further example of a method for situational personalized parameter adjustment of an image viewing device.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 1 shows an image viewing device 10 with situational personalized

parameter adjustment, comprising a display arrangement 12 with at least one display unit 14, a data processor 16, and a user interface 18. The display arrangement 12 is configured to display images and other visually perceivable content, and to display an interactive eye examination. The user interface 18 is configured to enter feedback signals by interaction of a user. The data processor 16 is configured to determine current eye-sight parameters of the user on behalf of the feedback signals, and to generate personal image display settings based on the determined eye-sight parameters.

According to an example (not further shown), the display arrangement is a display of a personal computer. In a further example (also not shown), the display arrangement is a display arrangement of a camera-based security system or closed-circuit television. According to a still further example, the display arrangement is a display arrangement of a weapons guidance system. In a further example, the display arrangement is a display arrangement of a military control centre. In a still further example, the display arrangement is a display arrangement of a public safety access point. In a further example, the display arrangement is display panel of a vehicle.

According to the example shown in Fig. 2a, the image viewing device 10 is a medical image viewing device 20, and the display arrangement 12 is provided for use in a planned interventional procedure to display medical images. The data processor 16 is configured to generate the personal display settings for the planned interventional procedure and to adjust the image display settings to the planned intervention. The display arrangement is configured to provide the interactive eye examination in an actual room setting of a planned spatial situation of an interventional room.

For example, the interventional room may be an X-ray laboratory 22, for example comprising a patient support table 24. The display arrangement 12 comprises a large screen monitor 26 supported by a movable support structure 28, for example supported from the ceiling. Further, Fig. 2 shows medical image content 30 in the left half, whereas the right half shows a Landolt chart 32, as an example for an optotype relating to acuteness of vision. The medical image content 30 may be provided as an optotype relating to X-ray image grey scale detectability.

By providing the respective interactive eye examination in a similar situation as the one occurring during an interventional procedure that is planned, i.e. by providing the monitor in a position that is equal or at least approximately equal to the position of the monitor that the surgeon prefers during the planned intervention, a spatial situation is

simulated that is equal to the planned spatial situation. Of course, slight deviations may be provided, but the basic settings should be the same or rather similar. Besides the geometric simulation of the planned spatial situation, also lighting situations may be simulated, i.e. the lights that are used during the intervention are also switched on or off according to the

5 planned settings, to further simulate a situation of the user to be as close as possible to the planned situation. Thus, the user's viewing capacity can thus be tested and determined with respect to the planned situation in order to provide optimal adjustment for the planned situation. For example, a user may have a rather high viewing capacity with respect to daylight brightness, but has a decreased, i.e. rather low viewing capacity with respect to dimmed light
10 situations. In case dimmed light situations are provided during an intervention inside the room, whereas only the operational area of interest is sufficiently illuminated, the respective user's viewing capacity should be taken into account when presenting medical images in the dimmed light situation inside the operational room.

Fig. 2a shows an overview in Fig. 2a and a detailed view of the display
15 arrangement is shown in Fig. 2b. Both figures are shown as line-drawings. Respective photographic illustrations are shown in Fig. 2c and Fig. 2d.

According to the example shown in Fig. 3, a medical imaging system 50 is provided, comprising an image acquisition device 52 and an image viewing device 54. The image acquisition device 52 is configured to acquire medical images of an object, and the
20 image viewing device 54 is configured to show the medical images. The image viewing device 54 is an image viewing device according to one of the above mentioned examples. For example, the image acquisition device 52 is a C-arm structure with an X-ray source 56 and an X-ray detector 58, arranged on opposing ends of a movable C-arm structure 60. The C-arm arrangement may be provided as a movable image acquisition device, which is also shown in
25 Fig. 2 in the background, where the C-arm structure has been moved away from the table 24, on which an object 62, for example a patient, can be provided for an interventional procedure.

According to a further example, the medical image viewing device may be provided for use within a picture archiving and communication system used for medical purposes.

30 Fig. 4 shows a method 100 for situational personalized parameter adjustment of an image viewing device, comprising the following steps: In a first step 110, an interactive eye examination is displayed on a display arrangement for displaying images and other visually perceivable content. In a second step 112, feedback signals are entered by interaction of a user

with a user interface. In a third step 114, current eye-sight parameters of the user are determined on behalf of the feedback signals. In a fourth step 116, personal image display settings are generated based on the determined eye-sight parameters. The first step 110 may also be referred to as step a), the second step 112 as step b), the third step 114 as step c), and the fourth step 116 as step d).

According to the example shown in Fig. 5, the actual monitor-to-user distance is adapted in a further step 118, and the steps a) to d) are provided as a re-testing loop, indicated with a loop-like arrow 120, for a generation of refined display settings.

Step a) may comprise presenting an optotype relating to acuteness of vision, and/or an optotype relating to X-ray image grey scale detectability (not further shown). For example, the optotype comprises a Snellen chart or a Landolt chart.

According to a further example (not further shown) the current eye-sight parameters are stored for the application during the planned interventional procedure. In another example, current eye-sight parameters of a plurality of users are stored and retrieved per user.

According to the example shown in Fig. 6, step b) comprises entering 122 of preferred display characteristics, comprising at least one of the group of brightness, contrast, type and number of images and information to be displayed, minimum size of written information, and magnification factor of medical images. Step c) comprises determining 124 a current user preference profile based on the preferred display characteristics. In step d), the image display settings for the planned interventional procedure are generated 126 based also on the current user preference profile.

According to a further example (not further shown), the interactive eye examination is provided for different room settings that are planned to occur during the planned interventional procedure, wherein temporally changing display settings are generated for the planned interventional procedure. For example, different positions of the surgeon during the examination may be taken into account.

According to a further example (not further shown), a warning signal is provided when the parameters and settings of the display arrangement are changed such that, due to the current eye-sight parameters, a degree of image information perception would be below a predetermined limit. For example, the display settings are automatically adjusted when the parameters and settings of the display arrangement are changed. This may be the case, for example, when the user moves in relation to the monitor, or when the monitor is moved away

or towards the user during the intervention, for example due to other reasons.

In another exemplary embodiment of the present invention, a computer program or a computer program element is provided that is characterized by being adapted to execute the method steps of the method according to one of the preceding embodiments, on
5 an appropriate system.

The computer program element might therefore be stored on a computer unit, which might also be part of an embodiment of the present invention. This computing unit may be adapted to perform or induce a performing of the steps of the method described above.

Moreover, it may be adapted to operate the components of the above described apparatus.

10 The computing unit can be adapted to operate automatically and/or to execute the orders of a user. A computer program may be loaded into a working memory of a data processor. The data processor may thus be equipped to carry out the method of the invention.

This exemplary embodiment of the invention covers both, a computer program that right from the beginning uses the invention and a computer program that by means of an
15 up-date turns an existing program into a program that uses the invention.

Further on, the computer program element might be able to provide all necessary steps to fulfil the procedure of an exemplary embodiment of the method as described above.

According to a further exemplary embodiment of the present invention, a
20 computer readable medium, such as a CD-ROM, is presented wherein the computer readable medium has a computer program element stored on it which computer program element is described by the preceding section.

A computer program may be stored and/or distributed on a suitable medium, such as an optical storage medium or a solid state medium supplied together with or as part of
25 other hardware, but may also be distributed in other forms, such as via the internet or other wired or wireless telecommunication systems.

However, the computer program may also be presented over a network like the World Wide Web and can be downloaded into the working memory of a data processor from such a network. According to a further exemplary embodiment of the present invention, a
30 medium for making a computer program element available for downloading is provided, which computer program element is arranged to perform a method according to one of the previously described embodiments of the invention.

It has to be noted that embodiments of the invention are described with

reference to different subject matters. In particular, some embodiments are described with reference to method type claims whereas other embodiments are described with reference to the device type claims. However, a person skilled in the art will gather from the above and the following description that, unless otherwise notified, in addition to any combination of
5 features belonging to one type of subject matter also any combination between features relating to different subject matters is considered to be disclosed with this application. However, all features can be combined providing synergetic effects that are more than the simple summation of the features.

While the invention has been illustrated and described in detail in the drawings
10 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 a claimed invention, from a study of the drawings, the disclosure, and the dependent claims.

15 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 fulfil the functions of several items re-cited in the claims. The mere fact that certain measures are re-cited 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
20 should not be construed as limiting the scope.

CLAIMS:

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1. An image viewing device (10) with situational personalized parameter adjustment, comprising:

- a display arrangement (12) with at least one display unit (14);
 - a data processor (16); and
 - 10 - a user interface (18);
- wherein the display arrangement is configured to display images and other visually perceivable content; and to display an interactive eye examination;
- wherein the user interface is configured to enter feedback signals by interaction of a user;
- 15 wherein the data processor is configured to determine current eye-sight parameters of the user on behalf of the feedback signals; and to generate personal image display settings based on the determined eye-sight parameters.

2. Image viewing device according to claim 1, wherein the display arrangement is
20 at least one of the group of:

- display of a personal computer;
- display arrangement of a camera-based security system or closed-circuit television;
- display arrangement of a weapons guidance system;
- 25 - display arrangement of a military control centre;
- display arrangement of a public safety access point; and
- display panel of a vehicle.

3. Image viewing device according to claim 1, wherein the image viewing device
30 is a medical image viewing device (20) and the display arrangement is provided for use in a planned interventional procedure to display medical images;

wherein the data processor is configured to generate the personal display settings for the planned interventional procedure and to adjust the image display settings to the

planned intervention; and

wherein the display arrangement is configured to provide the interactive eye examination in an actual room setting of a planned spatial situation of an interventional room.

5 4. A medical imaging system (50), comprising:

- an image acquisition device (52); and
- an image viewing device (54);

wherein the image acquisition device is configured to acquire medical images of an object;

10 wherein the image viewing device is configured to show the medical images;
and

wherein the image viewing device is an image viewing device according to the preceding claim.

15 5. A method (100) for situational personalized parameter adjustment of an image viewing device, comprising the following steps:

- a) displaying (110) an interactive eye examination on a display arrangement for displaying images and other visually perceivable content;
- b) entering (112) feedback signals by interaction of a user with a user interface;
- 20 c) determining (114) current eye-sight parameters of the user on behalf of the feedback signals; and
- d) generating (116) personal image display settings based on the determined eye-sight parameters.

25 6. Method according to claim 5, wherein the display arrangement is at least one of the group of:

- display of a personal computer;
- display arrangement of a camera-based security system or closed-circuit television;
- 30 - display arrangement of a weapons guidance system;
- display arrangement of a military control centre;
- display arrangement of a public safety access point; and
- display panel of a vehicle; and

wherein the interactive eye examination is provided in an actual room setting of the respective usage.

7. Method according to claim 5, wherein the display arrangement is a display arrangement of a medical image viewing device provided for displaying medical images, and for use in a planned interventional procedure;

wherein the personal display settings are generated for the planned interventional procedure and the image display settings are adjusted to the planned intervention; and

10 wherein the interactive eye examination is provided in an actual room setting of a planned spatial situation of an interventional room.

8. Method according to one of the claims 5 to 7, wherein in step d), a proposal is provided for at least one of the following, based on the determined current eye-sight

15 parameters:

- i) an optimum monitor-to-user-distance;
- ii) magnification factor for the display arrangement;
- iii) arrangement of different windows within the display arrangement;
- iv) brightness and/or contrast;
- 20 v) sharpness; and
- vi) filtering.

9. Method according to one of the claims 5 to 8, wherein the actual monitor-to-user-distance is adapted (118) and the steps a) to d) are provided as a re-testing loop (120) for
25 a generation of refined display settings.

10. Method according to one of the claims 7 to 9, wherein step a) comprises presenting:

- an optotype relating to acuteness of vision; and/or
- 30 - an optotype relating to X-ray image gray scale detectability.

11. Method according to one of the claims 7 to 10, wherein step b) comprises entering (122) of preferred display characteristics, comprising at least one of the group of:

brightness, contrast, type and number of images and information to be displayed, minimum size of written information, and magnification factor of medical images; and wherein step c) comprises determining (124) a current user preference profile based on the preferred display characteristics; and wherein in step d), the image display settings for the planned interventional
5 procedure are generated (126) based also on the current user preference profile.

12. Method according to one of the claims 7 to 11, wherein the interactive eye examination is provided for different room settings that are planned to occur during the planned interventional procedure; and
10 wherein temporally changing display settings are generated for the planned interventional procedure.

13. Method according to one of the claims 5 to 12, wherein a warning signal is provided when the parameters and settings of the display arrangement are changed such that,
15 due to the current eye-sight parameters, a degree of image information perception would be below a predetermined limit.

14. A computer program element for controlling an apparatus according to one of the claims 1 or 4, which, when being executed by a processing unit, is adapted to perform the
20 method steps of one of the claims 5 to 13.

15. A computer readable medium having stored the program element of claim 14.

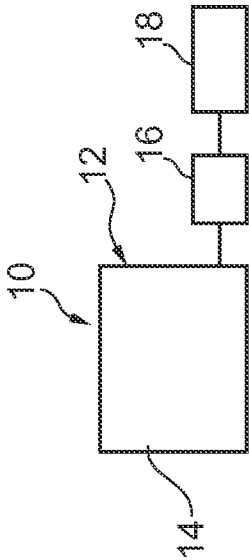


Fig. 1

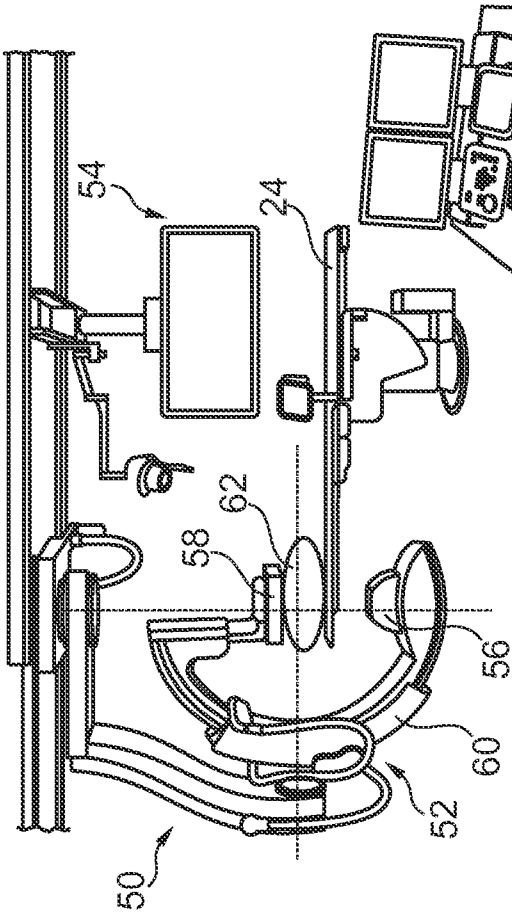


Fig. 3

2/5

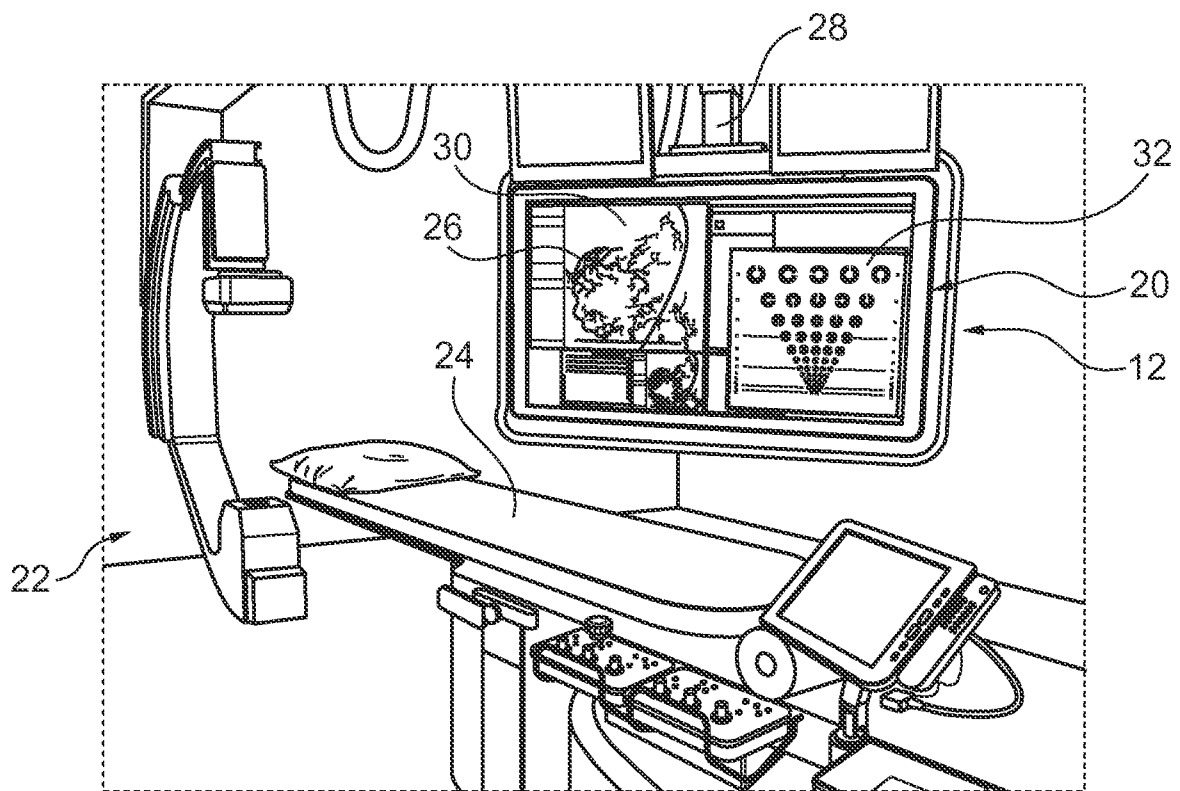


Fig. 2a

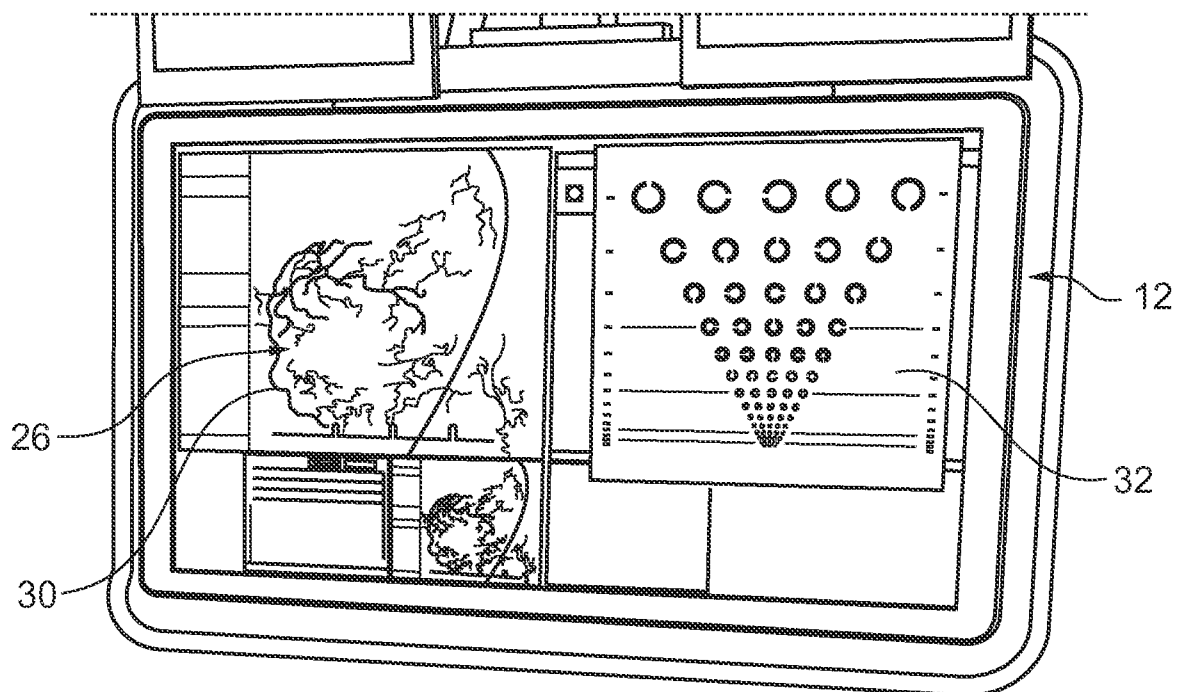


Fig. 2b

3/5

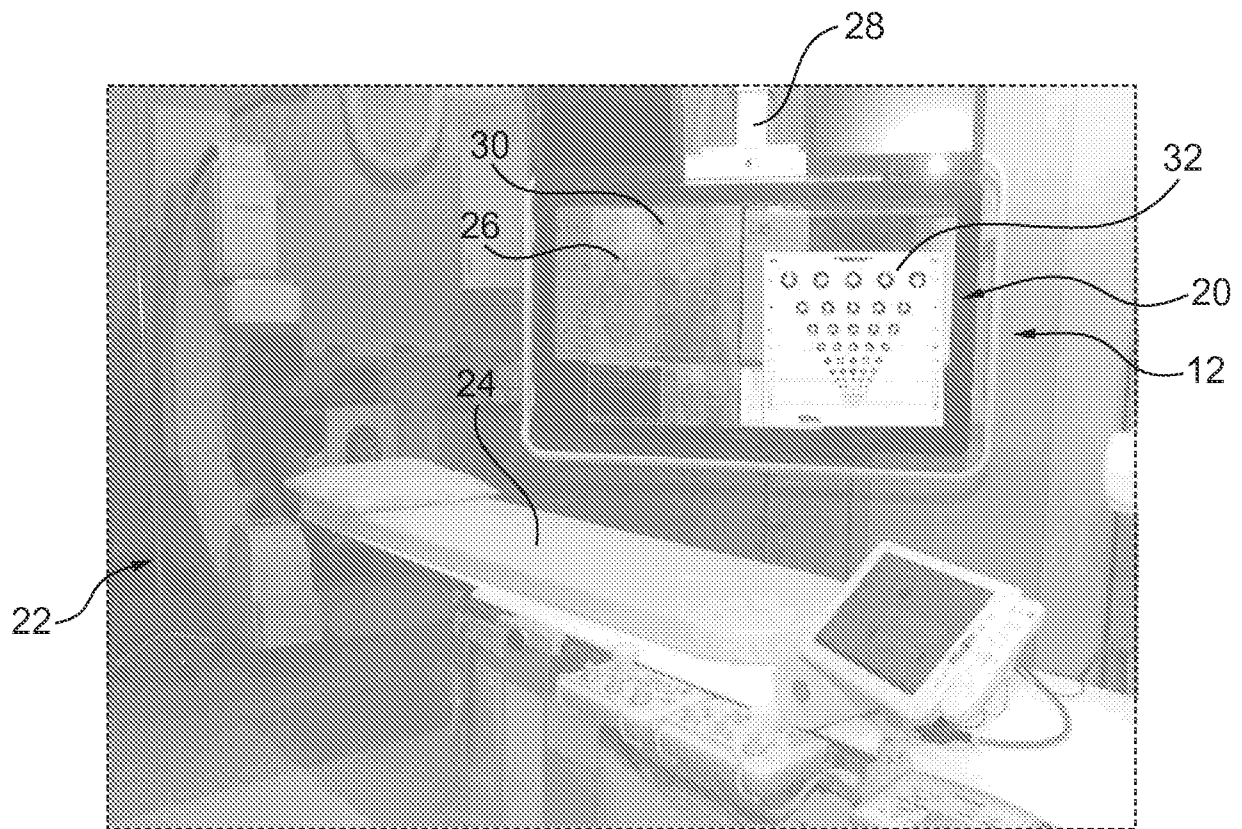


Fig. 2c

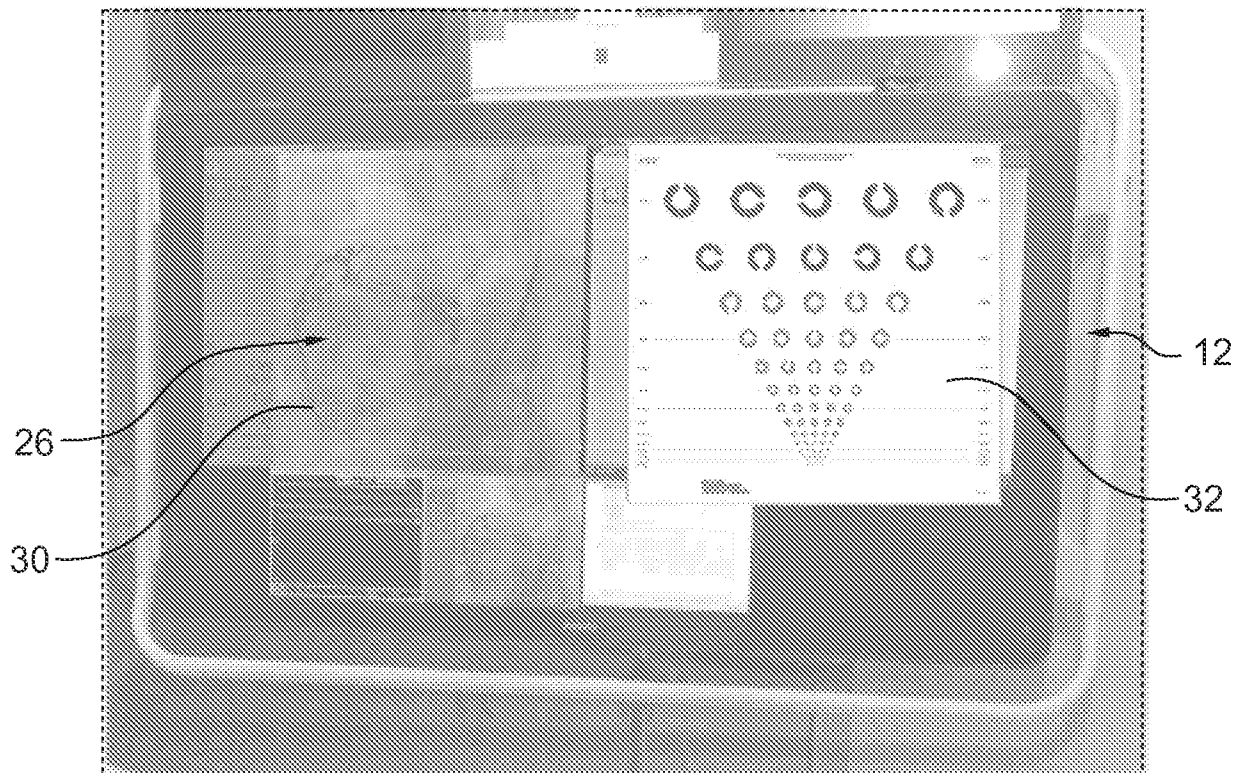


Fig. 2d

4/5

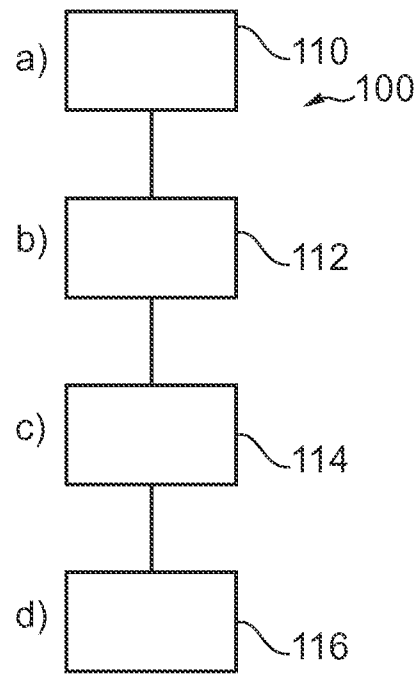


Fig. 4

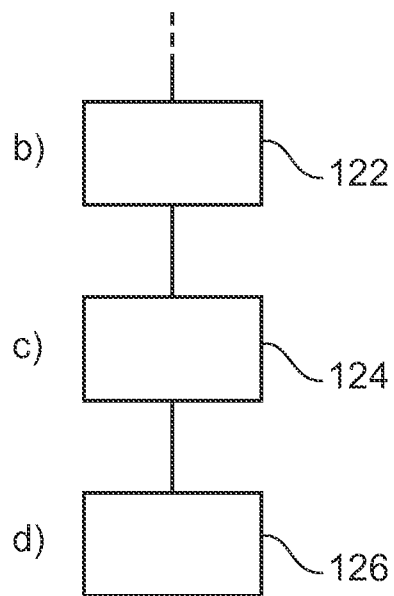


Fig. 6

5/5

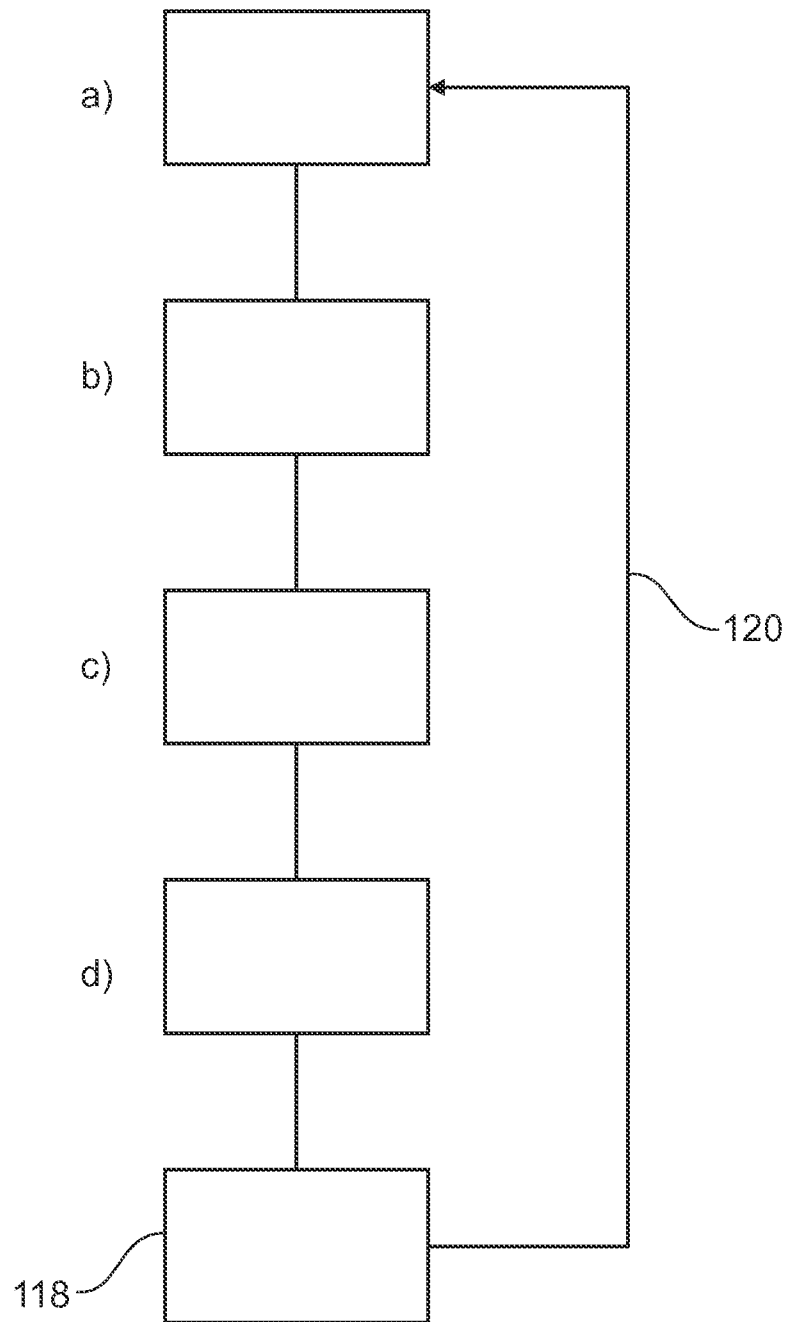


Fig. 5