



- (51) **International Patent Classification:**
A61B 3/12 (2006.01) *A61B 5/00* (2006.01)
A61B 3/00 (2006.01)
- (21) **International Application Number:**
PCT/NL2016/050894
- (22) **International Filing Date:**
20 December 2016 (20.12.2016)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**
2016013 23 December 2015 (23.12.2015) NL
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- (81) **Designated States** (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).
- Published:**
— with international search report (Art. 21(3))

(54) **Title:** EYE EXAMINATION SYSTEM COMPRISING A FUNDUS CAMERA AND AN ANALYZING SYSTEM

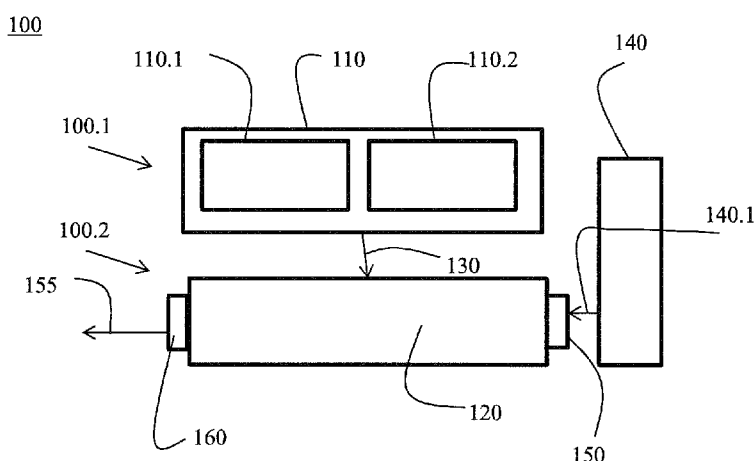


Figure 1

(57) **Abstract:** An eye examination system is described, the eye examination system comprising a fundus camera and an analyzing system, the fundus camera comprising: -a camera system configured to capture one or more images of a retina of a patient; the analyzing system comprising: -an image processing system, the image processing system being configured to - receive the one or more images and process the one or more images; - determine an optical performance parameter characterizing a status of the eye of the patient based on the one or more images; the image processing system further being configured to: - access a database and receive, via an input terminal of the image processing system, reference information related to the optical performance parameter; - determine a treatment parameter for the patient, based on the optical performance parameter and the reference information; and - output the treatment parameter via an output terminal of the image processing system.



Title: Eye examination system comprising a fundus camera and an analyzing system

5 FIELD OF THE INVENTION

The invention relates to the field of fundus cameras, and more specifically to the processing of fundus camera measurements in order to provide in a personalized advise for patients.

10

BACKGROUND OF THE INVENTION

The present invention relates to an eye examination system including a fundus camera, an ophthalmic instrument used to capture images of the retina of a person and an analyzing
15 system. Such retina images made with a fundus camera provide insight in the quality and health status of the retina of a person. Based on this information it is e.g. possible to suggest to the person what type of lenses (glasses) or nutraceuticals would benefit his or her eyes, both to improve vision as well as prevent further reduction of eye health over time. In case an anomaly is detected, there may be different manners in which to address this,
20 ranging from the application of less invasive measures, such as the use of nutraceuticals, to more invasive measures such as surgery. At present however, using known fundus cameras, it may be difficult to determine which measure may be most appropriate due to the limited analytical capabilities of these cameras.

25 SUMMARY OF THE INVENTION

It would be desirable to provide in an eye examination system enabling a more accurate assessment of the health status of an eye of a patient, in particular of a retina of a patient's eye. It would also be desirable to enable to forecast an evolution of the health
30 status of an eye or retina to enable to determine the most effective and efficient measure for a specific patient.

To better address one or more of these concerns, there is provided, in accordance with an aspect of the invention, an eye examination system, the eye examination system comprising a fundus camera and an analyzing system, the fundus camera comprising:

- 35
- a camera system configured to capture one or more images of a retina of a patient;
- the analyzing system comprising:

- an image processing system, the image processing system being configured to
 - o receive the one or more images and process the one or more images;
 - o determine an optical performance parameter characterizing a status of the eye of the patient based on the one or more images;

5 the image processing system further being configured to:

- o access a database and receive, via an input terminal of the image processing system, reference information related to the optical performance parameter;
- o determine a treatment parameter for the patient, based on the optical performance parameter and the reference information; and
- 10 o output the treatment parameter via an output terminal of the image processing system.

The eye examination system according to the present invention comprises a fundus camera and an analyzing system. The fundus camera as applied in the eye examination system
15 according to the present invention comprises a camera system for capturing one or more images of a retina of a patient. Such camera system may e.g. comprise a CCD or CMOS camera or the like. In an embodiment, the fundus camera comprises an SLO (scanning laser ophthalmoscope) based system. In such an SLO based system, the fundus camera may e.g. comprise a light source configured to consecutively make two or more images of a
20 retina at different frequencies, e.g. in a green wavelength range (typically around 520 nm) and in an infrared wavelength range (typically ranging from 750 to 800 nm). In these images, different structures may be observed because the different wavelengths are typically reflected by different layers of the eye. As such, based on a comparison of the images, e.g. the strength of the reflected intensity levels, different types of information about the status of
25 the retina may be extracted.

The eye examination system according to the present invention further comprises an analyzing system that comprises an image processing system for receiving and processing the captured images. In an embodiment, the image processing system comprises an input terminal for receiving the one or more images and a processing unit for processing the
30 images. In such an embodiment, the processing unit may e.g. comprise processor, a microprocessor, a computer or the like. The processing unit may also comprise a memory or memory unit for storing data or intermediate data that is being processed.

In accordance with an embodiment of the present invention, the processing unit of the image processing system is configured to process the one or more images and determine
35 an optical performance parameter characterizing a status of the eye of the patient based on the one or more images. Such an optical performance parameter may e.g. be a parameter that is based on an optical measurement as e.g. performed by the fundus camera or a

measure representing an optical performance of the eye. Examples of such optical performance parameters include the absorption of the eye's lens, the reflectivity of the retina, pigmentation development or pupil contraction in response to stimulus.

In accordance with the present invention, the image processing system is further
5 configured to access a database to retrieve reference information related to the optical performance parameter and provide the reference information to the processing unit. As an example, the image processing system may e.g. retrieve from a database, e.g. a remote database stored on a server accessible via a network, reference information that relates to the optical performance parameter of the patient as determined at a previous consultation.
10 Using this information, an assessment can e.g. be made of the evolution of the particular optical performance parameter for the particular patient. In another example, the reference information related to the optical performance parameter may e.g. relate to a group or population of other patients.

In an embodiment, the reference information in the database may also contain context or
15 personal information about the patient or the group or population of patients.

By doing so, the optical performance parameter of the patient and/or the evolution of the optical performance parameter may be compared, e.g. benchmarked, against a similar group of patients, e.g. similar with respect to age, sex or medical history. As such, an atypical evolution of the optical performance parameter may be detected at an early stage,
20 enabling to take the most appropriate measures. In particular, the processing unit as applied in the fundus camera according to the present invention is further configured to determine a treatment parameter for the patient, based on the optical performance parameter and the reference information and output the treatment parameter via the output terminal of the image processing system. Compared to a stand-alone fundus camera, the fundus camera
25 according to the present invention enables to gather more insight in the status of an eye or retina of a patient. By means of the retrieve reference information, projections may e.g. be made about an evolution of the optical performance parameter and depending on the rate of change of the optical performance parameter, more or less invasive measures or treatments may be proposed. E.g. based on a comparison of the rate of change of the optical
30 performance parameter of the patient with population of similar patient, one may decide that the preferred treatment is to use nutraceuticals, or to use a specific type of lens or coating on the lens, or to perform a surgical treatment.

These and other aspects of the invention will be more readily appreciated as the same becomes better understood by reference to the following detailed description and
35 considered in connection with the accompanying drawings in which like reference symbols designate like parts.

BRIEF DESCRIPTION OF THE DRAWINGS

- 5 - Figures 1 and 2 schematically depicts fundus cameras according to embodiments of the present invention.
- Figure 3 schematically depicts how radiation of different wavelengths reflect on various surfaces of an eye.
- Figure 4 schematically depicts substantially circular reflections in images captured with a green light source and an infrared (IR) light source.
- 10 - Figure 5 schematically depicts relevant regions to assess pigmentation.

DETAILED DESCRIPTION OF EMBODIMENTS

Figure 1 schematically depicts a first embodiment of an eye examination system 100 according to the present invention. The eye examination system 100 as schematically shown comprises a fundus camera 100.1 and an image processing system 100.2. The fundus camera 100.1 comprises a camera system 110 configured to capture one or more images of a patient's eye, e.g. of a patient's retina. The camera system 110 as shown comprises a light source 110.1, and a camera 110.2 configured to capture images reflected off the eye, e.g. reflected off the retina of the eye. Such images as captured may be provided to an image processing system 100.2 of the eye examination system 100, as indicated by connection 130. In accordance with the present invention, the image processing system is configured to process the one or more images and determine an optical performance parameter characterizing a status of the eye of the patient based on the one or more images.

In this respect, it should be pointed out that the processing of captured images as done by a conventional fundus camera is rather limited. Typically, a known fundus camera merely scales a captured image so as to maximize the contrast. Phrased differently, a received image from a camera system is scaled such that the intensity of image on a display ranges between a minimum intensity (e.g. no illumination) to a maximum available intensity of the display. Typically, such images, i.e. such images that are scaled to a maximum contrast, may be stored in a memory unit of the fundus camera and may be retrieved again at a later stage. Such images may even be stored remotely, e.g. in a central database to which a plurality of fundus cameras may be connected. In accordance with the present invention, rather than merely scaling the received images, an optical performance parameter characterizing a status of the eye of the patient is determined. Examples of such optical performance parameters include but are not limited to:

- Absorption or scattering of the eye's lens
- Reflectivity of the retina
- Pigmentation development
- Pupil contraction reflex

5 In order to assess these performance parameters, calculations can be performed, e.g. by a processing unit 120 of the image processing system 100.2, using the retrieved images. In a conventional fundus camera, some of the mentioned parameter may also be assessed, e.g. by means of a visual inspection of the aforementioned scaled images that are e.g. displayed on a display of the fundus camera. Based on such an assessment, a treatment
10 may be recommended. Using such an approach, the recommended treatment may however be sub-optimal: the assessment of the optical performance parameter made in this way does not take into account how the optical performance parameter has evolved or how a change in this parameter, if any, correlates with an expected or nominal change of said parameter, e.g. due to aging. In case such information would be incorporated in the
15 assessment, other, more appropriate treatments may be proposed to the patient.

In order to enable such a more detailed assessment of an optical performance parameter, enabling a more specific or appropriate treatment, the eye examination system 100 according to the present invention not only determines the optical performance parameter on the basis of the retrieved images but also retrieves reference information on
20 the optical performance parameter from a database. In particular, the image processing system 100.2 of eye examination system 100 according to the present invention is configured to access a database 140 and to receive (indicated by the arrow 140.1), via an input terminal 150 of the image processing system 100.2, reference information related to the optical performance parameter.

25 In accordance with an embodiment of the present invention, the database 140 may be provided as part of the eye examination system 100. The database may e.g. be a local database, e.g. stored in a memory unit of the image processing system 100.2 or may be a separate unit. As an alternative, as shown in Figure 2, the database 140 may be remote,
30 e.g. located on a server and accessible via a network interface. Note that the connection 140.1 between the database 140 and the input terminal of the image processing system 100.2 may be a wired or a wireless connection, whereby various modes of communication may be applied.

It can further be noted that the image processing unit 100.2 as applied in the eye
35 examination system 100 according to the present invention need not be located near the fundus camera 100.1 of the eye examination system 100 either. In an embodiment, the one or more images as captured by the camera system may thus be transmitted, e.g. via a

network connection, to the image processing system 100.2, which may e.g. be located on a remote computer.

In accordance with the present invention, the image processing system 100.2 is further configured to determine a treatment parameter for the patient, based on both the optical performance parameter as determined from the received images and the reference information and to output the treatment parameter (indicated by the arrow 155) via an output terminal 160 of the image processing system 100.2.

Within the meaning of the present invention, the feature 'treatment parameter' is used to denote information related to a particular treatment or a selection between possible

treatments. As such, the treatment parameter may e.g. comprise an advise or recommendation towards a particular treatment, e.g. a recommendation to prescribe certain vitamins. to use a certain type of lenses in the (prescription) glasses or to use lenses with particular coatings .

In an embodiment, the reference information that is retrieved from the database relates to the optical performance parameter of the patient as determined at a previous consultation or at previous consultations. In such embodiment, the manner in which the optical performance parameter evolves over time can be determined and taken into account in determining the most appropriate treatment. To illustrate this, one may e.g. assume that, based on the optical performance parameter as determined, two or more treatments seem suited, ranging from the use of vitamins or nutraceuticals, the use of dedicated lenses or the application of more invasive treatments including surgery. Taking the optical performance parameter as determined alone, there may be no argument to favor one of the available treatments. However, when also considering the reference information, one may e.g. determine whether or not the optical performance parameter is deteriorating at a slow pace or at a fast pace. Based on this, one may, by means of extrapolation, even provide in a forecast of the progression of the optical performance parameter over time. In case it is forecasted that a comparatively large deterioration is to be expected, a more invasive treatment may be appropriate whereas in case it is forecasted that a comparatively small deterioration is to be expected, a less invasive treatment may be applied.

In an embodiment, the processing unit is further configured to determine a treatment parameter based on context or personal information from the patient. Such information may e.g. include one or more of, but is not limited to:

- Age
- Gender
- Lifestyle
- Medical history

In an embodiment of the present invention, the reference information as retrieved from the database is associated with a population of patients. In such embodiment, the optical performance parameter as determined may e.g. be compared to the optical performance parameter as observed in a population of patients, e.g. patients having the same or similar characteristics such as age, gender, medical history. Such reference information may also be applied to better assess which treatment is most suited among a plurality of possible treatments. Such reference information on a population of patients may also include historical data representing how the optical performance parameter has changed or evolved in the population of patients.

As a first example of the optical performance parameter that can be determined by means of the eye examination system according to the present invention, the absorption or scattering in the eye's lens can be mentioned. A measure for the amount of light that is absorbed or scattered by the lens is the difference in attenuation between two images captured by the camera system. It can be noted that there are various methods to make fundus images. Traditionally white light cameras are used to make a color photograph of the eye. A more advanced method is the use of a (two or more color) confocal scanning laser ophthalmoscope (cSLO). In such a system two images are made sequentially at two or more different wavelengths, e.g. green and infrared. The different colors are reflected by the different layers in the eye, as illustrated in Figure 3. Figure 3 schematically indicates various layers of an eye:

Reference number 300 indicating the eye lens;

Reference number 310 indicating the retina;

Reference number 320 indicating the pigment layer;

Reference number 330 indicating the Choroid;

Reference number 340 indicating the Sclera;

Indicated by reference number 400 is a reflected light beam having a wavelength in the wavelength range 510 to 535 nm, also referred to as green light. Indicated by reference number 410 is a reflected light beam having a wavelength in the wavelength range 750 to 800 nm, also referred to as infrared (IR) light. As can be seen, an IR light beam penetrates much deeper into the surface of the eye, compared to a green light beam. By comparing the images and the strengths of the reflected intensity levels, different types of information about the status of the retina can be determined. In particular, in order to determine the absorption or scattering of the eye's lens, the camera system of the eye examination system according to the present invention is configured to capture a first image of the retina of the patient in a first wavelength range and a second image of the retina of the patient in a second wavelength range, the absorption of the eye lens being determined based on an attenuation between the first image and the second image. More specifically, the first image

may e.g. be made using a light source emitting light in a green wavelength range (typically around 520 nm), while the second image is made with a light source emitting light in an infrared (IR) wavelength range (typically ranging from 750 to 800 nm). The difference in attenuation between the green image and the and IR signal can be considered a measure for the amount of light that is absorbed/scattered by the eye lens. Various measures can be defined to quantify this effect. An example of a measure to quantify the absorption LensAbs is given by the following equation:

$$LensAbs \sim \frac{S_{Green}}{I_{O_{Green}}} / \frac{S_{IR}}{I_{O_{IR}}} \quad (1)$$

Wherein S_{Green} and S_{IR} are the average collected signal strengths in the green and infrared images respectively and $I_{O_{Green}}$ and $I_{O_{IR}}$ are the input strengths of the green and IR light sources, respectively.

As will be apparent from equation (1), in order to determine the proposed measure representative of the lens absorption, the input strength of the light sources needs to be known. As such, in order to accurately determine the attenuation of both images, it may be advantageous to calibrate, on a regular basis, the light sources as applied. Alternatively, or in addition, a light sensor may be applied in the fundus camera according to the present invention to measure, prior or during the capturing of the images, the intensity of the light source or light sources as applied.

With respect to equation (1), it may further be noted that the attenuated intensities S_{green} or S_{IR} may also be obtained as intensities taken at specific locations on the images, rather than taking the average intensity of the image. In particular, by means of pattern recognition algorithms, the image processing unit may be configured to determine one or more reference locations on the images, at which locations no particular features such as veins are present. By selecting one or more of such locations and assessing the intensities at these location, a value for the attenuates intensities may be obtained. By determining the attenuated intensities in the same manner for both images, the absolute value is not relevant, because equation (1) applies the ratio of both values.

In case a change in the lens absorption is noticed, e.g. by comparing the lens absorption measured at different instants in time, this may be an indication that the eye lens becomes cloudy, which can be an indication for cataract. By applying the measure as indicated by equation (1), this information can be quantified and thus translated into an advise for treatment. In particular, the quantified information on the changed lens absorption enables to advise on the following treatments:

- a. Relative effectivity of spectacle - lenses to improve / restore vision
- b. Effectivity to implant intra ocular lenses to improve / restore vision
- c. Application of lenses adjusting to light intensity, keeping the pupil relatively wide open so as to improve permeability of the eye lens.

- 5 As such, in an embodiment of the present invention, the image processing system of the eye examination system according to the present invention may be configured to output a treatment parameter indicating one of the above mentioned three possible treatments as the most appropriate treatment, based on the optical performance parameter as determined combined with the reference information as received from the database.
- 10 With respect to the determination of the lens absorption and in particular the change in the lens absorption, it should be pointed out that such determination may not be realized using images from a conventional fundus camera. As mentioned above, such a camera merely scales and displays captured images rather than determining a parameter such as the lens absorption. It is further worth nothing that in case previously captured images would be
- 15 stored or would have been stored in a local or remote database, these images will in general not be suited to derive the lens absorption either. This is due to the scaling that is applied to the images to render them more suitable to be displayed with sufficient contrast. Due to this scaling, one may no longer recover the actual intensity of the captured images, nor can one recover the intensity of the light sources as applied when the images were captured. As
- 20 such, rather than storing the processed or scaled images in a database, it is far more useful to store the optical performance parameter as derived from the raw, unprocessed images.

A second example of an optical performance parameter as can be determined and applied in a fundus camera according to the present invention is the reflectivity of the retina. The reflectivity of the retina as obtained from an infrared (IR) image, e.g. generated using a

25 light source emitting in a wavelength range between 750 – 800 nm, may be considered an indication for the age of the eye. For young people, clear substantially circular reflections can be observed in images captured with a substantially green light source (and slightly less in images captured with an infrared (IR) light source. This is illustrated in the ophthalmic images shown in Figure 4. In Figure 4, the image on the left is captured using a green light

30 source, whereas the image on the right is captured using an IR light source. Indicated by reference number 500 are high intensity portions which are arranged, as can be seen, in a substantially circular shape. Based on this, the reflectivity of the retina may be quantified by any of the following measures, or a combination thereof:

- a) The reflectivity of the retina can be assessed by quantifying the size and brightness of
- 35 the high intensity portions that are observed in the captured images (in particular in images captured with a green light source)

- b) The reflectivity of the retina can be assessed by quantifying the total IR reflection strength:

$$IR_reflection_strength \sim \frac{S_{IR}}{IO_{IR}} \quad (2)$$

When a reduction of the IR_reflection_strength is noticed, this can be considered an

5 indication that the eyes are getting older. Note that, in order to assess a change in the reflectivity, a comparison needs to be made with previous, older data, e.g. obtained at a previous consultations. When a conventional fundus camera is applied, similar considerations as described above would apply; i.e. by merely storing the scaled images as captured during a previous consultation or consultations, one would not be capable of
10 assessing the reflectivity at an earlier instant in time and as a result, one would not be able to assess any change in the reflectivity.

In case, using an embodiment of a fundus camera according to the present invention, an assessment of the aging is made, an appropriate treatment parameter can be determined and outputted. An ageing eye would e.g. be helped by lenses that are contrast enhancing.

15 In addition, many people with ageing eyes experience difficulties when environmental light is limited (e.g. driving at night), which could translate into an advise to use certain types of night vision lenses. As for prophylactic advice, consumers having ageing retina's would be helped by taking nutraceuticals and annual eye exams.

A third example of an optical performance parameter as can be determined and

20 applied in a fundus camera according to the present invention is pigmentation: Images captured when the retina is exposed to an infrared light source can be used to measure and scale the pigmentation development at the choroid layer of the Retina and more specific at the Macula area. The changes in pigmentation can e.g. be quantified in the green and IR images by assessing the amount of white spots 600 in the relevant areas 610, as e.g.

25 shown in Figure 5. In order to assess the amount of pigmentation in a certain area, image processing techniques may e.g. be applied to e.g. determine the area where pigmentation occurs, e.g. by determining the area or areas where the intensity is above a certain, e.g. predetermined level. Once this area or areas are identified, the total size of this high intensity area may be determined and considered a measure for the pigmentation. When an
30 increase in pigmentation is observed, this may cause a loss in vision for the patient. An accumulated pigmentation is supposedly caused by an exposure to UV light, also referred to as Blue hazardous light. As such, a further pigmentation may be prevented by advising lenses that protect the eye against UV light or Blue hazardous light. Several lens types and coatings are available that reduce the permeation of wavelengths resulting from UV / Blue
35 light.

A fourth example of an optical performance parameter as can be determined and applied in a fundus camera according to the present invention is the pupil contraction reflex pupillary light reflex. By measuring the size of the pupil before and after capturing an image of the retina, e.g. using a green light source, a measure for the pupil contraction reflex can be determined. Equation (3) describes one of possible measures indicative for the pupil contraction reflex:

$$Pupil_reflex \sim \frac{Diameter_post_fundus_exam}{Diameter_pre_fundus_exam} \quad (3)$$

where Diameter_post_fundus_exam and Diameter_pre_fundus_exam are the diameters of the pupil after and before the use of the green light source to generate retina image. When the size of the pupil is determined at fixed instants in time relative to the exposure of the eye to the green light source, any change in the pupil contraction reflex may be determined when comparing such measurements to measurements performed at previous consultations.

A reduction of the pupil contraction reflex is an indication that the eyes are getting older and that in particular in low light situations the vision of the person might be reduced. As such, when such reduced pupil contraction reflex is noticed, an treatment advise to the patient may include an advise to use night vision type glasses.

As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which can be embodied in various forms. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriately detailed structure. Further, the terms and phrases used herein are not intended to be limiting, but rather, to provide an understandable description of the invention.

The terms "a" or "an", as used herein, are defined as one or more than one. The term plurality, as used herein, is defined as two or more than two. The term another, as used herein, is defined as at least a second or more. The terms including and/or having, as used herein, are defined as comprising (i.e., open language, not excluding other elements or steps). Any reference signs in the claims should not be construed as limiting the scope of the claims or the invention.

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.

The term coupled, as used herein, is defined as connected, although not necessarily
5 directly, and not necessarily mechanically.

A single processor or other unit may fulfil the functions of several items recited in the claims.

CLAIMS

1. An eye examination system, the eye examination system comprising a fundus camera and an analyzing system, the fundus camera comprising:
- a camera system configured to capture one or more images of a retina of a patient; the analyzing system comprising:
- 5 - an image processing system, the image processing system being configured to
- receive the one or more images and process the one or more images;
 - determine an optical performance parameter characterizing a status of the eye of the patient based on the one or more images;
- the image processing system further being configured to:
- 10 ○ access a database and receive, via an input terminal of the image processing system, reference information related to the optical performance parameter;
- determine a treatment parameter for the patient, based on the optical performance parameter and the reference information; and
- 15 ○ output the treatment parameter via an output terminal of the image processing system.
2. The eye examination system according to claim 1, wherein the image processing unit comprises a processing unit configured to:
- 20 - determine the optical performance parameter characterizing the status of the eye of the patient based on the one or more images, and
- determine the treatment parameter for the patient, based on the optical performance parameter and the reference information.
- 25 3. The eye examination system according to claim 1 or 2, wherein the image processing unit is further configured to provide the optical performance parameter to the database for storage.
- 30 4. The eye examination system according to any of the preceding claims, wherein the reference information relates to the optical performance parameter of the patient as determined at a previous consultation.
5. The eye examination system according to any of the preceding claims, wherein the database is a remote database, and wherein the image processing system is

further configured to transmit, via the output terminal, a request to the remote database to retrieve the reference information.

5 6. The eye examination system according to any of the preceding claims, wherein the analyzing system further comprises the database.

7. The eye examination system according to any of the preceding claims, wherein the reference information is associated with a population of patients.

10 8. The eye examination system according to any of the preceding claims, wherein the input terminal is further configured to receive personal or context information related to the patient.

15 9. The eye examination system according to claim 8, wherein the personal or context information of the patient includes one or more of:

- age of the patient
- gender of the patient
- medical history information.

20

10. The eye examination system according to claim 8 or 9, wherein image processing system is configured to retrieve the reference information based on the personal or context information.

25 11. The eye examination system according to any of the preceding claims, wherein the image processing system is configured to upload the optical performance parameter of the patient as determined to the database.

30 12. The eye examination system according to any of the preceding claims, wherein the optical performance parameter comprises an absorption of the eye lens.

13. The eye examination system according to claim 12, further comprising a first light source for generating a first image and second light source for generating a second image.

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14. The eye examination system according to claim 12 or 13, wherein the camera system is configured to capture the first image of the retina of the patient in a first wavelength range and a second image of the retina of the patient in a second

wavelength range, the absorption of the eye lens being determined based on an attenuation between the first image and the second image.

15. The eye examination system according to claim 12, wherein the camera system is configured to:

- expose the retina of the patient to a first light beam in a first wavelength range and to expose the retina of the patient to a second light beam in a second wavelength range, the analyzing system being configured to:
- determine a first total reflected power based on a reflection of the first light beam and a second total reflected power based on a reflection of the second light beam; and
- determine the absorption of the eye lens based on an attenuation between the first total reflected power and the second total reflected power.

16. The eye examination system according to claim 14 or 15, wherein the first wavelength range is 510 – 535 nm and the second wavelength range is 750 – 800 nm.

17. The eye examination system according to claim 13, 14 or 15, wherein the attenuation is determined as:

$$LensAbs \sim \frac{S_{Green}}{IO_{Green}} / \frac{S_{IR}}{IO_{IR}}$$

wherein S_{Green} and S_{IR} are average signal strengths of the first image and the second images respectively and IO_{Green} and IO_{IR} are input strengths of a first light source used to generate the first image and second light source used to generate the second image respectively.

18. The eye examination system according to any of the preceding claims, wherein the optical performance parameter comprises a reflectivity of the retina of the patient.

19. The eye examination system according to claim 18, wherein the reflectivity of the retina is determined based on an image captured in an IR range.

20. The eye examination system according to claim 18, wherein the reflectivity of the retina is determined by quantifying the size and brightness of high intensity portions that are observed in the one or more captured images.

5 21. The eye examination system according to any of the preceding claims, wherein the optical performance parameter comprises pigmentation of the retina.

22. The eye examination system according to claim 21, wherein the image processing system is configured to:

- 10
- determine an area or areas on one or more of the captured images where the intensity is above a predefined level and
 - determine a total size of the area or areas as a measure for the pigmentation of the retina.

15 23. The eye examination system according to any of the preceding claims, wherein the optical performance parameter comprises a pupil contraction reflex.

24. A system comprising one or more eye examination systems according to any of the preceding claims and a database, the one or more fundus cameras of the eye examination systems being configured to:

- 20
- retrieve the reference information related to the optical performance parameter from the database, and
 - provide the optical performance parameter to the database for storage.

25

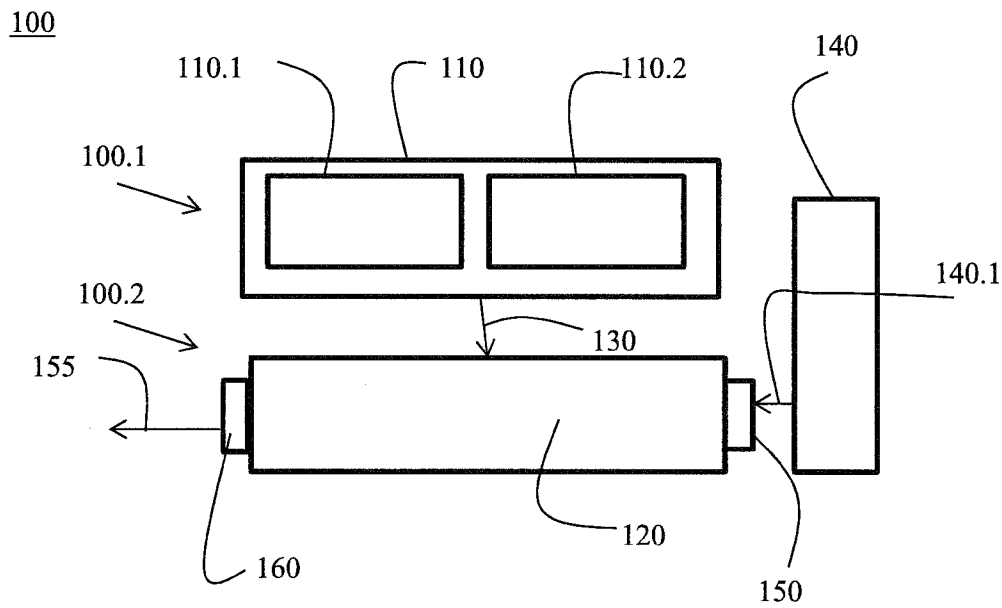


Figure 1

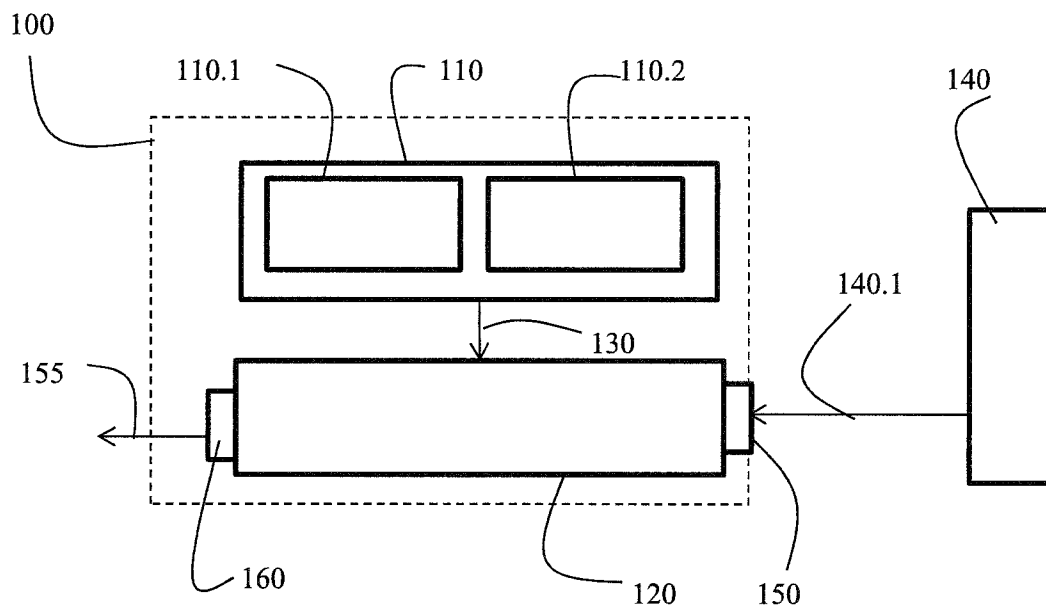


Figure 2

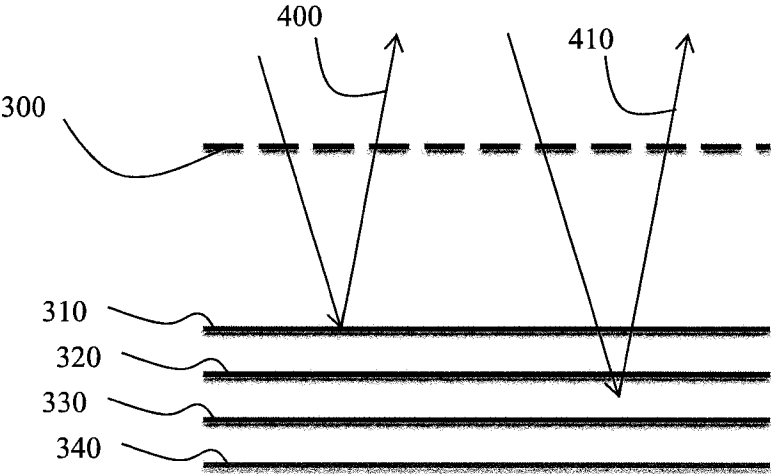


Figure 3

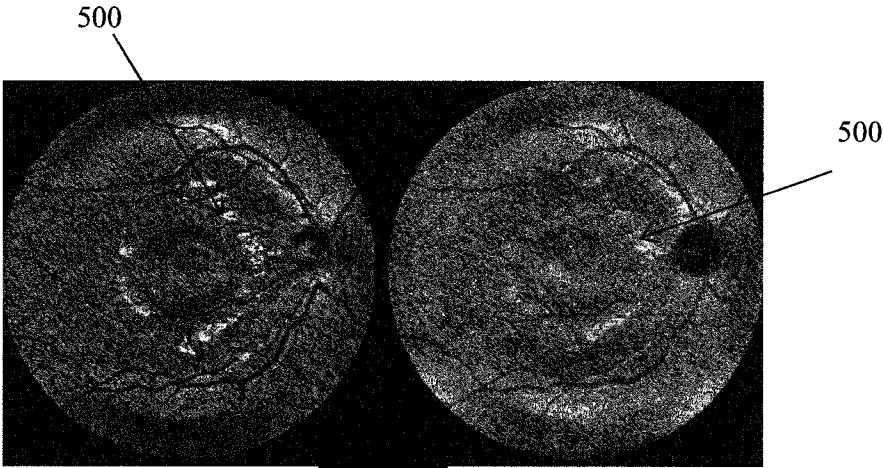


Figure 4

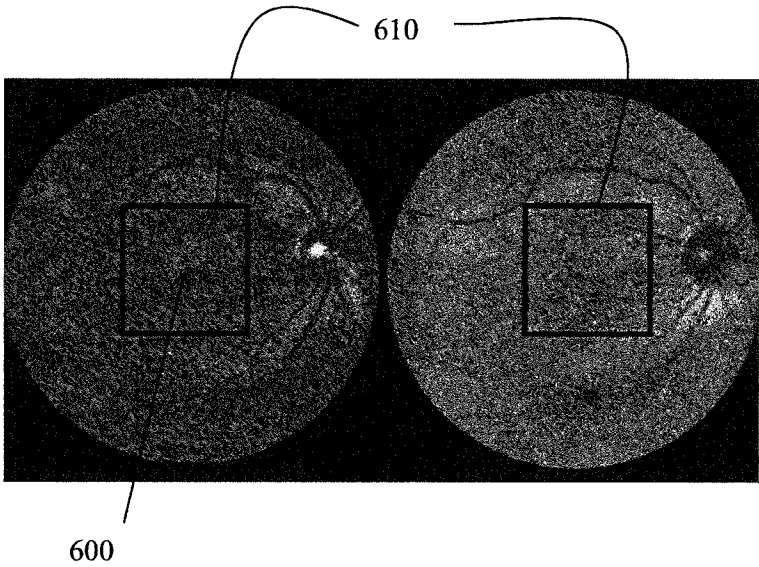


Figure 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2016/050894

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61B3/12 A61B3/00 A61B5/00
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)
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

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Y	abstract figures 1,2A,2B,10 paragraph [0037] - paragraph [0041] paragraph [0124] - paragraph [0132] paragraph [0142] - paragraph [0169] -----	4,5,7-24
Y	US 2013/301004 A1 (KAHN DAVID ALEXANDER [CA] ET AL) 14 November 2013 (2013-11-14) abstract paragraph [0025] - paragraph [0155] claims 1-34 figures 1A, 10-16 ----- -/-	4,5,7-24



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

16 March 2017

Date of mailing of the international search report

24/03/2017

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Tommaseo, Giovanni

INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2016/050894

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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A	US 2009/153796 A1 (RABNER ARTHUR [IL]) 18 June 2009 (2009-06-18) abstract claims 108-146 -----	1-24
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