



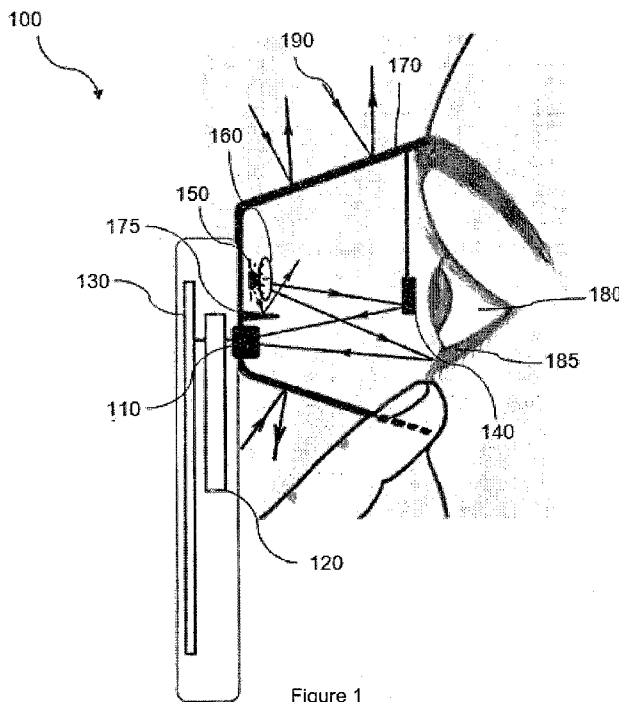
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(54) Title: METHOD AND SYSTEM FOR HAEMOGLOBIN MEASUREMENT



(57) Abstract: The present invention preferably provides a non-invasive system for haemoglobin measurement and method thereof. The system for haemoglobin measurement comprises an image capturing device for capturing an image of conjunctiva along with an image of colour mat for correcting the image of conjunctiva; a light source for providing light during imaging of conjunctiva; a diffuser adapted to the light source for providing uniform light during imaging of conjunctiva; an optical chamber for preventing external light from entering an eye during imaging of conjunctiva; a processing module, configured to receive and process the image captured from the image capturing device, for correcting the image of conjunctiva based on value of the image of colour mat, determining a RGB, HSV, or LAB value of the image of conjunctiva, and measuring the level of haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin; and a display module, configured to display the measured level of haemoglobin from the processing module.

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METHOD AND SYSTEM FOR HAEMOGLOBIN MEASUREMENT

FIELD OF THE INVENTION

The present invention relates to haemoglobin measurement, more particularly, to non-invasive systems for haemoglobin measurement and method thereof.

BACKGROUND OF THE INVENTION

Haemoglobin is an iron containing protein in blood cells which carries oxygen around the body. Lack of haemoglobin in blood results in inadequate supply of oxygen to the body and causes various complications such as anaemia. Some of the main causes of anaemia are loss of blood, nutritional deficiency, bone marrow problems, kidney failure, abnormal haemoglobin structure, etc. Also, a high level of haemoglobin in blood leads to several complications since it can impair circulation and also lead to abnormal clotting. Measurement of haemoglobin in blood is thus an important routine procedure for monitoring patients under treatment and for screening of anemia.

Several invasive and non-invasive techniques are available for measurement of haemoglobin. Invasive techniques include drawing of blood sample which is a painful experience for a patient. Also, it exposes a

health care provider handling the blood sample to risk of infectious diseases.

Non-invasive techniques include use of devices similar to oximeters on a thumb or an ear of patient to measure the level of haemoglobin. However
5 these oximeters are expensive and are mostly used in intensive care units for continuous monitoring of the patient.

Another conventional method of checking for low levels of haemoglobin i.e. checking for anaemic conditions of the subject is to check conjunctiva
10 of the eye of the subject visually by a healthcare worker. The conjunctiva is a thin membrane that covers inner surface of the eyelid and white part of the eyeball. The conjunctiva is normally visible when the eye is pulled
15 down. Doctors/physicians usually check the conjunctiva for its redness or paleness to examine anaemic condition of the patient. In case of anaemia, the anterior and the posterior rim of the conjunctiva will be same and will
20 be pale. For a healthy subject, the anterior rim of the conjunctiva will have more redness and will be dissimilar to that of the posterior part. However this technique is subjective and is only indicative of low level of haemoglobin or anaemic condition and does not give a quantitative
25 analysis of the amount of haemoglobin in blood. In view of the above, there is a need in the art for a method and system for haemoglobin measurement addressing at-least the above mentioned problems.

SUMMARY OF THE INVENTION

The present invention preferably provides non-invasive systems for haemoglobin measurement and method thereof.

In one embodiment, a system for haemoglobin measurement is provided.

5 The system comprises an image capturing device for capturing an image of conjunctiva along with an image of colour mat for correcting the image of conjunctiva; a light source for providing light during imaging of conjunctiva; a diffuser adapted to the light source for providing uniform light during imaging of conjunctiva; an optical chamber for preventing
10 external light from entering an eye during imaging of conjunctiva; a processing module, configured to receive and process the image captured from the image capturing device, for correcting the image of conjunctiva based on value of the image of colour mat, determining a RGB, HSV, or LAB value of the image of conjunctiva, and measuring the level of
15 haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin; and a display module, configured to display the measured level of haemoglobin from the processing module.

20 In another embodiment, the present invention provides a system for haemoglobin measurement, the system comprising an external device, comprising: an optical chamber for preventing external light from entering an eye during imaging of conjunctiva; a colour mat, adapted to the optical

chamber, for correcting an image of conjunctiva; a light source, adapted to the optical chamber, for providing light during imaging of conjunctiva; an external power source for providing power to the light source; and a diffuser adapted to the light source for providing uniform light during
5 imaging of conjunctiva; and an electronic device, adapted to the external device, the electronic device comprising: an image capturing device for capturing the image of conjunctiva along with the image of colour mat; a processing module, configured to receive and process the image captured from the image capturing device, for correcting the image of conjunctiva
10 based on value of the image of colour mat, determining a RGB, HSV, or LAB value of the image of conjunctiva, and measuring the level of haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin; and a display module,
15 configured to display the measured level of haemoglobin from the processing module.

Yet in another embodiment, a method of haemoglobin measurement is provided. The method comprises capturing an image of conjunctiva along
20 with an image of colour mat, by an image capturing device; correcting the image of conjunctiva based on value of the image of colour mat; determining a RGB, HSV, or LAB value of the image of conjunctiva; selecting a portion on the image of conjunctiva and determining the RGB,

HSV, or LAB value of the selected portion of the image of conjunctiva;
comparing the RGB, HSV, or LAB value of the image of conjunctiva and
the selected portion of the image of conjunctiva, and determining an
updated RGB, HSV, or LAB value of the image of conjunctiva; correcting
5 and eliminating, a gamma correction, exposure correction and reflection of
the image of conjunctiva; measuring the level of haemoglobin by
comparing the corrected RGB, HSV, or LAB value of the image of
conjunctiva with a calibrated colour values of haemoglobin to retrieve a
value which indicates the level of haemoglobin; and displaying the
10 measured level of haemoglobin.

BRIEF DESCRIPTION OF DRAWINGS

Reference will be made to embodiments of the invention, example of
which may be illustrated in the accompanying figures. These figures are
15 intended to be illustrative, not limiting. Although the invention is generally
described in the context of these embodiments, it should be understood
that it is not intended to limit the scope of the invention to these particular
embodiments.

20 Figure 1 shows a system for haemoglobin measurement according to the
present invention; and

Figure 2 shows a method of haemoglobin measurement according to the
present invention.

DETAILED DESCRIPTION OF THE INVENTION

Various embodiments of the present invention provide a systems and methods for haemoglobin measurement. More particularly the invention is directed to analyzing conjunctiva of an eye for measuring the level of
5 haemoglobin of a subject/patient.

In one embodiment, the present invention provides a system for haemoglobin measurement, the system comprises an external device, the external device includes a colour mat, an optical chamber, a light source,
10 and a diffuser adapted to the light source, the external device adaptable to an eye of a subject under test; and an electronic device, adaptable to the external device, the electronic device includes an image capturing device a processor, a display, and a storage means. The image capturing device is for capturing an image of conjunctiva of the eye and an image of the
15 colour mat illuminated by the light source provided on the external device or the electronic device. The processor is configured to receive and process the image captured from the image capturing device, for correcting the image of conjunctiva based on value of the image of colour mat; identifying plurality of RGB (Red, Green, and Blue), HSV (Hue,
20 Saturation, and Value), or LAB (L for lightness, and A, and B for the colour-opponent dimensions, based on nonlinearly compressed coordinates) of the image of conjunctiva, determining the RGB, HSV, or LAB value of the image of conjunctiva, and measuring the level of

haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated color values of haemoglobin to retrieve a value which indicates the level of haemoglobin, and displaying and storing the measured level of haemoglobin on the display and the storage means
5 respectively.

In an embodiment of the invention, the external device can be retrofitted on electronic devices such as a cell phone, a tablet, a phablet, a camera with a processor or a processing unit, or other portable electronic devices.
10 Accordingly, the external device can be adapted to different types of electronic devices and the external device is not limited to the arrangement illustrated.

In another embodiment, a system for haemoglobin measurement is
15 provided; the system comprises an external device and an electronic device. The external device is capable of being adapted to an eye of a subject/patient, by an eye cap. The external device comprises a first adapter, a fastening base, a light source, an optical chamber, a diffuser, a diffuser fastener, a colour mat, a second adapter, and an eye cap. The
20 first adapter is provided for adapting the electronic device with the external device. The first adapter holds the electronic device such that the image capturing device of the electronic device is aligned with the external device.

In accordance with the present invention, the first adapter has means for accommodating a power source for the light source of the external device.

The light source comprises a switch for illumination of the light. Alternately,
5 the light source of the external device can be powered through the electronic device via suitable means.

In accordance with the present invention, the fastening base fastens the optical chamber with the first adapter, and the light source inside the
10 optical chamber. The second adapter is adapted to the optical chamber to hold the colour mat in front of the light source inside the optical chamber, and has a means for holding the eye cap.

In accordance with the present invention, eye cap is placed on the eye
15 during imaging of conjunctiva. Advantageously, the eye cap is removable.

In an embodiment of the invention, the optical chamber, and the eye cap adapted to the second adapter of the external device are light occluding.

In this regard, the optical chamber, and the eye cap adapted the second adapter covers the eye such that the eye is isolated from ambient light.

20 Once the external device is placed on the eye, the light source of the external device is turned on by a switch and the eye is illuminated. In an embodiment, the diffuser is provided in front of the light source, by a

diffuser fastener, such that that light spreads uniformly over the entire eye area, thereby avoiding any patchy illumination.

Upon illuminating the eye, conjunctiva is exposed by pulling down lower
5 eyelid of the eye. Subsequently at-least one image of the conjunctiva along with the colour mat is captured via the image capturing device.

In an embodiment, a processing module of the electronic device, configured to receive and process the image captured from the image
10 capturing device, for correcting the image of conjunctiva based on value of the image of colour mat, determining a RGB, HSV, or LAB value of the image of conjunctiva, and measuring the level of haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates
15 the level of haemoglobin; and a display module, configured to display the measured level of haemoglobin from the processing module.

In another embodiment, the present invention provides a system for haemoglobin measurement, the system comprising an image capturing
20 device for capturing an image of conjunctiva along with an image of colour mat for correcting the image of conjunctiva; a light source for providing light during imaging of conjunctiva; a diffuser adapted to the light source for providing uniform light during imaging of conjunctiva; an optical

chamber for preventing external light from entering an eye during imaging of conjunctiva; a processing module, configured to receive and process the image captured from the image capturing device, for correcting the image of conjunctiva based on value of the image of colour mat, determining a RGB, HSV, or LAB value of the image of conjunctiva, and measuring the level of haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin; and a display module, configured to display the measured level of haemoglobin from the processing module.

In accordance with the present invention, the colour mat consists of colour combination of red, grey, white, and simulated colours matching those of skin; and the light source is configured to provide stable light during imaging of conjunctiva, includes a power source to provide energy for enabling the light. Advantageously, the light source can be included in the external device or the electronic device.

In accordance with the present invention, the optical chamber prevent external light from entering the eye during imaging of conjunctiva; the optical chamber includes a partition for preventing light directly emitted from the light source entering the image capturing device.

Advantageously, the optical chamber includes a removable eye cap to surround the eye during imaging of conjunctiva.

In accordance with the present invention, pixel by pixel operation is performed, by the processing module, on the image of conjunctiva and the colour mat, captured by the image capturing device, to obtain colour values. The colour values of the image of conjunctiva and the colour mat are then compared with the original colours of the colour mat; and a radiometric correction using gamma correction and/ or exposure correction are performed.

In accordance with the present invention, the determination of the RGB, HSV, or LAB value of the image of conjunctiva, by the processing module, includes determining the RGB, HSV, or LAB value of the image of conjunctiva; selecting a portion on the image of conjunctiva and determining the RGB, HSV, or LAB value of the selected portion of the image of conjunctiva, comparing the RGB, HSV, or LAB value of the image of the conjunctiva and the selected portion of the image of conjunctiva, determining an updated RGB, HSV, or LAB value of the image of conjunctiva, and correcting and eliminating, a gamma correction, exposure correction and reflection of the image of conjunctiva.

In accordance with the present invention, the calibrated colour values of haemoglobin consist of the RGB, HSV, or LAB value and its corresponding level of haemoglobin.

In accordance with the present invention, the display module is adapted to
5 print the displayed measured haemoglobin in gm/dL. Advantageously, the display module is configured to transmit the measured haemoglobin to remote server for record and further analysis.

In another embodiment, a method of haemoglobin measurement is
10 provided. The method comprises capturing an image of conjunctiva along with an image of colour mat, by an image capturing device; correcting the image of conjunctiva based on value of the image of colour mat; determining a RGB, HSV, or LAB value of the image of conjunctiva; selecting a portion on the image of conjunctiva and determining the RGB,
15 HSV, or LAB value of the selected portion of the image of conjunctiva; comparing the RGB, HSV, or LAB value of the image of conjunctiva and the selected portion of the image of conjunctiva, and determining an updated RGB, HSV, or LAB value of the image of conjunctiva; correcting and eliminating, a gamma correction, exposure correction and reflection of
20 the image of conjunctiva; measuring the level of haemoglobin by comparing the corrected RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a

value which indicated the level of haemoglobin; and displaying the measured level of haemoglobin.

In accordance with the present invention, the correcting and eliminating of method of image of conjunctiva consist of gamma correction, exposure
5 correction, white balancing, elimination of reflection and artifacts, and other image processing and corrections applied individually or in combination depending on the image of conjunctiva.

10 In accordance with the present invention, pixel by pixel operation is performed, by the processing module, on the image of conjunctiva and the colour mat, captured by the image capturing device, to obtain colour values. The colour values of the image of conjunctiva and the colour mat
are then compared with the original colours of the colour mat; and a
15 radiometric correction using gamma correction and/ or exposure correction are performed.

In accordance with the present invention, the method of capturing the image of conjunctiva includes enabling a light of a light source;
20 surrounding an eye, by an optical chamber, to prevent external light from entering the eye during imaging of conjunctiva; and capturing the image of conjunctiva along with the image of colour mat, by the image capturing device.

The subject matter is now described with reference to the drawings, wherein like reference numerals are used to refer to like elements throughout. In the following description, for purpose of explanation, numerous specific details are set forth in order to provide a thorough understanding of the claimed subject matter. It may be evident however, that such matter can be practiced with these specific details. In other instances, well-known structures are shown in diagram form in order to facilitate describing the invention.

10 Referring Figure 1 shows a system (100) for haemoglobin measurement in accordance with an embodiment of the present invention, the system (100) comprises an image capturing device (110) for capturing an image of conjunctiva (185) along with an image of colour mat (140) for correcting the image of conjunctiva (185); a light source (150) for providing stable
15 light during imaging of conjunctiva; a diffuser (160) adapted to the light source (150) for providing uniform light during imaging of conjunctiva; an optical barrier (170) for preventing external light (190) from entering an eye (180) during imaging of conjunctiva; a processing module (120) for processing the captured image and measuring the level of haemoglobin;
20 and a display module (130) for displaying the measured level of haemoglobin from the processing module (120).

As shown in Figure 1, the processing module (120), configured to receive and process the image captured from the image capturing device (110), for correcting the image of conjunctiva (185) based on value of the image of colour mat (140), determining a RGB, HSV, or LAB value of the image of the conjunctiva (185), and measuring the level of haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva (185) with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin.

As shown in Figure 1, the image capturing device (110) is adapted to the optical chamber (170) for capturing the image of conjunctiva (185) and the colour mat (140). The optical chamber (170) is adapted to include the light source (150), the color mat (140), and the diffuser (160) adapted to the light source (150) according to an embodiment of the present invention. Advantageously, the optical chamber (170) includes a partition (175) for preventing light directly emitted from the light source (150) entering the image capturing device (110) during imaging of the conjunctiva.

As shown in Figure 1, the image of conjunctiva and colour mat captured from the image capturing device (110) is transferred to the processing module (120) for processing and measuring the level of haemoglobin, and the display module (130) displays the measured level of haemoglobin received from the processing module (120). Advantageously, the image

capturing device (110), processing module (120), and the display module (130) can be elements of single electronic device.

Referring Figure 2, shows a method (200) of haemoglobin measurement in accordance with an embodiment of the present invention, the method (200) comprises the steps of capturing an image of conjunctiva along with an image of colour mat, by an image capturing device (210); correcting the image of conjunctiva based on value of the image of colour mat (220); determining a RGB, HSV, or LAB value of the image of conjunctiva (230); selecting a portion on the image of conjunctiva and determining the RGB, HSV, or LAB value of the selected portion of the image of conjunctiva (240); comparing the RGB, HSV, or LAB value of the image of conjunctiva and the selected portion of the image of conjunctiva, and determining an updated RGB, HSV, or LAB value of the image of conjunctiva (250); correcting and eliminating, a gamma correction, exposure correction and reflection of the image of conjunctiva (260); measuring the level of haemoglobin by comparing the corrected RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin (270); and displaying the measured level of haemoglobin (280).

As shown in Figure 2, the method of capturing the image of conjunctiva along with the image of colour mat (210), the method (210) includes

enabling a light of a light source; surrounding an eye, by an optical chamber, to prevent external light from entering the eye during imaging of conjunctiva; and capturing the image of conjunctiva along with the image of colour mat, by the image capturing device.

5

As shown in Figure 2, the correcting and eliminating of method of image of conjunctiva (260) consist of gamma correction, exposure correction, white balancing, elimination of reflection and artifacts, and other image processing and corrections applied individually or in combination depending on the image of conjunctiva.

10

As shown in Figure 2, the calibrated colour values of haemoglobin of method of measuring the level of haemoglobin (270) consists of the RGB, HSV, or LAB value and its corresponding level of haemoglobin.

15

While the present invention has been described herein with respect to the various exemplary embodiments, it will be apparent to one of the ordinary skill in the art that many modifications, improvements and sub combinations of the various embodiments, adaptations and variations can be made to the invention without departing from the scope thereof as claimed in the following claims.

20

CLAIMS :

1. A system for haemoglobin measurement, the system comprising:

an image capturing device for capturing an image of conjunctiva
5 along with an image of colour mat for correcting the image of
conjunctiva;

a light source for providing light during imaging of conjunctiva;

a diffuser adapted to the light source for providing uniform light
during imaging of conjunctiva;

10 an optical chamber for preventing external light from entering an
eye during imaging of conjunctiva;

a processing module, configured to receive and process the image
captured from the image capturing device, for correcting the image of
conjunctiva based on value of the image of colour mat, determining a
15 RGB, HSV, or LAB value of the image of conjunctiva, and measuring
the level of haemoglobin by comparing the RGB, HSV, or LAB value of
the image of conjunctiva with a calibrated colour values of
haemoglobin to retrieve a value which indicates the level of
haemoglobin; and

20 a display module, configured to display the measured level of
haemoglobin from the processing module.

2. The system as claimed in claim 1, wherein
the image capturing device, the processing module, and the display
module are preferably included in an electronic device; and
5 the light source, the diffuser, the optical chamber, and the colour
mat are preferably included in an external device;
wherein the external device is removably adapted to the electronic
device.
- 10 3. The system as claimed in claim 2, wherein the electronic device
comprises a camera, a cell phone, or other portable electronic devices.
4. The system as claimed in claim 1, wherein the colour mat consist of
colour combination of red, grey, white, and other simulated colours
15 matching those of skin.
5. The system as claimed in claim 1, wherein the light source preferably
includes an external power source to provide stable light during
imaging of conjunctiva.
- 20 6. The system as claimed in claim 1, wherein the optical chamber
includes a partition for preventing light directly emitted from the light
source entering the image capturing device.

7. The system as claimed in claim 1 or 6, wherein the optical chamber includes a removable eye cap to surround the eye during imaging of conjunctiva.

5

8. The system as claimed in claim 1 or 2, wherein the display module, is adapted to print the displayed measured haemoglobin in gm/dL.

9. The system as claimed in claim 1 or 2, wherein the display module, is configured to transmit the measured haemoglobin to remote server for record and further analysis.

10

10. A system for haemoglobin measurement, the system comprising:

an external device, comprising:

15

an optical chamber for preventing external light from entering an eye during imaging of conjunctiva;

a colour mat, adapted to the optical chamber, for correcting an image of conjunctiva;

20

a light source, adapted to the optical chamber, for providing light during imaging of conjunctiva;

an external power source for providing power to the light source; and

a diffuser adapted to the light source for providing uniform light during imaging of conjunctiva; and an electronic device, adapted to the external device, the electronic device comprising:

5 an image capturing device for capturing the image of conjunctiva along with the image of colour mat;

a processing module, configured to receive and process the image captured from the image capturing device, for correcting the image of conjunctiva based on value of the image of colour mat, determining a RGB, HSV, or LAB value of the image of conjunctiva, and measuring the level of haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin; and

15 a display module, configured to display the measured level of haemoglobin from the processing module.

11.A method of haemoglobin measurement, the method comprising:

20 capturing an image of conjunctiva along with an image of colour mat by an image capturing device;

correcting the image of conjunctiva based on value of the image of colour mat by a processing module;

determining a RGB, HSV, or LAB value of the image of conjunctiva by the processing module;

measuring the level of haemoglobin by comparing the RGB, HSV, or LAB value of the image of conjunctiva with a calibrated colour values of haemoglobin to retrieve a value which indicates the level of haemoglobin by the processing module; and

displaying the measured level of haemoglobin on a display module.

12. The method as claimed in claim 11, wherein the step of determination

of the RGB, HSV, or LAB value of the image of conjunctiva, includes:

determining the RGB, HSV, or LAB value of the image of conjunctiva;

selecting a portion on the image of conjunctiva and determining the RGB, HSV, or LAB value of the selected portion of the image of conjunctiva;

comparing the RGB, HSV, or LAB value of the image of conjunctiva and the selected portion of the image of conjunctiva, and determining an updated RGB, HSV, or LAB value of the image of conjunctiva; and

correcting and eliminating, a gamma correction, exposure correction and reflection of the image of conjunctiva.

13. The method as claimed in claim 12, wherein the correcting and eliminating of image of conjunctiva comprises gamma correction,

exposure correction, white balancing, elimination of reflection and artifacts, and other image processing and corrections applied individually or in combination depending on the image of conjunctiva.

5 14. The method as claimed in claim 11, wherein the calibrated colour values of haemoglobin comprises the RGB, HSV, or LAB value and its corresponding level of haemoglobin.

10 15. The method as claimed in claim 11, wherein the step of capturing the image, includes:

enabling a light of a light source;

surrounding an eye, by an optical chamber, to prevent external light from entering the eye during imaging of conjunctiva; and

15 capturing the image of conjunctiva along with the image of colour mat by the image capturing device.

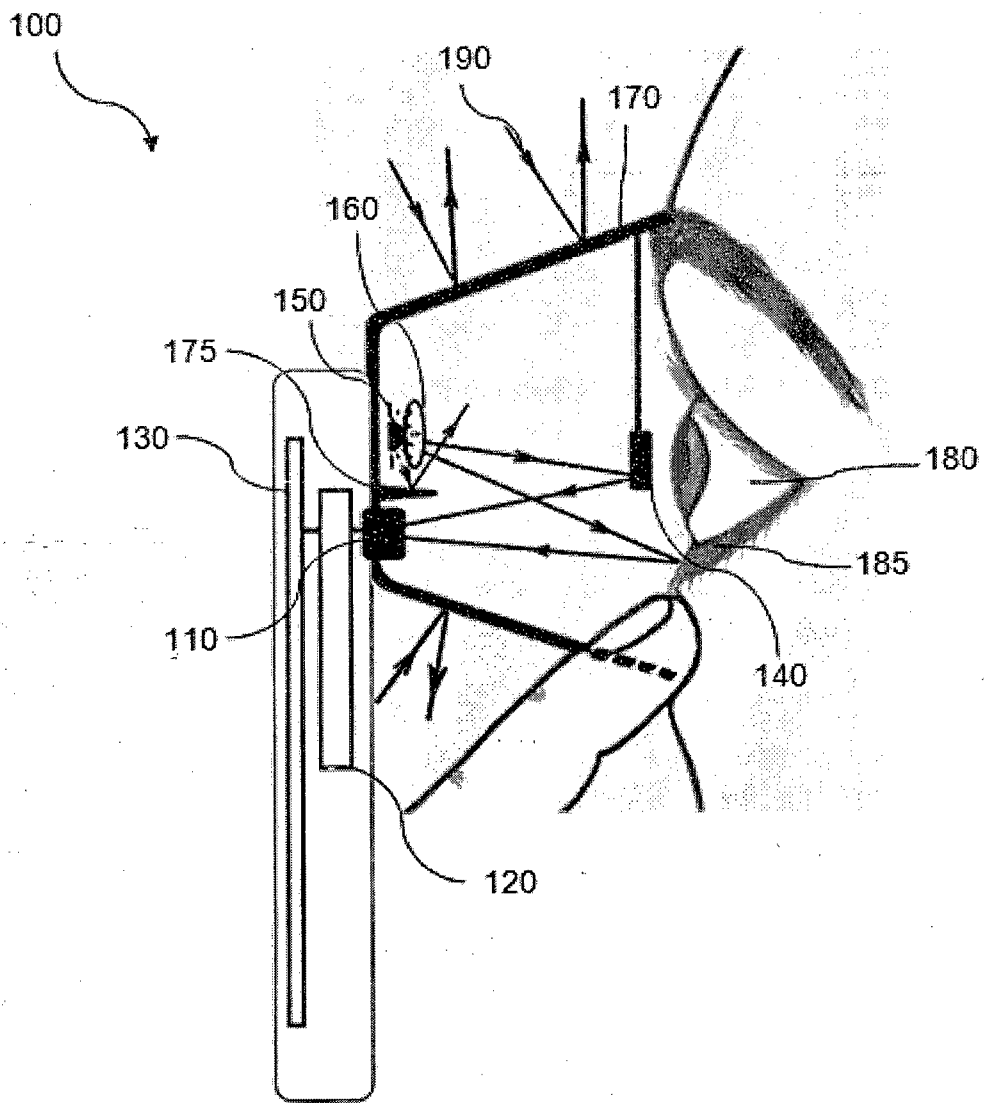


Figure 1

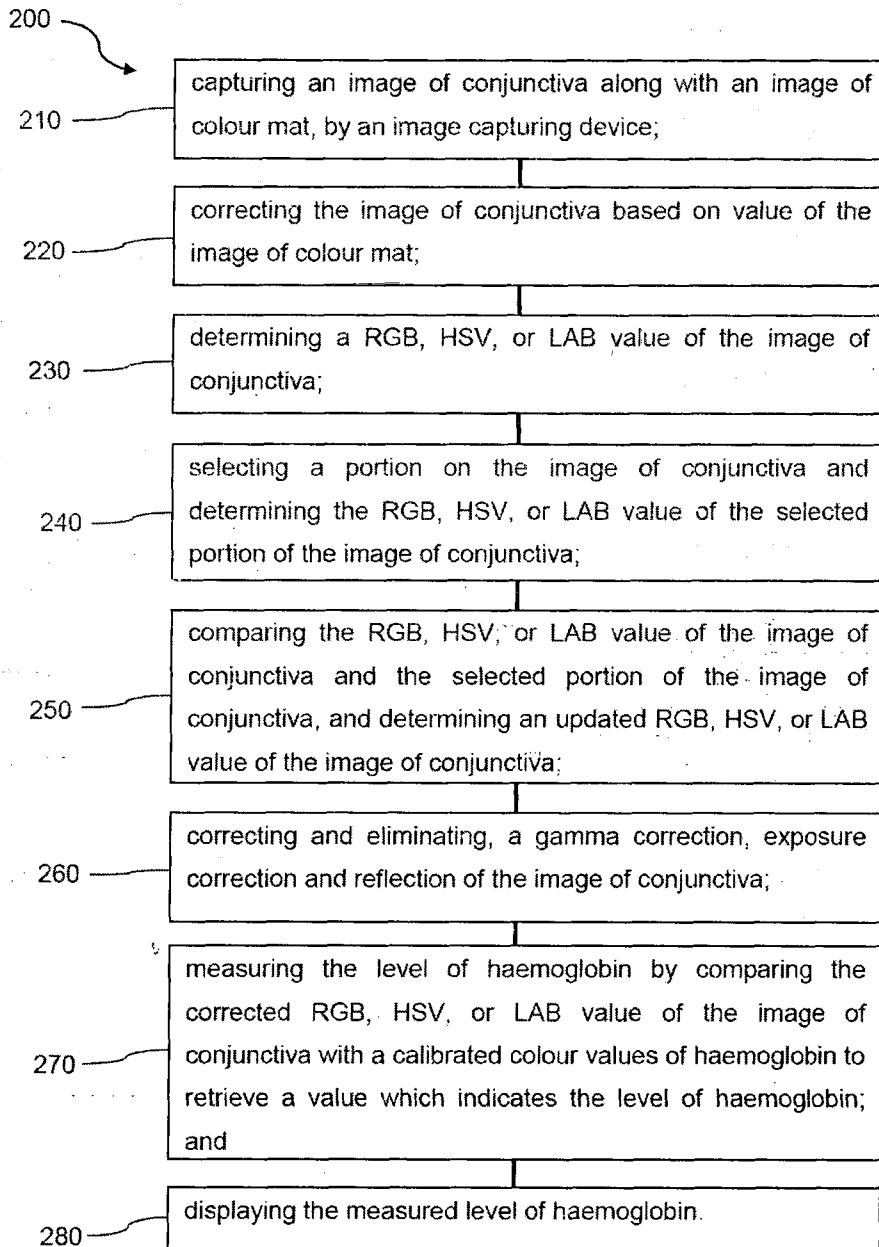


Figure 2