

(19)



(11)

EP 2 713 871 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
26.12.2018 Bulletin 2018/52

(51) Int Cl.:
A61B 5/103 ^(2006.01) **A61B 5/00** ^(2006.01)
A61G 11/00 ^(2006.01) **G01J 3/46** ^(2006.01)
H04N 1/56 ^(2006.01)

(21) Application number: **12729717.4**

(86) International application number:
PCT/IB2012/052630

(22) Date of filing: **25.05.2012**

(87) International publication number:
WO 2012/164462 (06.12.2012 Gazette 2012/49)

(54) METHOD AND SYSTEM FOR MONITORING THE SKIN COLOR OF A USER

VERFAHREN UND SYSTEM ZUR BEOBACHTUNG DER HAUTFARBE EINES BENUTZERS

MÉTHODE ET SYSTÈME DE SURVEILLANCE DE LA COULEUR DE PEAU D'UN UTILISATEUR

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

- **VEEN, Jeroen**
5656 AE Eindhoven (NL)
- **MEFTAH, Mohammed**
5656 AE Eindhoven (NL)

(30) Priority: **31.05.2011 EP 11168286**

(74) Representative: **Steffen, Thomas**
Philips Intellectual Property & Standards
High Tech Campus 5
5656 AE Eindhoven (NL)

(43) Date of publication of application:
09.04.2014 Bulletin 2014/15

(73) Proprietor: **Koninklijke Philips N.V.**
5656 AE Eindhoven (NL)

(56) References cited:
JP-A- 11 076 434 **US-A1- 2008 194 906**
US-A1- 2008 292 151 **US-A1- 2009 196 475**
US-A1- 2010 007 746 **US-B2- 6 679 830**

(72) Inventors:
• **FAZZI, Alberto**
5656 AE Eindhoven (NL)

EP 2 713 871 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

FIELD OF THE INVENTION

[0001] The invention relates to a method and a system for monitoring the skin color of a user, particularly a method and a system for monitoring the skin color of a neonate.

BACKGROUND OF THE INVENTION

[0002] It is common practice in neonatal intensive care units (NICU) to visually monitor and evaluate skin color of a neonate to have an indication of the neonate's physiopathologic conditions. For example, skin color provides indications of blood circulation, temperature and stress response of the neonate.

[0003] It is also common practice to shield the neonate, especially a premature neonate, from strong environmental light to avoid damage to eyes and to reduce the level of stress. The necessity of reducing exposure to light is recognized by the medical community and results in two main practices: having dimmed light within the NICU, and/or applying a cover to an incubator to provide shielding from light in the NICU environment.

[0004] However, the dimmed light will highly degrade the accuracy of skin color monitoring. Furthermore, while shielding the neonate from environmental light, the cover of the incubator also hinders visual monitoring of the neonate, and therefore, the cover needs to be periodically opened or removed to evaluate skin color.

[0005] While the monitoring of movements in the dark could be easily accomplished by simply using available infra-red cameras, there is currently no solution for monitoring skin color in the absence of light or at an extremely reduced light intensity.

[0006] US 6679830 B2 discloses an infant care unit and suggests using video cameras to monitor physiological parameters such as skin color. However, it does not disclose how to monitor skin color of a neonate when the neonate is within the infant care unit which is generally kept very dark to protect the neonate.

[0007] US 2009/196475 A1 discloses methods and systems for automatically generating a mask delineating a region of interest (ROI) within an image containing skin are disclosed. The image may be of an anatomical area containing skin, such as the face, neck, chest, shoulders, arms or hands, among others, or may be of portions of such areas, such as the cheek, forehead, or nose, among others. The mask that is generated is based on the locations of anatomical features or landmarks in the image, such as the eyes, nose, eyebrows and lips, which can vary from subject to subject and image to image. As such, masks can be adapted to individual subjects and to different images of the same subjects, while delineating anatomically standardized ROIs, thereby facilitating standardized, reproducible skin analysis over multiple subjects and/or over multiple images of each subject. Moreover,

the masks can be limited to skin regions that include uniformly illuminated portions of skin while excluding skin regions in shadow or hot-spot areas that would otherwise provide erroneous feature analysis results. Methods and systems are also disclosed for automatically registering a skin mask delineating a skin ROI in a first image captured in one imaging modality (e.g., standard white light, UV light, polarized light, multi-spectral absorption or fluorescence imaging, etc.) onto a second image of the ROI captured in the same or another imaging modality. Such registration can be done using linear as well as non-linear spatial transformation techniques.

[0008] US 2008/292151 A1 discloses a method for capturing images of an individual to determine wellness for such individual, including establishing baseline physiological data for the individual, and baseline capture condition data for the individual; detecting and identifying the presence of the individual in the image capture environment; providing semantic data associated with the individual; capturing one or more images of the individual during a capture event and determining the capture conditions present during the capture event; using the event capture conditions, the baseline physiological data for the individual and the baseline capture condition data to determine the acceptability of event captured images; and using the acceptable images and the semantic data in determining the wellness of the individual.

[0009] US 2008/194906 A1 shows an optical infant monitoring system with detection of the infant's silhouette. JP 11 076434 A shows an LED illumination for infant skin color monitoring. US 2010/007746 A1 shows a flash light control system with a face recognition system for determining if the infant's eyes are open.

SUMMARY OF THE INVENTION

[0010] Based on the understanding of the technical problems and prior art described above, it would be desirable to monitor skin color of a user without exposing the user to strong environmental light. It would also be desirable to monitor the skin color of a neonate inside an incubator with little to no light within the incubator and without the need to open the cover of the incubator. It would further be desirable to effectively control skin color monitoring so as to reduce disturbance of the user and well-being risks to the user.

[0011] To better address one or more of the above concerns, in an embodiment of a first aspect of the invention, a system for monitoring skin color of a user illuminated by a light source is provided. The system comprises:

a first controlling unit for controlling the direction and/or beam size of the light source to focus the light from the light source on a predefined part of the user; a capturing unit for capturing at least one image of the user over a predetermined time period; an obtaining unit for obtaining motion-related information of the user over the predetermined time pe-

riod;
 a deriving unit for deriving visual information from the at least one image on the basis of the motion-related information; and
 a determining unit for determining the skin color on the basis of the visual information.

[0012] At least one image is captured over a predetermined time period. Skin color can be detected on the proviso that a sufficient amount of reflected light from the skin of the user is accumulated, in time, during the predetermined period. Furthermore, since information about the user's motion, i.e. the so-called motion-related information, is obtained and then used for deriving visual information, distortion caused by the user's motions during the predetermined time can be mitigated. The distortion comprises an image being blurred due to the user's motion during the acquisition time when light information is being accumulated, and/or visual information derived from a plurality of images and being inaccurate because the position of the user in the plurality of the images changes due to the user's motions. Since the skin color is determined on the basis of the visual information derived from the at least one image, and the at least one image is captured over the predetermined period time, each measurement of the skin color approximately takes the predetermined period of time. However, considering that the skin color does not change rapidly, such a period of time is acceptable for monitoring the color of the skin.

[0013] According to the present invention, the system comprises a first controlling unit for controlling the direction and/or the beam size of the light source to focus the light from the light source on a predefined part of the user.

[0014] The predefined part of the user can refer to any specific part or spot of the user's body that is relevant and representative to be used for performing a measurement of the skin color.

[0015] In comparison with light diffusion over the user, when the light is focused on a predefined part of the user, the amount of light entering the visual space of the user can be reduced while the illumination of the predefined part remains the same. Thus, the disturbance of and risk of damage to the user can be reduced accordingly. Alternatively, by focusing the light on the predefined part of the user, the illumination of the predefined part can be increased while the amount of light entering the visual space of the user remains the same, thereby maintaining the same comfort level for the user. Thus, the predetermined time period for light accumulation can be reduced accordingly, and in turn the time consumption as well as the distortion due to the user's motions can be reduced also.

[0016] According to another embodiment, the system further comprises a detecting unit for detecting the status of the user, and a second controlling unit for controlling the illumination intensity of the light source according to the detected status of the user.

[0017] For example, the status of the user comprises

the status of the eyes of the user, and/or discomfort signs that indicate the discomfort of the user. When the eyes of the user are closed, the illumination intensity can be relatively increased and, in turn, the predetermined time period can be decreased compared to the scenario where the eyes of the user are open.

[0018] In this way, a good trade-off between the comfort level of the user and the effectiveness of the skin monitoring, such as time consumption and accuracy, can be adaptively achieved.

[0019] According to yet another embodiment, the system further comprises the light source, and the light source and the capturing unit are integrated into at least one of the following: mattress intended to be placed under the user, and clothing of the user. Additionally or alternatively, the light source and the capturing unit are attachable to the user.

[0020] In this way, the illumination can be highly localized and therefore, high illumination of the user's skin can be achieved without causing any disturbance to the user.

[0021] In an embodiment of a second aspect of the invention, a method of monitoring skin color of a user illuminated by a light source is provided. The method comprises the steps of:

controlling the direction and/or beam size of the light source to focus the light from the light source on a predefined part of the user;
 capturing at least one image of the user over a predetermined time period;
 obtaining motion-related information of the user over the predetermined time period;
 deriving visual information from the at least one image on the basis of the motion-related information;
 and
 determining the skin color on the basis of the visual information.

[0022] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

DESCRIPTION OF THE DRAWINGS

[0023] The above and other objects and features of the present invention will become more apparent from the following detailed description considered in connection with the accompanying drawings, in which:

Fig.1 shows a schematic diagram of an exemplary application scenario of a system in accordance with an embodiment of the invention.

Fig.2 shows a flowchart of a method in accordance with an embodiment of the invention.

Fig.3 shows a schematic diagram of an exemplary

application scenario of a system in accordance with another embodiment of the invention.

[0024] The same reference numerals are used to denote similar parts throughout the figures.

DETAILED DESCRIPTION

[0025] Fig.1 shows a schematic diagram of an exemplary application scenario of a system 100 in accordance with an embodiment of the invention.

[0026] The system 100 is configured to monitor skin color of a user illuminated by a light source. The system 100 can be applied for any kinds of person who need a skin color measurement or monitoring, such as adults, children and neonates. The advantages of the system are more obvious when the light intensity of the light source is low. For example, premature neonates will be disturbed or even injured by strong environmental light, so the light source illuminating the premature neonates should have a low light intensity. Preferably, the light emitted by the light source has a sufficiently wide and distributed spectrum in the visible range to enable correct color determination. Moreover, it can be beneficial to optimize the spectrum of the emitted light so that it causes as little stress as possible to the neonate.

[0027] According to an embodiment of the invention, the system 100 is applied to monitor skin color of a neonate.

[0028] Referring to Fig.1, a neonate 10 is lying on a mattress 20 within an incubator 30. The incubator 30 is generally kept as dark as possible for the purpose of reducing the stress for the neonate and the risk of eye damage. A light source 101 within the incubator 30 can be configured to provide diffused light with a low intensity; the intensity should be so low that the neonate is not disturbed. The system 100 can comprise the light source 101. Alternatively, the light source 101 can be a stand-alone device.

[0029] Further, referring to Fig.1, the system 100 comprises a capturing unit 102 for capturing at least one image of the user over a predetermined time period. The capturing unit 102 can be a photo camera, a video camera, a light detector, or the like. The at least one image can show the whole body of the user or part of the user's body. The predetermined time period can be related to the light intensity of the light source 101. For example, when the light intensity is lower, the predetermined time period is set to be longer so as to accumulate a sufficient amount of the reflected light from the user's skin for determination of the skin color. Furthermore, the number of the at least one image can be set according to the user's skin monitoring requirements. For example, when the number of the at least one image is smaller, a smaller number of images need to be processed to derive the visual information for skin color determination and the complexity of the skin monitoring operation can therefore

be reduced. In another example, when the number of the at least one image is larger, a higher flexibility can be provided when the visual information for skin color determination is derived, and the skin monitoring accuracy can be enhanced.

[0030] The capturing unit 102 can be configured to capture the at least one image in different ways.

[0031] In one embodiment, the capturing unit 102 captures an image at a point in time, with the shutter time being equal to or slightly smaller than the predetermined time period. The shutter time, also known as exposure time, represents the time it takes for light to reach the film or image sensor. By having a sufficiently long exposure time, the reflected light from the user will be accumulated over the exposure time, resulting in a single correctly exposed image.

[0032] In another embodiment, the capture unit 102 captures more than one image at a series of time points, and the total acquisition time of the more than one image is equal to the predetermined time period. The captured images will then be processed to accumulate visual information across these images to obtain a single correctly exposed image, which will be described later.

[0033] When the user moves during the image capturing process, the image will be blurred. Additionally, when the user moves during the capturing of a plurality of images, the position of the user's body will change across the plurality of images. Thus, the user's motion might make the skin color measurement less reliable.

[0034] In order to obtain information about the user's motion, the system 100 further comprises an obtaining unit 103 for obtaining motion-related information of the user over the predetermined time period. An example of such a unit could be an infra-red camera capable of visualizing movement of the user in a condition of extremely low light intensity.

[0035] The motion-related information can comprise any kind of information about the user's motion. In one embodiment, taking into consideration that a neonate, especially a premature neonate, mostly moves the limbs while other parts of the body remain mostly still, the motion-related information comprises a motion indication for each part of the user's body to indicate whether the part of the user's body moves in the image or not, or to further indicate the motion level. Additionally, the motion-related information comprises a motion indication for each image. In another embodiment, the motion-related information comprises information about the position of the user's body in each image and/or information about changes of the user's body position in different images. For example, when the left hand of the user moves from a first position in a first image to a second position in a second image, the motion-related information comprises the first position and the second position. Alternatively, the motion-related information may comprise the first position and the difference between the first and the second position.

[0036] The obtaining unit 103 can obtain the motion-

related information in different ways. In one embodiment, the obtaining unit 103 comprises a motion detector for detecting the user's motion. The motion detector can be an infra-red camera, a passive infra-red sensor, an accelerometer attached to the user or a pressure sensor integrated in the mattress or just below the mattress. In another embodiment, the obtaining unit 103 comprises a processor for obtaining the motion-related information by means of image processing. Various image processing techniques can be applied. For example, blurred areas of an image can be identified by detecting edges and boundaries. For another example, different parts of the user's body can be identified by a pattern recognition technique. On the basis of the identified different parts, the positions of each part in each image and/or the changes of the positions across a plurality of images can then be determined.

[0037] The system 100 further comprises a deriving unit 104 for deriving visual information from the at least one image on the basis of the motion-related information. The visual information refers to any information about the reflected light of the user captured in the at least one image. For example, when the deriving unit is provided with one image, the visual information can be the whole image or part of the image. In another example, when the deriving unit is provided with more than one image, the visual information can be an image generated by accumulating the more than one image.

[0038] The deriving unit 104 can derive the visual information in different ways.

[0039] In one embodiment, the deriving unit 104 selects non-blurred or less-blurred areas from an image and only uses the selected areas to derive the visual information for determining the skin color. Additionally or alternatively, when more than one image is provided, the deriving unit 104 selects non-blurred or less-blurred images from a plurality of images and uses only the selected images. For example, the selection can be performed on the basis of the motion indications provided by the obtaining unit 103.

[0040] In another embodiment, when the deriving unit 104 is provided with more than one image, it generates an image by accumulating the visual information across the more than one image therein by means of image processing. For example, the generated image is a superposition of the more than one image. Preferably, the deriving unit 104 can further use any algorithm known by the person skilled in the art for motion estimation and/or motion compensation to correct the distortion during the accumulating procedure. For example, the deriving unit 104 can use the algorithm to maximize the quality of the generated image. Additionally or alternatively, the deriving unit 104 can identify those parts of the more than one image in which the user does not move, or not move excessively, and apply the derivation procedure only to those.

[0041] Additionally, the deriving unit 104 can further evaluate the quality of the generated image, and judge,

for the generated image or for different parts of the generated image, whether there is sufficient visual information for a reliable skin color measurement. If the quality of parts of the generated image is not good enough for a reliable measurement, these parts of the generated images will be identified and will not be used for skin color determination.

[0042] The system 100 further comprises a determining unit 105. The determining unit 105 is configured to determine skin color on the basis of the visual information derived by the deriving unit 104. For example, the determining unit 105 can identify, from the image output by the deriving unit 104, which part contains skin and determine the skin color.

[0043] The system 100 further comprises a first controlling unit. The first controlling unit is configured to focus the light from the light source 101 on a predefined part of the user. For example, the first controlling unit can comprise a lighting controller, a light adjuster or the like. Preferably, the first controlling unit can control the direction and/or beam size of the light from the light source 101 on the basis of the motion-related information obtained by the obtaining unit 103, such as the user's position or the position of a predefined part of the user. In this way, the light can be focused on the predefined part of the user, even if its position changes due to the user's motions. Additionally, the light intensity can be also controlled in accordance with the predefined part to be illuminated. Preferably, the predefined part of the user comprises a part of the user's skin that is relevant and representative for performing a skin color monitoring process.

[0044] In this way, the percentage of the light emitted from the light source that enters the visual space of the user can be decreased. In comparison with the case where diffusing light is used, if the light is focused on the desired part of the user, it is possible to use stronger light while still maintaining the same level of comfort for the user. Accordingly, the image acquisition time can be reduced, and, in turn, distortion due to the user's motion during the predetermined time can be reduced as well.

[0045] Additionally, the first controlling unit can be further configured to be switchable between a mode of focusing the light from the light source on the desired part of the user and a mode of diffusing the light over the user.

[0046] The system 100 further comprises a detecting unit for detecting the status of the user, and a second controlling unit for controlling an illumination intensity of the light source 101 according to the detected status of the user. The status of the user can be one of the following, but is not limited thereto: the status of the user's eyes, and one or more discomfort signs. The status of the user's eyes refers to whether the eyes are open or closed. The discomfort signs comprise any sign indicating the discomfort of the user. The discomfort signs can be associated with eye blinking, eye movements or other parameters such as the amount of the user's motion and the type of motion. As an example of the functionality of

this second controlling unit, when the user's eyes are open, the second controlling unit reduces the illumination intensity of the light source 101. Alternatively, the light source 101 shuts down when the user's eyes are open. To the contrary, when the user's eyes are closed, the illumination intensity of the light source 101 is increased and image acquisition time can be reduced while still obtaining sufficient visual information for skin color determination. In another example, when discomfort signs are detected, the illumination intensity of the light source 101 is reduced to a level at which the discomfort signs disappear or fall within a predefined range.

[0047] The detecting unit can detect the status of the user in many ways. In an embodiment, infra-red imaging is used to detect the status of the eyes of the neonate, i.e. whether the eyes are open or closed. Infra-red imaging can be also used to detect the user's motion. When the obtaining unit 103 comprises a motion detector such as an infra-red camera, the detecting unit can comprise the same motion detector or in fact use the output information of said detector. Additionally or alternatively, the user is further monitored by an electrophysiological monitor 106, as shown in Fig.1. In this case, the status of the user can be detected according to Electroencephalogram (EEG) signals or Electrooculogram (EOG) signals. For example, an increase of alpha waves is known to be observed when the eyes are closed. Moreover, EOG signals are known to give an indication of eye movements.

[0048] The illumination intensity of the light source can be controlled using different techniques, such as in mechanical way or an optoelectronic way. In an embodiment, the light intensity of the light source is directly controlled to control the illumination intensity. For example, the second controlling unit can comprise a lighting controller, a light adjuster or the like. Referring to Fig.1, in another embodiment, the second controlling unit comprises a controllable unit 107 such as an adjustable shutter, a focusing element or a combination thereof. The controllable unit 107 is positioned in front of the light source and the illumination over the user is controlled by controlling the light passing through the controllable unit 107.

[0049] Fig.2 shows a flowchart of a method in accordance with an embodiment of the invention.

[0050] According to an embodiment of the present invention, a description is given of a method of monitoring the color of a user's skin which is illuminated by a light source.

[0051] Referring to Fig.2, the method comprises step 201 of capturing at least one image of the user over a predetermined time period.

[0052] The method further comprises step 202 of obtaining motion-related information of the user over the predetermined time period. For example, said step 202 comprises a sub-step of obtaining the motion-related information by detecting the user's motion. Additionally or alternatively, the step 202 comprises a sub-step of obtaining the motion-related information by means of image

processing.

[0053] The method further comprises step 203 of deriving visual information from the at least one image on the basis of the motion-related information. For example, said step 203 comprises the following sub-steps: selecting areas from a plurality of areas of the at least one image on the basis of the motion-related information obtained in step 202, and deriving the visual information from the selected areas. Additionally, when the at least one image comprises more than one image, the step S203 comprises a sub-step of deriving the visual information by accumulating the visual information across the more than one images.

[0054] The method further comprises step 204 of determining skin color on the basis of the visual information derived in step 203.

[0055] Moreover, steps 201 to 204 can be repeated to measure or monitor the skin color of the user at different times. For example, steps 201 to 204 can be repeated periodically, and the period can be set according to the skin color monitoring requirements of the user. For example, the period can be set to be short when the user requires intensive monitoring due to the user's unstable condition.

[0056] Additionally, the method can further comprise a step of controlling the direction and/or beam size of the light source to focus the light from the light source on a predefined part of the user. Furthermore, the method can comprise a step of controlling the illumination intensity of the light source according to a status of the user

[0057] Fig.3 shows a schematic diagram of an exemplary application scenario of a system in accordance with another embodiment of the invention.

[0058] Referring to Fig.3, the system 300 comprises a light source 301, a capturing unit 302, a deriving unit 304 and a determining unit 305. The light source 301 can be one or more LEDs; for the capturing unit 302 use can be made of photodiodes or other kind of sensors detecting the color of reflected light. The light source 301 is configured to direct the illumination to a measuring point; the capturing unit 302 is configured to capture the at least one image of the measuring point; the deriving unit 304 is configured to derive visual information about the user's skin at the measuring point from the captured at least one image; and the determining unit 305 is configured to determine the skin color of the user at the measuring point according to the derived visual information.

[0059] For example, the light source 301 and the capturing unit 302 are positioned at the measuring point. In another example, the light source 301 and the capturing unit 302 are light guides such as optical fibers. The light guides guide the light of an external light source to the measuring point and guide the reflected light at the measuring point to an external light detector.

[0060] In this way, the illumination can be highly localized and, therefore, a high illumination level on the user's skin can be achieved without causing any disturbance to the user.

[0061] In an embodiment, the light source 301 and the capturing unit 302 are integrated into at least one of the following: mattress 20 intended to be placed under the user, clothing of the user, and any other objects intended to be placed in the proximity of the user.

[0062] Further, the system 100 can comprise an array of pairs of such light sources 301 and capturing units 302. Each pair of the light sources 301 and capturing units 302 can be used to monitor the skin color at various measuring points.

[0063] Preferably, the system 100 comprises a third controlling unit for controlling the light sources 301 at the various measuring points so as to eliminate or reduce the risk of shining glaring light into the eyes of the user. For example, the third controlling unit identifies the light sources positioned near the head of the user on the basis of position information about the user, and shuts down the identified light sources. In this case, the system can further comprise an additional unit which is identical or similar to the obtaining unit 103 in Fig.1 to obtain the position information about the user, such as the position of the user with respect to the light sources 301.

[0064] In another embodiment, the light source 301 and the capturing unit 302 are attachable to the user.

[0065] In this way, skin monitoring can be performed at standardized positions with a more reproducible optical interface and the user's motion has little to no impact, leading to highly reliable and reproducible measurements.

[0066] For example, the light source 301 and the capturing unit 302 can be directly attached to the user's body via a holding fixture such as a band.

[0067] In another example, the light source 301 and the capturing unit 302 can be integrated into a wearable device. The integration into an existing type of devices such as a SPO2 sensing device is particularly attractive. A neonate inside a NICU is normally monitored with the SPO2 sensing device. Thus, the skin color of the neonate can be monitored without attaching any additional device or sensor to the neonate

[0068] A set of computer-executable instructions is further proposed to perform the methods described above. The instructions can reside in the obtaining unit, the deriving unit, the determining unit, the first controlling unit, the second controlling unit and/or the third controlling unit, to perform any step of the above disclosed methods.

[0069] Although the present invention will be described with reference to the embodiment shown in the drawings, it should be understood that the present invention may be embodied in many alternate forms including any combination of hardware and software. In addition, any suitable size, shape or type of materials, elements, computer program elements, computer program codes, or computer program modules could be used.

[0070] While discussed in the context of computer program code, it should be understood that the modules may be implemented in hardware circuitry, computer program code, or any combination of hardware circuitry and com-

puter program code.

[0071] It should be noted that the above-mentioned embodiments illustrate rather than limit the invention and that those skilled in the art will be able to design alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of elements or steps not listed in a claim or in the description. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. In the system claims enumerating several units, several of these units can be embodied by one and the same item of hardware or software. The use of the words first, second and third, et cetera, does not indicate any ordering. These words are to be interpreted as names.

20 **Claims**

1. A system (100) for monitoring the skin color of a user (10) illuminated by a light source (101), the system comprising:

a first controlling unit for controlling the direction and/or beam size of the light source (101) to focus the light from the light source (101) on a predefined part of the user;

a capturing unit (102) for capturing at least one image of the user over a predetermined time period;

an obtaining unit (103) for obtaining motion-related information of the user over the predetermined time period; and

characterised in that the system comprises:

a deriving unit for deriving visual information from the at least one image on the basis of the motion-related information; and

a determining unit for determining the skin color on the basis of the visual information.

2. A system as claimed in claim 1, wherein the obtaining unit (103) comprises:

a motion detector for obtaining the motion-related information by detecting the motion of the user.

3. A system as claimed in claim 1, wherein the obtaining unit (103) comprises:

a processor for obtaining the motion-related information by means of image processing.

4. A system as claimed in any one of claims 1 to 3, wherein:

the deriving unit is adapted for selecting areas from a plurality of areas of the at least one image on the basis of the motion-related information and deriving

the visual information from the selected areas.

5. A system as claimed in any one of claims 1 to 3, wherein:

the at least one image comprises more than one image; and
the deriving unit is adapted for deriving the visual information by accumulating the visual information across the more than one image.

6. A system as claimed in claim 1, further comprising:

a detecting unit for detecting the status of the user; and
a second controlling unit for controlling the illumination intensity of the light source (101) according to the detected status of the user.

7. A system (300) as claimed in claim 1, wherein:

the system further comprises the light source (301); and
the light source (301) and the capturing unit (302) are integrated into at least one of the following:

- mattress (20) intended to be placed under the user; and
- clothing of the user.

8. A system as claimed in claim 1, wherein:

the system further comprises the light source (301); and
the light source (301) and the capturing unit (302) are attachable to the user.

9. A method of monitoring skin color of a user (10) illuminated by a light source (101), the method comprising the steps of:

controlling the direction and/or beam size of the light source (101) to focus the light from the light source (101) on a predefined part of the user; capturing (S201) at least one image of the user over a predetermined time period; obtaining (S202) motion-related information of the user over the predetermined time period; and

characterised by:

deriving (S203) visual information from the at least one image on the basis of the motion-related information; and
determining (S204) the skin color on the basis of the visual information.

10. A method as claimed in claim 9, wherein the obtaining step (S202) comprises a sub-step of: obtaining the motion-related information by detecting the motion of the user.

11. A method as claimed in claim 9, wherein the obtaining step (S202) comprises a sub-step of: obtaining the motion-related information by means of image processing.

12. A method as claimed in any one of claims 9 to 11, wherein the deriving step (S203) comprises the sub-steps of:

selecting areas from a plurality of areas of the at least one image on the basis of the motion-related information; and
deriving the visual information from the selected areas.

13. A method as claimed in any one of claims 9 to 11, wherein:

the at least one image comprises more than one images; and
the deriving step (S203) comprises a sub-step of deriving the visual information by accumulating the visual information across the more than one images.

14. A set of computer-executable instructions, configured to perform any one of the claims 9 to 13.

35 Patentansprüche

1. System (100) zur Beobachtung der Hautfarbe eines Benutzers (10), der durch eine Lichtquelle (101) beleuchtet wird, wobei das System Folgendes umfasst:

eine erste Steuereinheit zum Steuern der Richtung und/oder Strahlenbündelgröße der Lichtquelle (101), um das Licht von der Lichtquelle (101) auf einen vordefinierten Teil des Benutzers zu fokussieren;
eine Aufnahmeeinheit (102) zum Aufnehmen von mindestens einem Bild des Benutzers über eine vorbestimmte Zeitdauer;
eine Erlangungseinheit (103) zum Erlangen bewegungsbezogener Informationen des Benutzers über die vorbestimmte Zeitdauer; und
dadurch gekennzeichnet, dass das System Folgendes umfasst:

eine Ableitungseinheit zum Ableiten visueller Informationen von dem mindestens einen Bild auf der Basis der bewegungsbezogenen Informationen; und

- eine Bestimmungseinheit zum Bestimmen der Hautfarbe auf der Basis der visuellen Informationen.
2. System nach Anspruch 1, wobei die Erlangungseinheit (103) Folgendes umfasst: einen Bewegungsdetektor zum Erlangen der bewegungsrelevanten Informationen durch Detektieren der Bewegung des Benutzers. 5
3. System nach Anspruch 1, wobei die Erlangungseinheit (103) Folgendes umfasst: einen Prozessor zum Erlangen der bewegungsrelevanten Informationen mittels Bildverarbeitung. 10
4. System nach einem der Ansprüche 1 bis 3, wobei: die Ableitungseinheit dafür ausgelegt ist, Bereiche aus einer Vielzahl von Bereichen des mindestens einen Bilds auf der Basis der bewegungsrelevanten Informationen auszuwählen und die visuellen Informationen von den ausgewählten Bereichen abzuleiten. 15 20
5. System nach einem der Ansprüche 1 bis 3, wobei das mindestens eine Bild mehr als ein Bild umfasst; und die Ableitungseinheit dafür ausgelegt ist, die visuellen Informationen durch Kumulieren der visuellen Informationen über das mehr als eine Bild abzuleiten. 25
6. System nach Anspruch 1, ferner umfassend: eine Detektionseinheit zum Detektieren des Zustands des Benutzers; und eine zweite Steuereinheit zum Steuern der Beleuchtungsintensität der Lichtquelle (101) entsprechend dem detektierten Zustand des Benutzers. 30 35
7. System (300) nach Anspruch 1, wobei das System ferner die Lichtquelle (301) umfasst; und die Lichtquelle (301) und die Aufnahmeeinheit (302) in mindestens eines von Folgendem integriert sind: 40
- Matratze (20), die dafür vorgesehen ist, unter dem Benutzer platziert zu werden; und
 - Kleidung des Benutzers. 45
8. System nach Anspruch 1, wobei: 50
- das System ferner die Lichtquelle (301) umfasst; und
 - die Lichtquelle (301) und die Aufnahmeeinheit (302) an dem Benutzer angebracht werden können. 55
9. Verfahren zur Beobachtung der Hautfarbe eines Benutzers (10), der durch eine Lichtquelle (101) be-
- leuchtet wird, wobei das Verfahren die folgenden Schritte umfasst:
- Steuern der Richtung und/oder Strahlenbündelgröße der Lichtquelle (101), um das Licht von der Lichtquelle (101) auf einen vordefinierten Teil des Benutzers zu fokussieren; Aufnehmen (S201) von mindestens einem Bild des Benutzers über eine vorbestimmte Zeitdauer; Erlangen (S202) bewegungsbezogener Informationen des Benutzers über die vorbestimmte Zeitdauer; und **gekennzeichnet durch:**
- Ableiten (S203) visueller Informationen von dem mindestens einen Bild auf der Basis der bewegungsbezogenen Informationen; und
 - Bestimmen (S204) der Hautfarbe auf der Basis der visuellen Informationen.
10. Verfahren nach Anspruch 9, wobei der Schritt des Erlangens (S202) den folgenden Teilschritt umfasst: Erlangen der bewegungsrelevanten Informationen durch Detektieren der Bewegung des Benutzers. 25
11. Verfahren nach Anspruch 9, wobei der Schritt des Erlangens (S202) den folgenden Teilschritt umfasst: Erlangen der bewegungsrelevanten Informationen mittels Bildverarbeitung. 30
12. Verfahren nach einem der Ansprüche 9 bis 11, wobei der Schritt des Ableitens (S203) die folgenden Teilschritte umfasst: 35
- Auswählen von Bereichen aus einer Vielzahl von Bereichen des mindestens einen Bilds auf der Basis der bewegungsrelevanten Informationen; und
 - Ableiten der visuellen Informationen von den ausgewählten Bereichen. 40
13. Verfahren nach einem der Ansprüche 9 bis 11, wobei das mindestens eine Bild mehr als ein Bild umfasst; und der Schritt des Ableitens (S203) einen Teilschritt des Ableitens der visuellen Informationen durch Kumulieren der visuellen Informationen über das mehr als eine Bild umfasst. 45
14. Satz von computerausführbaren Anweisungen, der konfiguriert ist, um einen der Ansprüche 9 bis 13 durchzuführen. 50 55

Revendications

1. Système (100) pour surveiller la couleur de la peau d'un utilisateur (10) éclairé par une source de lumière (101), le système comprenant :
- 5
- une première unité de commande pour commander la direction et/ou la taille de faisceau de la source de lumière (101) pour focaliser la lumière émanant de la source de lumière (101) sur une partie prédéfinie de l'utilisateur ;
- 10
- une unité de capture (102) pour capturer au moins une image de l'utilisateur sur une durée prédéterminée ;
- 15
- une unité d'obtention (103) pour obtenir des informations relatives au mouvement de l'utilisateur sur la durée prédéterminée ; et
- caractérisé en ce que** le système comprend :
- 20
- une unité de déduction pour déduire des informations visuelles d'après l'au moins une image sur la base des informations relatives au mouvement ; et
- 25
- une unité de détermination pour déterminer la couleur de la peau sur la base des informations visuelles.
2. Système selon la revendication 1, dans lequel l'unité d'obtention (103) comprend :
- 30
- un détecteur de mouvement pour obtenir les informations relatives au mouvement en détectant le mouvement de l'utilisateur.
3. Système selon la revendication 1, dans lequel l'unité d'obtention (103) comprend :
- 35
- un processeur pour obtenir les informations relatives au mouvement par traitement d'image.
4. Système selon l'une quelconque des revendications 1 à 3, dans lequel :
- 40
- l'unité de déduction est apte à sélectionner des zones parmi une pluralité de zones de l'au moins une image sur la base des informations relatives au mouvement et à déduire les informations visuelles d'après les zones sélectionnées.
- 45
5. Système selon l'une quelconque des revendications 1 à 3, dans lequel :
- 50
- l'au moins une image comprend des images multiples ; et
- l'unité de déduction est apte à déduire les informations visuelles en cumulant les informations visuelles sur les images multiples.
- 55
6. Système selon la revendication 1, comprenant en outre :
- une unité de détection pour détecter l'état d'un utilisateur ; et
- une seconde unité de commande pour commander l'intensité d'éclairage de la source de lumière (101) en fonction de l'état détecté de l'utilisateur.
7. Système (300) selon la revendication 1, dans lequel :
- le système comprend en outre la source de lumière (301) ; et
- la source de lumière (301) et l'unité de capture (302) sont intégrées dans au moins un des éléments suivants :
- un matelas (20) destiné à être placé sous l'utilisateur ; et
- un vêtement de l'utilisateur.
8. Système selon la revendication 1, dans lequel :
- le système comprend en outre la source de lumière (301) ; et
- la source de lumière (301) et l'unité de capture (302) peuvent être fixées à l'utilisateur.
9. Procédé de surveillance de la couleur de la peau d'un utilisateur (10) éclairé par une source de lumière (101), le procédé comprenant les étapes suivantes :
- commande de la direction et/ou de la taille de faisceau de la source de lumière (101) pour focaliser la lumière émanant de la source de lumière (101) sur une partie prédéfinie de l'utilisateur ;
- capture (S201) d'au moins une image de l'utilisateur sur une durée prédéterminée ;
- obtention (S202) d'informations relatives au mouvement de l'utilisateur sur la durée prédéterminée ; et
- caractérisé par :**
- la déduction (S203) d'informations visuelles d'après l'au moins une image sur la base des informations relatives au mouvement ; et
- la détermination (S204) de la couleur de la peau sur la base des informations visuelles.
10. Procédé selon la revendication 9, dans lequel l'étape d'obtention (S202) comprend une sous-étape consistant en :
- l'obtention d'informations relatives au mouvement par détection du mouvement de l'utilisateur.
11. Procédé selon la revendication 9, dans lequel l'étape d'obtention (S202) comprend une sous-étape consistant en :

l'obtention d'informations relatives au mouvement par traitement d'image.

- 12.** Procédé selon l'une quelconque des revendications 9 à 11, dans lequel l'étape de déduction (S203) comprend les sous-étapes suivantes :

sélection de zones parmi une pluralité de zones de l'au moins une image sur la base des informations relatives au mouvement ; et
déduction des informations visuelles d'après les zones sélectionnées.

- 13.** Procédé selon l'une quelconque des revendications 9 à 11, dans lequel :

l'au moins une image comprend des images multiples ; et
l'étape de déduction (S203) comprend une sous-étape de déduction des informations visuelles par cumul des informations visuelles sur les images multiples.

- 14.** Ensemble d'instructions exécutables par ordinateur, configuré pour effectuer l'une quelconque des revendications 9 à 13.

30

35

40

45

50

55

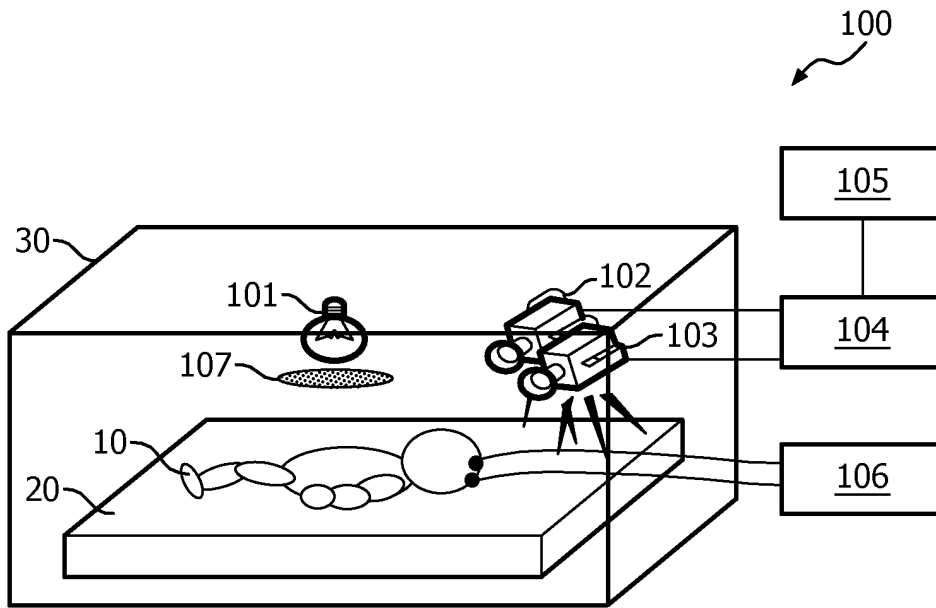


FIG. 1

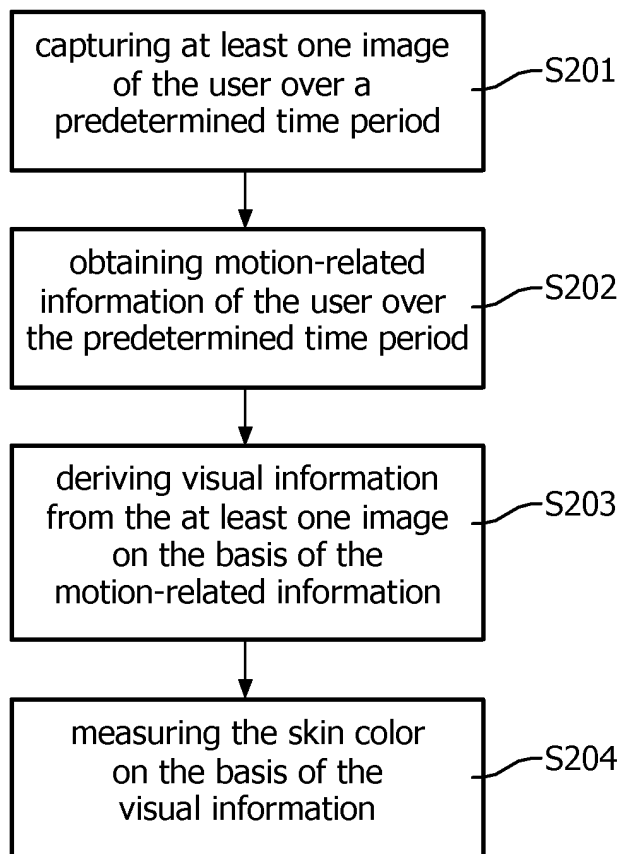


FIG. 2

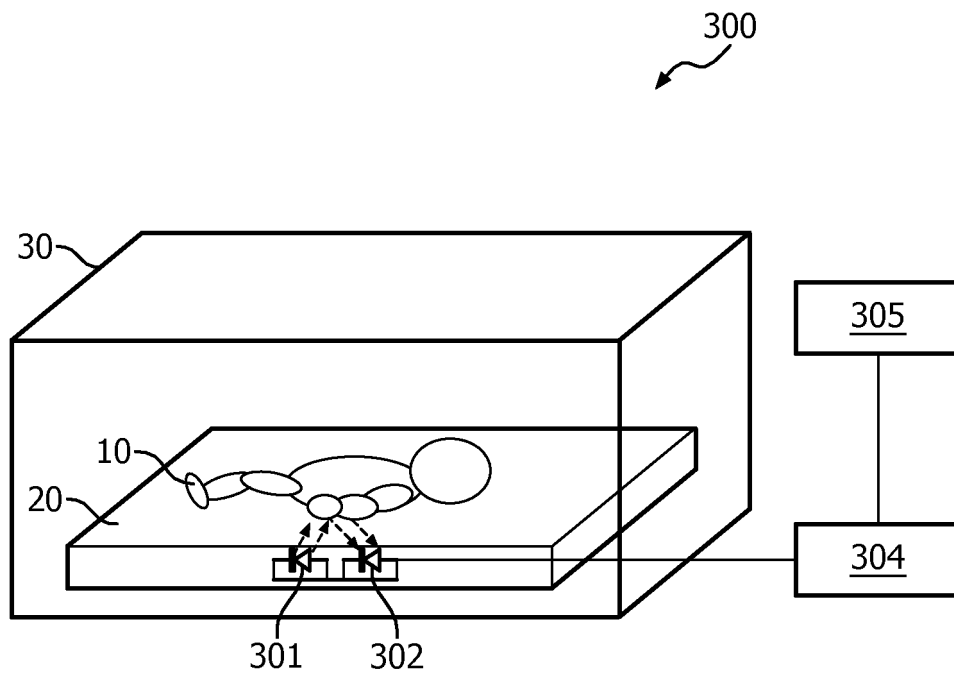


FIG. 3

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 6679830 B2 [0006]
- US 2009196475 A1 [0007]
- US 2008292151 A1 [0008]
- US 2008194906 A1 [0009]
- JP 11076434 A [0009]
- US 2010007746 A1 [0009]

专利名称(译)	用于监视用户的肤色的方法和系统		
公开(公告)号	EP2713871A1	公开(公告)日	2014-04-09
申请号	EP2012729717	申请日	2012-05-25
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦N.V.		
当前申请(专利权)人(译)	皇家飞利浦N.V.		
[标]发明人	FAZZI ALBERTO VEEN JEROEN MEFTAH MOHAMMED		
发明人	FAZZI, ALBERTO VEEN, JEROEN MEFTAH, MOHAMMED		
IPC分类号	A61B5/103 A61B5/00 A61G11/00 G01J3/46 H04N1/56		
CPC分类号	G06K9/00671 A61B5/0059 A61B5/1032 A61B5/441 A61B2503/045 A61G11/00 G01J3/50 G06T7/20		
代理机构(译)	STEFFEN , THOMAS		
优先权	2011168286 2011-05-31 EP		
其他公开文献	EP2713871B1		
外部链接	Espacenet		

摘要(译)

本发明涉及一种用于监测用户肤色的方法和系统。该系统包括捕获单元，获取单元，导出单元和确定单元。捕获单元在预定时间段内捕获用户的至少一个图像，并且获取单元在预定时间段内获得用户的运动相关信息。导出单元基于运动相关信息从至少一个图像导出视觉信息，并且确定单元基于导出的视觉信息确定肤色。以这种方式，可以有效地监视用户的肤色而不会使用户暴露在强烈的环境光下。