According to an aspect of the present invention, there is provided a method of evaluating suitability of lighting conditions for detecting an analyte in a sample using a mobile device having a camera, the method comprising:

a) providing a test strip configured for detecting the analyte in the sample and having at least one test field with a test chemical for an optical detection reaction;

b) capturing a first image of the test strip while an illumination source of the mobile device is turned off;

c) capturing a second image of the test strip while the illumination source is turned on, wherein the illumination source generates illumination having a known or predetermined spectral composition;

d) applying a sample to the test strip prior to step c);

e) comparing the first and second images and thereby determining a difference in lighting conditions between the first image and the second image, wherein the camera captures the images in steps b) and c) in at least one color channel and the camera and/or a processor of the mobile device determines first and second intensity distributions , respectively, for the at least one color channel associated with the first and second images, wherein the comparing the first and second images comprises comparing the first intensity distribution and the second intensity distribution of the at least one color channel;

f) determining an intensity of the illumination which originates from the illumination source used for illumination of the test strip when capturing the second image as a function of the known or predetermined spectral composition and wherein the known or predetermined spectral composition of the illumination source is obtained before capturing an image of the test strip of step a) with the mobile device;

g) deriving suitability information of the lighting conditions for analyte detection from the comparison in step e) and the determination of step f); and

h) determining that the lighting conditions are suitable for subsequent analyte detection using the second image when at least 70% of light intensity used for illumination of the test strip in the second image originates from the illumination source.

There is disclosed a method for evaluating a suitability of lighting conditions for detecting an analyte in a sample using a camera of a mobile device is disclosed. The method comprises the following steps which, as an example, may be performed in the given order. It shall be noted, however, that a different order is also possible. Further, it is also possible to perform one or more of the method steps once or repeatedly. Further, it is possible to perform two or more of the method steps simultaneously or in a timely overlapping fashion. The method may comprise further method steps which are not listed.

The method comprises the following steps:

a) capturing at least one first image of at least one test strip, wherein the test strip is adapted for detecting the analyte in the sample, the test strip having at least one test field comprising at least one test chemical for performing an optical detection reaction in the presence of the analyte, wherein, during the capturing of the first image, an illumination source of the mobile device is turned off;

b) capturing at least one second image of the test strip, wherein, during the capturing of the second image, the illumination source of the mobile device is turned on;

c) comparing the first and second images captured in steps a) and b), thereby determining a difference in lighting conditions between the first image and the second image; and

d) deriving at least one suitability information from the comparison in step c), wherein the suitability information comprises information on a suitability of the lighting conditions for analyte detection.

The term “mobile device” as used herein is a broad term and is to be given its ordinary and customary meaning to a person of ordinary skill in the art and is not to be limited to a special or customized meaning. The term specifically may refer, without limitation, to a mobile electronics device, more specifically to a mobile communication device such as a cell phone or smart phone. Additionally or alternatively, as will be outlined in further detail below, the mobile device may also refer to a tablet computer or another type of portable computer having at least one camera.

The term “test strip” as used herein is a broad term and is to be given its ordinary and customary meaning to a person of ordinary skill in the art and is not to be limited to a special or customized meaning. The term specifically may refer, without limitation, to an arbitrary element or device configured for performing a color-change detection reaction. The test strip may particularly have a test field containing at least one test chemical for detecting the at least one analyte. The test strip, as an example, may comprise at least one substrate,

in case the test strip having high reflection properties lower light intensity may be sufficient compared to dark or low reflection properties. Further, in case of bright ambient light conditions, for example due to sunlight, higher intensity may be required compared to shielded ambient light conditions.

There is disclosed a detection method for detecting an analyte in a sample by using a camera of a mobile device is disclosed. The method comprises the following steps which, as an example, may be performed in the given order. It shall be noted, however, that a different order is also possible. Further, it is also possible to perform one or more of the method steps once or repeatedly. Further, it is possible to perform two or more of the method steps simultaneously or in a timely overlapping fashion. The method may comprise further method steps which are not listed. The method comprising the following steps:

i) evaluating lighting conditions by using the method for evaluating a suitability of lighting conditions according to one of the preceding embodiments;

ii) if the suitability information on the suitability of the lighting conditions indicates the lighting conditions to be suitable for analyte detection, performing the following steps:

A) providing at least one test strip for detecting the analyte in the sample, the test strip having at least one test field comprising at least one test chemical for performing an optical detection reaction in the presence of the analyte;

B) applying at least one sample to the test field of the test strip;

C) capturing at least one image of the test field by using the camera, wherein during said capturing the illumination source of the mobile device is turned on; and

D) determining, from the image captured in step C), the analyte concentration in the sample.

With respect to embodiments and definition of the detection method reference is made to the description of the method for evaluating a suitability of lighting conditions above and as described in further detail below. In particular, with respect to method step i), reference may be made to the description of the method for evaluating a suitability of lighting conditions above.

The determining of the analyte concentration may comprise an optical detection. As used herein, the term “optical detection” refers to a detection of a reaction using an optical test chemical, such as a color-change test chemical which changes in color in the presence of

the method for evaluating a suitability of lighting conditions method and/or the detection method specifically may be part of the mobile device.

As outlined above, the mobile device specifically may be a mobile computer and/or a mobile communications device. Thus, specifically, the mobile device may be selected from the group consisting of: a mobile communications device, specifically a smart phone; a portable computer, specifically a notebook; a tablet computer.

As indicated above, further method steps may be computer implemented or computer assisted, specifically by a processor of the mobile device.

There is disclosed a computer program including computer-executable instructions for performing the method for evaluating a suitability of lighting conditions according to any one of the embodiments as described herein is disclosed. Specifically the computer- executable instructions may be suited for performing one or more of method steps a), b), c) and d). In particular, the program is executed on a computer or a computer network, specifically on a processor of a mobile device having at least one camera.

Thus, generally speaking, disclosed and proposed herein is a computer program including computer-executable instructions for performing the method for evaluating a suitability of lighting conditions according to the present invention in one or more of the embodiments enclosed herein when the program is executed on a computer or computer network. Specifically, the computer program may be stored on a computer-readable data carrier. Thus, specifically, one, more than one or even all of method steps as indicated above may be performed by using a computer or a computer network, preferably by using a computer program. The computer specifically may be fully or partially integrated into the mobile device, and the computer programs specifically may be embodied as a software app. Alternatively, however, at least part of the computer may also be located outside the mobile device.

Further disclosed and proposed herein is a data carrier having a data structure stored thereon, which, after loading into a computer or computer network, such as into a working memory or main memory of the computer or computer network, may execute the method for evaluating a suitability of lighting conditions according to one or more of the embodiments disclosed herein, specifically one or more of the method steps mentioned above.

description after having been loaded into a main and/or working storage of a computer or of a computer network, and

- a computer program product having program code means, wherein the program code means can be stored or are stored on a storage medium, for performing the method for evaluating a suitability of lighting conditions according to one of the embodiments described in this description, if the program code means are executed on a computer or on a computer network.

There is disclosed a computer program including computer-executable instructions for performing the detection method according to any one of the embodiments as described herein is disclosed. Specifically the computer-executable instructions may be suited for performing one or more of method steps i) and ii). In particular, the program is executed on a computer or a computer network, specifically on a processor of a mobile device having at least one camera.

Thus, generally speaking, disclosed and proposed herein is a computer program including computer-executable instructions for performing the detection method according to the present invention in one or more of the embodiments enclosed herein when the program is executed on a computer or computer network. Specifically, the computer program may be stored on a computer-readable data carrier. Thus, specifically, one, more than one or even all of method steps as indicated above may be performed by using a computer or a computer network, preferably by using a computer program. The computer specifically may be fully or partially integrated into the mobile device, and the computer programs specifically may be embodied as a software app. Alternatively, however, at least part of the computer may also be located outside the mobile device.

Further disclosed and proposed herein is a data carrier having a data structure stored thereon, which, after loading into a computer or computer network, such as into a working memory or main memory of the computer or computer network, may execute the detection method according to one or more of the embodiments disclosed herein, specifically one or more of the method steps mentioned above.

Further disclosed and proposed herein is a computer program product with program code means stored on a machine-readable carrier, in order to perform the detection method according to one or more of the embodiments disclosed herein, when the program is executed on a computer or computer network. As used herein, a computer program product refers to the program as a tradable product. The product may generally exist in an arbitrary format,

such as in a paper format, or on a computer-readable data carrier. Specifically, the computer program product may be distributed over a data network.

Finally, disclosed and proposed herein is a modulated data signal which contains instructions readable by a computer system or computer network, for performing the detection method according to one or more of the embodiments disclosed herein, specifically one or more of the steps of the detection method as mentioned above.

Specifically, further disclosed herein are:

- a computer or computer network comprising at least one processor, wherein the processor is adapted to perform the detection method according to one of the embodiments described in this description,
- a computer loadable data structure that is adapted to perform the detection method according to one of the embodiments described in this description while the data structure is being executed on a computer,
- a computer program, wherein the computer program is adapted to perform the detection method according to one of the embodiments described in this description while the program is being executed on a computer,
- a computer program comprising program means for performing the detection method according to one of the embodiments described in this description while the computer program is being executed on a computer or on a computer network,
- a computer program comprising program means according to the preceding embodiment, wherein the program means are stored on a storage medium readable to a computer,
- a storage medium, wherein a data structure is stored on the storage medium and wherein the data structure is adapted to perform the detection method according to one of the embodiments described in this description after having been loaded into a main and/or working storage of a computer or of a computer network, and
- a computer program product having program code means, wherein the program code means can be stored or are stored on a storage medium, for performing the detection method according to one of the embodiments described in this description, if the program code means are executed on a computer or on a computer network.

There is disclosed a mobile device for performing an analytical measurement is disclosed. The mobile devices comprises

- at least one camera;
- at least one illumination source; and

Claims

1. A method of evaluating suitability of lighting conditions for detecting an analyte in a sample using a mobile device having a camera, the method comprising:

a) providing a test strip configured for detecting the analyte in the sample and having at least one test field with a test chemical for an optical detection reaction;

b) capturing a first image of the test strip while an illumination source of the mobile device is turned off;

c) capturing a second image of the test strip while the illumination source is turned on, wherein the illumination source generates illumination having a known or predetermined spectral composition;

d) applying a sample to the test strip prior to step c);

e) comparing the first and second images and thereby determining a difference in lighting conditions between the first image and the second image, wherein the camera captures the images in steps b) and c) in at least one color channel and the camera and/or a processor of the mobile device determines first and second intensity distributions , respectively, for the at least one color channel associated with the first and second images, wherein the comparing the first and second images comprises comparing the first intensity distribution and the second intensity distribution of the at least one color channel;

f) determining an intensity of the illumination which originates from the illumination source used for illumination of the test strip when capturing the second image as a function of the known or predetermined spectral composition and wherein the known or predetermined spectral composition of the illumination source is obtained before capturing an image of the test strip of step a) with the mobile device;

g) deriving suitability information of the lighting conditions for analyte detection from the comparison in step e) and the determination of step f); and

h) determining that the lighting conditions are suitable for subsequent analyte detection using the second image when at least 70% of light intensity used for illumination of the test strip in the second image originates from the illumination source.

2. The method according to claim 1, wherein the illumination source is adapted to shine brighter than ambient light.

3. The method according to claim 1, wherein the first image is captured after applying the sample to the test strip in step d).

4. The method according to claim 1, wherein deriving the suitability information comprises comparing the difference in lighting conditions determined in step e) with a threshold value.

5. The method according to claim 1, wherein step h) comprises indicating that the lighting conditions are suitable for subsequent analyte detection when at least 80% of light intensity used for illumination of the test strip originates from the illumination source.

6. The method according to claim 1, further comprising checking and/or evaluating whether the illumination source provides sufficient illumination intensity.

7. The method according to claim 1, wherein the illumination source comprises at least one light-emitting diode integrated therein.

8. The method of claim 1, further comprising, when the suitability information indicates the lighting conditions are suitable for analyte detection, determining the analyte concentration in the sample using the second image.

9. A non-transitory computer readable medium having stored thereon computer executable instructions for performing the method of claim 1.

10. The non-transitory computer readable medium of claim 9, comprising a mobile device.

11. A mobile device, comprising:

a camera;

an illumination source; and

a processor or computer readable medium having stored thereon computer executable instructions for performing the method of claim 1.

12. The mobile device according to claim 11, wherein the mobile device is a mobile communications device.

13. The method according to claim 1, wherein the illumination of the test strip in the second image being assessed in step h) was provided by both ambient light and light originating from the illumination source.

14. The method according to claim 8, wherein the illumination of the test strip in the second image used to determine the analyte concentration was provided by both ambient light and light originating from the illumination source.

15. The method according to claim 1, further comprising a step of providing a visual indication with the mobile device to indicate a location for positioning the test strip relative to the camera when capturing the first and second images of the test strip wherein the visual indication is an outline of the test strip or a reference region of the test strip and is superimposed on a display of the mobile device.

16. The method according to claim 1, wherein the known or predetermined spectral composition is stored in a data storage device and the step of determining the intensity of the illumination which originates from the illumination source is performed as a function of the known or predetermined spectral composition stored on the data storage device.

17. The method according to claim 1, wherein the known or predetermined spectral composition is a known spectral composition of a standard illuminant.

18. The method according to claim 1, wherein the illumination source comprises at least one white light LED, wherein the at least one white light LED is controlled using a short current pulse to illuminate the test strip continuously during capture of the second image and wherein illuminance of flashes generated by the at least one white light LED are from 80 to 300 lux at an object distance of 1m.