Patent Claims

1. A system (1) for capturing measurement images of a measured object, comprising a mobile electronic device, wherein the mobile electronic device (2) comprises:

- a housing (5) ,
- a camera (6) which is integrated in the housing (5), for capturing measurement images (39) of a measured object (38) within an observation region (20) of the camera (6),
- a screen (7) which is integrated in the housing (5), for the light-emitting displaying of images, wherein the screen (7) faces the observation region (20) of the camera (6),
- a control unit (8) which is integrated in the housing (5) and is configured to activate the screen (7) of the mobile electronic device (2) into successively displaying several different illumination images (23) of a predefined illumination image sequence, wherein the control unit (8) is configured to activate the camera (6) of the mobile electronic device (2) into capturing a measurement image (39) of the measured object synchronously with the displaying of each illumination image (23) of the predefined illumination image sequence,

wherein each of the measurement images (39) comprises a plurality of image points (40) as well as image data which are assigned to the image points (40), wherein the system (1) comprises an evaluation unit (13, 14) which is configured to merge the image points (40) of the measurement images (39) by way of an image registration and to group the image data of merged image points (43) into measurement data sets, wherein the merged image points (40) form a registered measurement image (41), the image points (43) of which comprise the respectively assigned measurement data sets, wherein the evaluation unit (13, 15) is configured to detect, by means of an object recognition algorithm, in the registered image (41) object image points (42), each of which imaging an object point (43) of the measured object (38), wherein the evaluation unit (13, 15) is configured to determine, starting from a first image point, which is defined as an assumed object image point, how much the measurement data sets of adjacent image points differ from the measurement data set of the first image point, and to classify only those adjacent image points also as object image points for which the measurement data sets have a sufficiently low deviation from the measurement data set of the first image point, and to continue or iterate the object recognition algorithm, respectively starting from detected object points, until no further image points can be classified as object image points.

2. A system (1) according to claim 1, characterised in that the screen (7) of the mobile electronic device (2) comprises several colour channels, wherein the screen (7) has a channel-specific spectral emission characteristic in each of the colour channels, wherein the screen (7) comprises a multitude of light elements which are arranged in a grid, wherein each of the colour channels is formed by a subset of the light elements of the screen (7), whose spectral emission

characteristics correspond to the channel-specific spectral emission characteristics of the respective colour channel.

3. A system (1) according to claim 2, characterised in that the control unit (8) of the mobile electronic device (2) is configured to activate the screen (7) of the mobile electronic device (2) into displaying one or more of the illumination images (23) of the predefined illumination image sequence

- by way of activating the light elements of only a single colour channel of the screen (7) and by way of activating all activated light elements of this colour channel with a uniform brightness value which is predefined for this colour channel, or
- by way of activating the light elements of several colour channels and by way of activating all activated light elements with a uniform brightness value which is predefined for the respective colour channel, or
- by way of activating the light elements of one or more colour channels and by way of activating all active light elements with a gradient which is predefined for the respective colour channel.

4. A system (1) according to one of the claims 2 or 3, characterised in that the screen (7) of the mobile electronic device (2) comprises a red colour channel, a green colour channel, and a blue colour channel, wherein the illumination sequence comprises a red illumination image (23), a green illumination image (24), and a blue illumination image (25), wherein the control unit (8) of the mobile electronic device (2) is configured to activate the screen (7) into

- displaying the red illumination image (23) by way of activating the light elements of only the red colour channel of the screen (7) and by way of activating all activated light elements of the red colour channel with a uniform brightness value which is predefined for the red colour channel,
- displaying the green illumination image (24) by way of activating the light elements of only the green colour channel of the screen (7) and by way of activating all activated light elements of the green colour channel with a uniform brightness value which is predefined for the green colour channel, and/or
- displaying the blue illumination image (25) by way of activating the light elements of only the blue colour channel of the screen (7) and by way of activating all activated light elements of the blue colour channel with a uniform brightness value which is predefined for the blue colour channel.

5. A system (1) according to one of the preceding claims, wherein one or more of the following image characteristics of each illumination image (23) of the predefined illumination image sequence is or are predefined:

- a spectral composition of the light which is emitted by the screen (7) on displaying the respective illumination image and/or
- for each colour channel of the screen (7), a uniform brightness value inasmuch as this claim relates back to one of the claims 2 to 4, and/or
- a screen region which is filled out by the respective illumination image (28, 29, 30), and/or
- an arrangement of a screen region which is filled out by the respective illumination image (28, 29, 30), within the total image area (22) of the screen (7).

6. A system (1) according to one of the preceding claims, characterised in that each of the illumination images fills out only a part-region (33) of the total image area of the screen (7), wherein the filled-out part-regions (33) of the illumination images differ from one another in their arrangement on the total image area of the screen (7).

7. A system (1) according to claim 6, characterised in that the total image area of the screen (7) comprises an upper edge (34), wherein the filled-out part-regions (33) of the illumination images differ from one another in their distance from the upper edge (34) of the total image area of the screen (7), wherein the lens is arranged above the upper edge (34) of the total image area of the screen (7).

8. A system (1) according to one of the preceding claims, characterised in that the system (1) comprises at least one data memory (9, 11) in which illumination parameters which partly or completely define the predefined illumination image sequence are stored, wherein the control unit (8) of the mobile electronic device (2) is configured to retrieve the illumination parameters which are stored in the at least one data memory (9, 11), from the data memory (9, 11) and to determine the predefined illumination image sequence on the basis of the retrieved illumination parameters.

9. A system (1) according to one of the preceding claims, characterised in that the camera (6) of the mobile electronic device (2) comprises several different colour channels, wherein the camera (6) has a channel-specific spectral sensitivity for each of the colour channels, wherein the camera (6) comprises an image sensor which comprises a multitude of sensor elements which are arranged in a grid, wherein each of the colour channels of the camera (6) is formed by a subset of the sensor elements of the image sensor, whose spectral sensitivities correspond to the channel-specific sensitivity of the respective colour channel of the camera (6).

10. A system (1) according to claim 9, characterised in that the camera (6) of the mobile electronic (2) device comprises a red colour channel, a green colour channel, and a blue colour channel.

11. A system (1) according to one of the preceding claims, characterised in that the evaluation unit (13, 14) is configured to evaluate the measurement data sets by way of an algorithm which has been calibrated or trained by way of machine learning.

12. A system (1) according to claim 11, characterised in that the algorithm has been trained by way of a monitored learning method or by way of a non-monitored learning method.

13. A system (1) according to one of the preceding claims, characterised in that the evaluation unit (13, 14) is configured to evaluate the measurement data sets by way of a classification method.

14. A system (1) according to one of the preceding claims, characterised in that the evaluation unit (13, 14) is configured to evaluate the measurement data sets by way of an artificial neural network.

15. A system (1) according to one of the preceding claims, characterised in that the evaluation unit (13, 14) is configured to compare each of the measurement data sets with at least one predefined reference data set.

16. A system (1) according to one of the preceding claims, characterised in that the evaluation unit (13, 14) is configured to determine at least one reflection characteristic of the measured object (38) from the measurement data sets, preferably whilst taking into account a spectral sensitivity of the camera (6) and a spectral emission characteristic of the screen.

17. A system (1) according to claims 16, characterised in that the evaluation unit (13, 14) is configured to compare the at least one determined reflection characteristics of the measured object with at least one predefined reference reflection characteristic.

18. A system (1) according to one of the preceding claims combined with one of the claims 2 to 5 and one of the claims 9 or 10, characterised in that the screen (7) comprises M colour channels and the camera (6) N colour channels, wherein $M > 1$ and $N > 1$, wherein each measurement data set comprises at least $M \times N$ measurement values ($F(d, c)$ with $1 \leq d \leq M$ and $1 \leq c \leq N$), wherein the $M \times N$ measurement values correspond to $M \times N$ different combinations of colour channels of the screen with the colour channels of the camera (6).

19. A system (1) according to one of the preceding claims, characterised in that the mobile electronic device (2) comprises a user interface (16),

- wherein the predefined illumination image sequence can be set via the user interface (16) and/or
- wherein a selection between different predefined illumination image sequences is rendered possible by way of the user interface (16) and/or
- wherein a selection between different measured objects and/or between different characteristics of a measured object which are of interest is rendered possible by way of the user interface (16), wherein the control device is configured to select a predefined illumination image sequence between several stored predefined illumination image sequences in dependence on the made selection of a measured object and/or of a characteristic of interest.

20. A system (1) according to one of the preceding claims, characterised in that the mobile device (2) is switchable into a calibration mode, wherein the mobile device (2) is configured, in the calibration mode, to capture the mentioned measurement images of the calibration normal and carry out a calibration of the mobile device (2), in particular a calibration of the camera (6) and/or calibration the screen (7), using the measurement images of the calibration normal and of a stored reference data set which belongs to the calibration normal.

21. A system (1) according to one of the preceding claims, characterised in that the screen (7) is designed as a touchscreen.

22. A system (1) according to one of the preceding claims, characterised in that the mobile device is a smartphone or a tablet computer.

23. A method for capturing measurement images of a measured object by way of a system according to one of the preceding claims, comprising the steps:

- by way of the control unit (8), activating the screen (7) of the mobile electronic device (2) into successively displaying several different illumination images of the predefined illumination image sequence,
- activating the camera (6) of the mobile electronic device into capturing a measurement image of the measured object synchronously with the displaying of each illumination image of the predefined illumination image sequence, and
- merging image points (40) of the measurement images (39) and grouping image data assigned to merged image points (40) into measurement data sets, wherein the merged image points (40) form a registered measurement image (41), the image points (43) of which comprise the respectively assigned measurement data sets,
- carrying out an object recognition algorithm to detect, in the registered image (41) object image points (42), each of which imaging an object point (43) of the measured object (38), wherein carrying out the object recognition algorithm includes determining, starting

at a first image point, which is defined as an assumed object image point, how much the measurement data sets of adjacent image points differ from the measurement data set of the first image point, and classifying only those adjacent image points also as object image points for which the measurement data sets have a sufficiently low deviation from the measurement data set of the first image point, and continuing or iterating the object recognition algorithm, respectively starting from detected object points, until no further image points can be classified as object image points.

24. A computer program product (10) which can be loaded directly into an internal data memory (11) of the mobile electronic device (2) of the system according to one of the claims 1 to 22, and which comprises software code sections with which the steps of the method according to claim 23 are carried out when the computer program product (10) runs on the mobile electronic device (2).