

EXPOSURE TIME CALIBRATION METHOD AND APPARATUS, AND DEVICE AND STORAGE MEDIUM

[0001] The present application claims priority to Chinese Patent Application No. 202311770051.8, titled “EXPOSURE TIME CALIBRATION METHOD AND APPARATUS, AND DEVICE AND STORAGE MEDIUM”, filed on December 21, 2023 with the China National Intellectual Property Administration, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to the technical field of image processing, and in particular to an exposure time calibration method and apparatus, and a device and a storage medium.

BACKGROUND

[0003] Exposure time refers to a time period during which a photosensitive element of a camera or video camera is exposed to light, usually measured in seconds. The longer the exposure time, the more light the photosensitive element receives. The long exposure time is generally suitable for poor light conditions. The shorter the exposure time, the less light the photosensitive element receives. The short exposure time is generally suitable for good light conditions.

[0004] In practical application scenarios, to improve exposure efficiency, it is required that the exposure be completed while the light source is on. For this purpose, a deviation between the exposure time and the light source lighting time needs to be obtained. However, since both the exposure time and the light source lighting time are on the order of milliseconds or even microseconds, manual calibration of the deviation between the exposure time and the light source lighting time is difficult to ensure the accuracy of the calibration.

SUMMARY

[0005] Based on the above issue, an exposure time calibration method and apparatus, and a device and a storage medium are provided according to the present disclosure.

[0006] The following technical solutions are disclosed in the embodiments of the present disclosure.

5 **[0007]** In the first aspect, an exposure time calibration method is provided according to the present disclosure. The method includes:

[0008] photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target
10 photographing object;

[0009] adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve; and

[0010] determining a calibrated exposure start time instant and a calibrated exposure end time instant within a time period during which the grayscale value of the image remains
15 unchanged, based on the calibrated grayscale value variation curve.

[0011] In an implementation, the adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value
20 variation curve includes:

[0012] adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on the grayscale value of the image, such that an exposure time is before a light source lighting time, the exposure time is within the light source lighting time, and the exposure time is after the light
25 source lighting time, to obtain the calibrated grayscale value variation curve, where the exposure time indicates a period from the exposure start time instant to the exposure end time instant, and the light source lighting time indicates a period from the light source turn-on time instant to the light source turn-off time instant.

[0013] In an implementation, before photographing a target photographing object based on
30 an exposure start time instant, an exposure end time instant, a light source turn-on time instant,

and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object, the method further includes: determining a region of interest of the target photographing object;

[0014] the photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object includes: photographing the target photographing object based on the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant, to obtain a grayscale value of an image corresponding to the region of interest; and

[0015] the adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve includes: adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image corresponding to the region of interest, to obtain the calibrated grayscale value variation curve.

[0016] In an implementation, the determining a region of interest of the target photographing object includes: determining a flat region in the target photographing object, as the region of interest.

[0017] In an implementation, before determining a region of interest of the target photographing object, the method further includes: adjusting a height of a z-axis of a camera based on the sharpness of the target photographing object, to obtain a sharp target photographing object.

[0018] The determining a region of interest of the target photographing object includes: determining a region of interest of the sharp target photographing object.

[0019] In an implementation, after adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve, the method further includes: determining a start point of the calibrated

grayscale value variation curve as a calibrated light source turn-on time instant, and determining an end point of the calibrated grayscale value variation curve as a calibrated light source turn-off time instant.

[0020] In an implementation, a duration from the light source turn-on time instant to the light source turn-off time instant is 1.3 times a duration from the exposure start time instant to the exposure end time instant.

[0021] In a second aspect, an exposure time calibration apparatus is provided according to the present disclosure. The apparatus includes: a photographing unit, an adjustment unit, and a determination unit.

[0022] The photographing unit is configured to photograph a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object.

[0023] The adjustment unit is configured to adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve.

[0024] The determination unit is configured to determine a calibrated exposure start time instant and a calibrated exposure end time instant within a time period during which the grayscale value of the image remains unchanged, based on the calibrated grayscale value variation curve.

[0025] In an implementation, the adjustment unit is specifically configured to adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on the grayscale value of the image, such that an exposure time is before a light source lighting time, the exposure time is within the light source lighting time, and the exposure time is after the light source lighting time, to obtain the calibrated grayscale value variation curve, where the exposure time indicates a period from the exposure start time instant to the exposure end time instant, and the light source lighting time indicates a period from the light source turn-on time instant to the light source turn-off time instant.

[0026] In an implementation, the apparatus further includes: a region-of-interest determination unit.

[0027] The region-of-interest determination unit is configured to determine a region of interest of the target photographing object.

5 **[0028]** The photographing unit is further configured to photograph the target photographing object based on the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant, to obtain a grayscale value of an image corresponding to the region of interest.

10 **[0029]** The adjustment unit is further configured to adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image corresponding to the region of interest, to obtain the calibrated grayscale value variation curve.

15 **[0030]** In an implementation, the region-of-interest determination unit is specifically configured to determine a flat region in the target photographing object, as the region of interest.

[0031] In an implementation, the apparatus further includes: a sharpness adjustment unit.

[0032] The sharpness adjustment unit is configured to adjust a height of a z-axis of a camera based on a sharpness of the target photographing object, to obtain a sharp target photographing object.

20 **[0033]** The region-of-interest determination unit is specifically configured to determine a region of interest of the sharp target photographing object.

[0034] In an implementation, the apparatus further includes: a light source on/off determination unit.

25 **[0035]** The light source on/off determination unit is configured to determine a start point of the calibrated grayscale value variation curve as a calibrated light source turn-on time instant, and determine an end point of the calibrated grayscale value variation curve as a calibrated light source turn-off time instant.

[0036] In an implementation, a duration from the light source turn-on time instant to the light source turn-off time instant is 1.3 times a duration from the exposure start time instant to

the exposure end time instant.

[0037] In a third aspect, an electronic device is provided according to the present disclosure. The electronic device includes: a processor and a memory.

5 [0038] The memory is configured to store program codes and transmit the program codes to the processor.

[0039] The processor is configured to execute the steps of the exposure time calibration method as described above based on instructions in the program codes.

10 [0040] In a fourth aspect, a computer-readable storage medium is provided according to the present disclosure. The computer readable storage medium stores a computer program. The computer program, when executed by a processor, causes the processor to implement the steps of the exposure time calibration method as described above.

[0041] Compared with the conventional technology, the present disclosure has the following beneficial effects.

15 [0042] An exposure time calibration method and apparatus, and a device and a storage medium are provided according to the present disclosure. A target photographing object is photographed based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant; and a grayscale value of an image corresponding to the target photographing object is obtained; the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant are adjusted based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve; and a calibrated exposure start time instant and a calibrated exposure end time instant is determined within a time period during which the grayscale value of the image remains unchanged based on the calibrated grayscale value variation curve. In the present disclosure, the measurement of time is changed into the measurement of the grayscale value of the image, and the exposure time is calibrated based on the grayscale value of the image, thereby improving calibration accuracy.

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BRIEF DESCRIPTION OF THE DRAWINGS

30 [0043] For more clearly illustrating the technical solutions in the embodiments of the present disclosure or in the conventional technology, drawings referred to describe the

embodiments or the conventional technology will be briefly described hereinafter. Apparently, the drawings in the following description are only related to some embodiments of the present disclosure, and for those skilled in the art, other drawings may be obtained based on these drawings without any creative efforts.

5 [0044] FIG. 1 is a flowchart of an exposure time calibration method according to an embodiment of the present disclosure;

[0045] FIG. 2 is a schematic diagram of a flat region according to an embodiment of the present disclosure;

10 [0046] FIG. 3 is a schematic diagram of the relative relationship between exposure time and light source lighting time according to an embodiment of the present disclosure;

[0047] FIG. 4 is a schematic diagram of a grayscale value variation curve according to an embodiment of the present disclosure; and

[0048] FIG. 5 is a schematic structural diagram of an exposure time calibration apparatus according to an embodiment of the present disclosure.

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DETAILED DESCRIPTION

[0049] As described above, at present, how to improve the accuracy of calibrating exposure time has become a technical issue to be addressed by those skilled in the art.

20 [0050] In a photographing application scenario, to improve exposure efficiency, it is required that the exposure be completed while the light source is on. For this purpose, a deviation between the exposure time and the light source lighting time are obtained. However, on one hand, the deviation between the light source lighting time and the exposure time of the camera is difficult to obtain; on the other hand, since both the exposure time and the light source lighting time are on the order of milliseconds or even microseconds, the method of
25 manually calibrating the deviation between the exposure time and the light source lighting time is difficult to ensure the accuracy of the calibration.

[0051] Based on this, an exposure time calibration method is provided according to the present disclosure. A target photographing object is photographed based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light

source turn-off time instant; and a grayscale value of an image corresponding to the target photographing object is obtained; the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant are adjusted based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve; and a calibrated exposure start time instant and a calibrated exposure end time instant is determined within a time period during which the grayscale value of the image remains unchanged based on the calibrated grayscale value variation curve. In the present disclosure, the measurement of time is changed into the measurement of the grayscale value of the image, and the exposure time is calibrated based on the grayscale value of the image, thereby improving calibration accuracy.

[0052] In order to enable those skilled in the art to better understand the technical solutions according to the present disclosure, the technical solutions according to the embodiments of the present disclosure are described clearly and completely hereinafter with reference to the drawings in the embodiments of the present disclosure. Apparently, the described embodiments are only part of the embodiments according to the present disclosure, rather than all of the embodiments. Based on the embodiments of the present disclosure, all other embodiments obtained by those skilled in the art without any creative effort fall within the protection scope of the present disclosure.

[0053] Referring to FIG. 1, FIG. 1 is a flowchart of an exposure time calibration method according to an embodiment of the present disclosure. The method includes steps S101 to S103.

[0054] In step S101, a target photographing object is photographed based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object.

[0055] The grayscale value of the image refers to a brightness value of each pixel in the image, and is usually expressed as an integer from 0 to 255. In a grayscale image, the grayscale value of each pixel represents the brightness of that pixel. The larger the grayscale value, the higher the brightness of the pixel; and the smaller the grayscale value, the lower the brightness of the pixel. For example, a grayscale value of 0 represents black, a grayscale value of 255 represents white, and grayscale values between 0 and 255 represent different grayscale

levels.

[0056] In an embodiment, a region of interest (ROI) of the target photographing object may be determined, before the target photographing object is photographed based on the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant, and the grayscale value of the image corresponding to the target photographing object is obtained.

[0057] After the region of interest of the target photographing object is determined, the target photographing object may be photographed based on the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant, and the grayscale value of the image corresponding to the region of interest may be obtained. Thus, subsequently, the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant may be adjusted based on a change in the grayscale value of the image corresponding to the region of interest, to obtain a calibrated grayscale value variation curve.

[0058] In the embodiment of the present disclosure, the exposure time may be calibrated based on the change in the grayscale value of the image corresponding to the region of interest, rather than based on the grayscale values of the entire image, thereby effectively improving calibration efficiency.

[0059] For example, grayscale values of pixels in a flat region of the target photographing object are consistent, and thus the flat region of the target photographing object may be determined as the region of interest.

[0060] As shown in FIG. 2, FIG. 2 is a schematic diagram of a flat region according to an embodiment of the present disclosure. In FIG. 2, the upper diagram is a planar image, and the lower diagram is a stereoscopic image corresponding to the planar image, where a region 1-1, a region 1-2, a region 1-3, a region 1-4, and a region 1-5 are all flat regions, and the grayscale values of pixels in one flat region are the same. The exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant are adjusted based on the change in grayscale value of pixels in a flat region, to obtain a calibrated grayscale value variation curve.

[0061] The change in the grayscale value of the pixels in the flat region is caused by

different overlapping durations of the exposure time and the light source lighting time. Thus, the relationship between the exposure time and the light source lighting time may be determined based on the change in the grayscale values of the pixels in the flat region. For example, as the overlapping duration of the exposure time and the light source lighting time increases, the grayscale value of the pixels in the flat region increase accordingly. When the exposure time completely overlaps with the light source lighting time, the grayscale value of the pixels in the flat region reach the maximum. As the overlapping duration of the exposure time and the light source lighting time decreases, the grayscale value of the pixels in the flat region decrease accordingly.

[0062] For example, the grayscale value of pixels in a black region has a small amplitude of change with a light source, and the change in the grayscale value is not obvious. In the process of determining the region of interest in the image shown in FIG. 2, a white region 1-1 may be selected as the region of interest, in contrast to the black regions 1-2, 1-3, 1-4, and 1-5.

[0063] In an embodiment, before the region of interest of the target photographing object is determined, a height of a z-axis of a camera may be adjusted based on the sharpness of the target photographing object to obtain a sharp target photographing object. After the sharp target photographing object is obtained, the region of interest of the sharp target photographing object may be determined. Therefore, the accuracy of the calibration of the exposure time can be improved to a certain extent.

[0064] In step S102, the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant are adjusted based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve.

[0065] In an embodiment, the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant are adjusted based on the grayscale value of the image, so that the exposure time occurs before the light source lighting time, within the light source lighting time, and after the light source lighting time to obtain the calibrated grayscale value variation curve. The exposure time indicates a period from the exposure start time instant to the exposure end time instant. The light source lighting time indicates a period from the light source turn-on time instant to the light source turn-off

time instant.

[0066] As shown in FIG. 3, FIG. 3 is a schematic diagram of the relative relationship between exposure time and light source lighting time according to an embodiment of the present disclosure. t_{Ci0} represents the exposure start time instant of the camera; t_{Ci1} represents the exposure end time instant of the camera; t_{Li0} represents the light source turn-on time instant; t_{Li1} represents the light source turn-off time instant; and i is a positive integer greater than 0, indicating the number of group. The duration of the exposure time is equal to a difference between the exposure end time instant of the camera and the exposure start time instant of the camera, and the duration of the light source lighting time is equal to a difference between the light source turn-off time instant and the light source turn-on time instant.

[0067] In diagram (a) in FIG. 3, $i=1$, and t_{C10} represents the exposure start time instant of the camera, t_{C11} represents the exposure end time instant of the camera, t_{L10} represents the light source turn-on time instant, and t_{L11} represents the light source turn-off time instant.

Diagram (a) shows that the exposure start time instant is before the light source turn-on time instant, and the exposure end time instant is before the light source turn-off time instant, that is, the exposure time occurs before the light source lighting time, which corresponds to the case of early exposure. In diagram (b) in FIG. 3, $i=2$, and t_{C20} represents the exposure start time instant of the camera, t_{C21} represents the exposure end time instant of the camera, t_{L20} represents the light source turn-on time instant, and t_{L21} represents the light source turn-off time instant. Diagram (b) shows that the exposure start time instant is after the light source turn-on time instant, and the exposure end time instant is before the light source turn-off time instant, that is, the exposure time occurs within the light source lighting time, which corresponds to the case of appropriate exposure. In diagram (c) in FIG. 3, $i=3$, and t_{C30} represents the exposure start time instant of the camera, t_{C31} represents the exposure end time instant of the camera, t_{L30} represents the light source turn-on time instant, and t_{L31} represents the light source turn-off time instant. Diagram (c) shows that the exposure start time instant is after the light source turn-on time instant, and the exposure end time instant is after the light source turn-off time instant, that is, the exposure time occurs after the light source lighting time, which corresponds to the case of delayed exposure.

[0068] As shown in FIG. 4, FIG. 4 is a schematic diagram of a grayscale value variation

curve according to an embodiment of the present disclosure. In FIG. 4, a diagram (a), a diagram (b), and a diagram (c) respectively correspond to the cases that a light source lighting time is too long, the light source lighting time is appropriate, and the light source lighting time is too short. A grayscale H represents the maximum grayscale, and a grayscale L represents the minimum grayscale.

[0069] A rising segment G1 corresponds to the case of early exposure in FIG. 3, a flat segment G2 corresponds to the case of appropriate exposure in FIG. 3, and a falling segment G3 corresponds to the case of delayed exposure in FIG. 3.

[0070] In the embodiment of the present disclosure, the calibrated grayscale value variation curve can be obtained as shown in diagram (b) in FIG. 4 by adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant, such that the light source lighting time is appropriate.

[0071] In step S103, a calibrated exposure start time instant and a calibrated exposure end time instant is determined within a time period during which the grayscale value of the image remains unchanged, based on the calibrated grayscale value variation curve.

[0072] After the calibrated grayscale value variation curve is obtained, the calibrated exposure start time instant and the calibrated exposure end time instant may be determined within the time period during which the grayscale value of the image remains unchanged, that is, the flat segment G2 as shown in FIG. 4.

[0073] In an embodiment, a start point of the calibrated grayscale value variation curve is determined as the calibrated light source turn-on time instant, and an end point of the calibrated grayscale value variation curve is determined as the calibrated light source turn-off time instant.

[0074] In an embodiment, the duration from the light source turn-on time instant to the light source turn-off time instant is 1.3 times the duration from the exposure start time instant to the exposure end time instant.

[0075] In the present disclosure, the light source lighting time is controlled to be 30% longer than the camera exposure time, to avoid signal jitter and maintain the stability of photographing.

[0076] In summary, an exposure time calibration method is provided according to the

present disclosure. A target photographing object is photographed based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, and a grayscale value of an image corresponding to the target photographing object is obtained; the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant are adjusted based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve; and a calibrated exposure start time instant and a calibrated exposure end time instant is determined within a time period during which the grayscale value of the image remains unchanged based on the calibrated grayscale value variation curve. In the present disclosure, the measurement of time is changed into the measurement of the grayscale value of the image, and the exposure time is calibrated based on the grayscale value of the image, thereby improving calibration accuracy.

[0077] An exposure time calibration apparatus is provided according to the present disclosure. Referring to FIG. 5, FIG. 5 is a schematic structural diagram of an exposure time calibration apparatus according to an embodiment of the present disclosure. The specific implementation and the technical effects of the exposure time calibration apparatus are consistent with the implementation and the technical effects described in the above method embodiments, and thus some contents will not be repeated.

[0078] An exposure time calibration apparatus 1100 is provided according to the present disclosure. The exposure time calibration apparatus 1100 includes: a photographing unit 1101, an adjustment unit 1102, and a determination unit 1103.

[0079] The photographing unit 1101 is configured to photograph a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object.

[0080] The adjustment unit 1102 is configured to adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve.

[0081] The determination unit 1103 is configured to determine a calibrated exposure start time instant and a calibrated exposure end time instant within a time period during which the

grayscale value of the image remains unchanged, based on the calibrated grayscale value variation curve.

[0082] In an embodiment, the adjustment unit is further configured to: adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on the grayscale value of the image, such that an exposure time is before a light source lighting time, the exposure time is within the light source lighting time, and the exposure time is after the light source lighting time, to obtain the calibrated grayscale value variation curve, where the exposure time indicates a period from the exposure start time instant to the exposure end time instant, and the light source lighting time indicates a period from the light source turn-on time instant to the light source turn-off time instant.

[0083] In an embodiment, the apparatus further includes: a region-of-interest determination unit.

[0084] The region-of-interest determination unit is configured to determine a region of interest of the target photographing object.

[0085] The photographing unit is further configured to photograph the target photographing object based on the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant, to obtain a grayscale value of an image corresponding to the region of interest.

[0086] The adjustment unit is further configured to adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image corresponding to the region of interest, to obtain the calibrated grayscale value variation curve.

[0087] In an embodiment, the region-of-interest determination unit is further configured to determine a flat region in the target photographing object, as the region of interest.

[0088] In an embodiment, the apparatus further includes: a sharpness adjustment unit.

[0089] The sharpness adjustment unit is configured to adjust a height of a z-axis of a camera based on a sharpness of the target photographing object, to obtain a sharp target photographing object.

[0090] The region-of-interest determination unit is further configured to determine a region

of interest of the sharp target photographing object.

[0091] In an embodiment, the apparatus further includes: a light source on/off determination unit.

5 [0092] The light source on/off determination unit is configured to determine a start point of the calibrated grayscale value variation curve as a calibrated light source turn-on time instant, and determine an end point of the calibrated grayscale value variation curve as a calibrated light source turn-off time instant.

10 [0093] In an embodiment, a duration from the light source turn-on time instant to the light source turn-off time instant is 1.3 times a duration from the exposure start time instant to the exposure end time instant.

[0094] In summary, an exposure time calibration apparatus is provided according to the present disclosure, which can change the measurement of time into the measurement of the grayscale value of the image, and calibrate the exposure time based on the grayscale value of the image, thereby improving the accuracy of exposure time calibration.

15 [0095] An electronic device is provided according to the present disclosure. The electronic device includes: a processor and a memory.

[0096] The memory is configured to store program codes and transmit the program codes to the processor.

20 [0097] The processor is configured to execute the steps of the exposure time calibration method as described above based on instructions in the program codes.

[0098] A computer-readable storage medium is provided according to the present disclosure. The computer readable storage medium stores a computer program. The computer program, when executed by a processor, causes the processor to implement the steps of the exposure time calibration method as described above.

25 Embodiments

[0099] In a first embodiment, an exposure time calibration method includes:

[0100] photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target

photographing object;

[0101] adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve; and

5 [0102] determining a calibrated exposure start time instant and a calibrated exposure end time instant within a time period during which the grayscale value of the image remains unchanged, based on the calibrated grayscale value variation curve.

[0103] In a second embodiment, in the method according to the first embodiment, the adjusting the exposure start time instant, the exposure end time instant, the light source
10 turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve includes:

[0104] adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on the grayscale value of the image, such that an exposure time is before a light source lighting time, the exposure time is within the light source lighting time, and the exposure time is after the light
15 source lighting time, to obtain the calibrated grayscale value variation curve, where the exposure time indicates a period from the exposure start time instant to the exposure end time instant, and the light source lighting time indicates a period from the light source turn-on time instant to the light source turn-off time instant.

20 [0105] In a third embodiment, in the method according to the first or second embodiment, before photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object, the method further includes: determining a region of interest of the
25 target photographing object;

[0106] the photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object includes: photographing the target photographing object based on the
30 exposure start time instant, the exposure end time instant, the light source turn-on time instant,

and the light source turn-off time instant, to obtain a grayscale value of an image corresponding to the region of interest; and

[0107] the adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve includes: adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image corresponding to the region of interest, to obtain the calibrated grayscale value variation curve.

[0108] In a fourth embodiment, in the method according to the first to third embodiments, the determining a region of interest of the target photographing object includes: determining a flat region in the target photographing object, as the region of interest.

[0109] In a fifth embodiment, in the method according to the first to fourth embodiments, before determining a region of interest of the target photographing object, the method further includes: adjusting a height of a z-axis of a camera based on the sharpness of the target photographing object, to obtain a sharp target photographing object.

[0110] The determining a region of interest of the target photographing object includes: determining a region of interest of the sharp target photographing object.

[0111] In a sixth embodiment, in the method according to the first to fifth embodiments, after adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve, the method further includes: determining a start point of the calibrated grayscale value variation curve as a calibrated light source turn-on time instant, and determining an end point of the calibrated grayscale value variation curve as a calibrated light source turn-off time instant.

[0112] In a seventh embodiment, in the method according to the first to sixth embodiments, a duration from the light source turn-on time instant to the light source turn-off time instant is 1.3 times a duration from the exposure start time instant to the exposure end time instant.

[0113] In an eighth embodiment, an exposure time calibration apparatus is provided according to the present disclosure. The apparatus includes: a photographing unit, an

adjustment unit, and a determination unit.

[0114] The photographing unit is configured to photograph a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object.

[0115] The adjustment unit is configured to adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve.

[0116] The determination unit is configured to determine a calibrated exposure start time instant and a calibrated exposure end time instant within a time period during which the grayscale value of the image remains unchanged, based on the calibrated grayscale value variation curve.

[0117] In a ninth embodiment, an electronic device is provided according to the present disclosure. The electronic device includes: a processor and a memory.

[0118] The memory is configured to store program codes and transmit the program codes to the processor.

[0119] The processor is configured to execute the exposure time calibration method according to the embodiments first to seventh embodiments based on instructions in the program codes.

[0120] In a tenth embodiment, a computer-readable storage medium is provided according to the present disclosure. The computer readable storage medium stores a computer program. The computer program, when executed by a processor, causes the processor to implement the exposure time calibration method according to the first to seventh embodiments.

[0121] It should be noted that embodiments in this specification are described in a progressive way, the same and similar parts among the embodiments may refer to each other, and each of the embodiments emphasizes differences from other embodiments. In particular, with respect to the device and apparatus embodiments, since they are fundamentally similar to the method embodiments, the description thereof is relatively simple. For related aspects, reference may be made to the corresponding explanations in the method embodiments. The

device embodiments and apparatus embodiments described above are merely schematic, where the units described as separate components may or may not be physically separated, and the components indicated as units may or may not be physical units, that is, they may be located in one position or may be distributed over multiple network units. Some or all of the
5 modules may be adopted as needed to achieve the object of the solutions of the embodiments. Those skilled in the art can understand and implement the present disclosure without creative effort.

[0122] The above description is only a specific embodiment of the present disclosure, and the protection scope of the present disclosure is not limited thereto. Any changes or
10 replacements that may be easily conceived by those skilled in the art within the technical scope disclosed in the present disclosure should fall within the protection scope of the present disclosure. Therefore, the scope of protection of the present disclosure shall be determined by the scope of the claims.

CLAIMS

1. An exposure time calibration method, comprising:

photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object;

adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve; and

determining a calibrated exposure start time instant and a calibrated exposure end time instant within a time period during which the grayscale value of the image remains unchanged, based on the calibrated grayscale value variation curve.

2. The method according to claim 1, wherein the adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve comprises:

adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on the grayscale value of the image, such that an exposure time is before a light source lighting time, the exposure time is within the light source lighting time, and the exposure time is after the light source lighting time, to obtain the calibrated grayscale value variation curve,

wherein the exposure time indicates a period from the exposure start time instant to the exposure end time instant, and the light source lighting time indicates a period from the light source turn-on time instant to the light source turn-off time instant.

3. The method according to claim 1, wherein before photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object, the method further comprises:

determining a region of interest of the target photographing object;

the photographing a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object comprises:

photographing the target photographing object based on the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant, to obtain a grayscale value of an image corresponding to the region of interest; and

the adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve comprises:

adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image corresponding to the region of interest, to obtain the calibrated grayscale value variation curve.

4. The method according to claim 3, wherein the determining a region of interest of the target photographing object comprises:

determining a flat region in the target photographing object, as the region of interest.

5. The method according to claim 3, wherein before determining a region of interest of the target photographing object, the method further comprises:

adjusting a height of a z-axis of a camera based on the sharpness of the target photographing object, to obtain a sharp target photographing object; and

the determining a region of interest of the target photographing object comprises:

determining a region of interest of the sharp target photographing object.

6. The method according to claim 1, wherein after adjusting the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve, the method further comprises:

determining a start point of the calibrated grayscale value variation curve as a calibrated light source turn-on time instant, and determining an end point of the calibrated grayscale value variation curve as a calibrated light source turn-off time instant.

5 7. The method according to any one of claims 1 to 6, wherein a duration from the light source turn-on time instant to the light source turn-off time instant is 1.3 times a duration from the exposure start time instant to the exposure end time instant.

8. An exposure time calibration apparatus, comprising: a photographing unit, an adjustment unit, and a determination unit, wherein

10 the photographing unit is configured to photograph a target photographing object based on an exposure start time instant, an exposure end time instant, a light source turn-on time instant, and a light source turn-off time instant, to obtain a grayscale value of an image corresponding to the target photographing object;

15 the adjustment unit is configured to adjust the exposure start time instant, the exposure end time instant, the light source turn-on time instant, and the light source turn-off time instant based on a change in the grayscale value of the image, to obtain a calibrated grayscale value variation curve; and

20 the determination unit is configured to determine a calibrated exposure start time instant and a calibrated exposure end time instant within a time period during which the grayscale value of the image remains unchanged, based on the calibrated grayscale value variation curve.

9. An electronic device, comprising: a processor and a memory, wherein

the memory is configured to store program codes and transmit the program codes to the processor; and

25 the processor is configured to execute the exposure time calibration method according to any one of claims 1 to 7 based on instructions in the program codes.

10. A computer-readable storage medium, wherein the computer-readable storage medium stores a computer program, and the computer program, when executed by a processor, causes the processor to implement the exposure time calibration method according to any one of claims 1 to 7.