CLAIMS

1. An extended depth-of-field imaging device, comprising:

a movable imaging module, comprising an optical lens and a photosensitive element, wherein the photosensitive element is configured to image a target object within a field-of-view range of the optical lens, and a movement direction of the movable imaging module is parallel to a depth direction of the optical lens;

an adjustable light source module, configured to adjust a light-reception state of the target object; and

an image processing module, configured to generate an extended depth-of-field image of the target object based on at least two groups of depth image sequences, wherein the at least two groups of depth image sequences are obtained by imaging the target object by the photosensitive element under different imaging exposure conditions, wherein the imaging exposure condition under which the photosensitive element images the target object is associated with the light-reception state of the target object, and each group of the depth image sequences comprises a plurality of images captured by the photosensitive element with a same imaging exposure condition when the movable imaging module is located at a plurality of depth positions in the depth direction, respectively.

2. The extended depth-of-field imaging device according to claim 1, wherein the adjustable light source module comprises a plurality of illumination sources configured to selectively illuminate the target object according to any one of at least two illumination modes, the light-reception state of the target object is used for determining the imaging exposure condition under which the photosensitive element images the target object, enabled states of the plurality of illumination sources under different illumination modes are different, so that the light-reception state of the target object differs under the different illumination modes, and the plurality of illumination sources comprise:

a coaxial illumination source group, comprising a plurality of first illumination sources, wherein each of the plurality of first illumination sources is configured to generate a first single-source light beam parallel to the depth direction, the first single-source light beams respectively generated by the plurality of first illumination sources cover different fan-shaped phase intervals of a circular illuminated region in a field-of-view region of the optical lens, and the circular illuminated region is coaxial with an optical axis of the optical lens; and

an annular illumination source group, comprising a plurality of second illumination sources, wherein each of the plurality of second illumination sources is configured to generate a second single-source light beam inclined relative to the depth direction, the second single-source light beams respectively generated by the plurality of second illumination sources cover different annular-sector phase intervals of an annular illuminated region in the field-of-view region, and the annular illuminated region coaxially surrounds the circular illuminated region.

3. The extended depth-of-field imaging device according to claim 1, wherein the image processing module is configured to:

based on the at least two groups of depth image sequences, for each group of depth image sequences and for each pixel position, determine, under the imaging exposure condition of the group, single-source sharpness evaluation values respectively corresponding to the plurality of depth positions, and a single-source confidence of the single-source sharpness evaluation values;

for each pixel position, fuse, under the imaging exposure conditions of the at least two groups of depth image sequences, the single-source sharpness evaluation values and the single-source confidence into multi-source sharpness evaluation values at the pixel position respectively corresponding to the plurality of depth positions and a multi-source confidence of the multi-source sharpness evaluation values, wherein a fusion weight of the single-source sharpness evaluation values at each pixel position under the imaging exposure condition of each group of depth image sequences is associated with the single-source confidence at the pixel position under the imaging exposure condition of the group of depth image sequences; and

generate the extended depth-of-field image based on the multi-source sharpness evaluation values respectively corresponding to the plurality of depth positions and the multi-source confidence.

4. The extended depth-of-field imaging device according to claim 3, wherein the image processing module is further configured to:

based on the at least two groups of depth image sequences, for each group of depth image sequences and for each pixel position, determine, by respectively using at least two sharpness

evaluation metrics and under the imaging exposure condition of the group, single-metric sharpness evaluation values corresponding to the plurality of depth positions, and a single-metric confidence of the single-metric sharpness evaluation values; and

for each pixel position under the imaging exposure condition of each group of depth image sequences, fuse the single-metric sharpness evaluation values and the single-metric confidence, respectively determined by using the at least two sharpness evaluation metrics, into the single-source sharpness evaluation values at the pixel position corresponding to the plurality of depth positions under the imaging exposure condition of the group of depth image sequences and the single-source confidence of the single-source sharpness evaluation values, wherein a fusion weight of the single-metric sharpness evaluation values at each pixel position under the imaging exposure condition of each group of depth image sequences is associated with the single-metric confidence at the pixel position under the imaging exposure condition of the group of depth image sequences.

5. The extended depth-of-field imaging device according to claim 3, wherein the image processing module is further configured to:

determine, based on the at least two groups of depth image sequences, an overexposed region of the target object under the imaging exposure condition of each group of depth image sequences; and

wherein fusion of the single-source sharpness evaluation values and/or the single-source confidence at each pixel position under the imaging exposure condition of each group of depth image sequences is associated with a positional relationship indicating whether the pixel position is located within the overexposed region under the imaging exposure condition of the group of depth image sequences.

6. The extended depth-of-field imaging device according to claim 3, wherein the image processing module is configured to:

determine, based on the at least two groups of depth image sequences, a single-source three-dimensional evaluation tensor and a single-source confidence map of each group of depth image sequences; wherein the single-source three-dimensional evaluation tensor of any one group of depth image sequences comprises single-source evaluation vectors at respective pixel

positions, the single-source evaluation vector at each pixel position comprising a plurality of single-source sharpness evaluation values at the pixel position respectively corresponding to the plurality of depth positions; and the single-source confidence map of any one group of depth image sequences comprises single-source confidences of the single-source evaluation vectors at respective pixel positions in the single-source three-dimensional evaluation tensor of the group of depth image sequences;

determine a multi-source three-dimensional evaluation tensor and a multi-source confidence map based on the single-source three-dimensional evaluation tensors and the single-source confidence maps of the at least two groups of depth image sequences; wherein the multi-source three-dimensional evaluation tensor comprises multi-source evaluation vectors at respective pixel positions, the multi-source evaluation vector at each pixel position comprising a plurality of multi-source sharpness evaluation values at the pixel position respectively corresponding to the plurality of depth positions; and the multi-source confidence map comprises multi-source confidences of the multi-source evaluation vectors at respective pixel positions in the multi-source three-dimensional evaluation tensor; and

generate the extended depth-of-field image based on the multi-source three-dimensional evaluation tensor and the multi-source confidence map,

wherein the image processing module is configured to:

based on the at least two groups of depth image sequences, determine, for each group of depth image sequences, a single-metric three-dimensional evaluation tensor and a single-metric confidence map corresponding to each of at least two sharpness evaluation metrics; wherein the single-metric three-dimensional evaluation tensor of any one group of depth image sequences comprises single-metric evaluation vectors at respective pixel positions, the single-metric evaluation vector at each pixel position comprising a plurality of single-metric sharpness evaluation values at the pixel position respectively corresponding to the plurality of depth positions; and the single-metric confidence map of any one group of depth image sequences comprises the single-metric confidences of the single-metric evaluation vectors at respective pixel positions in the single-metric three-dimensional evaluation tensor of the group of depth image sequences; and

determine the single-source three-dimensional evaluation tensor and the single-source confidence map of each group of depth image sequences based on fusion of the single-metric three-dimensional evaluation tensors and the single-metric confidence maps corresponding to

the at least two sharpness evaluation metrics for the group of depth image sequences,

wherein the image processing module is configured to:

based on the at least two groups of depth image sequences, determine, for each group of depth image sequences, the single-metric three-dimensional evaluation tensors corresponding to at least two sharpness evaluation metrics, wherein, in the single-metric three-dimensional evaluation tensor of any one group of depth image sequences corresponding to any one sharpness evaluation metric, the single-metric sharpness evaluation values of the single-metric evaluation vector at each pixel position are obtained by evaluating the group of depth image sequences by using the sharpness evaluation metric; and

determine, based on the single-metric three-dimensional evaluation tensors of each group of depth image sequences respectively corresponding to the at least two sharpness evaluation metrics, the single-metric confidence maps of each group of depth image sequences respectively corresponding to the at least two sharpness evaluation metrics, wherein, in the single-metric confidence map of any one group of depth image sequences corresponding to any one sharpness evaluation metric, the single-metric confidence at each pixel position is determined based on a vector feature of the single-metric evaluation vector at the pixel position,

wherein the image processing module is further configured to:

generate, based on the at least two groups of depth image sequences, a single-source highlight mask corresponding to each group of depth image sequences, wherein the single-source highlight mask corresponding to any one group of depth image sequences represents an overexposed region of the target object under the imaging exposure condition of the group of depth image sequences;

calibrate the single-source highlight mask by using the single-metric confidence maps of each group of depth image sequences respectively corresponding to the at least two sharpness evaluation metrics;

generate a multi-source highlight mask based on mask fusion of the single-source highlight masks respectively corresponding to the at least two groups of depth image sequences, wherein the multi-source highlight mask is used to represent overexposed regions of the target object under different imaging exposure conditions, and the multi-source highlight mask is used to optimize the extended depth-of-field image generated based on multi-source fusion; and

wherein calibrating the single-source highlight mask of any one group of depth image

sequences comprises: if any one pixel position is present in the single-source highlight mask, and the single-metric confidences at the pixel position in the single-metric confidence maps of the at least two sharpness evaluation metrics are all greater than a preset single-metric high-confidence threshold, removing the pixel position from the single-source highlight mask.

7. The extended depth-of-field imaging device according to claim 6, wherein the image processing module is configured to:

detect, in the single-metric three-dimensional evaluation tensor of each group of depth image sequences corresponding to each sharpness evaluation metric, evaluation value distribution characteristic of the single-metric evaluation vector at each pixel position, wherein the vector feature comprises the evaluation value distribution characteristic;

determine, based on a preset reference distribution characteristic and the evaluation value distribution characteristic detected in the single-metric three-dimensional evaluation tensor of each group of depth image sequences corresponding to each sharpness evaluation metric, the single-metric confidence map of each group of depth image sequences respectively corresponding to the at least two sharpness evaluation metrics;

wherein, in the single-metric three-dimensional evaluation tensor of any one group of depth image sequences corresponding to any one sharpness evaluation metric:

if the evaluation value distribution characteristic at any one pixel position matches the reference distribution characteristic, the single-metric confidence at the pixel position in the single-metric confidence map of the group of depth image sequences corresponding to the sharpness evaluation metric is set to a value representing high confidence; and

if the evaluation value distribution characteristic at any one pixel position fails to match the reference distribution characteristic, the single-metric confidence at the pixel position in the single-metric confidence map of the group of depth image sequences corresponding to the sharpness evaluation metric is set to a value representing low confidence, wherein the image processing module is configured to:

determine a value peak in the single-metric evaluation vector at each pixel position in the single-metric three-dimensional evaluation tensor of each group of depth image sequences corresponding to each sharpness evaluation metric, wherein the value peak is a set of the single-metric sharpness evaluation values in the single-metric evaluation vector that are greater than

or equal to a corresponding peak determination threshold, and the peak determination threshold corresponding to the single-metric evaluation vector is determined according to a maximum value, a minimum value, and an average value of the single-metric sharpness evaluation values in the single-metric evaluation vector;

wherein:

the reference distribution characteristic comprises at least one of: the single-metric evaluation vector having a unimodal distribution characteristic, the single-metric evaluation vector having a fluctuation amplitude greater than a preset peak-valley fluctuation threshold, or each value peak of the single-metric evaluation vector having a peak distribution width in the depth direction within a preset peak width interval;

and/or,

the image processing module is further configured to: if any one single-metric evaluation vector has two adjacent peaks with an inter-peak interval located within a preset interval range, perform peak clipping suppression on one value peak, among the two adjacent peaks, that is located within a position region subject to light shielding, so that a top of the value peak is suppressed to the corresponding peak determination threshold.

8. The extended depth-of-field imaging device according to claim 6, wherein the image processing module is configured to:

perform confidence voting respectively on the plurality of depth positions in the depth direction at a granularity of pixel positions, based on the single-metric three-dimensional evaluation tensors and the single-metric confidence maps of each group of depth image sequences respectively corresponding to at least two sharpness evaluation metrics;

determine, based on a voting result of the confidence voting, the single-source three-dimensional evaluation tensor and the single-source confidence map of each group of depth image sequences, so as to perform vector intra-source fusion on the single-metric evaluation vectors in the single-metric three-dimensional evaluation tensors corresponding to at least two sharpness evaluation metrics for each pixel position, and to perform confidence intra-source fusion on the single-metric confidences at pixel positions in the single-metric confidence maps corresponding to at least two sharpness evaluation metrics; and

wherein, in the single-metric three-dimensional evaluation tensors of any one group of

depth image sequences respectively corresponding to at least two sharpness evaluation metrics, a fusion weight of the single-metric evaluation vector at any one pixel position in the vector intra-source fusion is associated with the voting result; the single-source confidence at any one pixel position in the single-source confidence map of any one group of depth image sequences is associated, in the confidence intra-source fusion, with a voting value of a depth position that wins the voting; and the single-source confidence at any one pixel position in the single-source confidence map of any one group of depth image sequences is bound, in the confidence intra-source fusion, to the depth position that wins the voting.

9. The extended depth-of-field imaging device according to claim 8, wherein the image processing module is configured to:

assign, at each pixel position, one voting right for the confidence voting to each sharpness evaluation metric;

determine, by using the single-metric three-dimensional evaluation tensor, a voting range set by the confidence voting for each of at least two sharpness evaluation metrics at each pixel position, wherein, for the single-metric three-dimensional evaluation tensor of any one group of depth image sequences corresponding to any one sharpness evaluation metric, the voting range set by the confidence voting for the sharpness evaluation metric at each pixel position comprises: a depth position corresponding to a maximum sharpness evaluation value in the single-metric evaluation vector of the pixel position, and other depth positions in a position neighborhood of the depth position;

determine, by using the single-metric confidence map, a voting value contributed by the confidence voting for each of at least two sharpness evaluation metrics at each pixel position, wherein, for the single-metric confidence map of any one group of depth image sequences corresponding to any one sharpness evaluation metric: if the single-metric confidence at any one pixel position is greater than or equal to a preset voting value determination threshold, the voting value contributed by the confidence voting for the sharpness evaluation metric at the pixel position is a first voting value; if the single-metric confidence at any one pixel position is less than the preset voting value determination threshold, the voting value contributed by the confidence voting for the sharpness evaluation metric at the pixel position is a second voting value smaller than the first voting value.

10. The extended depth-of-field imaging device according to claim 8, wherein the image processing module is configured to:

set, in the single-source confidence map of each group of depth image sequences, the single-source confidence at each pixel position as a highest voting value obtained by a depth position winning in the confidence voting; and

perform, in the single-source three-dimensional evaluation tensor of each group of depth image sequences, the vector intra-source fusion by using, as a weight, a voting value contributed by the pixel position to the depth position winning the voting, wherein, in the single-source evaluation vector at any one pixel position, the single-source sharpness evaluation value corresponding to any one depth position is a weighted value, the voting values contributed by the confidence voting at the pixel position to the depth position winning the voting as weights, of normalized results of the single-metric sharpness evaluation values corresponding to the depth position in the single-metric evaluation vectors of the single-metric three-dimensional evaluation tensors respectively corresponding to at least two sharpness evaluation metrics.

11. The extended depth-of-field imaging device according to claim 8, wherein the image processing module is configured to:

determine, based on the single-source confidence maps of the at least two groups of depth image sequences, a maximum single-source confidence among at least two single-source confidences at each pixel position;

based on a matching confidence level of the maximum single-source confidence at each pixel position among preset confidence levels, perform vector multi-source fusion on the single-source evaluation vectors at the pixel position in the single-source fusion three-dimensional evaluation tensors of the at least two groups of depth image sequences, and perform confidence multi-source fusion on the single-source confidences at the pixel position in the single-source confidence maps of the at least two groups of depth image sequences;

wherein the preset confidence levels comprise a high confidence level, a medium confidence level, and a low confidence level, and:

if the matching confidence level of the maximum single-source confidence is the high confidence level or the medium confidence level, the vector multi-source fusion is configured

such that, for each pixel position, the multi-source sharpness evaluation value corresponding to any one depth position in the multi-source evaluation vector, is determined by an average of single-source sharpness evaluation values corresponding to the depth position in the single-source evaluation vectors whose single-source confidences reach the matching confidence level;

if the matching confidence level of the maximum single-source confidence is the low confidence level, the vector multi-source fusion is configured such that, for each pixel position, the multi-source sharpness evaluation value corresponding to any one depth position in the multi-source evaluation vector is the single-source sharpness evaluation value corresponding to the depth position in the single-source evaluation vector having the maximum single-source confidence; and

the confidence multi-source fusion is configured to determine the multi-source confidence at the pixel position in the multi-source confidence map based on the matching confidence level at each pixel position.

12. The extended depth-of-field imaging device according to claim 11, wherein the image processing module is further configured to:

generate, based on the at least two groups of depth image sequences, a single-source highlight mask corresponding to each group of depth image sequences, wherein the single-source highlight mask corresponding to any one group of depth image sequences represents an overexposed region of the target object under the imaging exposure condition of the group of depth image sequences;

generate a multi-source highlight mask based on mask fusion of the single-source highlight masks respectively corresponding to the at least two groups of depth image sequences, wherein the multi-source highlight mask represents overexposed regions of the target object under different imaging exposure conditions, and the multi-source highlight mask is used to optimize the extended depth-of-field image generated based on the multi-source fusion;

wherein the mask fusion of the single-source highlight masks comprises:

determining whether each pixel position is located within the multi-source highlight mask based on a number of times the pixel position is present in the single-source highlight masks respectively corresponding to the at least two groups of depth image sequences;

and/or,

in a single-source highlight mask of a group of depth image sequences corresponding to the maximum single-source confidence at each pixel position, if the pixel position is located outside the single-source highlight mask of the group of depth image sequences and the multi-source confidence at the pixel position in the multi-source confidence map meets the high confidence level, prohibiting the pixel position from being placed in the multi-source highlight mask.

13. The extended depth-of-field imaging device according to claim 11, wherein the image processing module is configured to:

if the matching confidence level of the maximum single-source confidence at any one pixel position is the high confidence level or the medium confidence level, verify the matching confidence level at the pixel position based on a high-confidence-level matching number of single-source confidences at the pixel position that match the high confidence level and associated depth positions of the single-source confidences at the pixel position that match the high confidence level, wherein when verification of the matching confidence level at any one pixel position succeeds, the multi-source confidence at the pixel position is set to meet the matching confidence level at the pixel position, and when verification of the matching confidence level at any one pixel position fails, the multi-source confidence at the pixel position is set to meet a next lower confidence level relative to the matching confidence level at the pixel position; and

if the matching confidence level of the maximum single-source confidence at any one pixel position is the low confidence level, set the multi-source confidence at the pixel position according to an average of at least two single-source confidences at the pixel position,

wherein the image processing module is configured to:

if the high-confidence-level matching number at any one pixel position is greater than or equal to a confidence determination threshold and a position distribution span of the associated depth positions is less than or equal to a preset interval threshold, determine that verification of the matching confidence level at the pixel position succeeds; and

if the high-confidence-level matching number at any one pixel position is less than the confidence determination threshold and/or the position distribution span of the associated depth

positions is greater than the preset interval threshold, determine that verification of the matching confidence level at the pixel position fails,

wherein the image processing module is configured to:

determine, based on the single-source confidence maps of the at least two groups of depth image sequences, a single-source confidence sum of at least two single-source confidences at each pixel position; and

determine the confidence determination threshold adapted to the pixel position based on the single-source confidence sum of the single-source confidences at the pixel position.

14. The extended depth-of-field imaging device according to claim 2, wherein

the light-reception state of the target object comprises a light-reception orientation of the target object, wherein:

the light-reception orientation is associated with a deployment position, in the coaxial illumination source group, of at least one enabled first illumination source in the coaxial illumination source group, and/or

the light-reception orientation is associated with a deployment position, in the annular illumination source group, of at least one enabled second illumination source in the annular illumination source group;

and/or the light-reception state of the target object comprises light-reception intensity, wherein:

the light-reception intensity is associated with an intensity of the first single-source light beam generated by at least one enabled first illumination source in the coaxial illumination source group, and/or

the light-reception intensity is associated with an intensity of the second single-source light beam generated by at least one enabled second illumination source in the annular illumination source group, and/or

the light-reception intensity caused by the coaxial illumination source group is greater than the light-reception intensity caused by the annular illumination source group;

and/or the imaging exposure condition under which the photosensitive element images the target object is further associated with an exposure duration of the photosensitive element;

wherein the illumination modes comprise at least two of a coaxial epi-illumination mode, a coaxial side-illumination mode, an annular epi-illumination mode, and an annular side-illumination mode:

in the coaxial epi-illumination mode, all of the plurality of first illumination sources in the coaxial illumination source group are enabled, and all of the plurality of second illumination sources in the annular illumination source group are disabled;

in the coaxial side-illumination mode, a part of the plurality of first illumination sources in the coaxial illumination source group is enabled, another part of the plurality of first illumination sources in the coaxial illumination source group is disabled, and all of the plurality of second illumination sources in the annular illumination source group are disabled;

in the annular epi-illumination mode, all of the plurality of second illumination sources in the annular illumination source group are enabled, and all of the plurality of first illumination sources in the coaxial illumination source group are disabled; and

in the annular side-illumination mode, a part of the plurality of second illumination sources in the annular illumination source group is enabled, another part of the plurality of second illumination sources in the annular illumination source group is disabled, and all of the plurality of first illumination sources in the coaxial illumination source group are disabled;

wherein:

the coaxial epi-illumination mode comprises a normal-exposure coaxial epi-illumination mode and a low-exposure coaxial epi-illumination mode, wherein,

in the normal-exposure coaxial epi-illumination mode, the first single-source light beams respectively generated by the plurality of first illumination sources that are all enabled have a first illumination intensity, and/or exposure duration of the photosensitive element is configured as a first exposure duration,

in the low-exposure coaxial epi-illumination mode, the first single-source light beams respectively generated by the plurality of first illumination sources that are all enabled have a second illumination intensity less than the first illumination intensity, and/or the exposure duration of the photosensitive element is configured as a second exposure duration shorter than the first exposure duration;

and/or the annular epi-illumination mode comprises a normal-exposure annular epi-illumination mode and a low-exposure annular epi-illumination mode, wherein,

in the normal-exposure annular epi-illumination mode, the second single-source light beams respectively generated by the plurality of second illumination sources that are all enabled have a third illumination intensity, and/or the exposure duration of the photosensitive element is configured as a third exposure duration,

in the low-exposure annular epi-illumination mode, the second single-source light beams respectively generated by the plurality of second illumination sources that are all enabled have a fourth illumination intensity less than the third illumination intensity, and/or the exposure duration of the photosensitive element is configured as a fourth exposure duration shorter than the third exposure duration;

and/or the coaxial side-illumination mode comprises at least two directional coaxial side-illumination modes having different side-illumination directions, and the first illumination sources respectively enabled in any two of the directional coaxial side-illumination modes are not completely identical;

and/or the annular side-illumination mode comprises at least two directional annular side-illumination modes having different side-illumination directions, and the second illumination sources respectively enabled in any two of the directional annular side-illumination modes are not completely identical;

wherein the adjustable light source module is configured to:

when a magnification of the optical lens is greater than or equal to a preset magnification threshold, respectively illuminate the target object in the normal-exposure coaxial epi-illumination mode, the low-exposure coaxial epi-illumination mode, and at least two directional coaxial side-illumination modes;

and/or,

when the magnification of the optical lens is less than the preset magnification threshold, respectively illuminate the target object in the normal-exposure coaxial epi-illumination mode, the normal-exposure annular epi-illumination mode, the low-exposure annular epi-illumination mode, and at least two directional annular side-illumination modes;

wherein:

the plurality of first illumination sources are located on an axial inner side of the optical lens, and the first single-source light beams pass through the optical lens and are emitted toward the circular illuminated region; and/or,

the plurality of second illumination sources are located on a radial outer side of the optical lens, and the second single-source light beams are obliquely emitted from the radial outer side of the optical lens toward the annular illuminated region;

wherein the movable imaging module comprises a module housing, the photosensitive element is located in the module housing, and the optical lens is mounted at an end opening of the module housing facing the target object, wherein:

the plurality of first illumination sources are fixedly mounted in the module housing, and the first single-source light beams are constrained by a beam splitter in the module housing to be parallel to the depth direction; and/or,

the plurality of second illumination sources are fixedly mounted on an outer peripheral wall of the module housing near the end opening;

wherein:

each of the plurality of first illumination sources comprises a first light-emitting element group and a first light homogenizing plate covering the first light-emitting element group, wherein a beam cross section of the first single-source light beam generated by the first illumination source is shaped by the first light homogenizing plate, the first light homogenizing plate is fan-shaped, and the first light homogenizing plates of the respective first illumination sources are spliced into a circle; and/or,

each of the plurality of second illumination sources comprises a second light-emitting element group and a second light homogenizing plate covering the second light-emitting element group, wherein a beam cross section of the second single-source light beam generated by the second illumination source is shaped by the second light homogenizing plate, the second light homogenizing plate is in an annular-sector shape, and the second light homogenizing plates of the respective second illumination sources are spliced into a ring.

15. An image generation method for an extended depth-of-field image, comprising:

acquiring at least two groups of depth image sequences obtained by imaging a target object by a photosensitive element of a movable imaging module under different imaging exposure conditions, wherein the imaging exposure condition under which the photosensitive element images the target object is associated with a light-reception state of the target object, and each group of the depth image sequences comprises a plurality of images captured by the

photosensitive element with a same imaging exposure condition when the movable imaging module is located at a plurality of depth positions, respectively; and

generating the extended depth-of-field image of the target object based on the at least two groups of depth image sequences.