

WHAT IS CLAIMED IS:

1. A method of detecting moving object, comprising:
 - acquiring depth information of pixels of an image to be processed;
 - acquiring optical flow information between the image to be processed and a
 - 5 reference image, wherein the reference image and the image to be processed are two images that are collected by an image pickup device in a continuous photographing mode and have timing sequence relationship;
 - acquiring, according to both the depth information and the optical flow information, a three-dimensional motion field of the pixels of the image to be processed
 - 10 with respect to the reference image; and
 - determining a moving object involved in the image to be processed according to the three-dimensional motion field.
2. The method according to claim 1, wherein acquiring the depth information of
- 15 the pixels of the image to be processed comprises:
 - acquiring a first disparity map of the image to be processed; and
 - acquiring the depth information of the pixels of the image to be processed according to the first disparity map.
- 20 3. The method according to claim 2, wherein
 - the image to be processed comprises a monocular image, and
 - acquiring the first disparity map of the image to be processed comprises:
 - inputting the image to be processed into a convolutional neural network for
 - performing a disparity analysis by the convolutional neural network, to acquire the first

disparity map of the image to be processed based on output of the convolutional neural network;

5 acquiring a second horizontal mirror image of a second disparity map of a first horizontal mirror image of the image to be processed, wherein the first horizontal mirror image of the image to be processed is a mirror image generated by performing a horizontal mirroring on the image to be processed, and the second horizontal mirror image of the second disparity map is a mirror image generated by performing a horizontal mirroring on the second disparity map; and

10 performing a disparity adjustment on the first disparity map according to both a weight distribution map of the first disparity map and a weight distribution map of the second horizontal mirror image, to finally acquire the first disparity map of the image to be processed;

wherein the convolutional neural network is trained with binocular image samples.

15 4. The method according to claim 3, wherein acquiring the second horizontal mirror image of the second disparity map of the first horizontal mirror image of the image to be processed comprises:

20 inputting the first horizontal mirror image of the image to be processed into the convolutional neural network for performing a disparity analysis by the convolutional neural network, to acquire the second disparity map of the first horizontal mirror image of the image to be processed based on output of the convolutional neural network; and

performing a mirroring on the second disparity map to acquire the second horizontal mirror image.

5. The method according to claim 3 or 4, wherein the weight distribution map comprises at least one of:

a first weight distribution map indicating a weight distribution map uniformly set for a plurality of images to be processed; and

5 a second weight distribution map indicating a weight distribution map set individually for each of different images to be processed;

wherein the first weight distribution map comprises at least two horizontally juxtaposed regions with different weight values.

10 6. The method according to claim 5, wherein,

in a case that the image to be processed is taken as a left-eye image,

for any two regions in the first weight distribution map of the first disparity map, a weight value of a right region is greater than a weight value of a left region;

15 for any two regions in the first weight distribution map of the second horizontal mirror image, a weight value of a right region is greater than a weight value of a left region;

for at least one region of the first weight distribution map of the first disparity map, a weight value of a left part of the region is not greater than a weight value of a right part of the region; and

20 for at least one region of the first weight distribution map of the second horizontal mirror image, a weight value of a left part of the region is not greater than a weight value of a right part of the region; and

in a case that the image to be processed is taken as a right-eye image,

for any two regions in the first weight distribution map of the first disparity

map, a weight value of a left region is greater than a weight value of a right region;

for any two regions in the first weight distribution map of the second horizontal mirror image, a weight value of a left region is greater than a weight value of a right region;

5 for at least one region of the first weight distribution map of the first disparity map, a weight value of a right part of the region is not greater than a weight value of a left part of the region; and

for at least one region of the first weight distribution map of the second horizontal mirror image, a weight value of a right part of the region is not greater than

10 a weight value of a left part of the region.

7. The method according to claim 5 or 6, wherein setting the second weight distribution map of the first disparity map comprises:

performing a horizontal mirroring on the first disparity map to generate a mirror
15 disparity map; and

for a pixel of the mirror disparity map,

in a case that a disparity value of the pixel is greater than a first variable for the pixel, setting a weight value of the pixel for the second weight distribution map of the first disparity map to a first value, and

20 in a case that the disparity value of the pixel is less than or equal to the first variable for the pixel, setting the weight value of the pixel for the second weight distribution map of the first disparity map to a second value;

wherein the first value is greater than the second value, and the first variable for the pixel is set according to both the disparity value of the pixel in the first disparity

map and a constant value greater than zero.

8. The method according to any one of claims 5 to 7, wherein setting the second weight distribution map of the second horizontal mirror image comprises:

5 for a pixel of the second horizontal mirror image,

 in a case that a disparity value of the pixel in the first disparity map is greater than a second variable for the pixel, setting a weight value of the pixel for the second weight distribution map of the second horizontal mirror image to a first value; and

 in a case that the disparity value of the pixel in the first disparity map is less
10 than or equal to the second variable for the pixel, setting the weight value of the pixel for the second weight distribution map of the second horizontal mirror image to a second value;

 wherein the first value is greater than the second value, and the second variable for the pixel is set according to both a disparity value of a corresponding pixel in the
15 horizontal mirror image of the first disparity map and a constant value greater than zero.

9. The method according to any one of claims 5 to 8, wherein performing a disparity adjustment on the first disparity map according to both the weight distribution map of the first disparity map and the weight distribution map of the second horizontal
20 mirror image, comprises:

 adjusting a disparity value of the first disparity map according to both a first weight distribution map and a second weight distribution map of the first disparity map;

 adjusting a disparity value of the second horizontal mirror image according to both a first weight distribution map and a second weight distribution map of the second

horizontal mirror image; and

combining the first disparity map with adjusted disparity value and the second horizontal mirror image with adjusted disparity value to finally acquire the first disparity map of the image to be processed.

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10. The method according to any one of claims 1 to 9, wherein acquiring the optical flow information between the image to be processed and the reference image comprises:

acquiring posture change information between capturing the image to be processed
10 and capturing the reference image by the image pickup device;

establishing a correspondence between pixel values of pixels in the image to be processed and pixel values of pixels in the reference image according to the posture change information;

performing a conversion on the reference image according to the correspondence;
15 and

determining optical flow information between the image to be processed and the reference image according to both the image to be processed and the reference image that has been subject to the conversion.

20 11. The method according to claim 10, wherein establishing the correspondence between the pixel values of pixels in the image to be processed and the pixel values of pixels in the reference image according to the posture change information comprises:

acquiring, according to the depth information and a preset parameter of the image pickup device, a first coordinates of pixel in the image to be processed within a three-

dimensional coordinate system of the image pickup device corresponding to the image to be processed;

converting the first coordinates to a second coordinates within a three-dimensional coordinate system of the image pickup device corresponding to the reference image
5 according to the posture change information;

acquiring a projected two-dimensional coordinates of the image to be processed by projecting the second coordinates onto a two-dimensional coordinate system of a two-dimensional image; and

establishing a correspondence between pixel values of pixels in the image to be
10 processed and pixel values of pixels in the reference image according to both the projected two-dimensional coordinates of the image to be processed and a two-dimensional coordinates of the reference image.

12. The method according to any one of claims 1 to 11, wherein determining the
15 moving object involved in the image to be processed according to the three-dimensional motion field comprises:

acquiring three-dimensional movement information of pixels in the image to be processed according to the three-dimensional motion field;

performing a clustering on the pixels according to the three-dimensional
20 movement information of the pixels; and

determining a moving object involved in the image to be processed according to a result of the clustering.

13. The method according to claim 12, wherein acquiring three-dimensional

movement information of pixels in the image to be processed according to the three-dimensional motion field comprises:

calculating speeds of pixels of the image to be processed in the three coordinate axis directions of the three-dimensional coordinate system of the image pickup device
5 corresponding to the image to be processed according to both the three-dimensional motion field and a time difference between capturing the image to be processed and capturing the reference image.

14. The method according to claim 12 or 13, wherein
10 the three-dimensional movement information of the pixels comprises: speed magnitudes of the pixels, and

performing the clustering on the pixels according to the three-dimensional movement information of the pixels comprises:

filtering the speed magnitudes of the pixels in the image to be processed with
15 a preset speed threshold to generate a motion mask of the image to be processed;

determining a motion region in the image to be processed according to the motion mask; and

performing a clustering on pixels in the motion region according to both three-dimensional space positions and three-dimensional movement information of the
20 pixels in the motion region.

15. The method according to claim 14, wherein

performing the clustering on the pixels in the motion region according to both the three-dimensional spatial position and the three-dimensional movement information of

pixels in the motion region comprises:

converting the three-dimensional coordinates of pixels in the motion region into a predetermined coordinate interval;

5 converting the speeds of the pixels in the motion region into a predetermined speed interval; and

performing a density clustering on the pixels in the motion region according to the three-dimensional coordinates that has been converted and the speed that has been converted, to acquire at least one cluster; and

10 determining the moving object involved in the image to be processed according to the result of the clustering comprises:

determining, for a class cluster of at least one class cluster, a speed magnitude and a speed direction of a moving object according to speed magnitudes and speed directions of a plurality of pixels of the class cluster;

15 wherein the class cluster is the moving object involved in the image to be processed.

16. The method according to any one of claims 12 to 15, wherein determining the moving object involved in the image to be processed according to the result of the clustering further comprises:

20 determining a moving object bounding box in the image to be processed according to spatial position information of pixels of a same class cluster.

17. A method of intelligent driving control, comprising:

acquiring, by an image pickup device mounted on a vehicle, a video stream of a

road where the vehicle is located;

performing a moving object detection on at least one video frame of the video stream via the method according to any one of claims 1 to 16, to determine a moving object involved in the at least one video frame; and

5 generating and outputting a control instruction for the vehicle according to the moving object.

18. An electronic apparatus, comprising:

memory, configured to store computer program; and

10 a processor, configured to execute the computer program stored in the memory, wherein in a case of executing the computer program is executed, operations of the method according to any one of claims 1 to 17 are implemented.

19. A computer-readable storage medium on which a computer program is stored,

15 wherein in a case that the computer program is executed by a processor, operations of the method according to any one of claims 1-17 are implemented.

20. A computer program comprising computer instructions, wherein in a case that the computer instructions are run in a processor of a device, operations of the method

20 according to any one of claims 1-17 are implemented.