

CNN to perform disparity analysis to the monocular image, and obtain the first disparity map of the monocular image based on an output of the CNN. The CNN is trained with the binocular image samples. The second sub-module is configured to, by mirroring the monocular image in the environment image, obtain the first mirror image, and obtain the disparity map of the first mirror image. The third sub-module is configured to, according to the disparity map of the first mirror image, perform disparity adjustment on the first disparity map of the monocular image to obtain the first disparity map subjected to disparity adjustment. The third sub-module may include: a first unit and a second unit. The first unit is configured to, after mirroring the disparity map of the first mirror image, obtain the second mirror image. The second unit is configured to, according to the weight distribution map of the first disparity map and the weight distribution map of the second mirror image, perform disparity adjustment on the first disparity map to obtain the first disparity map subjected to disparity adjustment. The weight distribution map of the first disparity map includes weight values corresponding respectively to multiple disparity values in the first disparity map, and the weight distribution map of the second mirror image includes weights corresponding respectively to multiple disparity values in the second mirror image.

Optionally, the weight distribution map in the disclosure includes at least one of a first weight distribution map and a second weight distribution map. The first weight distribution map is a weight distribution map uniformly set for multiple environment images. The second weight distribution map is a weight distribution map respectively set for different environment images. The first weight distribution map includes at least two areas separated to the left and right, and different areas have different weight values.

Optionally, when the monocular image is the left eye image, for any two areas in the first weight distribution map of the first disparity map, the weight value of the area on the right is not less than the weight value of the area on the left; for any two areas in the first weight distribution map of the second mirror image, the weight value of the area on the right is not less than the weight value of the area on the left. For at least one area in the first weight distribution map of the first disparity map, the weight value of the left part of the area is not greater than the weight value of the right part of the area. For at least one area in the first weight distribution map of the second mirror image, the weight value of the left part of the area is not greater than the weight value of the right part of the area.

Optionally, when the monocular image is the right eye image, for any two areas in the first weight distribution map of the first disparity map, the weight value of the area on the left is not less than the weight value of the area on the right; for any two areas in the first weight

What is claimed is:

1. An obstacle detection method, comprising:
 - obtaining a first disparity map of an environment image, the environment image being an image representing information of a space environment where an intelligent device is moving;
 - determining a plurality of obstacle pixel areas in the first disparity map of the environment image;
 - clustering the plurality of obstacle pixel areas to obtain at least one class cluster; and
 - determining an obstacle detection result according to obstacle pixel areas belonging to the same class cluster.
2. The method as claimed in claim 1, wherein the environment image comprises a monocular image;
 - after obtaining the first disparity map of the environment image, the method further comprising:
 - obtaining a first mirror image by mirroring the monocular image, and obtaining a disparity map of the first mirror image;
 - performing disparity adjustment on the first disparity map of the monocular image according to the disparity map of the first mirror image, to obtain the first disparity map subjected to disparity adjustment;
 - determining the plurality of obstacle pixel areas in the first disparity map of the environment image comprises:
 - determining the plurality of obstacle pixel areas in the first disparity map subjected to disparity adjustment.
3. The method as claimed in claim 2, wherein performing disparity adjustment on the first disparity map of the monocular image according to the disparity map of the first mirror image, to obtain the first disparity map subjected to disparity adjustment comprises:
 - obtaining a second mirror image after mirroring the disparity map of the first mirror image;
 - performing disparity adjustment on the first disparity map according to a weight distribution map of the first disparity map and a weight distribution map of the second mirror image, to obtain the first disparity map subjected to disparity adjustment;
 - wherein the weight distribution map of the first disparity map comprises weight values corresponding to a plurality of disparity values in the first disparity map, and the weight distribution map of the second mirror image comprises weights corresponding to the plurality

of disparity values in the second mirror image.

4. The method as claimed in claim 3, wherein the weight distribution maps comprise at least one of: a first weight distribution map, or a second weight distribution map;

the first weight distribution map is a weight distribution map uniformly set for a plurality of environment images;

the second weight distribution map is a weight distribution map respectively set for different environment images.

5. The method as claimed in claim 4, wherein the first weight distribution map comprises at least two areas separated to the left and right, and different areas have different weight values.

6. The method as claimed in claim 5, wherein
when the monocular image is a left eye image:

for any two areas in the first weight distribution map of the first disparity map, the weight value of the area on the right is not less than the weight value of the area on the left;

for any two areas in the first weight distribution map of the second mirror image, the weight value of the area on the right is not less than the weight value of the area on the left;

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

for at least one area in the first weight distribution map of the second mirror image, the weight value of a left part of the area is not greater than the weight value of a right part of the area; or

when the monocular image is a right eye image:

for any two areas in the first weight distribution map of the first disparity map, weight value of the area on the left is not less than the weight value of the area on the right;

for any two areas in the first weight distribution map of the second mirror image, the weight value of the area on the left is not less than the weight value of the area on the right;

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

for at least one area in the first weight distribution map of the second mirror image, the weight value of the right part of the area is not greater than the weight value of the left part of the area.

7. The method as claimed in any one of claims 4 to 6, wherein a setting mode of the second weight distribution map of the first disparity map comprises:

mirroring the first disparity map to form a mirror disparity map; and

according to a disparity value in the mirror disparity map of the first disparity map, setting the weight value in the second weight distribution map of the first disparity map, according to a disparity value in the mirror disparity map of the first disparity map, wherein

setting the weight value in the second weight distribution map of the first disparity map according to the disparity value in the mirror disparity map of the first disparity map comprises:

for a pixel at any position in the mirror disparity map:

when the disparity value of the pixel at the position satisfies a first predetermined condition, setting the weight value of the pixel at the position in the second weight distribution map of the first disparity map as a first value; or

when the disparity value of the pixel at the position does not satisfy the first predetermined condition, setting the weight value of the pixel at the position in the second weight distribution map of the first disparity map as a second value, wherein the first value is greater than the second value, wherein

the first predetermined condition comprises: the disparity value of the pixel at the position is greater than a first reference value of the pixel at the position; the first reference value of the pixel at the position is set according to the disparity value of the pixel at the position in the first disparity map and a constant value that is greater than zero.

8. The method as claimed in any one of claims 4 to 7, wherein a setting mode of the second weight distribution map of the second mirror image comprises:

setting the weight value in the second weight distribution map of the second mirror image according to the disparity value in the first disparity map, wherein

setting the weight value in the second weight distribution map of the second mirror image according to the disparity value in the first disparity map comprises:

for the pixel at any position in the second mirror image:

when the disparity value of the pixel at the position in the first disparity map satisfies a second predetermined condition, setting the weight value of the pixel at the

position in the second weight distribution map of the second mirror image as a third value;
or

when the disparity value of the pixel at the position in the first disparity map does not satisfy the second predetermined condition, setting the weight value of the pixel at the position in the second weight distribution map of the second mirror image as a fourth value, wherein the third value is greater than the fourth value, wherein

the second predetermined condition comprises: the disparity value of the pixel at the position in the first disparity map is greater than a second reference value of the pixel at the position, and the second reference value of the pixel at the position is set according to the disparity value of the pixel at the position in the mirror disparity map of the first disparity map and a constant value that is greater than zero.

9. The method as claimed in any one of claims 4 to 8, wherein, performing disparity adjustment on the first disparity map according to the weight distribution map of the first disparity map and the weight distribution map of the second mirror image, to obtain the first disparity map subjected to disparity adjustment comprises:

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

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

combining the first disparity map subjected to disparity adjustment and the second mirror image subjected to disparity value adjustment to finally obtain the first disparity map subjected to disparity adjustment.

10. The method as claimed in claim 1, wherein the environment image comprises the monocular image;

obtaining the first disparity map of the environment image comprising:

performing disparity analysis on the monocular image with a Convolutional Neural Network (CNN), and obtaining a first disparity map of the monocular image based on an output of the CNN, wherein the CNN is trained with binocular image samples, wherein

a training process of the CNN comprises:

inputting one of the binocular image samples into a CNN to-be-trained to conduct disparity analysis, obtaining the disparity map of a left eye image sample and the disparity map of a right eye image sample based on the output of the CNN;

reconstructing the right eye image according to the left eye image sample and the disparity map of the right eye image sample;

reconstructing the left eye image according to the right eye image sample and the disparity map of the left eye image sample; and

adjusting a network parameter of the CNN according to a difference between the reconstructed left eye image and the left eye image sample and a difference between the reconstructed right eye image and the right eye image sample.

11. The method as claimed in any one of claims 1 to 10, wherein determining a plurality of obstacle pixel areas in the first disparity map of the environment image comprises:

performing edge detection on the first disparity map of the environment image, to obtain obstacle edge information;

determining an obstacle area in the first disparity map of the environment image; and

determining a plurality of obstacle pixel columnar areas in the obstacle area according to the obstacle edge information, wherein

determining the obstacle area in the first disparity map of the environment image comprises:

performing statistical analysis on disparity values of each row of pixels in the first disparity map, to obtain statistical information of the disparity values of each row of pixels;

determining a statistical disparity map based on the statistical information of the disparity values of each row of pixels;

performing first linear fitting on the statistical disparity map, and determining a ground area and a non-ground area according to a result of the first linear fitting, wherein the non-ground area comprises one of: a first area above the ground, or a first area above the ground and a second area below the ground; and

determining the obstacle area according to the non-ground area, wherein

determining the obstacle area according to the non-ground area comprises:

performing second linear fitting on the statistical disparity map, and determining in the first area a first target area whose height above the ground is less than a first predetermined height value, according to a result of the second linear fitting, wherein the first target area is the obstacle area; and

when there is a second area below the ground in the non-ground area, determining in the second area a second target area whose height below the ground is greater than a second predetermined height value, wherein the second target area is the obstacle area.

12. The method as claimed in claim 11, wherein determining the plurality of obstacle pixel columnar areas in the obstacle area of the first disparity map according to the obstacle

edge information comprises:

setting a disparity value of a pixel of a non-obstacle area in the first disparity map and a disparity value of a pixel of the obstacle edge information as predetermined values;

taking N pixels in a column direction of the first disparity map as a traversal unit, traversing the disparity values of N pixels in each row from a set row of the first disparity map, and determining a target row where the disparity value of the pixel has a jump between the predetermined value and a non-predetermined value, wherein N is a positive integer;

determining the obstacle pixel columnar area in the obstacle area by taking N pixels in the column direction as a column width, and taking the determined target row as the boundary of the obstacle pixel columnar area in the row direction.

13. The method as claimed in any one of claims 1 to 12, wherein the obstacle pixel area comprises the obstacle pixel columnar area;

clustering the plurality of obstacle pixel areas comprises:

determining spatial location information of the plurality of obstacle pixel columnar areas; and

clustering the plurality of obstacle pixel columnar areas according to the spatial location information of the plurality of obstacle pixel columnar areas, wherein

determining the spatial location information of the plurality of obstacle pixel columnar areas comprises:

for any obstacle pixel columnar area, determining attribute information of the obstacle pixel columnar area according to pixels contained in the obstacle pixel columnar area, and determining the spatial location information of the obstacle pixel columnar area according to the attribute information of the obstacle pixel columnar area, wherein

the attribute information of the obstacle pixel columnar area comprises at least one of: bottom information of the pixel columnar area, top information of the pixel columnar area, disparity value of the pixel columnar area, and column information of the pixel columnar area;

the spatial location information of the obstacle pixel columnar area comprises: a coordinate of the obstacle pixel columnar area on a horizontal coordinate axis and a coordinate of the obstacle pixel columnar area on a depth coordinate axis; and

the spatial location information of the obstacle pixel columnar area further comprises: a highest point coordinate of the obstacle pixel columnar area on a vertical coordinate axis and a lowest point coordinate of the obstacle pixel columnar area on the vertical coordinate axis, wherein the highest point coordinate and the lowest point coordinate are used for determining

the height of the obstacle.

14. The method as claimed in any one of claims 1 to 13, wherein the obstacle pixel area comprises the obstacle pixel columnar area;

determining an obstacle detection result according to obstacle pixel areas belonging to the same class cluster comprises:

determining an obstacle bounding-box in the environment image according to the spatial location information of the obstacle pixel columnar areas belonging to the same class cluster; and/or

determining the spatial location information of the obstacle according to the spatial location information of the obstacle pixel columnar areas belonging to the same class cluster, wherein

determining the spatial location information of the obstacle according to the spatial location information of the obstacle pixel columnar areas belonging to the same class cluster comprises:

determining distances between a plurality of obstacle pixel columnar areas and a camera device generating the environment image, according to the spatial location information of the plurality of obstacle pixel columnar areas belonging to the same class cluster; and

determining the spatial location information of the obstacle according to the spatial location information of the obstacle pixel columnar area that is closest to the camera device.

15. An intelligent driving control method, comprising:

obtaining an environment image of an intelligent device during moving via an image acquisition apparatus mounted on the intelligent device;

performing obstacle detection on the obtained environment image and determining an obstacle detection result by using the method as claimed in any one of claims 1 to 14; and

generating and outputting a control instruction according to the obstacle detection result.

16. An obstacle detection apparatus, comprising:

an obtaining module, configured to obtain a first disparity map of an environment image, the environment image being an image representing information of a space environment where an intelligent device is moving;

a first determining module, configured to determine a plurality of obstacle pixel areas in the first disparity map of the environment image;

a clustering module, configured to cluster the plurality of obstacle pixel areas to obtain at least one class cluster; and

a second determining module, configured to determine an obstacle detection result

according to the obstacle pixel areas belonging to the same class cluster.

17. The apparatus as claimed in claim 16, wherein the obtaining module further comprises:

- a second sub-module, configured to obtain a first mirror image by mirroring the monocular image in the environment image, to obtain a disparity map of the first mirror image;

- a third sub-module, configured to perform disparity adjustment on the first disparity map of the monocular image according to the disparity map of the first mirror image to obtain the first disparity map subjected to disparity adjustment;

- the first determining module is further configured to:

- determine the plurality of multiple obstacle pixel areas in the first disparity map subjected to disparity adjustment.

18. An intelligent driving control apparatus, comprising:

- an obtaining module, configured to obtain an environment image of an intelligent device during moving through an image acquisition apparatus provided on the intelligent device,

- and perform obstacle detection to the obtained environment image and determine an obstacle detection result by using the apparatus as claimed in claim 16 or 17; and

- a control module, configured to generate and output a control instruction according to the obstacle detection result.

19. An electronic device, comprising:

- a memory, configured to store a computer program;

- a processor, configured to execute the computer program stored in the memory; when executed, the computer program implements the method as claimed in any one of claims 1 to 14.

20. A computer-readable storage medium, storing a computer program, wherein when executed by a processor, the computer program implements the method as claimed in any one of claims 1 to 14.