CLAIMS

1. A method for training a neural network, comprising:

determining first coordinates of a pupil reference point in a first image in a first camera coordinate system, and determining second coordinates of a cornea reference point in the first image in the first camera coordinate system, wherein the first image comprises at least an eye image;

determining a first line-of-sight direction of the first image according to the first coordinates and the second coordinates;

performing line-of-sight detection on the first image through the neural network to obtain a first detected line-of-sight direction; and

training the neural network according to the first line-of-sight direction and the first detected line-of-sight direction.

2. The method of claim 1, wherein training the neural network according to the first line-of-sight direction and the first detected line-of-sight direction comprises:

adjusting one or more network parameters of the neural network according to a loss between the first line-of-sight direction and the first detected line-of-sight direction.

3. The method of claim 1 or 2, further comprising: before training the neural network according to the first line-of-sight direction and the first detected line-of-sight direction,

performing normalization processing respectively on the first line-of-sight direction and the first detected line-of-sight direction,

wherein training the neural network according to the first line-of-sight direction and the first detected line-of-sight direction comprises:

training the neural network according to the first line-of-sight direction

subjected to the normalization processing and the first detected line-of-sight direction subjected to the normalization processing.

4. The method of any one of claims 1 to 3, wherein performing the line-of-sight detection on the first image through the neural network to obtain the first detected line-of-sight direction comprises:

in response to that the first image is a video image, detecting a line-of-sight direction of each of N adjacent frames of images through the neural network, wherein N is an integer greater than 1; and

determining, according to the line-of-sight directions of the N adjacent frames of images, a line-of-sight direction of an N-th frame of image as the first detected line-of-sight direction.

5. The method of claim 4, wherein determining, according to the line-of-sight directions of the N adjacent frames of images, the line-of-sight direction of the N-th frame of image as the first detected line-of-sight direction comprises:

determining, according to an average of the line-of-sight directions of the N adjacent frames of images, the line-of-sight direction of the N-th frame of image as the first detected line-of-sight direction.

6. The method of any one of claims 1 to 5, wherein determining the first coordinates of the pupil reference point in the first image in the first camera coordinate system comprises:

determining coordinates of the pupil reference point in a second camera coordinate system; and

determining, according to a relationship between the first camera coordinate system and the second camera coordinate system and the coordinates of the pupil reference point in the first camera coordinate system, the first coordinates of the

pupil reference point in the first camera coordinate system.

7. The method of claim 6, wherein determining the coordinates of the pupil reference point in the second camera coordinate system comprises:

determining coordinates of the pupil reference point in the first image; and

determining, according to the coordinates of the pupil reference point in the first image and a focal length and a principal point position of a second camera, the coordinates of the pupil reference point in the second camera system.

8. The method of any one of claims 1 to 7, wherein determining the second coordinates of the cornea reference point in the first image in the first camera coordinate system comprises:

determining coordinates of reflection points on the cornea in the first image in the second camera coordinate system, wherein the reflection points are positions where images of light sources are formed on the cornea; and

determining, according to the relationship between the first camera coordinate system and the second camera coordinate system and the coordinates of the reflection points on the cornea in the second camera coordinate system, the second coordinates of the cornea reference point in the first camera coordinate system.

9. The method of claim 8, wherein determining, according to the relationship between the first camera coordinate system and the second camera coordinate system and the coordinates of the reflection points on the cornea in the second camera coordinate system, the second coordinates of the cornea reference point in the first camera coordinate system comprises:

determining coordinates of the light sources in the second camera coordinate system; and

determining the second coordinates of the cornea reference point in the first

camera coordinate system according to the coordinates of the light sources in the second camera coordinate system, the relationship between the first camera coordinate system and the second camera coordinate system and the coordinates of the reflection points on the cornea in the second camera coordinate system.

10. The method of claim 9, determining the second coordinates of the cornea reference point in the first camera coordinate system according to the coordinates of the light sources in the second camera coordinate system, the relationship between the first camera coordinate system and the second camera coordinate system and the coordinates of the reflection points on the cornea in the second camera coordinate system comprises:

determining coordinates of Purkinje spots respectively corresponding to the light sources in the second camera coordinate system; and

determining the second coordinates of the cornea reference point in the first camera coordinate system according to the coordinates of the Purkinje spots respectively corresponding to the light sources in the second camera coordinate system, the coordinates of the light sources in the second camera coordinate system, the relationship between the first camera coordinate system and the second camera coordinate system, and the coordinates of the reflection point on the cornea in the second camera coordinate system.

11. The method of any one of claims 8 to 10, wherein determining the coordinates of the reflection points on the cornea in the first image in the second camera coordinate system comprises:

determining coordinates of the reflection points in the first image; and

determining coordinates of the reflection points in the second camera coordinate system according to the coordinates of the reflection points in the first image and a focal length and a principal point position of a second camera.

12. The method of any one of claims 9 to 11, wherein determining the coordinates of the light sources in the second camera coordinate system comprises:

determining coordinates of the light sources in a world coordinate system; and

determining the coordinates of the light sources in the second camera coordinate system according to a relationship between the world coordinate system and the second camera coordinate system.

13. The method of any one of claims 8 to 12, wherein the light sources comprise infrared light sources or near-infrared light sources, the light sources comprise at least two light sources, and a number of the reflection points corresponds to a number of the light sources.

14. A method for detecting a line of sight, comprising:

performing face detection on a second image comprised in video stream data;

determining positions of key points in a face area in a detected second image to determine eye areas in the face area;

clipping an eye-area image from the second image; and

inputting the eye-area image into a neural network trained in advance using the method of any one of claims 1 to 13, and outputting a line-of-sight direction of the eye-area image.

15. The method of claim 14, further comprising: after inputting the eye-area image into the neural network trained in advance and outputting the line-of-sight direction of the eye-area image,

determining a line-of-sight direction of the second image according to the line-of-sight direction of the eye-area image and a line-of-sight direction of at

least one adjacent frame of image of the second image.

16. The method of claim 14 or 15, wherein performing the face detection on the second image comprised in the video stream data comprises:

in response to that a triggering instruction is received, performing the face detection on the second image comprised in the video stream data; or

in response to that a vehicle is traveling, performing the face detection on the second image comprised in the video stream data; or

in response to that a traveling speed of the vehicle reaches a reference speed, performing the face detection on the second image comprised in the video stream data.

17. A device for training a neural network, comprising:

a first determining unit, configured to determine first coordinates of a pupil reference point in a first image in a first camera coordinate system, and determine second coordinates of a cornea reference point in the first image in the first camera coordinate system, wherein the first image comprises at least an eye image;

a second determining unit, configured to determine a first line-of-sight direction of the first image according to the first coordinates and the second coordinates;

a detecting unit, configured to perform line-of-sight detection on the first image through the neural network to obtain a first detected line-of-sight direction; and

a training unit, configured to train the neural network according to the first line-of-sight direction and the first detected line-of-sight direction.

18. A device for detecting a line of sight, comprising:

a face detecting unit, configured to perform face detection on a second

image comprised in video stream data;

a first determining unit, configured to determine positions of key points in a face area in the detected second image to determine eye areas in the face area;

a clipping unit, configured to clip an eye-area image from the second image; and

an inputting and outputting unit, configured to input the eye-area image into a neural network trained in advance using the method of any one of claims 1 to 13, and output a line-of-sight direction of the eye-area image.

19. An electronic device, comprising a processor and a memory interconnected with each other by a line, wherein the memory is configured to store program instructions that, when executed by the processor, cause the processor to perform the method of any one of claims 1 to 16.

20. A computer-readable storage medium having stored thereon program instructions that, when executed by a processor, cause the processor to perform the method of any one of claims 1 to 16.