CLAIMS

What is claimed is:

1. A focusing method, comprising:

obtaining image sharpness scores and code reading scores of a lens of a code reading camera at multiple positions, wherein the code reading scores are configured to characterize a code reading success rate of the code reading camera;

determining an optimal position of the lens according to the image sharpness scores and the code reading scores at the multiple positions; and

focusing according to the optimal position of the lens.

2. The method according to claim 1, wherein determining the optimal position of the lens according to the image sharpness scores and the code reading scores at the multiple positions, comprises:

determining at least one rough position of the lens from the multiple positions according to the image sharpness scores at the multiple positions;

determining the optimal position of the lens according to the at least one rough position of the lens and the code reading scores at the multiple positions; and

focusing according to the optimal position of the lens.

3. The method according to claim 2, wherein obtaining the image sharpness scores and the code reading scores of the lens of the code reading camera at the multiple positions, comprises:

obtaining an image sharpness score and a code reading score of the lens at a search starting position, wherein the search starting position is a travel starting position or a travel ending position of the lens, the travel starting position of the lens is a position where a vertical distance between the lens and a target surface of an object whose code is to be read is maximum, and the travel ending position of the lens is a position where the vertical distance between the lens and the target surface is minimum;

controlling the lens to move from the search starting position along a specified search direction with a specified search step size, wherein when the search starting position is the travel starting position of the lens, the specified search direction refers to a direction from the travel starting position to the travel ending positionof the lens; and when the search starting position is the travel ending position of the lens, the specified search direction refers to a direction from the travel ending position to the travel starting position of the lens; and

every time the lens moves the specified search step size, obtaining an image sharpness score and a code reading score after movement of the lens.

4. The method according to claim 3, wherein determining the at least one rough position of the lens from the multiple positions according to the image sharpness scores at the multiple positions, comprises:

during movement of the lens along the specified search direction, if already obtained multiple image sharpness scores show a trend of first increasing and then decreasing as the lens moves and a decrease ratio of a most recently obtained image sharpness score relative to a maximum value among the multiple image sharpness scores reaches a first threshold, determining whether a code reading score at a first position corresponding to the maximum value among the multiple image sharpness scores is greater than a second threshold; and

if the code reading score at the first position is greater than the second threshold, taking the first position as the rough position of the lens.

5. The method according to claim 2, wherein determining the at least one rough position of the lens from the multiple positions according to the image sharpness scores at the multiple positions, comprises:

drawing a relationship curve between the multiple positions and the image sharpness scores at the multiple positions;

obtaining at least one image sharpness score peak from the relationship curve;

from at least one position corresponding to the at least one image sharpness score peak, determining a second position where a corresponding code reading score is greater than a second

threshold;

taking the determined second position as the at least one rough position of the lens.

6. The method according to claim 2, wherein determining the optimal position of the lens according to the at least one rough position of the lens and the code reading scores at the multiple positions, comprises:

determining a candidate search interval corresponding to each rough position, wherein the candidate search interval is a lens position interval centered on the rough position;

determining a local maximum code reading score within each candidate search interval from the code reading scores corresponding to respective positions comprised in the candidate search interval; and

determining the optimal position of the lens according to the local maximum code reading score within each candidate search interval.

7. The method according to claim 6, wherein determining the optimal position of the lens according to the local maximum code reading score within each candidate search interval, comprises:

if there is one candidate search interval and there is one position corresponding to the local maximum code reading score within the candidate search interval, taking the position corresponding to the local maximum code reading score within the candidate search interval as the optimal position of the lens;

if there is one candidate search interval and there are multiple positions corresponding to the local maximum code reading score within the candidate search interval, selecting a third position closest to a rough position corresponding to the candidate search interval from the multiple positions corresponding to the local maximum code reading score within the candidate search interval, and taking the third position as the optimal position of the lens; and

if there are multiple candidate search intervals, taking a maximum value among local maximum code reading scores within the multiple candidate search intervals as a global

maximum value; if there is one position corresponding to the global maximum value, taking the position corresponding to the global maximum value as the optimal position of the lens; if there are multiple positions corresponding to the global maximum value, determining a distance between each position of the multiple positions corresponding to the global maximum value and a rough position corresponding to a candidate search interval where the position itself is located, and taking a position with a smallest distance from the rough position corresponding to the candidate search interval where the position itself is located as the optimal position of the lens.

8. The method according to claim 1, wherein focusing according to the optimal position of the lens, comprises:

determining a focusing movement direction and a movement distance of the lens according to the optimal position and a current position of the lens; and

driving the lens to move to the optimal position of the lens according to the focusing movement direction and the movement distance of the lens to complete focusing.

9. A focusing apparatus, comprising:

an obtaining module, configured for obtaining image sharpness scores and code reading scores of a lens of a code reading camera at multiple positions, wherein the code reading scores are configured to characterize a code reading success rate of the code reading camera;

a determining module, configured for determining an optimal position of the lens according to the image sharpness scores and the code reading scores at the multiple positions; and

a focusing module, configured for focusing according to the optimal position of the lens.

10. The apparatus according to claim 9, wherein the determining module comprises:

a first determining module, configured for determining at least one rough position of the lens from the multiple positions according to the image sharpness scores at the multiple positions; and

a second determining module, configured for determining the optimal position of the lens according to the at least one rough position of the lens and the code reading scores at the

multiple positions;

the obtaining module is mainly configured for: obtaining an image sharpness score and a code reading score of the lens at a search starting position, wherein the search starting position is a travel starting position or a travel ending position of the lens, the travel starting position of the lens is a position where a vertical distance between the lens and a target surface of an object whose code is to be read is maximum, and the travel ending position of the lens is a position where the vertical distance between the lens and the target surface is minimum; controlling the lens to move from the search starting position along a specified search direction with a specified search step size, wherein when the search starting position is the travel starting position of the lens, the specified search direction refers to a direction from the travel starting position to the travel ending position of the lens; and when the search starting position is the travel ending position of the lens, the specified search direction refers to a direction from the travel ending position to the travel starting position of the lens; and every time the lens moves the specified search step size, obtaining an image sharpness score and a code reading score after movement of the lens;

the first determining module is mainly configured for: during movement of the lens along the specified search direction, if already obtained multiple image sharpness scores show a trend of first increasing and then decreasing as the lens moves and a decrease ratio of a most recently obtained image sharpness score relative to a maximum value among the multiple image sharpness scores reaches a first threshold, determining whether a code reading score at a first position corresponding to the maximum value among the multiple image sharpness scores is greater than a second threshold; and if the code reading score at the first position is greater than the second threshold, taking the first position as the rough position of the lens;

or, the first determining module is mainly configured for: drawing a relationship curve between the multiple positions and the image sharpness scores at the multiple positions; obtaining at least one image sharpness score peak from the relationship curve of the image sharpness scores; determining, from at least one position corresponding to the at least one image sharpness score peak, a second position where a corresponding code reading score is greater than a second threshold; taking the determined second position as the at least one rough position of the lens;

~~the second determining module is mainly configured for: determining a candidate search interval corresponding to each rough position, wherein the candidate search interval is a lens position interval centered on the rough position; determining a local maximum code reading score within each candidate search interval from the code reading scores corresponding to respective positions comprised in the candidate search interval; and determining the optimal position of the lens according to the determined local maximum code reading score;~~

~~the second determining module is mainly further configured for: if there is one candidate search interval and there is one position corresponding to the local maximum code reading score within the candidate search interval, taking the position corresponding to the local maximum code reading score within the candidate search interval as the optimal position of the lens; if there is one candidate search interval and there are multiple positions corresponding to the local maximum code reading score within the candidate search interval, selecting a third position closest to a rough position corresponding to the candidate search interval from the multiple positions corresponding to the local maximum code reading score within the candidate search interval, and taking the third position as the optimal position of the lens; and if there are multiple candidate search intervals, taking a maximum value among local maximum code reading scores within the multiple candidate search intervals as a global maximum value; if there is one position corresponding to the global maximum value, taking the position corresponding to the global maximum value as the optimal position of the lens; if there are multiple positions corresponding to the global maximum value, determining a distance between each position of the multiple positions corresponding to the global maximum value and a rough position corresponding to a candidate search interval where the position itself is located, and taking a position with a smallest distance from the rough position corresponding to the candidate search interval where the position itself is located as the optimal position of the lens; and~~

~~the focusing module is mainly configured for: determining a focusing movement direction and a movement distance of the lens according to the optimal position and a current position of the lens; and driving the lens to move to the optimal position of the lens according to the focusing movement direction and the movement distance of the lens to complete focusing~~.

11. The apparatus according to claim 10, wherein the obtaining module is mainly

configured for:

obtaining an image sharpness score and a code reading score of the lens at a search starting position, wherein the search starting position is a travel starting position or a travel ending position of the lens, the travel starting position of the lens is a position where a vertical distance between the lens and a target surface of an object whose code is to be read is maximum, and the travel ending position of the lens is a position where the vertical distance between the lens and the target surface is minimum;

controlling the lens to move from the search starting position along a specified search direction with a specified search step size, wherein when the search starting position is the travel starting position of the lens, the specified search direction refers to a direction from the travel starting position to the travel ending position of the lens; and when the search starting position is the travel ending position of the lens, the specified search direction refers to a direction from the travel ending position to the travel starting position of the lens; and

every time the lens moves the specified search step size, obtaining an image sharpness score and a code reading score after movement of the lens.

12. The apparatus according to claim 11, wherein the first determining module is mainly configured for:

during movement of the lens along the specified search direction, if already obtained multiple image sharpness scores show a trend of first increasing and then decreasing as the lens moves and a decrease ratio of a most recently obtained image sharpness score relative to a maximum value among the multiple image sharpness scores reaches a first threshold, determining whether a code reading score at a first position corresponding to the maximum value among the multiple image sharpness scores is greater than a second threshold; and

if the code reading score at the first position is greater than the second threshold, taking the first position as the rough position of the lens.

13. The apparatus according to claim 10, wherein the first determining module is mainly configured for:

drawing a relationship curve between the multiple positions and the image sharpness scores at the multiple positions;

obtaining at least one image sharpness score peak from the relationship curve of the image sharpness scores;

determining, from at least one position corresponding to the at least one image sharpness score peak, a second position where a corresponding code reading score is greater than a second threshold;

taking the determined second position as the at least one rough position of the lens.

14. The apparatus according to claim 10, wherein the second determining module is mainly configured for:

determining a candidate search interval corresponding to each rough position, wherein the candidate search interval is a lens position interval centered on the rough position;

determining a local maximum code reading score within each candidate search interval from the code reading scores corresponding to respective positions comprised in the candidate search interval; and

determining the optimal position of the lens according to the determined local maximum code reading score.

15. The apparatus according to claim 14, wherein the second determining module is mainly further configured for:

if there is one candidate search interval and there is one position corresponding to the local maximum code reading score within the candidate search interval, taking the position corresponding to the local maximum code reading score within the candidate search interval as the optimal position of the lens;

if there is one candidate search interval and there are multiple positions corresponding to the local maximum code reading score within the candidate search interval, selecting a third position closest to a rough position corresponding to the candidate search interval from the

multiple positions corresponding to the local maximum code reading score within the candidate search interval, and taking the third position as the optimal position of the lens; and if there are multiple candidate search intervals, taking a maximum value among local maximum code reading scores within the multiple candidate search intervals as a global maximum value; if there is one position corresponding to the global maximum value, taking the position corresponding to the global maximum value as the optimal position of the lens; and

if there are multiple positions corresponding to the global maximum value, determining a distance between each position of the multiple positions corresponding to the global maximum value and a rough position corresponding to a candidate search interval where the position itself is located, and taking a position with a smallest distance from the rough position corresponding to the candidate search interval where the position itself is located as the optimal position of the lens.

16. The apparatus according to claim 9, wherein the focusing module is mainly configured for:

determining a focusing movement direction and a movement distance of the lens according to the optimal position and a current position of the lens; and

driving the lens to move to the optimal position of the lens according to the focusing movement direction and the movement distance of the lens to complete focusing.

~~11~~17. A focusing apparatus, comprising a controlling unit, a motor, a lens, and a moving mechanism;

wherein the moving mechanism drives the lens to move in a direction perpendicular to a lens surface of the lens; and

the controlling unit is connected to the motor, and is configured to carry out the method according to any one of the claims 1-8 to control the motor to drive the moving mechanism, which in turn drives the lens to move, so as to complete focusing.

~~12~~18. A computer-readable storage medium having computer program stored therein, wherein the computer programs when executed by a processor, carry out the method according to any one of claims 1-8.