CLAIMS

1. A calibration method for a sensor, wherein the sensor comprises a camera and a radar, a plurality of calibration plates are located within a common Field Of View (FOV) range of the camera and the radar, and the plurality of calibration plates have different position-orientation information, the method comprising:

for the plurality of calibration plates, collecting an image by the camera, and collecting radar point cloud data by the radar;

for each of the plurality of calibration plates, detecting first coordinate points of the calibration plate in the image and second coordinate points of the calibration plate in the radar point cloud data; and

calibrating an external parameter between the camera and the radar according to the first coordinate points and the second coordinate points of each of the plurality of calibration plates.

2. The method according to claim 1, wherein detecting the first coordinate point of the calibration plate in the image comprises:

determining candidate corner points corresponding to the calibration plate in the image; and

clustering the candidate corner points to obtain clustered corner points corresponding to the calibration plate in the image,

wherein the first coordinate points of the calibration plate in the image are detected based on the corner points corresponding to the calibration plate in the image.

3. The method according to claim 2, wherein after the corner points corresponding to the calibration plate in the image are obtained, the method further comprises:

correcting positions of the clustered corner points in the image according to a straight line constraint relationship of three or more lattice points on the calibration plate; and

determining the clustered corner points with corrected positions to be the first coordinate points of the calibration plate in the image.

4. The method according to any one of claims 1 to 3, wherein calibrating the external parameter between the camera and the radar according to the first coordinate points and the second coordinate points of each of the plurality of calibration plates comprises:

for each of the plurality of calibration plates,

determining first position-orientation information of the calibration plate in a camera coordinate system according to the first coordinate points of the calibration plate and an internal parameter of the camera;

determining second position-orientation information of the calibration plate in a radar coordinate system according to the second coordinate points of the calibration plate; and

calibrating the external parameter between the camera and the radar according to the first position-orientation information and the second position-orientation information of the calibration plate.

5. The method according to claim 4, wherein determining the second position-orientation information of the calibration plate in the radar coordinate system according to the second coordinate points of the calibration plate comprises:

determining a plane region in the radar point cloud data on which the calibration plate is located; and

determining position-orientation information corresponding to the plane region as the second position-orientation information of the calibration plate in the radar coordinate system.

6. The method according to claim 4 or 5, wherein the external parameter between the camera and the radar comprises a conversion relationship between the camera coordinate system and the radar coordinate system, and

wherein calibrating the external parameter between the camera and the radar according to the first position-orientation information and the second position-orientation information of the calibration plate comprises:

for each corner point of the calibration plate in the camera coordinate system, determining a corresponding point of the corner point in the radar coordinate system and forming a point pair including the corner point and the corresponding point of the corner point;

determining a pending conversion relationship according to a plurality of point pairs corresponding to the calibration plate;

converting the second coordinate points according to the pending conversion relationship to obtain third coordinate points in the image; and

in response to determining that a distance between the third coordinate points and the first coordinate points corresponding to the third coordinate points in the image is less than a threshold, determining the pending conversion relationship as the conversion relationship.

7. The method according to claim 6, wherein, for each corner point of the calibration plate in the camera coordinate system, determining the corresponding point of the corner point in the radar coordinate system comprises:

determining a central position of the calibration plate, and determining a fourth coordinate point of the central position in the camera coordinate system and a fifth coordinate point of the central position in the radar coordinate system;

determining a matching relationship of the calibration plate in the camera coordinate system and the radar coordinate system according to a corresponding relationship between the fourth coordinate point in the camera coordinate system and the fifth coordinate point in the radar coordinate system; and

determining a position of the corresponding point of the corner point in the radar coordinate system in a region where the matching relationship exists with the calibration plate according to a position of the corner point of the calibration plate in the camera coordinate system.

8. The method according to any one of claims 1 to 7, wherein a pattern of the calibration plate comprises at least one of a feature point set and a feature edge.

9. The method according to any one of claims 1 to 8, wherein the radar and the camera are deployed on a vehicle.

10. The method according to any one of claims 1 to 9, wherein the image comprises complete reflections of the plurality of calibration plates, and the radar point cloud data comprises complete point cloud data corresponding to the plurality of calibration plates.

11. The method according to any one of claims 1 to 10, wherein the radar comprises a lidar, and a laser line emitted by the lidar intersects with respective planes on which each of the plurality of calibration plates is located.

12. The method according to any one of claims 1 to 11, wherein the plurality of calibration plates are configured to have at least one of:

no overlapping region in a FOV of the camera or a FOV of the radar,

at least one of the plurality of calibration plates located at an edge position of the FOV of the camera or the FOV of the radar, or

different horizontal distances from at least two of the plurality of calibration plates to the camera or the radar.

13. A calibration apparatus for a sensor, wherein the sensor comprises a camera and a radar, a plurality of calibration plates are located within a common Field Of View (FOV) range of the camera and the radar, and the plurality of calibration plates have different position-orientation information, the apparatus comprising:

a collecting module configured to, for the plurality of calibration plates, collect an image by the camera and collect radar point cloud data by the radar;

a detection module configured to, for each of the plurality of calibration plates, detect first coordinate points of the calibration plate in the image and second coordinate points of the calibration plate in the radar point cloud data; and

a calibration module configured to calibrate an external parameter between the camera and the radar according to the first coordinate points and the second coordinate points of each of the plurality of calibration plates.

14. The apparatus according to claim 13, wherein detecting, by the detection module, the first coordinate point of the calibration plate in the image further comprises:

determining candidate corner points corresponding to the calibration plate in the image; and

clustering the candidate corner points to obtain clustered corner points corresponding to the calibration plate in the image,

wherein the first coordinate points of the calibration plate in the image are detected based on the corner points corresponding to the calibration plate in the image.

15. The apparatus according to claim 14, wherein after the corner points corresponding to the calibration plate in the image are obtained, the detection module is further configured to:

correct positions of the clustered corner points in the image according to a straight line constraint relationship of three or more lattice points on the calibration plate; and

determine the clustered corner points with corrected positions to be the first coordinate points of the calibration plate in the image.

16. A calibration system, comprising a camera, a radar and a plurality of calibration plates, wherein the plurality of calibration plates are located within a common Field Of View (FOV) range of the camera and the radar, the plurality of calibration plates do not shade each other and have different position-orientation information.

17. A vehicle, comprising a vehicle body and the calibration apparatus according to claim 13, wherein the camera is a vehicle-mounted camera, the radar is a lidar, and the vehicle-mounted camera, the lidar and the calibration apparatus are all disposed on the vehicle body.

18. A calibration device, comprising a memory, a processor and a computer program, wherein the computer program is stored in the memory and is configured to be executed by the processor to implement the method according to any one of claims 1 to 12.

19. A computer readable storage medium having a computer program stored thereon, wherein the computer program, when being executed by a processor, implements the method according to any one of claims 1 to 12.

20. A computer program comprising computer readable code, wherein the computer readable code, when running on a device, causes a processor in the device to perform the method according to any one of claims 1 to 12.