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# Smart identification system and smart identification method by using wide-angle camera

## Abstract


A smart identification system and a smart identification method by using a wide-angle camera are provided. The system includes a memory and a processor. The processor can load instructions stored in the memory to perform the smart identification method. The method includes: providing an image correction pattern; capturing an image of the image correction pattern by using a wide-angle camera to obtain a correction pattern image; and performing a picture rotation correction, a lens pitch angle correction, an inverse perspective projection and lens yaw angle correction on the wide-angle camera by using a matrix of lens rotation correction, a matrix of lens pitch angle correction, a matrix of lens yaw angle correction and inverse perspective projection, and a matrix of coordinates transformation, to straighten grid lines in the correction pattern image and transform coordinates in the correction pattern image captured by the wide-angle camera to world coordinates.



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## Background/Summary

BACKGROUND

Field of Invention

(1) The present invention relates to a smart identification system and a smart identification method by using a wide-angle camera.

Description of Related Art

(2) Driving safety is a very important issue for vehicle drivers and passengers. At present, the industry provides many technologies to enhance driving safety. For example, plural wide-angle cameras are installed on a vehicle to capture images from various directions of the vehicle. For another example, a car computer is provided to receive the images captured by the wide-angle cameras and determine whether the current driving situation of the vehicle is safe or not.

(3) However, the images captured by the wide-angle camera are distortion images, which mean that the images captured by the wide-angle camera are distorted, such that it is difficult for the car computer to accurately judge the current road conditions. For example, it is difficult for the car computer to accurately calculate the distance between the driver's vehicle and surrounding objects (vehicles), which will affect the judgment of the car computer on the current road conditions.

(4) Therefore, a smart identification system and a smart identification method using a wide-angle camera are needed to correct the distorted images captured by the wide-angle camera to facilitate image identification.

SUMMARY

(5) Embodiments of the present invention propose a smart identification system and a smart identification method using a wide-angle camera, which can correct distorted images captured by the wide-angle camera.

(6) According to some examples of the present invention, a smart identification method using a wide-angle camera includes: providing an image correction pattern; capturing an image of the image correction pattern by using a wide-angle camera to obtain a correction pattern image; and performing a correction step to performing a picture rotation correction, a lens pitch angle correction, an inverse perspective projection and yaw angle correction on the wide-angle camera by using a correction formula, so as to straighten grid lines in the correction pattern image and transform wide-angle image coordinates in the correction pattern image to world coordinates. The correction formula used in the correction step is:

(7) $\begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} = ABCD \begin{bmatrix} X_i \\ Y_i \\ 1 \\ 1 \end{bmatrix}$

wherein X.sub.w, Y.sub.w, Z.sub.w represent three-dimensional coordinates of a world coordinate axis; X.sub.i, Y.sub.i represent two-dimensional coordinates of a wide-angle image coordinate axis; and a matrix A is a lens rotation correction matrix, a matrix B is a lens pitch correction and inverse perspective projection matrix, a matrix C is a lens yaw angle correction, and a matrix D is a coordinate transformation matrix, which are expressed as follows:

(8) thematrix $A = \begin{bmatrix} \cos(\theta_{roll}) & -\sin(\theta_{roll}) & 0 & 0 \\ \sin(\theta_{roll}) & \cos(\theta_{roll}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

thematrix $B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta_{pitch}) & \sin(\theta_{pitch}) & -H \text{ .Math. } \cos(\theta_{pitch}) \\ 0 & -\sin(\theta_{pitch}) & \cos(\theta_{pitch}) & H \text{ .Math. } \sin(\theta_{pitch}) \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$

thematrix $C = \begin{bmatrix} \cos(\theta_{yaw}) & \sin(\theta_{yaw}) & 0 & 0 \\ -\sin(\theta_{yaw}) & \cos(\theta_{yaw}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ thematrix $D = \begin{bmatrix} \frac{1}{Z_c}K_x & 0 & \frac{1}{Z_c}\frac{w}{2} & 0 \\ 0 & -\frac{1}{Z_c}K_y & \frac{1}{Z_c}\frac{h}{2} & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$

wherein θ.sub.yaw is a lens yaw angle; θ.sub.pitch is a lens pitch angle; θ.sub.roll is a lens roll angle; H is a height of the wide-angle camera; Z.sub.c is a camera depth; K.sub.x is a proportional constant between an image pixel coordinate in an X-axis direction and the world coordinates; K.sub.y is a proportional constant between an image pixel coordinate in a Y-axis direction and the world coordinates; w is an image width (for example, in pixels); and h is an image height (for example, in pixels).

(9) According to one embodiment, the wide-angle camera is a fisheye lens camera.

(10) According to one embodiment, when the wide-angle camera is used to capture the image correction pattern, the wide-angle camera is mounted on a vehicle, and the image correction pattern is placed on a ground next to the vehicle.

(11) According to one embodiment, the image correction pattern extends along the ground.

(12) According to some embodiments of the present invention, a smart identification system by using a wide-angle camera includes a memory and a processor. The memory configured to store plural instructions. The processor is configured to load the instructions to perform steps of: providing an image correction pattern; capturing an image of the image correction pattern by using a wide-angle camera to obtain a correction pattern image; and performing a correction step to use a correction formula to perform a picture rotation correction, a lens pitch angle correction, an inverse perspective projection and lens yaw angle correction on the wide-angle camera to straighten plural grid lines in the correction pattern image and transform plural wide-angle image coordinates in the correction pattern image to plural world coordinates, wherein the correction formula used in the correction step is:

(13) $\begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} = ABCD \begin{bmatrix} X_i \\ Y_i \\ 1 \\ 1 \end{bmatrix}$

wherein X.sub.w, Y.sub.w, Z.sub.w represent three-dimensional coordinates of a world coordinate axis; X.sub.i, Y.sub.i represent two-dimensional coordinates of a wide-angle image coordinate axis; and a matrix A is a lens rotation correction matrix, a matrix B is a lens pitch correction and inverse perspective projection matrix, a matrix C is a lens yaw angle correction, and a matrix D is a coordinate transformation matrix, which are expressed as follows:

(14) thematrix $A = \begin{bmatrix} \cos(\theta_{roll}) & -\sin(\theta_{roll}) & 0 & 0 \\ \sin(\theta_{roll}) & \cos(\theta_{roll}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

thematrix $B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta_{pitch}) & \sin(\theta_{pitch}) & -H \text{ .Math. } \cos(\theta_{pitch}) \\ 0 & -\sin(\theta_{pitch}) & \cos(\theta_{pitch}) & H \text{ .Math. } \sin(\theta_{pitch}) \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$

thematrix $C = \begin{bmatrix} \cos(\theta_{yaw}) & \sin(\theta_{yaw}) & 0 & 0 \\ -\sin(\theta_{yaw}) & \cos(\theta_{yaw}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ thematrix $D = \begin{bmatrix} \frac{1}{Z_c} K_x & 0 & \frac{1}{Z_c}\frac{w}{2} & 0 \\ 0 & -\frac{1}{Z_c} K_y & \frac{1}{Z_c}\frac{h}{2} & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$

wherein θ.sub.yaw is a lens yaw angle; θ.sub.pitch is a lens pitch angle; θ.sub.roll is a lens roll angle; H is a height of the wide-angle camera; Z.sub.c is a camera depth; K.sub.x is a proportional constant between an image pixel coordinate in an X-axis direction and the world coordinates; K.sub.y is a proportional constant between an image pixel coordinate in a Y-axis direction and the world coordinates; w is an image width (for example, in pixels); and h is an image height (for example, in pixels).

(15) In some embodiments, the wide-angle camera is a fisheye lens camera.

(16) In some embodiments, the image correction pattern comprises a black and white checkerboard pattern.

(17) In some embodiments, when the wide-angle camera is used to capture the image correction pattern, the wide-angle camera is mounted on a vehicle, and the image correction pattern is placed on a ground next to the vehicle.

(18) In some embodiments, the image correction pattern extends along the ground.

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## Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a schematic diagram showing an image captured by a wide-angle camera.

(2) FIG. **2** is a schematic flowchart illustrating a smart identification method by using a wide-angle camera in accordance with one embodiment of the present invention.

(3) FIG. **3** illustrates an image correction pattern in accordance with one embodiment of the present invention.

(4) FIG. **4** illustrates a shooting method of an image correction pattern in accordance with one embodiment of the present invention.

(5) FIG. **5** illustrates straightening of a wide-angle image in accordance with one embodiment of the present invention.

(6) FIG. **6** illustrates grid width restoration of a wide-angle image in accordance with one embodiment of the present invention.

(7) FIG. **7** illustrates grid length restoration of a wide-angle image in accordance with one embodiment of the present invention.

(8) FIG. **8** illustrates roll angle rotation of a wide-angle image in accordance with one embodiment of the present invention.

(9) FIG. **9** illustrates a smart identification system by using a wide-angle camera in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

(10) Referring to FIG. **1**, FIG. **1** is a schematic diagram showing an image **100** captured by a wide-angle camera. The wide-angle camera is mounted on a vehicle of a driver to shoot the road conditions around the vehicle of the driver and transmits the captured image **100** to a car computer for the car computer to determine whether the vehicle of the driver is too close to other

vehicles/objects. Specifically, the car computer will detect objects **110** in the image **100** and determine whether the objects **110** are too close to the vehicle of the driver to further decide whether to issue a warning. However, the image **100** captured by the wide-angle camera is distorted, such that it is difficult for the car computer to accurately calculate the distances between the vehicle of the driver and the surrounding objects **110** and accurately issue a warning.

(11) Referring to FIG. **2**, FIG. **2** is a schematic flowchart illustrating a smart identification method **200** by using a wide-angle camera in accordance with one embodiment of the present invention. The smart identification method **200** by using a wide-angle camera is used to correct the image data of the image **100** captured by the wide-angle camera. For example, the coordinate data in the image **100** is corrected, such that it can accurately correspond to the camera coordinates, and thus the car computer can accurately calculate the distances between the vehicle of the driver and surrounding objects. In the smart identification method **200** by using a wide-angle camera, a step **210** is first performed to provide an image correction pattern **300**, as shown in FIG. **3**. In the present embodiment, the image correction pattern **300** includes a black and white checkerboard pattern. Specifically, black grids **312** and white grids **314** are alternately arranged in a matrix to form the image correction pattern **300**, but the embodiments of the present invention are not limited thereto. In some embodiments, the image correction pattern **300** is formed on a correction plate, but embodiments of the present invention are not limited thereto.

(12) Returning to FIG. **2**, after the step **210**, a step **220** is performed to capture an image of the image correction pattern **300** on the correction plate by using a wide-angle camera **410**, as shown in FIG. **4**. In the present embodiment, the wide-angle camera **410** is mounted on a side of a vehicle **420**, such as a side view mirror. The wide-angle camera **410** may be, for example, a fisheye lens, but the embodiments of the present invention are not limited thereto. The correction plate is placed on the ground at a side of the vehicle **420**, such that the image correction pattern **300** is aligned with the vehicle **420** and extends along the ground. In the present embodiment, a center line **310**C of the image correction pattern **300** and a center line **420**C of the vehicle **420** are parallel to each other, such that the wide-angle camera **410** can accurately capture the image correction pattern **300**.

(13) In some embodiments, the wide-angle camera **410** is disposed behind the vehicle **420**, and the correction plate is placed on the ground behind the vehicle **420**, such that the image correction pattern **300** is aligned with the vehicle **420** and extends along the ground to facilitate the wide-angle camera **410** to accurately capture the image correction pattern **300**.

(14) Returning to FIG. **2**, after the step **220**, a step **230** is performed to correct the correction pattern image captured in the step **220**. In the correction step, a correction formula is used to calculate intrinsic parameters and extrinsic parameters of the wide-angle camera **410** to obtain a corresponding coordinate transformation matrix. Specifically, the correction step of the step **230** uses the correction formula to perform a picture rotation correction, a lens pitch angle correction, an inverse perspective projection and lens yaw angle correction on the wide-angle camera **410** to straighten plural grid lines in the correction pattern image and transform wide-angle image coordinates in the correction pattern image to world coordinates. The world coordinates are based on the camera as the origin, such that the distances between the vehicle of the driver and the surrounding objects can be calculated. The correction formula used in the present embodiment is as follows:

(15) $$\begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} = ABCD \begin{bmatrix} X_i \\ Y_i \\ 1 \\ 1 \end{bmatrix} \quad (1)$$

wherein X.sub.w, Y.sub.w, Z.sub.w represent three-dimensional coordinates of a world coordinate axis; X.sub.i, Y.sub.i represent two-dimensional coordinates of a wide-angle image coordinate axis; and a matrix A is a lens rotation correction matrix, a matrix B is a lens pitch correction and inverse

perspective projection matrix, a matrix C is a lens yaw angle correction, and a matrix D is a coordinate transformation matrix, which are expressed as follows:

$$\text{thematrix}A = \begin{bmatrix} \cos(\theta_{roll}) & -s\sin(\theta_{roll}) & 0 & 0 \\ \sin(\theta_{roll}) & \cos(\theta_{roll}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2)$$

(16)

$$\text{thematrix}B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta_{\text{pitch}}) & \sin(\theta_{\text{pitch}}) & -H \text{ .Math. } \cos(\theta_{\text{pitch}}) \\ 0 & -\sin(\theta_{\text{pitch}}) & \cos(\theta_{\text{pitch}}) & H \text{ .Math. } \sin(\theta_{\text{pitch}}) \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1} \quad (3)$$

$$\text{thematrix}C = \begin{bmatrix} \cos(\theta_{\text{yaw}}) & \sin(\theta_{\text{yaw}}) & 0 & 0 \\ -\sin(\theta_{\text{yaw}}) & \cos(\theta_{\text{yaw}}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (4)$$

$$\text{thematrix}D = \begin{bmatrix} \frac{1}{Z_c}K_x & 0 & \frac{1}{Z_c}\frac{w}{2} & 0 \\ 0 & -\frac{1}{Z_c}K_y & \frac{1}{Z_c}\frac{h}{2} & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1} \quad (5)$$

(17) In the matrixes A to D, θ.sub.yaw is a lens yaw angle; pitch is a lens pitch angle; θ.sub.roll is a lens roll angle; His a height of the wide-angle camera; Z.sub.c is a camera depth; K.sub.x is a proportional constant between an image pixel coordinate in an X-axis direction and the world coordinates; K.sub.y is a proportional constant between an image pixel coordinate in a Y-axis direction and the world coordinates; w is an image width (for example, in pixels); and h is an image height (for example, in pixels).

(18) The design of the matrix A, matrix B, matrix C, and matrix D (hereinafter collectively referred to as the conversion matrix) takes the intrinsic parameters (camera distortion correction) and the extrinsic parameters (pitch/yaw/roll angle calculation) into account to correct the distorted wide-angle image. For example, as shown in FIG. **5**, the distorted wide-angle image can be corrected and straightened after being processed in the step **230** of the present embodiment. Specifically, the wide-angle image in FIG. **5** has grid lines, and the grid lines represent the distortion of the wide-angle image. After being processed in the step **230** of the present embodiment, the grid lines are straightened. For another example, as shown in FIG. **6**, the visually distorted grid line width can be restored through the yaw angle correction in the step **230** of the present embodiment. For still another example, as shown in FIG. **7**, the visually distorted grid line length can be restored through the pitch angle correction in the step **230** of the present embodiment. For yet another example, as shown in FIG. **8**, the step **230** of the present embodiment performs roll angle rotation on the entire picture.

(19) By substituting the coordinate values (world coordinates/wide-angle image coordinates) of the known positions on the correction plate into the above correction formula, the transformation matrix can be obtained, and then the relationship between X.sub.w, Y.sub.w, Z.sub.w (the three-dimensional coordinates of the world coordinate axis) and X.sub.i, Y.sub.i (the two-dimensional coordinates of the wide-angle image coordinate axis) can be obtained. When the user uses the wide-angle camera **410** to take pictures, the car computer can use the above transformation matrix to correct the wide-angle image captured by the wide-angle camera **410** and to calculate the distances between the vehicle of the driver and the surrounding objects.

(20) For example, in some embodiments, after the wide-angle camera **410** is corrected by the smart identification method **200** by using a wide-angle camera, the transformation matrix of the wide-angle camera **410** can be obtained. After the transformation matrix is written into the car computer, in the subsequent driving stage of the vehicle, the car computer can use the stored transformation matrix to correct the wide-angle image captured by the wide-angle camera **410** and calculate the distances between the vehicle of the driver and the surrounding objects.

(21) Referring to FIG. **9**, FIG. **9** illustrates a smart identification system **900** by using a wide-angle camera in accordance with one embodiment of the present invention. The smart identification system **900** by using a wide-angle camera includes a memory **910** and a processor **920**. The memory **910** stores plural instructions, and the processor **920** is electrically connected to the memory **910** to load the instructions to perform the above smart identification method **200** by using a wide-angle camera. In some embodiments, the smart identification system **900** by using a wide-angle camera can be implemented as a computer device, which can receive the wide-angle image captured by the wide-angle camera **410** and apply the smart identification method **200** by using a wide-angle camera to correct the wide-angle image captured by the wide-angle camera **410** to obtain the above transformation matrix.

(22) According to the aforementioned description, the smart identification method **200** by using a wide-angle camera and the smart identification system **900** by using a wide-angle camera of the embodiment of the present invention use a lens rotation correction matrix (matrix A), a lens pitch correction and inverse perspective projection matrix (matrix B), a lens yaw correction matrix (matrix C), and a coordinate transformation matrix (matrix D) to correct the image of the wide-angle camera, so as to eliminate image distortion, and calculate the distance between each object in the image and the coordinate origin (camera). Applying such a method can enhance the accuracy of the car computer in determining the distances between the vehicle of the driver and the surrounding objects, and facilitate the car computer to identify each object in the image, thereby greatly enhancing the driver's driving safety.

(23) Although the present invention has been disclosed above with embodiments, it is not intended to limit the present disclosure. Any person having ordinary skill in the art can make various changes and modifications without departing from the spirit and scope of the present invention. Therefore, the protection scope of the present invention should be defined by the scope of the appended claims.

## Claims

1. A smart identification method by using a wide-angle camera, suitable for a wide-angle camera image correction system, wherein the smart identification method by using the wide-angle camera comprises: providing an image correction pattern; capturing an image of the image correction pattern by using the wide-angle camera to obtain a correction pattern image; and performing a correction step to use a correction formula to perform a picture rotation correction, a lens pitch angle correction, an inverse perspective projection and lens yaw angle correction on the wide-angle camera to straighten a plurality of grid lines in the correction pattern image and transform a plurality of wide-angle image coordinates in the correction pattern image to a plurality of world coordinates, wherein the correction formula used in the correction step is: $\begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} = ABCD \begin{bmatrix} X_i \\ Y_i \\ 1 \\ 1 \end{bmatrix}$

wherein X.sub.w, Y.sub.w, Z.sub.w represent three-dimensional coordinates of a world coordinate axis; X.sub.i, Y.sub.i represent two-dimensional coordinates of a wide-angle image coordinate axis; and a matrix A is a lens rotation correction matrix, a matrix B is a lens pitch correction and inverse

perspective projection matrix, a matrix C is a lens yaw angle correction, and a matrix D is a coordinate transformation matrix, which are expressed as follows:

$$\text{thematrix}\,A = \begin{bmatrix} \cos(\theta_{roll}) & -\sin(\theta_{roll}) & 0 & 0 \\ \sin(\theta_{roll}) & \cos(\theta_{roll}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\text{thematrix}\,B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta_{\text{pitch}}) & \sin(\theta_{\text{pitch}}) & -H\ .\text{Math.}\cos(\theta_{\text{pitch}}) \\ 0 & -\sin(\theta_{\text{pitch}}) & \cos(\theta_{\text{pitch}}) & H\ .\text{Math.}\sin(\theta_{\text{pitch}}) \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$$

$$\text{thematrix}\,C = \begin{bmatrix} \cos(\theta_{\text{yaw}}) & \sin(\theta_{\text{yaw}}) & 0 & 0 \\ -\sin(\theta_{\text{yaw}}) & \cos(\theta_{\text{yaw}}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\text{thematrix}\,D = \begin{bmatrix} \frac{1}{Z_c}K_x & 0 & \frac{1}{Z_c}\frac{w}{2} & 0 \\ 0 & -\frac{1}{Z_c}K_y & \frac{1}{Z_c}\frac{h}{2} & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$$

wherein θ.sub.yaw is a lens yaw angle; θ.sub.pitch is a lens pitch angle; θ.sub.roll is a lens roll angle; His a height of the wide-angle camera; Z.sub.c is a camera depth; K.sub.x is a proportional constant between an image pixel coordinate in an X-axis direction and the world coordinates; K.sub.y is a proportional constant between an image pixel coordinate in a Y-axis direction and the world coordinates; w is an image width; and h is an image height.

2. The smart identification method by using the wide-angle camera of claim 1, wherein the wide-angle camera is a fisheye lens camera.

3. The smart identification method by using the wide-angle camera of claim 1, wherein the image correction pattern comprises a black and white checkerboard pattern.

4. The smart identification method by using the wide-angle camera of claim 1, wherein when the wide-angle camera is used to capture the image correction pattern, the wide-angle camera is mounted on a vehicle, and the image correction pattern is placed on a ground next to the vehicle.

5. The smart identification method by using the wide-angle camera of claim 4, wherein the image correction pattern extends along the ground.

6. A smart identification system by using a wide-angle camera, comprising: a memory configured to store a plurality of instructions; and a processor electrically connected to the memory and configured to load the instructions to perform steps of: providing an image correction pattern; capturing an image of the image correction pattern by using the wide-angle camera to obtain a correction pattern image; and performing a correction step to use a correction formula to perform a picture rotation correction, a lens pitch angle correction, an inverse perspective projection and lens yaw angle correction on the wide-angle camera to straighten a plurality of grid lines in the correction pattern image and transform a plurality of wide-angle image coordinates in the correction pattern image to a plurality of world coordinates, wherein the correction formula used in the correction step is: $\begin{bmatrix} X_w \\ Y_w \\ Z_w \\ 1 \end{bmatrix} = ABCD\begin{bmatrix} X_i \\ Y_i \\ 1 \\ 1 \end{bmatrix}$ wherein X.sub.w, Y.sub.w, Z.sub.w represent three-dimensional coordinates of a world coordinate axis; X.sub.i, Y.sub.i represent two-dimensional coordinates of a wide-angle image coordinate axis; and a matrix A is a lens rotation correction matrix, a matrix B is a lens pitch correction and inverse perspective projection matrix, a matrix C is a lens yaw angle correction, and a matrix D is a coordinate transformation matrix, which are

expressed as follows: thematrix $A = \begin{bmatrix} \cos(\theta_{roll}) & -\sin(\theta_{roll}) & 0 & 0 \\ \sin(\theta_{roll}) & \cos(\theta_{roll}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

thematrix $B = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos(\theta_{pitch}) & \sin(\theta_{pitch}) & -H \text{ .Math. } \cos(\theta_{pitch}) \\ 0 & -\sin(\theta_{pitch}) & \cos(\theta_{pitch}) & H \text{ .Math. } \sin(\theta_{pitch}) \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$

thematrix $C = \begin{bmatrix} \cos(\theta_{yaw}) & \sin(\theta_{yaw}) & 0 & 0 \\ -\sin(\theta_{yaw}) & \cos(\theta_{yaw}) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ thematrix $D = \begin{bmatrix} \frac{1}{Z_c} K_x & 0 & \frac{1}{Z_c}\frac{w}{2} & 0 \\ 0 & -\frac{1}{Z_c} K_y & \frac{1}{Z_c}\frac{h}{2} & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}^{-1}$

wherein θ.sub.yaw is a lens yaw angle; θ.sub.pitch is a lens pitch angle; θ.sub.roll is a lens roll angle; H is a height of the wide-angle camera; Z.sub.c is a camera depth; K.sub.x is a proportional constant between an image pixel coordinate in an X-axis direction and the world coordinates; K.sub.y is a proportional constant between an image pixel coordinate in a Y-axis direction and the world coordinates; w is an image width; and h is an image height.

7. The smart identification system by using the wide-angle camera of claim 6, wherein the wide-angle camera is a fisheye lens camera.

8. The smart identification system by using the wide-angle camera of claim 6, wherein the image correction pattern comprises a black and white checkerboard pattern.

9. The smart identification system by using the wide-angle camera of claim 6, wherein when the wide-angle camera is used to capture the image correction pattern, the wide-angle camera is mounted on a vehicle, and the image correction pattern is placed on a ground next to the vehicle.

10. The smart identification system by using the wide-angle camera of claim 9, wherein the image correction pattern extends along the ground.