CALIBRATION METHOD AND APPARATUS FOR MANIPULATOR, TERMINAL DEVICE AND COMPUTER-READABLE STORAGE MEDIUM

TECHNICAL FIELD

The present disclosure relates generally to a technical field of machining, and more specifically, relates to a calibration method and apparatus for a manipulator, a terminal device and a computer-readable storage medium.

BACKGROUND

With the continuous development of science and technology, application scenarios of a manipulator in various industries are becoming more and more abundant. Whether the manipulator can accurately insert documents into a warehouse during an operation process has become a crucial part of the whole operation process.

At present, when initializing a control of the manipulator, it is necessary to manually configure control instructions that drive the manipulator to each groove of the warehouse, and to repeatedly test and adjust the movement of the manipulator, which not only leads to a large amount of manual work, but also has low accuracy. Therefore, how to accurately calibrate a position deviation between the manipulator and the warehouse has become a technical problem that needs to be solved in the industry.

SUMMARY

The object of embodiments of the present application is to provide a calibration method and apparatus for a manipulator, a terminal device and a computer-readable storage medium, aiming at the technical problem in the prior art that how to configure or calibrate an adjustment signal for driving the manipulator to the warehouse conveniently.

In a first aspect, a calibration method for a manipulator is provided, including:

acquiring a calibration instruction, and acquiring a target image containing a target storage groove according to the calibration instruction;

determining groove feature information of the target storage groove according to the target image, and determining position information of the target storage groove according to the groove feature information; and

determining a corresponding adjustment signal according to the position information, and binding the groove feature information with the adjustment signal to form a calibration database for the manipulator to implement a position adjustment according to the calibration database.

In an embodiment of this disclosure, the calibration method for the manipulator further includes, after binding the groove feature information with the adjustment signal to form a calibration database:

acquiring one or more pieces of groove feature information and corresponding adjustment signal in the calibration database; and

adjusting a movement of the manipulator according to the adjustment signal and acquiring a corresponding verification image, and verifying the calibration database according to the verification image and the groove feature information.

In an embodiment of this disclosure, determining groove feature information of the target storage groove according to the target image, includes:

determining the groove feature information of one target storage groove according to the target image.

In an embodiment of this disclosure, determining the groove feature information of one target storage groove according to the target image, includes:

taking images for a plurality of storage grooves within a predetermined range one by one based on the calibration instruction, wherein one storage groove is used as a target storage groove for image taking, and one target image has one target storage groove.

In an embodiment of this disclosure, determining groove feature information of the target storage groove according to the target image, further includes:

determining the groove feature information of a plurality of target storage grooves according to the target image.

In an embodiment of this disclosure, determining the groove feature information of a plurality of target storage grooves according to the target image, includes:

taking images for a plurality of storage grooves within a predetermined range, wherein one target image has an image of at least one or more target storage grooves; wherein the storage groove in the target image is used as the storage groove.

In an embodiment of this disclosure, determining the groove feature information of a plurality of target storage grooves according to the target image, includes:

acquiring a plurality of target images within a preset time period and determining the groove feature information which is respectively corresponding to each target image according to the calibration instruction.

In an embodiment of this disclosure, determining the groove feature information of a plurality of target storage grooves according to the target image, includes:

acquiring a video image within a preset time period, acquiring the target image according to the video image and determining the groove feature information which is respectively corresponding to the target image.

In an embodiment of this disclosure, the calibration method for the manipulator further includes, after binding the groove feature information with the adjustment signal to form a calibration database:

acquiring the groove feature information and the adjustment signal which corresponds to the groove feature information in the calibration database;

recording a video for the target storage groove to acquire an video image and extracting dynamic feature information of the target storage groove from the video image;

detecting whether the target storage groove shakes according to the dynamic feature information; and

if yes, determining that the target storage groove has an unstable structure and outputting an alarm message.

In an embodiment of this disclosure, the calibration method for the manipulator further includes, before determining groove feature information of the target storage groove according to the target image:

constructing a grid in a viewfinder corresponding to the target image, and extracting contour information of the target storage groove;

comparing the grid with the contour information to obtain an angle value between each side of the contour information and the grid; and

outputting an alarm message if determining that the angle value is greater than a preset angle threshold.

In an embodiment of this disclosure, the calibration method for the manipulator further includes, after binding the groove feature information with the adjustment signal to form a calibration database:

acquiring an access instruction;

acquiring an access target image according to the access instruction, and determining position information between the manipulator and the target storage groove in the access instruction according to the access target image;

comparing the position information with standard position information in the calibration database to determine whether the calibration database includes the target position information which is consistent with the position information; and

if not, acquiring the adjustment signal for calibrating the position information based on the calibration database for the position adjustment of the manipulator according to the calibration database.

In a second aspect, a terminal device is provided, which includes a memory, a processor and a calibration program for a manipulator which is stored in the memory and capable of being implemented by the processor, wherein when the calibration program for the manipulator is implemented by the processor, the calibration method for the manipulator described above is implemented.

In a third aspect, a computer-readable storage medium is provided, on which a calibration program for a manipulator is stored, wherein when the calibration program for the manipulator is implemented by a processor, the calibration method for the manipulator described above is implemented.

In a fourth aspect, a calibration apparatus for a manipulator is provided, including:

an image acquisition module, which is configured to acquire a calibration instruction, and acquire a target image containing a target storage groove according to the calibration instruction;

a feature determination module, which is configured to determine groove feature information of the target storage groove according to the target image, and determine position information of the target storage groove according to the groove feature information; and

a data binding module, which is configured to determine a corresponding adjustment signal according to the position information, and bind the groove feature information with the adjustment signal to form a calibration database for the manipulator to implement a position adjustment according to the calibration database.

In an embodiment of this disclosure, the data binding module includes:

a calibration data acquisition unit, which is configured to acquire one or more pieces of groove feature information and corresponding adjustment signal in the calibration database; and

a database calibration unit, which is configured to adjust a movement of the manipulator according to the adjustment signal and acquire a corresponding verification image, and verify the calibration database according to the verification image and the groove feature information.

In an embodiment of this disclosure, the feature determination module includes:

a single-feature determination unit, which is configured to determine the groove feature information of one target storage groove according to the target image.

In an embodiment of this disclosure, the feature determination module includes:

a multiple-feature determination unit, which is configured to determine the groove feature information of a plurality of target storage grooves according to the target image.

In an embodiment of this disclosure, the data binding module further includes:

an adjustment signal acquisition unit, which is configured to acquire the groove feature information and the adjustment signal which corresponds to the groove feature information in the calibration database;

a dynamic feature extraction unit, which is configured record a video for the target storage groove to acquire the video image and extract dynamic feature information of the target storage groove from the video image;

a shake determination unit, which is configured detect whether the target storage groove shakes according to the dynamic feature information; and

an alarm output unit, which is configured to determine that the target storage groove has an unstable structure and output an alarm message, if detecting the target storage groove shakes according to the dynamic feature information.

In an embodiment of this disclosure, the feature determination module further includes:

a contour extraction unit, which is configured to construct a grid in a viewfinder corresponding to the target image, and extract contour information of the target storage groove;

an angle determination unit, which is configured to compare the grid with the contour information to obtain an angle value between each side of the contour information and the grid; and

a second alarm output unit, which is configured to output an alarm message if determining that the angle value is greater than a preset angle threshold.

In an embodiment of this disclosure, the data binding module further includes:

an instruction acquisition unit, which is configured to acquire an access instruction;

a position detection unit, which is configured to acquire an access target image according to the access instruction, and determine the position information

between the manipulator and the target storage groove in the access instruction according to the access target image;

a position comparison unit, which is configured to compare the position information with standard position information in the calibration database to determine whether the calibration database includes the target position information which is consistent with the position information in the standard position information; and

a position calibration unit, which is configured to acquire the adjustment signal for calibrating the position information based on the calibration database for the position adjustment of the manipulator according to the calibration database, if determining the calibration database fails to include the target position information which is consistent with the position information in the standard position information.

The terminal device, calibration apparatus for the manipulator and computer-readable storage medium according to the present application acquire a calibration instruction, and acquires a target image containing a target storage groove according to the calibration instruction; determine groove feature information of the target storage groove according to the target image, the determine position information of the target storage groove according to the groove feature information; and finally determine a corresponding adjustment signal according to the position information, and binding the groove feature information with the adjustment signal to form a calibration database for the manipulator to implement a position adjustment according to the calibration database.

In the embodiments of this disclosure, the terminal device acquires a calibration instruction sent by a user during a movement of the terminal device, and calls a visual camera module to acquire a target image containing a target storage groove according to the calibration instruction. Meanwhile, the terminal

device extracts image feature information in the target image, and then determines the groove feature information of the target storage groove. Then, the terminal device determines a corresponding adjustment signal according to the groove feature information, and binds the groove feature information with the adjustment signal to form a calibration database for a manipulator in the terminal device to implement a position adjustment according to the calibration database.

In this way, embodiments of this disclosure acquires the target image containing the target storage groove, determines the groove feature information of the target storage groove according to the target image, then determines the adjustment signal corresponding to the groove feature information, and finally binds the groove feature information with the adjustment information to form a calibration database, thus configuring or calibrating the adjustment signal for driving the manipulator to the warehouse conveniently.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to more clearly illustrate the technical solution in the embodiment of the present disclosure, the drawings used in the embodiments or prior arts will be briefly introduced. It is obvious that the drawings in the following description are only some embodiments of the present application. For ordinary technicians in the present art, they can also obtain other drawings without paying creative labor according to these drawings.

Fig. 1 is a structure diagram of a terminal device involved in an embodiment of this disclosure.

Fig. 2 is a flow diagram of a calibration method for a manipulator according to an embodiment of this disclosure.

Fig. 3 is a detailed flow diagram of a calibration method for a manipulator according to an embodiment of this disclosure.

Fig. 4 is a schematic diagram of function modules of a calibration apparatus of a manipulator according to an embodiment of this disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In order to make the item, technical scheme and advantages of the present application clearer, the present application will be further described in detail in combination with the drawings and the embodiments. It should be understood that the specific embodiments described herein are only used to explain the present application and are not used to limit the present application.

Fig. 1 is a structure diagram of a terminal device involved in an embodiment of this disclosure. Referring Fig.1, the terminal device involved in an embodiment of this disclosure can be a terminal device configured with a manipulator. Of course, the terminal device can also be a mobile terminal device or a fixed terminal device such as a PC (Personal Computer), configured with a manipulator.

As shown in Fig.1, the terminal device can include a processor 1001, such as a central processing unit (CPU), a communication bus 1002, a user interface 1003, a network interface 1004, and a memory 1005. Among them, the communication bus 1002 is configured to realize communication connection between these components. The user interface 1003 may include a display, an input unit, such as a keyboard. Optionally, the user interface 1003 may also include a standard wired interface and a wireless interface. Optionally, the network interface 1004 can include a standard wired interface and wireless interface (such as a wireless fidelity (WI-FI) interface). The memory 1005 can be high-speed random access memory or a stable non-volatile memory, such as disk memory. Optionally, the memory 1005 may be a

storage apparatus independent of the aforementioned processor 1001. The memory 1005 can also be a computer-readable storage medium which is independent of the aforementioned processor 1001.

One skilled in the art can understand that the structure shown in Fig.1 does not constitute a limitation on the terminal device, and the terminal device can include more or fewer components than shown in the figure, or combine some components, or arrange different components.

As shown in Fig.1, the memory 1005 as a storage medium may include an operating system, a data storage module, a network communication module, a user interface module, and a calibration program for the manipulator.

In the terminal device shown in Fig.1, the network interface 1004 is mainly used for data communication with other devices, the user interface 1003 is mainly used for data interaction with users. The processor 1001 and memory 1005 in the terminal device of this disclosure can be arranged inside the terminal device. The terminal device calls the calibration program for the manipulator stored in the memory 1005 through the processor 1001 and executes the calibration method for the manipulator provided by the embodiment of this disclosure.

Based on the above terminal device, various embodiments of the calibration method for the manipulator of this disclosure are provided.

Please refer to Fig.2. Fig. 2 is a flow diagram of a calibration method for a manipulator according to an embodiment of this disclosure. It should be understood that although a logic sequence is shown in the flow diagram, in some cases, the calibration method for the manipulator of this disclosure can also perform the steps shown or described in a different sequence.

In this embodiment, the calibration method for the manipulator is applied to the terminal device provided with a visual camera module to calibrate the built-in

manipulator of the terminal device. The calibration method for the manipulator of this disclosure can include following steps.

In step S10, a calibration instruction is acquired, and a target image containing a target storage groove is further acquired according to the calibration instruction.

In this embodiment, in an initial state of the terminal device, there is no calibration database, or the calibration database is empty, so the operator triggers the calibration instruction through a mobile terminal or other operator terminals, so that the terminal device that manages documents can acquire the calibration database according to the calibration instruction. Data corresponding to one target storage groove in the calibration database includes a serial number of the target storage groove, a storage type of the target storage groove, an occupation state of the target storage groove, and a drive signal for driving the manipulator to reach the target groove. Furthermore, the data corresponding to one target storage groove in the calibration database even includes a serial number of stored document. The terminal device receives the calibration instruction triggered by the operator during the operation process. According to the calibration instruction, the terminal device calls a built-in visual camera module to take the target image of the target storage groove which is contained in the instruction, and inputs the target image to a built-in storage module of the terminal device for storage.

It can be understood that the calibration instruction in this embodiment is an instruction that allows the above terminal device to adjust a position of the manipulator to repair a position relationship between the manipulator and the above target storage groove. After receiving and responding to the calibration instruction, the terminal device acquires the corresponding calibration database for controlling the calibration operation of the manipulator according to position information of

each storage groove and serial number information of each storage groove contained in the calibration instruction.

In this embodiment, the process of acquiring a target image containing a target storage groove according to the calibration instruction can be simply described as follows. The terminal device receives the calibration instruction from the operator through the above operator terminal to adjust the position of the manipulator, and the terminal device receives and analyzes the position information and serial number information of each storage groove contained in the calibration instruction. Meanwhile the terminal device stores the acquired position information of each storage groove and serial number information of each storage groove in the built-in memory of the terminal device, and then the terminal device calls a control system integrated in an embedded control board to read the serial number information of each storage groove and the position information of each storage groove in the memory, and calls the above visual camera module to take images for each target storage groove in the calibration instruction according to the serial number information of each storage groove and the position information of each storage groove, so as to obtain the plurality of target images containing the target storage grooves.

In step S20, groove feature information of the target storage groove is determined according to the target image, and position information of the target storage groove is determined according to the groove feature information.

In this embodiment, the terminal device reads the target image from the storage module and inputs the target image into an image processing module built in the terminal device for processing. The image processing module parses the target image and determines the groove feature information corresponding to the target storage groove in the target image. Meanwhile The terminal device determines the position information of the target storage groove corresponding to

the groove feature information based on the database containing the position information of each target storage groove in the storage module.

It can be understood that the groove feature information in this embodiment is character identification or other image identification (such as A1, A2, A3, etc.) on the above target storage grooves, which is set by the operator according to different positions of each target storage grooves in the warehouse. When the terminal device obtains the target image containing each target storage groove through the visual camera module, the terminal device inputs the target image into the image processing module for processing and extracts feature information corresponding to the above character identification or image identification from image feature information in the target image, and marks the feature information as the groove feature information of the target storage groove, through image analysis algorithm based on image segmentation technology and preset by the user in the image processing module. Meanwhile, the embedded control board in the terminal device calls the control system to read the memory to obtain a data package containing the above serial number information and position information of the storage groove, which are stored by the operator in advance. The terminal device filters the data package based on the groove feature information of the target storage groove to determine the serial number information and position information of the storage groove which match with the groove feature information in the data package and then determine the position information of the target storage groove relative to the current position of the manipulator.

In an embodiment of this disclosure, the above step S20 can specifically include following embodiments.

In the first embodiment, the groove feature information of one target storage groove is determined according to the target image. That is to say, a plurality of storage grooves within a predetermined range can be taken images one by one based

on the calibration instruction, and one storage groove is used as a target storage groove for image taking, so that one target image has one target storage groove.

Among them, the predetermined range can be set as a size of the warehouse. For example, when the warehouse is arranged in a rectangular profile, a movable predetermined range of the manipulator is arranged as the rectangular profile of the warehouse. Similarly, the above means can also be used when the warehouse is arranged in a cylindrical shape.

In this embodiment, the terminal device reads the target image containing one target storage groove from the storage module. The terminal device inputs the target image into the image processing module, and the image processing module extracts the groove feature information corresponding to one target storage groove from the target image.

For example, the terminal device reads the target image containing one target storage groove from the memory. The terminal device inputs the target image into the image processing module built in the terminal device for processing, and analyzes the target image through the image analysis algorithm in the image processing module and determines the groove feature information corresponding to one target storage groove in the target image.

It can be understood that the terminal device can control the manipulator to take images for each target storage groove in the warehouse according to different image taking methods in the calibration instruction through the above mentioned embedded control board, according to the calibration instruction issued by the operator. For example, when the preset image taking method in the calibration instruction is to take images of each storage groove in the warehouse horizontally from left to right, the terminal device calls the above-mentioned visual camera module on the manipulator to successively take images of each target storage groove in the warehouse horizontally from left to right. Similarly, when the preset

image taking method in the calibration instruction is to take images of each storage groove in the warehouse longitudinally from up to down, the terminal device calls the above-mentioned visual camera module on the manipulator to successively take images of each target storage groove in the warehouse longitudinally from up to down. In this way, the terminal device can acquire a plurality of target images each contains only a single target storage groove and improve the accuracy of the acquired target image.

In the second embodiment, the groove feature information of a plurality of target storage grooves is determined according to the target image. That is to say, a plurality of storage grooves within a predetermined range can be taken images based on the calibration instruction, and one target image has at least one target storage groove. For example, when the acquired target image has a plurality of storage grooves, the plurality of storage grooves are used as the target storage groove, respectively.

In this embodiment, the terminal device reads the target image containing the plurality of target storage grooves from the storage module. The terminal device inputs the target image into the image processing module, and the image processing module extracts the groove feature information respectively corresponding to the plurality of target storage grooves from the target image.

For example, the terminal device reads the target image containing the plurality of target storage grooves from the memory. The terminal device inputs the target image into the image processing module built in the terminal device for processing, and segments the plurality of target storage grooves in the target image through the image analysis algorithm in the image processing module and extracts the groove feature information which is respectively corresponding to each target storage groove.

In one embodiment of this disclosure, the above second embodiment can specifically include following specific embodiments.

In the first embodiment, the plurality of target images within a preset time period are acquired and the groove feature information which is respectively corresponding to each target image is determined according to the calibration instruction. That is to say, based on the calibration instruction, the plurality of target images can be acquired by taking images for the plurality of storage grooves within the predetermined range, and one target storage groove can be obtained from each target image. The storage groove in the target image is used as the target storage groove, so that one target image has a target storage groove.

In this embodiment, the calibration instruction acquired by the terminal device includes the preset time period and an image acquisition frequency. The terminal device acquires the plurality of target images containing at least one target storage groove according to the preset time period and image acquisition frequency. The terminal device inputs the acquired target images into the image processing module and extracts the groove feature information of the target storage groove corresponding to each target image, through the image analysis algorithm in the image processing module.

It can be understood that the terminal device firstly confirms a time period and image taking frequency for taking images of the target storage groove in the above calibration instruction. For example, the preset time period for the visual camera module to take images for the target storage groove in the calibration instruction is 10s, and the image taking frequency is 10 images per second. Then the terminal device controls the visual camera module to take images of the target storage groove according to the preset time period and image taking frequency and obtain a corresponding number of target images. The terminal device inputs the acquired target images into the image processing module, and extracts at least the above

groove feature information from each target image based on the above image segmentation technology, through the image analysis algorithm in the image processing module, and determines whether the target storage grooves acquired by the terminal device are successive storage grooves, based on the above data package containing the position information and serial number information of each target storage groove and the groove feature information.

In the second embodiment, a video image within a preset time period is acquired, the target image according to the video image is acquired and the groove feature information which is respectively corresponding to the target image, are determined. That is, based on the calibration instruction, the plurality of storage grooves within the predetermined range can be recorded, and one target image can be obtained from the recorded video. The target image can be a composite long image. Based on the target image, at least one storage groove can be obtained, and the storage groove in the target image is used as the target storage groove, so that one target image has at least one target storage groove.

In this embodiment, the terminal device acquires the preset time period contained in the above calibration instruction, and the terminal device acquires the video image containing the plurality of target storage grooves according to the time period. The terminal device inputs the video image into the image processing module, and the image processing module extracts the plurality of target images containing the target storage groove from each video image, and extracts at least groove feature information of the target storage groove corresponding to each target image through the above image analysis algorithm.

It can be understood that the terminal device firstly confirms the time period for taking images for the target storage groove in the above calibration instruction. If the preset time period in the calibration instruction is 10s, the terminal device controls the visual camera module to record the plurality of target storage grooves

for 10s and obtains video images containing a plurality of target storage grooves with a video time period of 10s. The terminal device inputs the video image into the image processing module, extracts the plurality of target images in the video image through the image analysis algorithm preset in the image processing module, and enables the plurality of target images to contain different target storage grooves, respectively. The terminal device further extracts at least groove feature information from each target image through the above image analysis algorithm based on the image segmentation technology, through the image analysis algorithm in the image processing module, and determines whether the target storage grooves acquired by the terminal device are successive storage grooves, based on the above data package containing the position information and serial number information of each target storage groove and the groove feature information.

It should be noted that in this embodiment, the terminal device can also call the visual camera module to take images of each target storage groove according to the above calibration instructions for a second time, and obtain the same number of target images and/or video images of the same duration, according to the same time period and frequency for taking images of the target storage groove in the same instructions. The terminal device inputs the target image and/or video image obtained by the second time into the image processing module, which compares the target image and/or video image with the groove feature information in the target image and/or video image obtained by the first time to verify whether the target image and/or video image obtained by the first time is accurate, thus further improving the accuracy of the groove feature information.

In step S30, a corresponding adjustment signal is determined according to the position information, and the groove feature information is bonded with the adjustment signal to form a calibration database for the manipulator to implement a position adjustment according to the calibration database.

In this embodiment, after the terminal device acquires the position information corresponding to the target storage groove, the terminal device determines the adjustment signal that controls the movement of the manipulator according to the position information. Meanwhile, the terminal device records the groove feature information corresponding to the target storage groove and the adjustment signal during the movement of the manipulator, and binds the recorded groove feature information and the adjustment signal to form the calibration database, The terminal device uploads the calibration database to the control module for the manipulator in the terminal device to adjust its position according to the calibration database.

For example, after the terminal device acquires the position information corresponding to the target storage groove, the terminal device determines the adjustment signal used by the embedded control board to control the movement of the manipulator according to the position information. For example, when the terminal device determines that the target storage groove is in front of the manipulator on the right according to the position information corresponding to the target storage groove, and then it determines that the manipulator needs to move forward by 2cm, and then move 0.5cm to the right. The terminal device converts this moving distance into the adjustment signal to control the manipulator to move, and converts the adjustment signal into a pulse signal through a converter and outputs it to the embedded control board, which controls the manipulator to move the corresponding distance according to the adjustment signal. Meanwhile, the terminal device records signal characteristic data corresponding to different adjustment signals when the manipulator is in different positions during its movement, and uploads the recorded signal characteristic data to the control system, which binds the recorded groove characteristic information and the signal characteristic data to form the calibration database, so that the terminal device can control the manipulator to be calibrated according to the database.

In an embodiment of this disclosure, the calibration method for the manipulator further includes following steps, after the step S30 of binding the groove feature information with the adjustment signal to form a calibration database.

In step A01, one or more pieces of groove feature information and adjustment signal corresponding to each groove feature information in the calibration database, are acquired.

In this embodiment, the terminal device reads the above calibration database, extracts one or more pieces of groove feature information and each adjustment signal binding with the groove feature information from the calibration database, and uploads the groove feature information and each adjustment signal to the control system of the terminal device.

In step A02, a movement of the manipulator is adjusted according to the adjustment signal and a corresponding verification image is acquired, and the calibration database is verified according to the verification image and the groove feature information.

In this embodiment, the control system of the terminal device controls the manipulator for position calibration according to the above groove feature information and the above adjustment signals, and calls the image acquisition module to obtain the verification image after calibration. The terminal device binds the above verification image and the above groove feature information, and determines whether the verification image and the groove feature information match according to the binding result, and verifies the calibration database for the second time according to the matching result.

It can be understood that in this embodiment, the terminal device reads the above calibration database stored in the memory. Meanwhile, the terminal device randomly samples 10% of the groove feature information and each corresponding adjustment signal of the groove feature information from all groove feature

information in the calibration database according to a sampling scheme preset by the operator. The terminal device uploads the sampled groove feature information and adjustment signals to the embedded control board of the terminal device, and the control system in the embedded control board controls the manipulator to implement position calibration according to the groove feature information and the adjustment signals. Meanwhile the embedded control board calls the visual camera module to obtain the above verification images according to the groove feature information and the adjustment signals, and inputs the verification image into the image processing module, which determines whether the verification image and the groove feature information match. If the image processing module determines that the verification image and the groove feature information do not match, the terminal device corrects each adjustment signal, and updates and caches the calibration database according to the corrected adjustment signals and groove feature information.

In this embodiment, for the constructed calibration database, the manipulator is driven to verify all contents of the database, according to the data of the calibration database, such that the data accuracy of the calibration database is verified.

It can be understood that when acquiring the groove feature information and each adjustment signal binding with the groove feature information, in the above calibration database, in addition to the random sampling by the sampling detection method mentioned above, the terminal device can also sample the calibration database by dichotomy. For example, The terminal device sorts the groove feature information in the calibration database according to the character identification (such as A1, A2, A3, etc.) of the storage groove corresponding to the groove feature information, and use the dichotomy to filter the target groove feature information and the adjustment signal corresponding to the groove feature information from the groove feature information. The terminal device uploads the extracted groove

feature information and each adjustment signal to the embedded control board of the terminal device to perform the above verification operation.

In an embodiment of this disclosure, the calibration method for the manipulator further includes following steps, after the step S30.

In step B01, an access instruction is acquired.

In this embodiment, the terminal device receives the access instruction triggered by the user to access documents after constructing the above calibration database.

In step B02, an access target image is acquired according to the access instruction, and the position information between the manipulator and the target storage groove in the access instruction is determined according to the access target image.

In this embodiment, after reading the above access instruction, the terminal device calls the image acquisition module to obtain the access target image according to the access instruction. The terminal device determines the position information between the manipulator in the terminal device and the above target storage groove according to the access target image.

In step B03, the position information is compared with standard position information in the calibration database to determine whether the calibration database includes the target position information which is consistent with the position information in the standard position information.

In this embodiment, the terminal device inputs the above position information into an image comparison module built in the terminal device, and the image comparison module compares the position information with the standard position information in the calibration database to determine whether the standard position information contains the target position information which is consistent with the position information.

In step B04, if not, the adjustment signal for calibrating the position information is acquired based on the calibration database for the position adjustment of the manipulator according to the calibration database.

In this embodiment, if the terminal device detects that the standard position information in the above calibration database does not contain the above target position information, the terminal device determines that the manipulator has deviated, and the terminal device filters the calibration database according to the above access target image to obtain the adjustment signal corresponding to the access target image for the manipulator to be calibrated according to the adjustment signal.

For example, after constructing the above calibration database, the terminal device receives the access instruction triggered by the user to access the document through the embedded control board. When the terminal device receives the access instruction, the terminal device calls the visual camera module to acquire the access target image according to the access instruction and inputs the access target image into the image processing module, determines the position information between the manipulator in the terminal device and the target storage groove in the access target image through the image analysis algorithm in the image processing module. Then the terminal device inputs the position information into the image comparison module in the terminal device. The terminal device compares the position information with the standard position information in the calibration database through the image comparison module to determine whether the standard position information contains the target position information which is consistent with the position information. When the terminal device determines that the target position information is not included, the terminal device determines that the manipulator has deviated. The terminal device filters the calibration database according to the access

target image to obtain the adjustment signal corresponding to the access target image for the manipulator to be calibrated according to the adjustment signal.

In an embodiment of this disclosure, the calibration method for the manipulator of this disclosure can also include, after the above step S30,

Step C01, acquiring the groove feature information and the adjustment signal which corresponds to the groove feature information in the calibration database;

Step C02, recording a video for the target storage groove to acquire the video image and extracting dynamic feature information of the target storage groove from the video image;

Step C03, detecting whether the target storage groove shakes according to the dynamic feature information;

Step C04, if yes, determining that the target storage groove has an unstable structure and outputting an alarm message.

For example, the terminal device randomly extracts the groove feature information which corresponds to one or more target grooves in the calibration database and corresponding adjustment signal according to the above sampling detection method preset by the operator. The adjustment signal includes signal for adjusting the manipulator according to at least one storage groove, so as to facilitate the manipulator to record a video of the storage groove for the preset time period at a fixed spot. Then, by identifying the groove in the video within the preset time period, we can determine whether the groove has displacement within the preset time, and determine whether the target storage groove shakes.

It can be understood that the terminal device calls the visual camera module to acquire the video image containing the target storage grooves according to the adjustment signal, inputs the video image to the image processing module, extracts the dynamic feature data corresponding to each target storage groove in the video image by the image analysis algorithm preset in the image processing module, and

the image processing module detects the dynamic feature information, determines whether the target storage groove shakes according to the detection result. If the image processing module detects that the target storage groove shakes, the image processing module determines that the structure of the target storage groove is unstable, and outputs the result to an alarm apparatus of the terminal device, which outputs the alarm message.

In an embodiment of this disclosure, the calibration method for the manipulator further includes following steps, before the above step S30.

In step D01, a grid is constructed in a viewfinder corresponding to the target image, and contour information of the target storage groove is extracted. That is to say, take the manipulator as the reference position to form a grid which is constructed with interlaced lines of latitude and longitude. The edge of the storage groove is obtained by identifying the contour information of the related storage groove, and the inclination of the storage groove is determined by defining the angle between a side edge and the lines of longitude and latitude. Among them, the common setting of storage groove is rectangle.

In this embodiment, the terminal device inputs the above target image into the image processing module built in the terminal device. The image processing module constructs the grid in the viewfinder corresponding to the target image, and the image processing module extracts the contour information of the target image.

In step D02, the grid is compared with the contour information to obtain an angle value between each side of the contour information and the grid.

In this embodiment, the image processing module of the terminal device compares the extracted contour information with the grid constructed by the image processing module, and reads the angle value between the contour information and the grid. Meanwhile the image processing module detects whether the angle value is greater than the angle threshold preset by the user.

In step D02, an alarm message is outputted if determining that the angle value is greater than a preset angle threshold.

In this embodiment, if the image processing module of the terminal device detects that the angle value between the above contour information and the grid is greater than the angle threshold preset by the user, the image processing module outputs an alarm message.

For example, the terminal device inputs the above target image into the image processing module, and takes the manipulator as the reference position to form a grid which is constructed with interlaced lines of latitude and longitude through the image analysis algorithm in the image processing module. The image processing module extracts the contour information corresponding to the target storage groove in the target image from the target image, and determines an edge of the target storage groove according to the contour information. The image processing module compares one side of the contour information with the grid to obtain a deviation angle between the contour information and the grid. Then, the image analysis algorithm compares the deviation angle with a preset angle threshold from the user. The terminal device determines that the deviation angle of the target storage groove is too large and outputs the detection result to the alarm apparatus, when determining that the angle value between the above contour information and the grid is greater than the angle threshold preset by the user, through that the image analysis algorithm. The alarm apparatus outputs the alarm message to the mobile terminal bound by the user.

In this embodiment, the angle threshold preset by the operator is an angle threshold preset by the operator based on the deviation of the terminal device in the actual work process, considering whether the deviation of the target storage groove is too large. For example, the angle threshold can be preset to any angle from 5 ° to 30 °, including 10 °, 15 °, 20 °, 25 ° and 30 °. It can be understood that when the

operator believes that the deviation between the manipulator and the target storage groove is greater than 10 °, that is, the deviation is too large, then the operator presets 10 ° as the angle threshold to determine whether the deviation angle of the target storage groove is too large. Of course, the angle threshold can also be the angle value preset by the operator based on other conditions. This disclosure makes no limitation in this regard.

In this embodiment, in an initial state of the terminal device, there is no calibration database , so the operator triggers the calibration instruction through a mobile terminal or other operator terminals, so that the terminal device that manages documents can obtain the calibration database according to the calibration instruction. First of all, the terminal device receives the calibration instruction triggered by the operator during the operation process. According to the calibration instruction, the terminal device calls a built-in visual camera module to take the target image of the target storage groove which is contained in the instruction, and inputs the target image to the built-in storage module of the terminal device for storage. Then the terminal device reads the target image from the storage module, inputs the target image into the image processing module built in the terminal device for processing. The image processing module parses the target image and determines the groove feature information corresponding to the target storage groove in the target image. Meanwhile the terminal device determines the position information of the target storage groove corresponding to the groove feature information, based on the database containing the position information of each target storage groove in the storage module. Finally, after the terminal device acquires the position information corresponding to the target storage groove, the terminal device determines the adjustment signal that controls the manipulator to move according to the position information, and records the groove feature information corresponding to the target storage groove and the adjustment signal

during the movement of the manipulator, and binds the recorded groove feature information and the adjustment signal to form the calibration database. The terminal device uploads the calibration database to the control module for the manipulator in the terminal device to adjust its position according to the calibration database.

In this way, embodiments of this disclosure acquires the target image containing the target storage groove, determines the groove feature information of the target storage groove according to the target image, then determines the adjustment signal corresponding to the groove feature information, and finally binds the groove feature information with the adjustment information to form the calibration database, thus configuring or calibrating the adjustment signal for driving the manipulator to the warehouse conveniently.

In an embodiment of this disclosure, please refer to Fig.3, a preferred embodiment of the calibration method for the manipulator of this disclosure, is disclosed. In this embodiment, the terminal device firstly calls the embedded control board to control the manipulator connected to the terminal device to move to the initial position. Meanwhile the terminal device reads movement parameters preset by the user to for controlling the movement of the manipulator, and controls the manipulator to implement in a low-speed linear movement according to the movement parameters. When the manipulator moves to the specified position, the embedded control board calls the visual camera module built in the terminal device to acquire image information containing the manipulator and the storage groove corresponding to the position of the manipulator. After that, the terminal device inputs the image information into the image processing module built in the terminal device, processes the image through the visual processing algorithm preset in the image processing module, and determines whether the image needs correction. Finally, The image processing module outputs a database composed of each image

feature data in the image and the adjustment parameters corresponding to the image feature data, and stores the database in the storage apparatus built in the terminal device. The terminal device reads the database, and determines the adjustment instruction for adjusting the storage groove based on the image feature data in the image containing the storage groove.

It should be noted that in this embodiment, when the image processing module determines that the image needs to be corrected, it corrects the image, controls the manipulator to perform fine adjustment again according to the corrected image, and acquires the image information again after the fine adjustment of the manipulator.

In addition, this disclosure further provides a terminal device, which includes a memory, a processor and a calibration program for a manipulator which is stored in the memory and capable of being implemented by the processor, wherein when the calibration program for the manipulator is implemented by the processor, the calibration method for the manipulator described according to any embodiment of this disclosure is implemented.

The specific embodiments of the terminal device of this disclosure are basically the same as the above embodiments of the calibration method for the manipulator and are not repeated for concise.

In addition, this disclosure also provides a terminal device including a calibration apparatus for a manipulator. The calibration apparatus is applied to the terminal device provided with a visual camera module, and the terminal device is internally provided with a warehouse .

Please refer to Fig.4, which is the functional module diagram of an embodiment of a calibration apparatus for a manipulator of this disclosure. The calibration apparatus of the manipulator of this disclosure includes:

an image acquisition module, which is configured to acquire a calibration instruction, and acquire a target image containing a target storage groove according to the calibration instruction;

a feature determination module, which is configured to determine groove feature information of the target storage groove according to the target image, and determine position information of the target storage groove according to the groove feature information; and

a data binding module, which is configured to determine a corresponding adjustment signal according to the position information, and bind the groove feature information with the adjustment signal to form a calibration database for the manipulator to implement a position adjustment according to the calibration database.

In an embodiment of this disclosure, the data binding module further includes:

a calibration data acquisition unit, which is configured to acquire one or more pieces of groove feature information and corresponding adjustment signal in the calibration database; and

a database calibration unit, which is configured to adjust a movement of the manipulator according to the adjustment signal and acquire a corresponding verification image, and verify the calibration database according to the verification image and the groove feature information.

In an embodiment of this disclosure, the feature determination module includes:

a single-feature determination unit, which is configured to determine the groove feature information of one target storage groove according to the target image.

In an embodiment of this disclosure, the feature determination module includes:

a multiple-feature determination unit, which is configured to determine the groove feature information of a plurality of target storage grooves according to the target image.

In an embodiment of this disclosure, the data binding module further includes:

an adjustment signal acquisition unit, which is configured to acquire the groove feature information and the adjustment signal which corresponds to the groove feature information in the calibration database;

a dynamic feature extraction unit, which is configured record a video for the target storage groove to acquire the video image and extract dynamic feature information of the target storage groove from the video image;

a shake determination unit, which is configured detect whether the target storage groove shakes according to the dynamic feature information;

an alarm output unit, which is configured to determine that the target storage groove has an unstable structure and output an alarm message, if detecting the target storage groove shakes according to the dynamic feature information.

In an embodiment of this disclosure, the feature determination module includes:

a contour extraction unit, which is configured to construct a grid in a viewfinder corresponding to the target image, and extract contour information of the target storage groove;

an angle determination unit, which is configured to compare the grid with the contour information to obtain an angle value between each side of the contour information and the grid;

a second alarm output unit, which is configured to output an alarm message if determining that the angle value is greater than a preset angle threshold.

In an embodiment of this disclosure, the data binding module further includes:

an instruction acquisition unit, which is configured to acquire an access instruction;

a position detection unit, which is configured to acquire an access target image according to the access instruction, and determine the position information between the manipulator and the target storage groove in the access instruction according to the access target image;

a position comparison unit, which is configured to compare the position information with standard position information in the calibration database to determine whether the calibration database includes the target position information which is consistent with the position information in the standard position information;

a position calibration unit, which is configured to acquire the adjustment signal for calibrating the position information based on the calibration database for the position adjustment of the manipulator according to the calibration database, if determining the calibration database fails to include the target position information which is consistent with the position information in the standard position information.

In addition, this disclosure also provides a computer-readable storage medium is provided, on which a calibration program for a manipulator is stored, wherein when the calibration program for the manipulator is implemented by a processor, the calibration method for the manipulator described in any embodiments discussed above is implemented.

The specific embodiments of the computer-readable storage medium of this disclosure are basically the same as those of the calibration method for the manipulator, and is not described herein for concise.

It should be noted that in this disclosure, the terms "including", "containing", “comprising” or any other variation thereof are intended to cover non-exclusive

inclusion, so that a process, method, article or system including a series of elements includes not only those elements, but also other elements not explicitly listed, or further elements inherent in such a process, method, article or system. Without further restrictions, the element defined by the statement "including a..." does not exclude the existence of another identical element in the process, method, article or system that includes the element.

The serial number of the above embodiments of this disclosure is only for description and does not represent the advantages and disadvantages of the embodiments.

Through the description of the above embodiments, those skilled in the art can clearly understand that the above embodiments can be realized by means of software and necessary general hardware platform, and of course, can also be realized by means of hardware, but in many cases the former is the better implementation. Based on this understanding, the technical solution of this disclosure, or the part that contributes to the existing technology, can be embodied in the form of software products, which are stored in a storage medium (such as ROM/RAM, disk, optical disk) as described above. These computer software products include several instructions to enable a terminal device (which can be a terminal device configured with a manipulator, of course, the terminal device can also be a mobile terminal device configured with a manipulator, a mobile terminal device configured with a manipulator, or a fixed terminal device configured with a manipulator, such as a PC, etc.) to execute the methods described in various embodiments of this disclosure.

The above is only the preferred embodiment of this disclosure, and does not limit the protection scope of this disclosure. Any equivalent structure transformation or equivalent process transformation made by using the description of this disclosure and the attached drawings, or directly or indirectly applied in other relevant technical fields, are equally included in the patent protection scope of this disclosure.

CLAIMS

1. A calibration method for a manipulator, comprising:

acquiring a calibration instruction, and acquiring a target image containing a target storage groove according to the calibration instruction;

determining groove feature information of the target storage groove according to the target image, and determining position information of the target storage groove according to the groove feature information; and

determining a corresponding adjustment signal according to the position information, and binding the groove feature information with the adjustment signal to form a calibration database for the manipulator to implement a position adjustment according to the calibration database.

2. The calibration method for the manipulator according to claim 1, wherein the calibration method for the manipulator further comprises, after binding the groove feature information with the adjustment signal to form a calibration database:

acquiring one or more pieces of groove feature information and corresponding adjustment signal in the calibration database; and

adjusting a movement of the manipulator according to the adjustment signal and acquiring a corresponding verification image, and verifying the calibration database according to the verification image and the groove feature information.

3. The calibration method for the manipulator according to claim 1, wherein determining groove feature information of the target storage groove according to the target image, comprises:

determining the groove feature information of one target storage groove according to the target image.

4. The calibration method for the manipulator according to claim 3, wherein determining the groove feature information of one target storage groove according to the target image, comprises:

taking images for a plurality of storage grooves within a predetermined range one by one based on the calibration instruction, wherein one storage groove is used as a target storage groove for image taking, and one target image has one target storage groove.

5. The calibration method for the manipulator according to claim 1, wherein determining groove feature information of the target storage groove according to the target image, further comprises:

determining the groove feature information of a plurality of target storage grooves according to the target image.

6. The calibration method for the manipulator according to claim 5, wherein determining the groove feature information of a plurality of target storage grooves according to the target image, comprises:

taking images for a plurality of storage grooves within a predetermined range, wherein one target image has an image of at least one or more target storage grooves; wherein the storage groove in the target image is used as the storage groove.

7. The calibration method for the manipulator according to claim 5, wherein determining the groove feature information of a plurality of target storage grooves according to the target image, comprises:

acquiring a plurality of target images within a preset time period and determining the groove feature information which is respectively corresponding to each target image according to the calibration instruction.

8. The calibration method for the manipulator according to claim 5, wherein determining the groove feature information of a plurality of target storage grooves according to the target image, comprises:

acquiring a video image within a preset time period, acquiring the target image according to the video image and determining the groove feature information which is respectively corresponding to the target image.

9. The calibration method for the manipulator according to claim 1, wherein the calibration method for the manipulator further comprises, after binding the groove feature information with the adjustment signal to form a calibration database:

acquiring the groove feature information and the adjustment signal which corresponds to the groove feature information in the calibration database;

recording a video for the target storage groove to acquire an video image and extracting dynamic feature information of the target storage groove from the video image;

detecting whether the target storage groove shakes according to the dynamic feature information; and

if yes, determining that the target storage groove has an unstable structure and outputting an alarm message.

10. The calibration method for the manipulator according to claim 1, wherein the calibration method for the manipulator further comprises, before determining groove feature information of the target storage groove according to the target image:

constructing a grid in a viewfinder corresponding to the target image, and extracting contour information of the target storage groove;

comparing the grid with the contour information to obtain an angle value between each side of the contour information and the grid; and

outputting an alarm message if determining that the angle value is greater than a preset angle threshold.

11. The calibration method for the manipulator according to claim 1, wherein the calibration method for the manipulator further comprises, after binding the groove feature information with the adjustment signal to form a calibration database:

acquiring an access instruction;

acquiring an access target image according to the access instruction, and determining position information between the manipulator and the target storage groove in the access instruction according to the access target image;

comparing the position information with standard position information in the calibration database to determine whether the calibration database comprises the target position information which is consistent with the position information; and

if not, acquiring the adjustment signal for calibrating the position information based on the calibration database for the position adjustment of the manipulator according to the calibration database.

12. A terminal device comprising a memory, a processor and a calibration program for a manipulator which is stored in the memory and capable of being implemented by the processor, wherein when the calibration program for the manipulator is implemented by the processor, the calibration method for the manipulator according to any one of claims 1-11 is implemented.

13. A computer-readable storage medium, on which a calibration program for a manipulator stored, wherein when the calibration program for the manipulator is implemented by a processor, the calibration method for the manipulator according to any one of claims 1-11 is implemented.

14. A calibration apparatus for a manipulator, comprising

an image acquisition module, which is configured to acquire a calibration instruction, and acquire a target image containing a target storage groove according to the calibration instruction;

a feature determination module, which is configured to determine groove feature information of the target storage groove according to the target image, and determine position information of the target storage groove according to the groove feature information; and

a data binding module, which is configured to determine a corresponding adjustment signal according to the position information, and bind the groove feature information with the adjustment signal to form a calibration database for the manipulator to implement a position adjustment according to the calibration database.

15. The calibration apparatus for the manipulator according to claim 14, wherein the data binding module comprises:

a calibration data acquisition unit, which is configured to acquire one or more pieces of groove feature information and corresponding adjustment signal in the calibration database; and

a database calibration unit, which is configured to adjust a movement of the manipulator according to the adjustment signal and acquire a corresponding verification image, and verify the calibration database according to the verification image and the groove feature information.

16. The calibration apparatus for the manipulator according to claim 14, wherein the feature determination module comprises:

a single-feature determination unit, which is configured to determine the groove feature information of one target storage groove according to the target image.

17. The calibration apparatus for the manipulator according to claim 14, wherein the feature determination module comprises:

a multiple-feature determination unit, which is configured to determine the groove feature information of a plurality of target storage grooves according to the target image.

18. The calibration apparatus for the manipulator according to claim 14, wherein the data binding module further comprises:

an adjustment signal acquisition unit, which is configured to acquire the groove feature information and the adjustment signal which corresponds to the groove feature information in the calibration database;

a dynamic feature extraction unit, which is configured record a video for the target storage groove to acquire the video image and extract dynamic feature information of the target storage groove from the video image;

a shake determination unit, which is configured detect whether the target storage groove shakes according to the dynamic feature information; and

an alarm output unit, which is configured to determine that the target storage groove has an unstable structure and output an alarm message, if detecting the target storage groove shakes according to the dynamic feature information.

19. The calibration apparatus for the manipulator according to claim 14, wherein the feature determination module further comprises:

a contour extraction unit, which is configured to construct a grid in a viewfinder corresponding to the target image, and extract contour information of the target storage groove;

an angle determination unit, which is configured to compare the grid with the contour information to obtain an angle value between each side of the contour information and the grid; and

a second alarm output unit, which is configured to output an alarm message if determining that the angle value is greater than a preset angle threshold.

20. The calibration apparatus for the manipulator according to claim 14, wherein the data binding module further comprises:

an instruction acquisition unit, which is configured to acquire an access instruction;

a position detection unit, which is configured to acquire an access target image according to the access instruction, and determine the position information between the manipulator and the target storage groove in the access instruction according to the access target image;

a position comparison unit, which is configured to compare the position information with standard position information in the calibration database to determine whether the calibration database comprises the target position information which is consistent with the position information in the standard position information; and

a position calibration unit, which is configured to acquire the adjustment signal for calibrating the position information based on the calibration database for the position adjustment of the manipulator according to the calibration database, if determining the calibration database fails to comprise the target position information which is consistent with the position information in the standard position information.