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Research Article

Automatic Detection of Electric Meter Position in Automated Assembly Line Turnover Box

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Abstract: In the process of metering and automatic production system in the measurement and verification of the loading robot, if there is a positional shift of the electric meter, the gripper of the loading robot will mechanically collide with the electric meter. Due to the large force of the loading robot, the appearance of the electric meter is damaged, and the mechanical arm of the loading robot is broken, which reduces the service life of the measuring and verifying equipment, which is not conducive to the continuous and stable operation of the automatic verification system. In this paper, an automatic detection system of electric meter position in the turnaround box is proposed, which can reduce the failure rate of the automatic verification system, improve the verification efficiency, reduce the loss of metering assets and the occurrence of safety accidents by realizing the offset detection and correction of the electric meter position in the turnover box.

Keywords: *turnover box; position detection; offset; data acquisition*

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1 Introduction

With the increase in the demand for smart electric meters of power supply companies in various cities, the verification tasks of provincial-level measurement centers have been increasing, and the manual verification methods can no longer meet the requirements. In order to improve the efficiency of metering and verification of smart electric meter, realize metering intelligence and automation, an automatic electric meter verification system was built. The electric meter in the automated assembly line is docked with the intelligent three-dimensional warehouse, and the production dispatching platform sends a command to discharge the turnover box filled with the electric meter to the automatic roller line interface of the electric meter, and the turnover box is transmitted to the loading port after the information is reviewed, then the loading robot grabs the electric meter. During the process of grabbing the electric meter by the robot, if there is a positional shift of the electric meter, the gripper of the loading robot and the electric meter may mechanically collide. Due to the large force of the loading robot, the appearance of the electric meter is damaged, and the mechanical arm of the loading robot is broken. This not only loses the measurement assets, but also reduces the service life of the measuring and verifying equipment, which is not conducive to the normal operation of the automated assembly line.

In summary, the automatic detection condition of the electric meter position offset in the automated assembly line turnover box requires high measurement precision, and the invention discloses a device and method for detecting the positional deviation of the electric meter in the turnover box which is adapted to the automated assembly line and the correction processing device not only reduces the labor intensity of workers but also improves the efficiency of measurement verification and ensures the safety of people and equipment.

2 Research status and application plan

2.1 Research Status

The position offset detection methods mainly include non-contact type and contact type. Contact measurement

refers to a measurement method in which the gage obtains measurement information by direct contact with the object to be measured, such as a ruler, a platform feeler, and a continuous flatness measurement method. Non-contact measurement is based on photoelectric, electromagnetic and other technologies. Without direct contact with the object to be measured, the parameter information is obtained by the measurement methods, such as eddy current method, ultrasonic measurement method, machine vision measurement method, laser ranging measurement method, etc.[1].

At present, the principle of laser ranging is widely divided into laser triangulation method, laser echo analysis method, pulse method or time division method and phase laser range finder[2-4]. The principle of the laser triangulation method is to direct the visible red laser light from the laser emitter through the lens to the surface of the object to be measured. The laser light reflected by the object to be measured passes through the receiver lens and is accepted by the internal CCD linear camera. According to different distances, the CCD Linear cameras can measure light spots at different angles. The digital signal processor calculates the distance between the laser emitter and the object to be measured based on the angle between the laser and the camera. The laser echo analysis method uses the principle of echo analysis to measure the distance. The laser transmitter beautifully emits millions of laser pulses on the object to be measured and the reflected pulses returns to the receiver. The processor calculates the time taken for the laser pulse to encounter the object to be measured and returns to the receiver, and the average of the above thousands of measurements is taken as the distance value. The pulse method or the time division method is to use the laser emitted by the range finder to hit the surface of the object to be measured, and the object to be measured reflects the laser. The range finder receives the reflected laser and records the round trip time of the laser, taking one-half of the speed of light and the product of time is the distance between the rangefinder and the object being measured[5]. The phase laser rangefinder uses the frequency of the radio wave segment to modulate the amplitude of the laser beam and determine the phase delay caused by the modulation light round trip line, and then converts the distance represented by this phase delay according to the wavelength of the modulated light.

2.2 Application plan

As shown in Figure 1, the electric meter automatic verification system docks the intelligent three-dimensional warehouse, sends a command through the production dispatching platform to discharge the turnover box filled with the electric meter, and the electric meter automatic verification system roller line will transport the turnover to be measured box to the electric meter information checkpoint after demolition. After the electric meter information is checked, the position offset detecting device of the electric meter in the turnover box of the present invention is installed, and if the position of the electric meter is offset but qualified, it is transported to the loading port by the roller line. If the electric meter is offset, and if it is unqualified it will be transported to the buffer area by the roller line to wait for the correction processing. After the correction processing, the line is re-executed and the electric meter information check and the electric meter position offset detection are performed again.

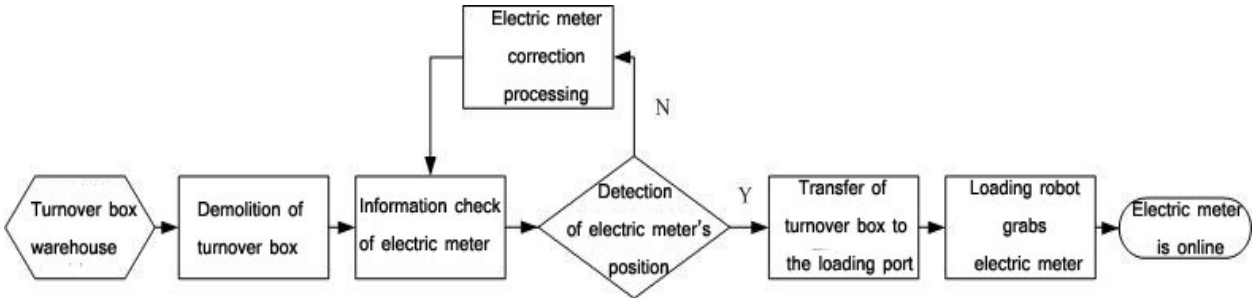

Figure 1. Connection diagram of application plan

3 Design of function module of electric meter position detecting device

The electric meter position detecting device comprises a turnover box clamping mechanism, a laser emitting module, a data collecting system and a correction processing module, wherein the turnover box clamping mechanism is used for fixing the turnover box conveyed

on the roller line at a specific position, and the laser emitting module generates a laser beam. The distance between the electric meter in the turnover box and the laser emitting module is obtained, and the data collecting module analyzes the distance information between the electric meter in the turnover box and the laser emitting module through the system software and determines whether the electric meter exceeds the qualified range.

3.1 Clamping mechanism

The turnover box clamping mechanism includes a baffle, a cylinder, a photoelectric switch, a solenoid valve, an arm, a main arm and a clamping device. When the turnover box to be measured is conveyed to a position corresponding to the turnover box clamp mechanism through the roller line, the baffle blocks the advancement of the turnover box to be measured, and the photoelectric switch is symmetrically arranged on the roller line on both sides of the turnover box detection position. When the turnover box is detected at the position, the solenoid valve switches and the air cylinder pushes the arm to move, and the arm drives the main arm to rotate. The clamping device on the main arm clamps the turnover box to be measured as shown in Figure 2.

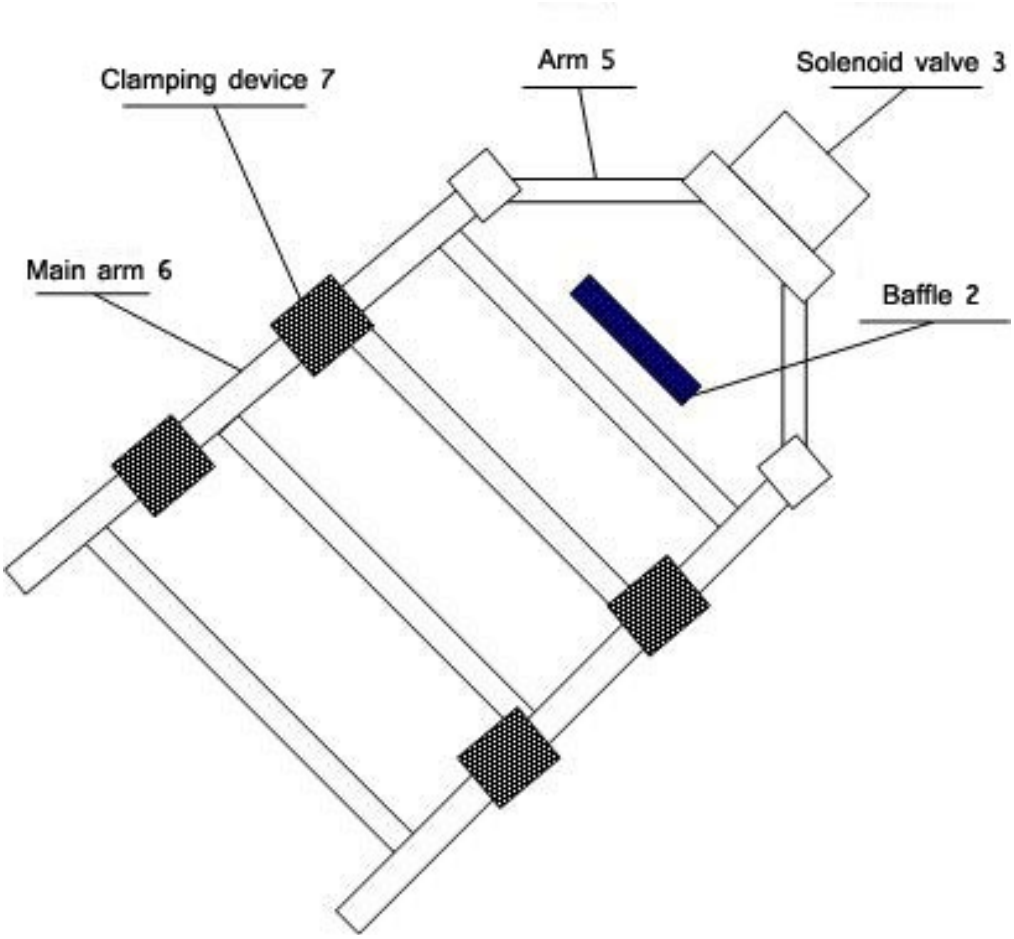

Figure 2. Schematic diagram of the turnover box clamping mechanism

3.2 Laser emission

The laser emitting module comprises a laser displacement sensor, a base, a guide rail, a slider and a support, wherein a guide rail is arranged on a plane above the turnover box and perpendicular to the conveying direction of the roller line, and each is arranged according to a size between two fingers of the loading robot gripper rail arrangement spacing. The slider is connected to the guide rail, and the laser displacement sensor is mounted on the guide rail through the base and the slider, wherein the laser displacement sensor moves along the guide rail at a certain speed, and the laser displacement sensor emits a laser beam. The distance between the bottom of tested tote and the characteristic points on the surface of the electric meter to the laser displacement sensor is measured by the emitted laser beam. Figure 3 is a plan view of the offset detecting device.

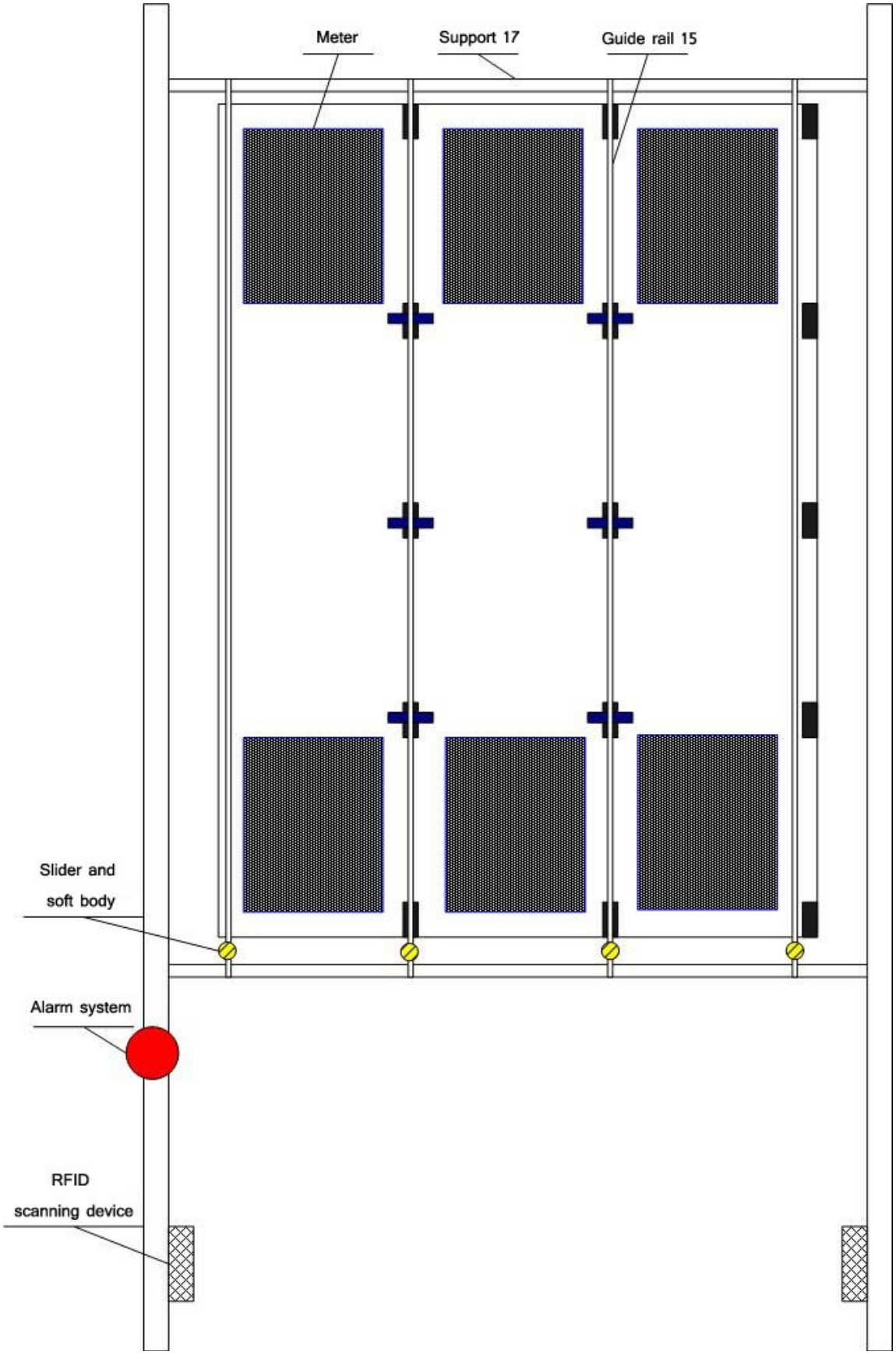

Figure 3. Top view of the offset detection device

3.3 Data collection

The data acquisition module includes an industrial computer, a middleware, and a main control PC. The industrial computer and the laser displacement sensor interface are docked, and the collected distance data information between the laser displacement sensor and each characteristic point in the turnover box is analyzed and calculated, and the position offset value of the electric meter in the measured turnover box is obtained, and the deviation is judged. Whether the shift value is within the set value range, the test result is sent to the master PC. If the offset value is within the set value range, the master PC sends a command, and the middleware controls the electronic control device to release the tested tote. If the offset value exceeds the set value range, the master PC sends a correction processing command, and the middleware controls the electronic control device to transmit the tested tote to the buffer area.

3.4 Correction processing

The correction processing module includes a support, a guide rail, a slider, a soft body, an RFID scanning device, and an alarm device. The soft body is mounted on the guide rail through the slider, and the turnover box clamping mechanism fixes the turnover box, and the soft body moves along the guide rail. After the correction processing is completed, the online calibration is repeated for the electric meter information check and the electric meter position offset detection. The RFID scanning device is symmetrically mounted on the roller line, and scans the turnover box barcode. If the same barcode is counted more than twice, the alarm device operates.

4 Electric meter position detection principle

When the turnover box to be measured is conveyed to the position corresponding to the turnover box clamping mechanism through the roller line, the turnover box clamping mechanism chucking device fixes the to-be-measured box. The slider of the laser emitting module drives the laser displacement sensor to move along the guide rail at a certain speed, and the laser displacement sensor emits a laser beam, and simultaneously acquires the distance between the bottom of the turnover box and the characteristic point of the surface of the electric meter to the laser displacement sensor. The industrial computer is docked with the laser displacement sensor interface, and the distance information between the collected laser displacement sensor and each feature point in the turnover box is analyzed and calculated, and the position offset value of the electric meter in the measured turnover box is obtained, and it is determined whether the offset value is within the set value range and the detection result is sent to the master PC. If the offset value is within the set value range, the master PC sends a command, and the middleware controls the electronic control device to release the measured turnover box. If the offset value exceeds the set value range, the master PC sends a correction processing command, and the middleware controls the electronic control device transmits the measured turnover box to the buffer area. The correction processing module corrects the position of the electric meter by the soft body, and repeats the offset detection after the correction processing is completed, and the RFID scanning device scans the measured turnover box barcode, if the same barcode counts more than twice, then the alarm device operates.

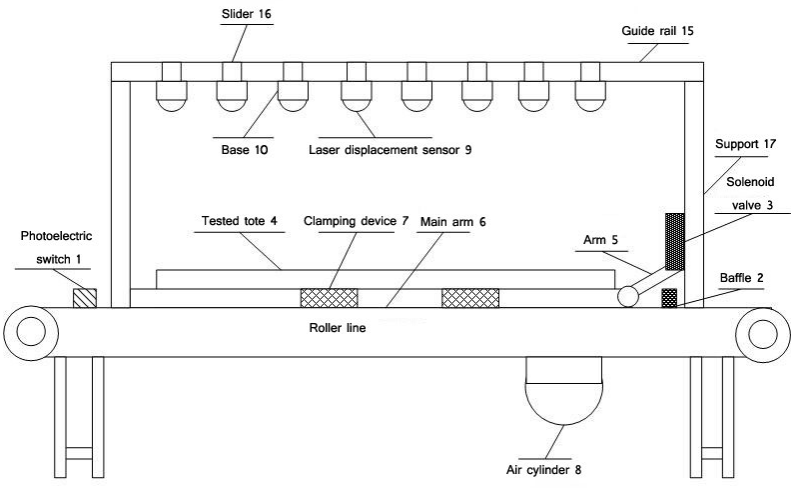

Figure 4. Schematic diagram of the structure of the offset detection device

5 Conclusion

he energy meter position deviation detecting device and method and the correction processing device in the turnover box are economically considered due to the frequent failure rate of the electric meter position offset detection in the turnover box, the method of setting and correction processing device, the damage to the measuring assets and the robot gripper and the arm, the economic loss is extremely negligible, and the spare parts are expensive. Invisibly it greatly improved the operating cost, compared to the installation, leading to the annual savings of hundreds of thousands of dollars; in terms of efficiency, robot smash meter failure results in an average shutdown time of about 2 hours every time, before the comparison results are installed, the production shutdowns is reduced nearly by 100 times, and the efficiency of electric meter verification has been improved by 90%. It avoids unplanned shutdowns and risk factors of healthy operation and control of automated assembly lines, which is conducive to long-term stable operation of the line body. From the safety aspect, each fault handling requires manual processing, and the failure rate of the running equipment is high. The comparison results avoid accidents such as malfunctions and misoperations before installation, which reduces potential safety hazards of personnel and equipment.

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