

# Development and application of intelligent traceability system for vehicle shock absorber assembly line

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## Research Article

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# Abstract

In view of the existing problems in the vehicle shock absorber industry, such as time-consuming to trace the product quality problems, there is no data information of vehicle shock absorber, and the product quality problems are unpredictable in the production process. Based on the existing equipment, an intelligent traceability system is designed to collect manufacturing process information in real time, monitor the operation status of production line and equipment in real time, reduce fault response and equipment downtime, improve production efficiency, and provide data basis for equipment improvement. Through this system, recall cost can be reduced, and product reliability and safety can be improved.

## 0 Preface

In recent years, China's economic development has promoted the rapid development of the vehicle industry. Although the shock absorber market in China is in short supply, the domestic shock absorber enterprises are facing increasing competitive pressure due to the constant influx of foreign shock absorber enterprises into the domestic market. Therefore, it poses a greater challenge in improving product quality and production efficiency.

The shock absorbers mainly produced by foreign shock absorber manufacturers are used by internationally renowned brands of automobiles, which are basically concentrated in family cars. Due to the long development time, high overall level, high intelligence, high efficiency, excellent materials used, software control and rich technical experience, the shock absorber production assembly line has a strong premium ability and high price. However, there are many shock absorber manufacturers in China, but the shock absorber assembly line has a low degree of intelligence. Only a small part of the shock absorber assembly line uses semi-intelligent systems, and most of them use manual tracing. Because of the uncontrollable labor, the error rate is high, the efficiency is low, and the labor cost is high, which increases the burden of enterprises.

After the traceability system of vehicle parts is established, consumers can tell whether the products they buy are genuine or not. If there is a quality problem, consumers can scan the QR code of the product through their mobile phones, and then report the situation to the product manufacturers and regulatory authorities, thus avoiding bigger problems<sup>[4-7]</sup>. For enterprises, through the functions of real-time collection of on-site data, online real-time monitoring data collection, monitoring parameter management, remote operation and maintenance, product information transmission, product quality control, etc., it is easy to realize the interconnection between devices in the workshop, realize integrated management, information sharing and production collaboration<sup>[8-17]</sup>, and improve the quality control ability of enterprises; When there is a problem, the risk can be reduced.

## 1 Hardware Design

This design is an intelligent traceability system, which uses intelligent platform to realize fully intelligent traceability of shock absorber assembly, effectively control the cost of traceability and reach the domestic advanced level. The system framework is shown in Figure 1.

The main research and development contents of the traceability system are divided into two parts: hardware and software. Among them, the main contents of the hardware part are as follows.

## **1.1 SCADA (Supervisory Control And Data Acquisition data acquisition and monitoring control system)**

At present, the stations involved in the assembly line and the data to be collected are: the cleaning machine needs to collect the cleaning temperature, rinsing temperature, torque and displacement of the wire feeding machine; Riveting force of stop riveting machine; Oil filling quantity of oil filling machine; Time and displacement of indicator; Pressure of sealing machine; Inflating pressure and rebound force of inflator; Pressure and displacement of working cylinder bottom valve press machine, etc. For these stations, we can add corresponding sensors or communication modules. PLC can adopt small S7-1200 or S7-200 Smart, and add analog input and output modules.

## **1.2 Scan code of incoming materials and code into SCADA system**

In the process of vehicle parts and other intelligent assembly lines, firstly, the bar code should be printed on the main parts, and then the bar code information should be stored in the industrial computer database. For each barcode, it is the unique identifier of each product. No matter where the product is sent, there will be recorded information in the barcode. When there is a problem with the product, the relevant information of the product can be found in the corresponding database by scanning the barcode, thus solving the problems of after-sales service and quality tracking.

In this item, you can scan codes individually or in batches. For the installation of code scanning equipment, one part should be fixed and can scan code accurately from a single angle, and the other part should be movable to realize multi-angle code scanning. High sensitivity is required for code scanning equipment, and both command control and automatic scanning modes are supported. Avoid the unstable scanning condition of barcode scanning equipment [2].

In the process of scanning code, the product code will be constantly adjusted according to the actual needs. If the barcode length is too long, it is necessary to shorten the barcode length or change it to a two-dimensional code; The paste position of bar code should be fixed and unified, because the fixed scanning code requires more accurate bar code position, otherwise it will not be scanned easily. It is necessary to use the stop switch on the assembly line to control the code scanning, and all stops and stops should be able to be used normally, as shown in Fig. 2. In this design process, the original two-dimensional code requires the last six digits to be numbers, but now the requirement is that the last digit remains unchanged, adding 1 to the middle four digits, and sweeping the previous date. The problem of repeated

scanning is due to the high speed of the transmission line or the low sensitivity of the scanning gun. The QR code is shown in Fig. 3 below.

The scanning gun of each station cannot be exchanged casually, and the prefix of scanning gun of pressure displacement station of bottom pressing valve is B; The prefix of the recovery valve station scanner is C; The prefix of the indicator station scanning gun is D; Sealing station scanner prefix is E; The prefix of inflation station scanning gun is F.

The specific settings of the code sweeper are as follows: A baud rate is 9600, data is 8, stop bit is 1, check bit is not available, flow control is not available, and suffix and prefix is not available, and B is set to always-on mode.

## **1.3 Disposal of substandard products**

All unqualified products need to be placed in the designated location, where sensors are installed, if not placed, the equipment will not operate.

## **1.4 IP allocation of each device**

The equipment communicating through Ethernet in this design includes industrial computer, PLC, power indicator, oil injection machine and recovery valve. The IP distribution is shown in Table 1.

# **2 Software Design**

## **2.1 Interface display function**

The HMI interface function adopts a multi-window style design, including the monitoring of the main equipment status of the production line; the monitoring of the running status of the entire production line; displaying the type, online quantity and offline quantity of the product of the entire production line, and setting the production line product batch number, model, quantity, etc. Features.

Real-time monitoring of the operating status of the production line and its equipment, reducing the impact of failures and equipment downtime, improving production efficiency, and providing data basis for equipment improvement<sup>[3]</sup>.

Through the report system page, you can access the system's production performance, failure rate and other reports.

Realize the authority management of different operators.

In addition, there are alarm function, report management function, trend function, authority management function and its redundancy function.

## **2.2 Data collection function**

The main function of data collection and processing is to receive the bottom-level data of the modified production line, process the data, and upload it according to a specific communication protocol for display, storage, query and other applications on the back-end equipment.

Data collection of the display machine: use the local network sharing to share the data collection folder; on the upper computer, map the shared file of the display machine as a network drive; use WinCC to read the network drive file to obtain data (speed, pull, qualified Or not).

Use the torque wrench's own control software ICS to set the output data format and communication protocol; use Visual C# to write the communication software between the upper computer and the torque wrench, obtain the torque wrench data and write it into the WinCC readable file to facilitate WinCC unified management; the upper computer configuration program WinCC obtains readable and writable data files to read torque and angle<sup>[1-4]</sup>.

## 2.3 Process problems and methods

Process parameter setting function, the system provides process parameter setting function according to the needs of production line operation, and can be saved and recalled.

## 2.4 PLC input and output

According to the requirements of this traceability system, combined with field equipment, the I/O address allocation table of the PLC system is analyzed, as shown in Table 2.

Table 1  
IP allocation of device

Name	IP	Virtual serial port (com)
Host computer	192.168.2.200	
PLC	192.168.2.100	
Display machine	192.168.2.105	
Oil filling machine (manned module)	192.168.2.102	11
Recovery valve (personal module)	192.168.2.103	12

Table 2  
I / O address allocation table of PLC system

<b>Input signal</b>	<b>Input signal address</b>	<b>output signal</b>	<b>Output signal address</b>
Rinse water temperature	AI0	Piston tightening alarm	Q0.0
Washing water temperature	AI1	Riveting alarm	Q0.1
Press-fitting station pressure	AI2	Oil filling alarm	Q0.2
Press-fitting station displacement	AI3	Seal the alarm	Q0.3
Riveting pressure	AI4	Characteristic test alarm	Q0.4
Oil filling 1	AI5		
Oil injection 2	AI6		
Sealing pressure	AI7		
Inflation pressure	AI8		
Inflatable rebound force	AI9		
Piston tightening torque	AI10		
Piston tightening torque angle	AI11		
Dedusting of oil storage tank	I0.0		
Oil storage tank cleaning	I0.1		
Press station	I0.2		
Piston tightening start	I0.3		
Riveting start	I0.4		
Oil filling start	I0.5		
Characteristic test started	I0.6		
Sealed start	I0.7		
Inflation start	I1.0		
Number of water changes	I1.1		

### 3 Debugging Results

The wiring and debugging of each station is completed, the data is uploaded successfully, the upper computer displays normally, and the database is stored correctly.

When producing products, you need to select the upper and lower limits of the corresponding upper process parameters in the formula management of the product. If there is no suitable creation of a new formula, click the download after the formula is selected to use. It is shown in Fig. 4.

Query the stored formula, select the required formula as required, and click the download button to call the selected formula. If there is no suitable formula, please click the edit button to allow the required formula to be created after editing. The formula number is 1–20 digits, and other values cannot be filled in. The name can be no more than 10 characters. After filling in, click the save button, The formula can be saved, as shown in Fig. 5.

Double-click each station icon on the main screen to pop up the report query window for each station. After selecting the required time period, click the query button to query the parameter report value of the selected time period., as shown in Fig. 6.

Main screen alarm selection button: left-click the alarm selection button with the mouse, and the button will no longer output an alarm signal to the outside after the button turns gray. Right-click the alarm selection button with the mouse, and the button will output an alarm signal to the outside if there is an alarm after the button turns green.

## 4 Conclusion

The system is easy to operate, low in cost and highly compatible. At present, there are many shock absorber production lines, many of which need to be upgraded, and the market prospect is expected to be very good. Retrospectively transform a vehicle assembly line, and then gradually implement it in other production lines, and then expand it to other industrial production lines.

The traceability system is characterized by a set of online real-time monitoring system software developed by applying advanced automatic control, network, communication and other related technologies to meet the development needs of shock absorber industry and customer requirements. The system adopts the design pattern of industrial configuration software, a platform, and different application modules, which truly achieves the goal of "one set of software, one maintenance and full-line application". The whole process of PLC control is used for data collection, data analysis and data storage, and the whole process of product monitoring is carried out. Realize fully intelligent traceability, reduce error rate, improve production efficiency and reduce cost.

Through the control of the production process and the realization of the intelligent traceability system, the needs of enterprises and consumers have been met. The software platform can connect different data and communication interfaces according to different requirements of the enterprise, so as to realize the exchange of information with different layers of systems, so as to improve the production management

level of the assembly line of automobile shock absorbers. It not only facilitates the operation and control of on-site personnel, but also helps managers to grasp the situation of the front line of production in a timely and accurate manner, so as to respond and make decisions as soon as possible, so that the product quality is more guaranteed, and the production efficiency of the shock absorber is improved. When there is a problem with the product At the same time, through the traceability system, in order to reduce the cost of recall, improve the reliability and safety of products, and make enterprises more competitive.

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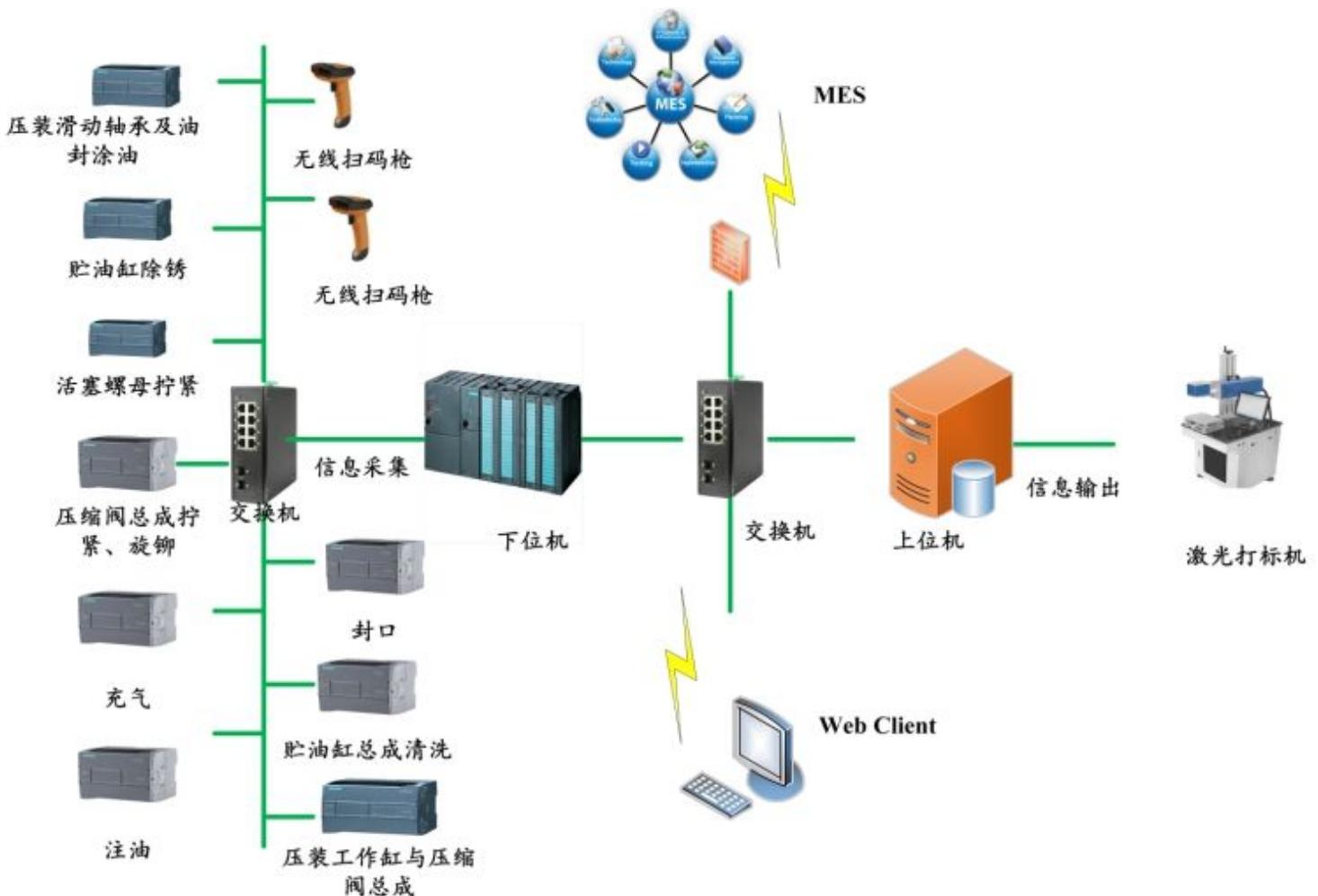
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## Declarations

### Competing interests:

The authors declare no competing interests.

## Figures



**Figure 1**

**System framework diagram**

**Figure 2**

**Gear stop switch**

**Figure 3**

**QR code**

**Figure 4**

**Choose recipe**

**Figure 5**

**Create recipe**

**Figure 6**

**Main interface**