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Construction of Supervisory Control and Data Acquisition in Shop-level based on Product

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ABSTRACT*: This paper analyzes the development trend of manufacturing and research hot topics in recent years, drawn to contemporary trends in manufacturing automation and information technology development, and then analyzes the deficiencies in manufacturing enterprises in MES Plant-level Supervisory Control And Data Acquisition. We also design the network structure and system hardware as well as client and server, and finally we prove the effectiveness of the system to the production line in product quality and efficiency as the evaluation criteria.*
Keywords: *MES, Plant-level Supervisory Control and Data Acquisition, evaluation criteria*

I. INTRODUCTION

With the development of advanced manufacturing technology and Internet technology, the direction of manufacturing is gradually to automation and informatization[1]. Modern manufacturing enterprises have six competitive factors: cost (Cost, 60 years ago the focus of attention of enterprises)[2], quality (Quality, 70 years of hot spots)[3], delivery (Time, 80's hot)[4], service (Service, 90's hot)[5], environmental protection (Environment, 90 years at the end of the hot spots)[6] and knowledge innovation capacity (Knowledge Creative, 21 century hot spot) [7]. In the process of global economic integration, driven by market competition intensified, manufacturing companies succeed in the global market place, it must be information technology, to make improvements from the above six areas, and constantly improve the level of automation and information technology, to meet the trends in the world of manufacturing, promoting automation and integration of information technology to increase their own competitiveness [8].

Through years of efforts and development of the manufacturing sector in developing countries we have made long-term progress in the application of information technology, but overall still at a low level [9]. Compared with the world manufacturing power, manufacturing information technology applications in developing countries are still at the single system in most of enterprises, and cannot be achieved with the combination between company's overall business processes and business model. And most companies focus on construction of ERP and other enterprise-level information management, few companies are able to focus on the information construction at the bottom of production line. By the reason of the long-term lack of systematic researching, planning and designing, a large number of “information isolated island” has formed, within the regional system interference seriously [10]. construction of a modern production line in manufacturing enterprises are in the form of global tender, each hardware vendors provide its own set of data collection methods to gather data saved to the database, therefore the data acquisition interface, database table structure and interaction with MES interface cannot be unified, which causes the acquired data is difficult to apply for production management, the establishment of a unified set of equipment on the production line monitoring, process management, material tracking, production management, data collection, data storage and data in-one platform for interaction and so is imminent[11].

II. SYSTEM FUNCTIONAL ANALYSIS AND DESIGN

Modern manufacturing want to achieve product quality in control, without loss of effectiveness of establishing a dynamic data network for each of the products, including product processing information and material information on each station, so that the quality is visible. So the entire supervisory control and data acquisition (SCADA) network base on modern technology and software technology. The system collect data at the traditional C/S (Client/Server) mode, the bottom of the controller and the device as a client, the client connect with server with a unified communications protocol and driver. Compared with the traditional OPC technology, this connection model is more efficient. With data presentation layer using B/S mode, so the representation of collected data is more flexible.

2.1 system function topology

For ease of analysis, design and commissioning, the whole system is built on the basis of modern Internet technology. using modular design, the plant management and data acquisition system is divided into the following modules: Universal Interface Module (shielding devices), business processing module, business management module, data storage module, data management module, monitor module and application interface module; the business logic module provide to other modules as the services, the underlying device communicate with the business logic modules with a defined interface standard and communication mode; their logic Fig.1as follows:

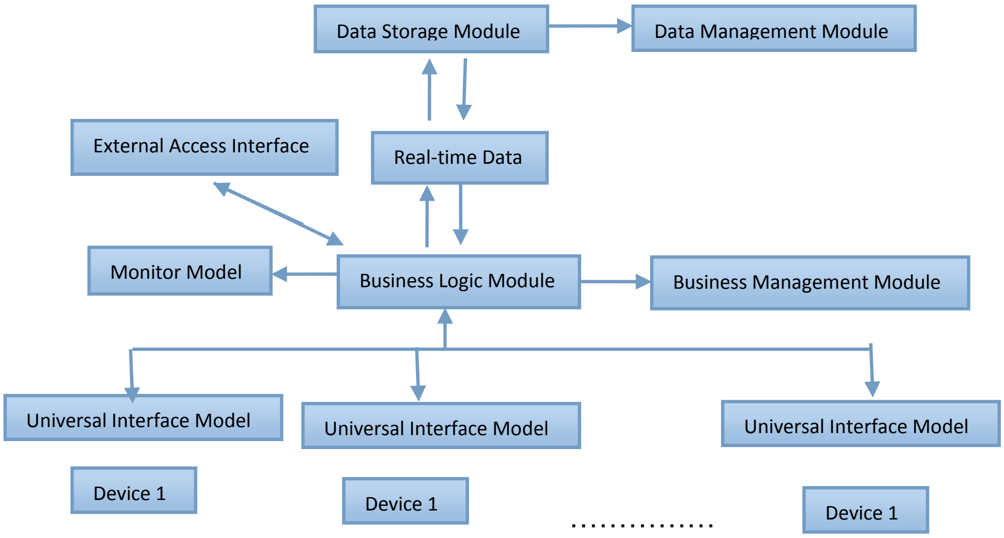


Fig.1 the logic diagram of SCADA

In this logic diagram the business logic module is the core of the whole data acquisition system, which monitor the underlying equipment and production data acquisition and store it to the database through a pre-defined common interface module, and provide on-site real-time operation to monitor module, but also provide means through which business management model can manage the underlying device effectively.

2.2 System Data Flow Diagram

Line Server provides the entire business logic processing, through the appropriate device driver to communicate with the next crew to realize the underlying device control. Production line servers will collect real-time data synchronization to the database through the database, and the collected data show up in the pages by the B/S pattern. Its structure is in Fig.2, as follows:

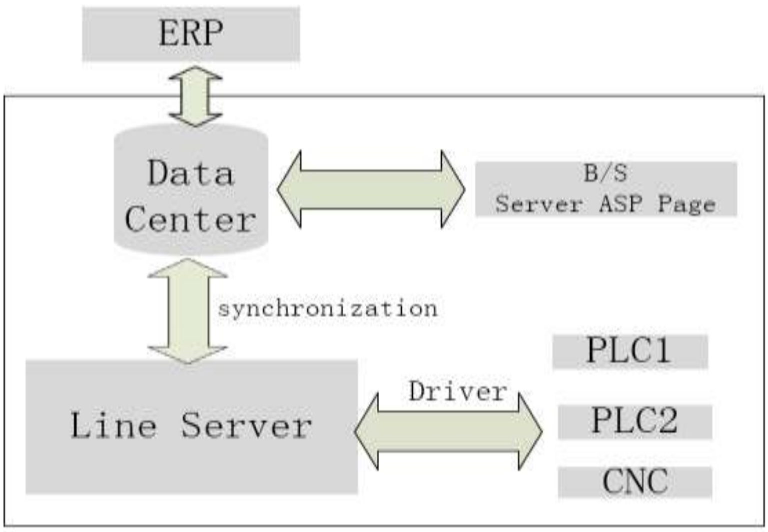


Fig.2 the flowing data

III. SYSTEM NETWORK HARDWARE STRUCTURE

Line Server is responsible for the underlying device as monitoring and management, and print barcode related products to achieve unified management of data. Wireless devices are connected to the Line Server to achieve the management of materials by AP hotspots. Users can access via a web server to realize the query and field production data monitoring indicators, as shown in Figure 3. The system is composed of database management systems, Web servers, the underlying equipment and related auxiliary equipment.

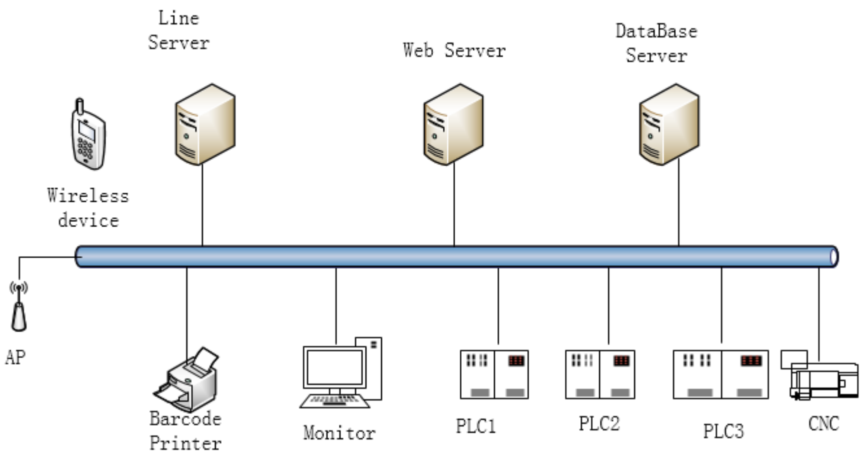


Fig.3 the network diagram

IV. SYSTEM SOFTWARE DESIGN

4.1 server software design

Line Server successfully read barcode information after establishing contraction through the appropriate driver with the underlying device. the business logic model determine whether the barcode of the station's compliance with the rules setting by business management module. And the next step determines whether the current product barcode is corresponding to the type of products. if the judge failed, it returns the associated error messages and error codes in each decision step, and finally return successful result, then the device can begin production. The process shown in Fig.4:

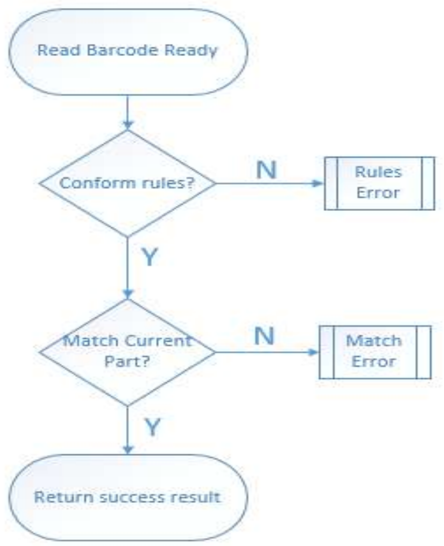


Fig.4 Server Flow Diagram

4.2 device-side software design

The underlying device contact with the Line Server through the appropriate driver. First the client set the corresponding flag LC as 1, the server will cycle scan these flags and read the appropriate barcode after the flag changed. the server will make appropriate judgments according to the barcode result. the device can be produced after receiving successful signal. if an exception is encountered, it will promptly send status information to the Line Server, so Line Server timely can record the information about the production. if the device is working success, the data of the production will timely upload to the Line Server .

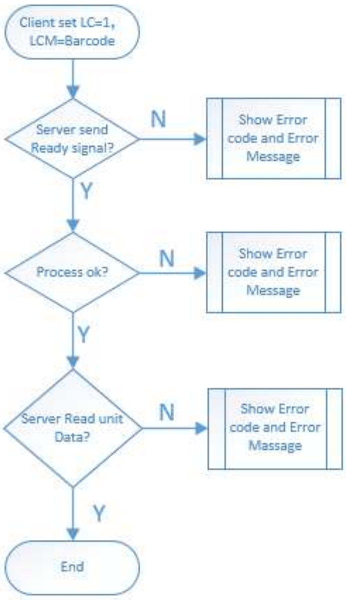


Fig.5 client Flow Diagram

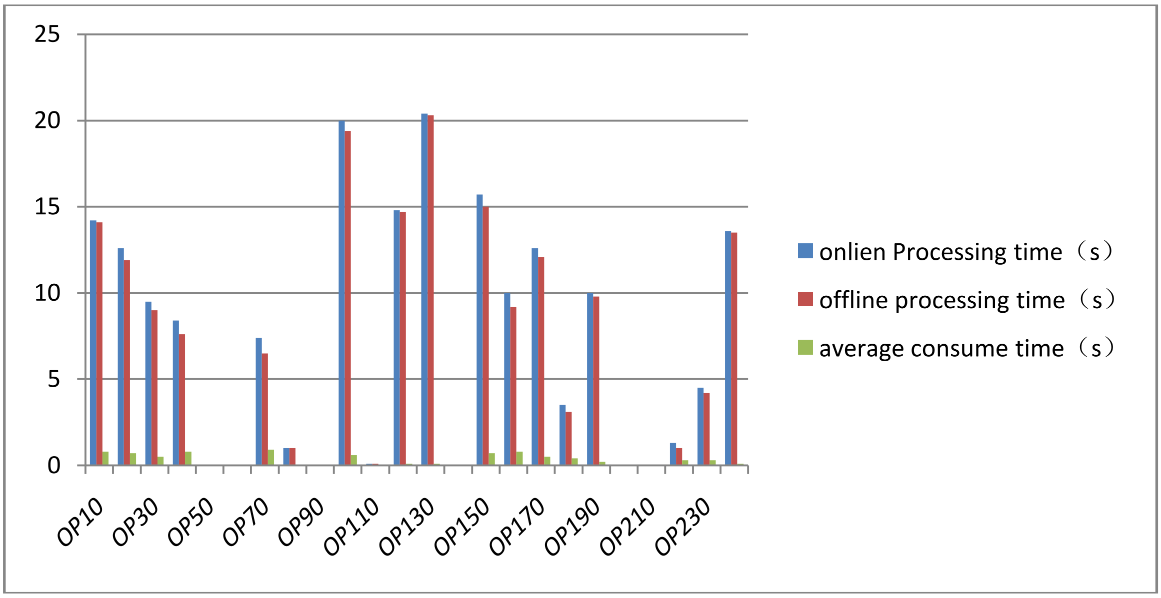
V. SYSTEM PERFORMANCE ASSESSMENT

5.1 real-time analysis

Processed using actual control function (s) = online processing cycle (s) - offline processing cycle (s). Table 1 is the statistics processing time table. The difference of the cycle time in different stations is great. The online processing cycle time, the offline processing cycle time and the difference between above shown in table 2. The basic curve snapping x-axis represents that the data acquisition and control feedback is very short time-consuming.

Station(OP No)	10	20	30	40	50	60	70	80
online Processing time（s）	14.2	12.6	9.5	8.4	0	0	7.4	1
offline processing time（s）	14.1	11.9	9	7.6	0	0	6.5	1
average consume time（s）	0.8	0.7	0.5	0.8	0	0	0.9	0
Station(OP No)	90	100	110	120	130	140	150	160
Online Processing time（s）	0	20	0.1	14.8	20.4	0	15.7	10
offline processing time（s）	0	19.4	0.1	14.7	20.3	0	15	9.2
average consume time（s）	0	0.6	0	0.1	0.1	0	0.7	0.8
Station(OP No)	170	180	190	200	210	220	230	240
online Processing time（s）	12.6	3.5	10	0	0	1.3	4.5	13.6
offline processing time（s）	12.1	3.1	9.8	0	0	1	4.2	13.5
average consume time（s）	0.5	0.4	0.2	0	0	0.3	0.3	0.1
the average time of system(s)	3.2							
the overall consume time of the line(s)	7.7							

Tab.1 the cycle time of every station



Tab.2 the histogram of the cycle time

After the statistical calculations, the consuming time in single station which work in our system is 0.32 seconds, and the result meet real-time requirements of industrial automation. After the implementation of the system, it took an average of about 209.47 seconds, the execution time of the whole production line is about 7.7 seconds, only 3.67 percent of the entire completion time, no effect on the timely completion of the production plan.

5.2 Quality Control Results and Analysis

Table 2 count the number of unqualified workpiece in August 2015 in each station, there are 31,760 qualified products in this mouth, 946 times of failed process and 188 times of the workpiece rework. The rejection of this Month = all waste reject number / total number of parts × 100% ≈2.39%. Without implement of the system, the average rejection rate is 2.96%.which we can be obtained, the rejection rate decreased about 20%.

Station(OP No)	10	20	30	40	50	60	70	80
Failure/Rework(time)	561	0	9	15	3	0	6	67
Station(OP No)	90	100	110	120	130	140	150	160
Failure/Rework(time)	67	157	7	45	Test	6	Test	Test
Station(OP No)	170	180	190	200	210	220	230	240
Failure/Rework(time)	Test	Test	4	0	1	0	0	0

Tab.2 the statistics of Failure and Rework unit

VI. Conclusion

With hardware and software operating efficiency, the program execution cycle time is not more than 1 second. By means of the actual statistics of online and offline cycle time, we analyze that the actual operating cycle time of each station is an average of about 0.32 seconds and the total process is about 7.7 seconds ,which meet the real-time system and do not affect production line plan. Based on the statistics of the number of nonconforming product of each station in using this system before and after, the rejection rate decreased by about 20% , indicating that the design of the system are effective in quality control.

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