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Application of Device Control and Manage Method in Military Barracks

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ABSTRACT

The intelligent device detection and control system in military barracks is often instrumented with a large number of devices. In order to improve device management level and ensure device operation stabilization, a device control and manage method and its application is proposed in this paper. The proposed method can be broken down into four parts: scheme design, data acquisition, data upload and transfer, applications. The details of each part have been illustrated comprehensively. Finally, a typical application demonstrates that the proposed method can realize the field device controlling and management real time, improve control efficiency and reliability.

Keywords: Device control, DCMS, DCM, Data acquisition.

1. INTRODUCTION

With the improvement of automation and development of military modernization, SCADA systems and intelligent devices have been largely used in modern military barracks [1], which leads to an increase of the amount of work and the difficulty in device management [2]. Instead of the traditional ones, these devices such as water meters, power meters, calorimeters can be monitored and controlled with remote computers, which has brought incredible convenience to the managers [3]. Therefore, how to manage and control these intelligent devices in military barracks has become an increasingly important problem [4].

In order to improve device management level and ensure device operation stabilization, a lot of work has been done [5]-[10]. Computer technology, database technology, the fieldbus technology etc. have been introduced. Honestly speaking, current device management systems mostly solve the problem, and have received good results [11]-[13]. However, most of them are offline and static [14]-[16]. This situation finally causes isolation between device control and device diagnosis. Given all these considerations above, in order to improve device management and controlling efficiency, by taking consideration of the whole unit, a new device control method in military barracks is necessary to be adopted.

2. SCHEME DESIGN

In order to dispose of imperfection that requires a lot of human labor to manage devices that result in an inefficient manage of all devices, high-energy consumption and weak visualization, this paper presents a device control method in military barracks.

Based on the system analysis, the main architecture of the device control and manage scheme is organized in three layers: Decision Layer (DL), Control Layer (CL), Execution Layer (EL) and Data Transfer Layer (DTL). The schematic diagram of method logic tiers is shown in figure 1.

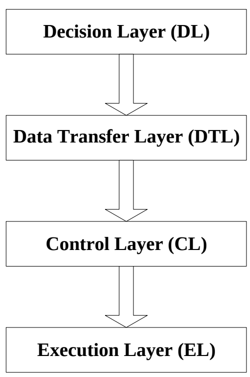

Figure 1. The structure diagram of DCMS

2.1 Decision layer (DL)

Decision Layer consists mainly of engineer station, data server, sub-system monitoring stations, decision and control station which sending steering order to CL and receiving data from them. Some of the key features are described below:

(1) Engineer Station: Based on the idea of designing function-modules, the program of detecting and controlling machines (DCM) in CL is designed and

compiled by using ladder diagram language (LAD). Meanwhile, by downloading control scheme from DCM, sub-system monitoring stations is configured and field devices are monitored.

(2) Data Server: Object Linking and Embedding for Process Control (OPC) technology is used for obtaining the real time data correctly. Then, by using data server, we can collect dynamic data, analysis and treat the data, simulate the status of field devices, save the data, query the data and set working parameters, etc. make reports and print, etc.

(3) Sub-System Monitoring Stations: Device control and manage system (DCMS) is composed of several sub-systems as follows: power supply sub-system, water supply sub-system, heating sub-system, central air conditioning sub-system, etc. Therefore, the monitoring stations are constructed with their corresponding sub-systems, which acquire data from data server and achieve the friendly Human-Machine Interface (HMI).

(4) Decision and Control Station: It receives instructions from operators and then by using LAN, remote control field devices next.

2.2 Control layer (CL)

Its main components are detecting and controlling machines (DCM), which sending steering order to EL and acquiring sample signals from EL. According to CL, we can not only achieve to control and operate the intelligent devices in EL, but also isolate driven circuit and realize delay protection, mutual-exclusion locks. Some of the key features are described as follows:

(1) CPU: This paper takes SIEMENS S7-1200 1214C as DCM's CPU, which is responsible for data preprocessing and transmission from EL, with data server for data exchange.

(2) Analog Input Circuit: It realizes the gather and control the analog value such as liquidometer, thermometer, etc. and send the data to CPU.

(3) Fieldbus Interface Circuit: It acquire data from devices which employ corresponding communication protocols and then send the data to CPU. Meanwhile, it receives the control commands from CPU.

(4) DC Power: It will provide a continuous DC voltage to field devices which is rated at 24V DC.

(5) I/O Interface Board: It employs modular design to control field devices such as pump and valve, etc. Moreover, each driven circuit is isolated, and delay protection, mutual-exclusion locks are realized by this proposed I/O interface board.

(6) Wire Slot: In the cabinets of both sides provides the user with alignment wire slot, the general lines are fixed through it.

2.3 Execution layer (EL)

Execution layer mainly consists of intelligent field devices of different varieties in military barracks. It takes an important part in the whole DCMS.

2.4 Data transfer layer (DTL)

Data transfer layer mainly consists of three parts: industrial Ethernet which connects EL to CL; LAN which connects CL to DL and switches which connect industrial Ethernet to LAN.

We can learn from the above system design that according to field devices, DCM, engineer station, data server, sub-system stations and decision and control station, etc., a distributed monitoring system is designed and applied successfully. By using this system, we can not only monitor the parameters of field devices on real time, but also aggregate, analyze and save the data as well as control the devices. It provides convenient for administrators to know the status of each field device in military barracks in detail. Also, DCMS provides the efficient data support for correct instructions and energy saving plans. Moreover, instead of acquiring data and controlling devices manually, work efficiency can be largely improved by using the proposed device control method and system. The structure diagram of DCMS is illustrated in the figure 2.

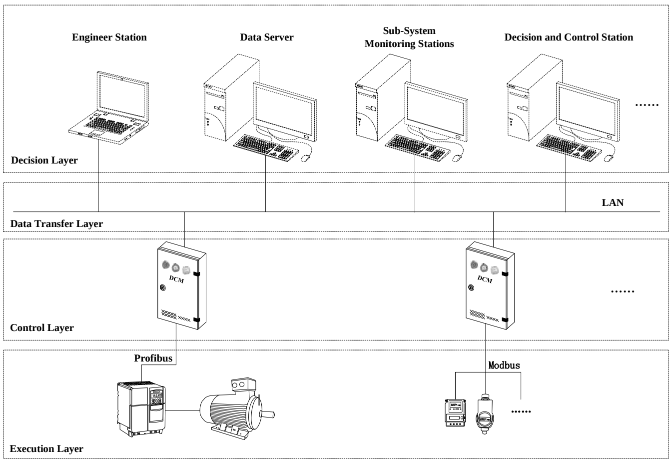

Figure 2. The structure diagram of DCMS

3. DATA ACQUISITION

3.1 DCM

The parameter acquisition process has been done by DCM that directs the operation of field devices connected to them. According to different data type of the gathering parameters, they can be classified into three categories: device IDs, standard analog signal parameters and fieldbus communication signal parameters. Firstly, generally speaking, device IDs are their names. Further, they can also include the device configurations, types and specifications, etc. Next, standard analog signal parameters are 4~20 mA analog signals which describe the signals sampled from sensors, such as pressure, liquid level, velocity, temperature, humidity, etc. Then, fieldbus communication signal parameters describe parameters of each intelligent field devices acquired from corresponding fieldbus protocols, such as electricity consumption, water consumption, gas consumption, etc. The structure diagram of DCM is illustrated in the figure 3.

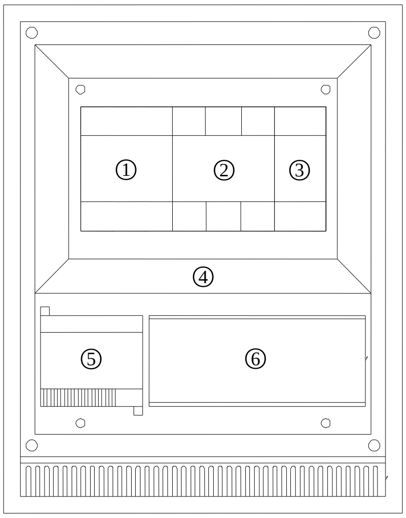

Figure 3. The structure diagram of DCM

where ① is fieldbus interface circuit, ② is the CPU of DCM, ③ is analog input circuit, ④ is wire slot, ⑤ is DC power and ⑥ is I/O interface board.

3.2 Data server

OLE for process control (OPC) is adopted to resolve the problem that field devices from different factory can not communicate freely. As OPC server, data server real-timely receiving various data from DCMs, via the data transfer layer. Then, DCMS make full use of these data in data server to classify, count and summarize and form the information that can be used by sub-system monitoring stations and decision and control station. The schematic diagram of data server is shown as figure 4 below:

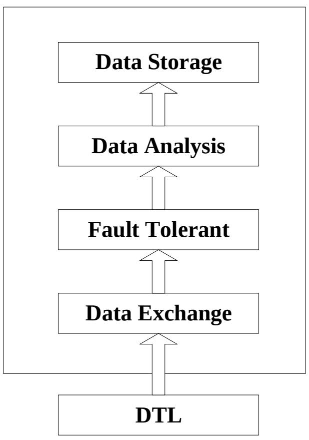

Figure 4. The schematic diagram of data server

3.3 Sub-system monitoring stations

As OPC clients, sub-system monitoring stations get field device data from data server, which is used as OPC server. Then, instead of the traditional tables, a good HMI composed of physical maps and process flow charts is given to operators which enables data display and all operations more visible.

3.4 Engineering station

Engineering station, which is one of the most important part of DCMS, is key to monitoring strategy design and sub-system monitoring stations configuration. Furthermore, the monitoring and diagnosis of CL and EL has been realized through it. The schematic diagram is given in figure 5 as bellow.

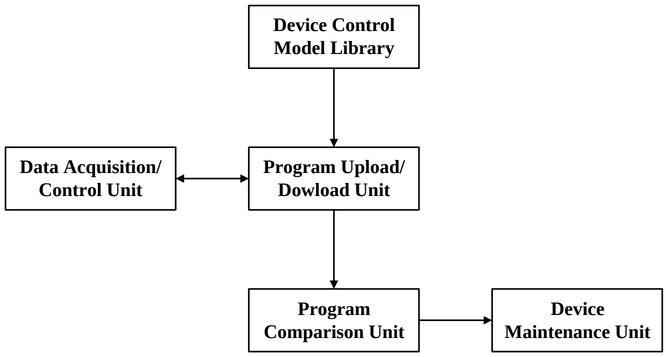

Figure 5. The schematic diagram of engineering station

3.5 Decision and control station

Decision and control station, which is consists of data interface unit, analysis unit, decision unit and control unit, is used to give recommendations for managers of military barracks. More specifically, as OPC client, data interface unit obtains field device parameters from data server. Next, parameters will be analyzed in analysis unit and the result provides important references for operators. Besides, in case of emergency or accident, operators can control field devices manually through control unit. In the illustration bellow is the structure diagram of decision and control station.

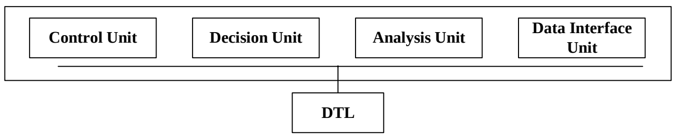

Figure 5. The structure diagram of decision and control station

Generally speaking, the data acquisition, storage and transfer processes are running independently on each DCM. However, by using OPC protocol, all data can be gathered and analyzed comprehensively on data server. And in doing so, all field devices in military barracks can be connected into one complete set, which make them much more convenient to monitor and operate.

4. DATA UPLOAD AND TRANSFER

4.1 Analog input circuit

Thanks to I/O interface board, Analog input circuit acquires all parameters of field devices which connect to it. Next, standard analog electrical signals have been formed to send to the CPU of DCM, which makes analog signal upload realize and allow multi-channel to be sampled simultaneously, such as pressure, temperature, humidity, liquid level, etc.

4.2 Fieldbus interface circuit

Field bus technology has become a hot topic in the field of automation technology, which results in a profound innovation of automation system structure and devices. Parameters of field devices that support the corresponding fieldbus protocols can be gathered from the fieldbus interface circuit. Once the data have been obtained, it will be transferred to the CPU of DCM for further analysis and processing. Parameters of field devices mainly include water consumption, electricity consumption, gas consumption, etc.

4.3 CPU

Before uploading to DL, the data should be preprocessed by means of data integration, selection and transformation to make it standardization. Then, operation instructions will be delivered from DL to CPU through DTL. Moreover, CPU determines whether there are requisite conditions for the instructions to execute. When available, the instructions will be transferred to EL. One important thing to note about this command executing process is that the operation instructions from DL could be some single operation, like turning on/off the light. However, it could also be a certain device control policy, such as turning on/off the lights automatically when the illuminance exceeds an established threshold.

5. APPLICATIONS

After the data of field devices is acquired, uploaded and transferred, using DTL based on TCP/IP protocol as the method of data transmission, we can realize the dream of monitoring and controlling any device real-timely. Sub-system monitoring stations can be one computer or plenty of computers. More specifically, power supply sub-station, water supply sub-station, heating sub-station, central air conditioning sub-station and environment monitoring sub-station are include in them. By using these sub-stations, each field device can be remote monitored and controlled. The structure diagram of sub-system monitoring stations is shown in figure 7 as follows.

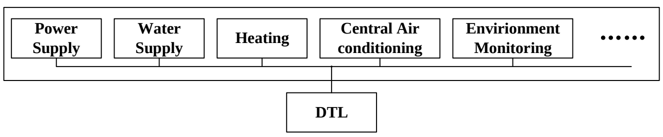

Figure 7. The structure diagram of sub-system monitoring stations

5.1 Power supply sub-station

Electricity supply sub-station can be divided into three modular by function: power transforming and distributing part, transformer part and electricity consumption part. And specifically, power transforming and distributing part can achieve the following functions:

(1) Completing acquisition and processing of power data;
(2) Realizing power parameter calculation, statistic analysis and storage;
(3) By using Oracle database technology, integrate DCMS with other systems;
(4) Realizing not only local, but also remote control of spot anti-error operation;
(5) Implementing alarm display, history check and report statistics;
(6) The history curves of power transforming and distributing devices are proposed.

Similarly, transformer part is consists of 2 transformers under parallel operation mode. The status of breakers, three-phase voltage and current at low voltage side is adopted to calculate some basic parameters such as the current rms, voltage rms, active power, reactive power, apparent power and power factor, etc.

Besides, electricity consumption part can carry out the real time monitoring of the power consumption, which could offer thoughts and reference for energy management and saving work.

5.2 Water supply sub-station

The pressure of pump chamber water output and water supply network, the consumption of total water, user water, green spray can be measured automatically by water supply sub-station. Then, when the data is transferred to DL, constant-pressure control of pump chamber is achieved. Moreover, according to a pre-determined quota, user water consumption and charging state, water valves prefer to open or close automatically.

5.3 Heating sub-station

Heating sub-station can not only analyze and process the real-time heating data, but also get the heat consumption of each user. By using WinCC configurable software, the base load, history energy consumption, weather condition of heat supply center are real-timely monitored. And comparing with actual running data, the theoretical energy consumption data calculated by decision and control station can provide evidence for energy saving work, and warning at abnormal time.

5.4 Central air conditioning sub-station

Central air conditioning sub-station is available to monitor the temperature control panel, variable frequency controller, climate compensator, pipe temperature sensor, pipe pressure sensor and regulating valve continuously. Moreover, once the data has been transferred to decision and control station, it is can be modified and extended to the real decision process, and make the decision process more flexible.

5.5 Environment monitoring sub-station

According to different functions, environment monitoring sub-station can be divided into water quality monitoring part, fire detection part, elevator monitoring part, environment temperature and humidity monitoring part, ambient noise monitoring part and illuminance monitoring part, etc. Once the environment monitoring data has been obtained and transferred to decision and control station, the latest environment information can be tracked.

More specifically, the application diagram of proposed device control and manage method in military barracks is shown in figure 8 as follows.

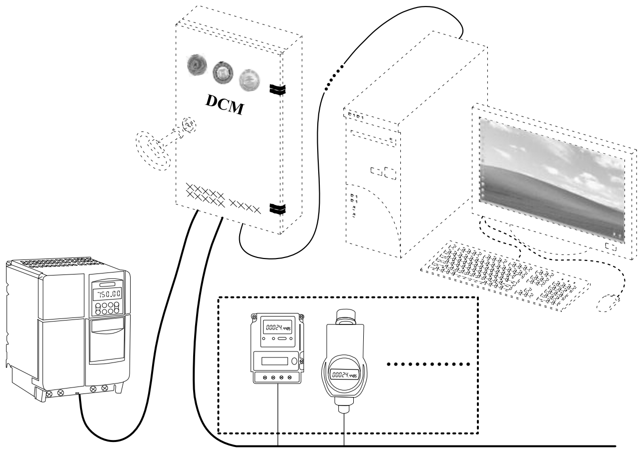

Figure 8. The application diagram of proposed method

6. CONCLUSIONS

Device control and manage attracts an increasing attention in recent years, as a result of growing demand for higher efficiency, reliability and better real-time in military barracks.

In order to monitor and control all the field devices remotely and reliably, a device control and manage method is proposed. This paper describes the proposed method and its application from four parts: scheme design, data acquisition, data upload and transfer, applications. The details of each part have been illustrated comprehensively. Finally, an application diagram of proposed device control and manage method is given. The application demonstrates that the proposed method can realize the field device controlling and management real time, improve control efficiency and reliability.

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