Design and Implementation of Intelligent Storage System for Change Back Meter

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Abstract. Designed and developed a set of intelligent storage system for the change back meter. The storage system supports various types of inbound and outbound tasks in the MDS system and the four-line one-library interface specification, including the transfer of the inbound and outbound warehouses, the returning of the warehouses, the returning of the warehouses, and the returning of the warehouses. "Device outbound interface". The warehousing system can receive multiple tasks simultaneously by receiving the MDS system, and has a queuing processing mechanism in the case of multi-task concurrency. The system has a complete operation and maintenance log, and automatically records information such as warehouse system inventory maintenance, manual operation, and software upgrade. Fully realize the process of asset management, back office management, and plan management management to achieve comprehensive measurement process management. The realization of process is more conducive to the orderly planning of measurement management, which is conducive to the assessment of work quality, reducing work handover and work errors, and improving work efficiency.

1. Introduction
In order to adapt to the sorting, change back meter, and pre-installation verification of disassembled meters, the intelligent storage system for dismantled watt-hour meters was developed, and a warehousing information management system was developed. The warehousing system and automatic sorting and re-checking system were designed in accordance with the corresponding interface specifications. Interface of metering production scheduling platform to realize the coordinated operation of the system.

The warehouse of the warehousing system can store 20160 single-phase meters, and the turnover box is 1,680. In terms of operating efficiency, the delivery and storage of warehouses are carried out at the same time as the inspection and storage of warehouses, which translates into a single-phase meter distribution and storage of warehouses with an efficiency of not less than 2000 units / hour, and the verification of the efficiency of warehouses with no less than 2000 units / hour.

The warehousing system is divided into four major areas: temporary storage area for entering and leaving the warehouse, operation area in front of the warehouse, shelf storage area, and transportation connection area. The temporary storage area is mainly used for temporary storage of goods to be inspected, to be delivered, and delivery trolleys. This area can store less than 20 stacks, and can be divided according to the requirements of the tenderer to implement temporary storage of different meters.
The work area in front of the warehouse is mainly used for storage and operation of key equipment in and out of the warehouse. The shelf storage area is mainly used to store single-phase and three-phase meters in various states such as to be sorted, to be re-inspected, to be scrapped, to be paid, and to be repaired. The storage system shelf storage area should have a connection system to the front work area, and be equipped with two AGV stackers for the stacker loading in the warehouse.

2. The overall technology of dismantling the energy meter storage system

The intelligent storage platform for disassembled tables consists of warehouse monitoring software, sorting pipelines for disassembled tables, and 3D simulation of warehouses, video monitoring, supporting business display and other functional software. The overall system architecture is shown in Figure 1.

![Figure 1. Overall structure diagram of the electric energy table scheduling system](image)

(1) Hardware equipment includes: assembly line, AGV trolley, and system data server, WEB server, network communication equipment, security equipment and other equipment.

(2) The software platform includes: warehouse monitoring software, warehouse 3D simulation, verification software, control software and operating system, database management system, WEB middleware, message middleware, report middleware, and metering equipment information management system.

(3) The system design adopts advanced design ideas such as service-oriented to support J2EE or .NET framework deployment.

3. Realization of warehouse system hardware and workstation functions

The system hardware uses mainstream, mature, and industry-standard products, and its performance indicators meet system response, reliability, load factor, storage capacity and other indicators. The system control manager should adopt a 1 + 1 active-standby configuration, install a genuine mainstream operating system, and the hardware configuration meets the system operation requirements.
The system uses Lenovo P330 workstation, no less than 2 manual operating machines, and installs genuine mainstream operating systems, graphics cards and other configurations to the latest mainstream models to ensure the smooth operation of various software required by the system. The specific configuration requirements of the server system and system workstation are shown in Table 1.

### Table 1. Warehouse system hardware and workstation configuration table

| Server hardware configuration | System workstation |
|------------------------------|--------------------|
| Server brand: IBM; CPU type: Intel Core i7 series; Server form: rack type; CPU frequency: ≥2.8GHz; | CPU frequency: ≥2.6GHz; |
| CPU frequency: ≥2.8GHz; Number of CPU cores: ≥4; | Number of CPU cores: ≥8; |
| Memory type: DDR3; Memory capacity: ≥16GB; | Memory capacity: ≥4GB; |
| Effective storage capacity: ≥1TB Hard disk speed: ≥7200rpm |

Storage system management hardware installation requires cabinets, switches, brackets, KVM all-in-one auxiliary equipment, all equipment network wiring (including interconnection with the internal network), installation and wiring meet the relevant requirements of the ICT department.

The warehouse system has measures such as identity authentication, access control, security audit, intrusion prevention, malicious code protection, residual information protection, and resource control. The storage system security protection meets the information security protection requirements of the State Grid Corporation of China.

### 4. Data interaction interface service design

The warehousing system needs to communicate with related systems (ERP, etc.) to achieve data sharing, eliminate information silos, and give full play to the value of data. The shared data mainly includes: inventory parameter file, equipment location, equipment outbound information, etc.

The metering production scheduling platform is fully compatible with the energy meter and the acquisition terminal. The interface methods used by the automated verification and detection system include: WebService method, WebService + intermediate library method, intermediate library method, and real-time interface API method. Among them, the real-time interface API method passes the large screen monitoring requirements Real-time information, the other three methods are used for production scheduling information. The description of each interface mode is shown in Table 2.

### Table 2. System interface mode and description table

| Interface method | Way description |
|------------------|-----------------|
| WebService method | The callee provides a WebService interface, the caller calls the interface, and the callee returns the interface call information. |
| WebService+ Intermediate library | Callee provides WebService interface |
| Intermediate library | One party writes the data to the intermediate library, and the other party obtains relevant information through query. |
| Real-time API | The real-time information required for large-screen monitoring uses real-time API to obtain data. |

The division of labor of the disassembled energy meter storage system is as follows.

1. Metering production scheduling platform: Develop sampling plans and send them to sampling / testing systems, process task information and process information, only receive group unpacking and group destacking information, do not participate in decision-making, do not participate in process control.
(2) The energy meter and the acquisition terminal are fully compatible with the automatic verification and detection system: the spot check / inspection plan issued by the metering production scheduling platform is received, and the spot check / inspection is performed according to this plan, and the group unpacking, group destacking, and information uploading are completed.

(3) Warehousing system (manual warehousing, intelligent warehousing): receiving out of storage tasks, realizing equipment out of storage and information uploading.

The metering production scheduling platform formulates sampling inspection tasks according to the sampling inspection plan. First, the sampling inspection tasks are checked to the storage system to determine the number of equipment to be inspected, and then the sampling inspection tasks are issued to the normal running pipeline or sampling station.

The metering production scheduling platform can control the tasks sent to the spot check, including task suspension, task restart, task termination, and task priority adjustment. The task control process is shown in Figure 2.

The metering production scheduling platform can participate in the start, stop, pause, and emergency stop operations of the sampling inspection system. The system control flow is shown in Figure 3.

The warehouse production task is generated by the metering production scheduling platform, and the warehouse system is issued, and the warehouse system completes the warehouse task. The sampling inspection system continuously executes the process of "equipment application-equipment sampling inspection-uploading results" until the sampling inspection task is completed.

The energy meter and the acquisition terminal are fully compatible with the automatic verification and detection system based on the random inspection / inspection scheme issued by the metering production scheduling platform for random inspection / inspection.

The change back meter system provides a dismantling task information interface, and the metering production scheduling platform calls the dismantling task information interface. The metering production scheduling platform updates the disassembled task information to the intermediate library, and then informs the disassembled system to read the disassembled task information from the intermediate library through the WebService.
Precondition: The metering production scheduling platform receives the information of the total number of disassembled tasks returned from the storage system.

Interface method: WebService + intermediate library
Interface function: String setVerificationTaskinfo (String xmlPara)
Interface parameter description: as shown in Table 3.

Table 3. Describe the task information interface parameter description table

| Input parameter Chinese name | Input parameter English name | Input parameter format | meaning                      |
|------------------------------|------------------------------|------------------------|------------------------------|
| System number                | SYS_NO                       | STRING16               | Disassembly line number      |
| Removal of the ticket number | DETECT_TASK_NO               | STRING32               |                              |
| Chinese name of output parameter | English name of output parameter | Output parameter format |                              |
| Success sign                 | RESULT_FLAG                  | STRING2                | Success sign                 |
| Error message                | ERROR_INFO                   | STRING1024             | Describe the failure error message |

The metering production scheduling platform provides an interface for uploading the verification information of the dismantled equipment, and the disassembly system calls the interface for uploading the verification information of the dismantled equipment.

The retrieval system uploads the scanned barcode information of the retrieved equipment and the box barcode (which can be empty) to the metering production scheduling platform. If the scanned box barcode information, equipment barcode information is compared with the outbound storage details of the retrieved equipment When inconsistencies occur, the dismantling system uploads the found abnormal information to the metering production scheduling platform.

This interface is called in two ways: when the number of devices is 1, the data is uploaded directly through WebService; when the number of devices is> 1, the data needs to be written to the intermediate library.

Interface method: WebService + intermediate library
Interface function: String equipCheckInfo (String xmlPara)
Interface parameter description: as shown in Table 4.
Table 4. Remove the device check information upload interface parameter description table

| Input parameter Chinese name | Input parameter English name | Input parameter format | meaning |
|-----------------------------|-----------------------------|------------------------|---------|
| System number               | SYS_NO                      | STRING16               | Remove the system number |
| Removal of the ticket number| DETECT_TASK_NO              | STRING32               |         |
| Box barcode                 | BOX_BAR_CODE                | STRING32               |         |
| Equipment Quantity          | EQUIP_NUM                   | STRING8                |         |
| Equipment barcode           | EQUIP_NOS                   | STRING1024             |         |
| Check result identification | CHECK_FLAG                  | STRING16               | Success sign |
| Check time                  | CHECK_TIME                  | STRING32               |         |
| Exception Additional Information | ALARM_INFO                | STRING256             |         |

| Chinese name of output parameter | English name of output parameter | Output parameter format | meaning |
|----------------------------------|----------------------------------|-------------------------|---------|
| Success sign                     | RESULT_FLAG                      | STRING2                 | Success sign |
| Error message                    | ERROR_INFO                       | STRING1024              | Failure error message |

5. Software function design of warehouse system

The software system of the warehousing system is divided into three parts: master control service, master control and data management web, and verification plane. It adopts the C / S + B / S model. The system is divided into four layers of information management, verification and interface, mechanical control and detection equipment. It adopts C / S + B / S mode, selects LAN as the communication medium, and uses the TCP / IP communication protocol for data stream transmission to form a set. Network-based communication management system.

Interactive methods of the warehouse system include:

(1) In order to ensure the success rate of communication, all commands use handshake for interaction and verification.

(2) The data exchange mode adopts the database plus XML format message for transmission.

(3) The verification data of all terminals are uploaded in real time and stored in the database. The master control workstation interacts with the PLC control system in real time, and performs system scheduling based on real-time running information and running data.

6. Design of power supply, gas source and information source for storage system

The design scheme of the power, gas and information sources of the smart meter storage system after disassembly is as follows.

When disassembling the intelligent storage system for change back meters, the general requirement is not less than 500kg / m². In the intelligent storage system, the heaviest equipment in a unit area is a fully loaded shelf. The total weight of a single shelf, turnover box, and meter is about 200kg. The area of a single shelf is: 0.75 * 0.61 = 0.46m². The ground load capacity is: 200kg / 0.46m² = 435kg / m². In summary, the load per square meter of the laboratory floor is 435kg / m². Considering the redundancy, the load in the unit area must be kept at least 500kg / m².

The power capacity requirements are shown in Table 5.
Table 5. Power capacity requirement table

| Serial number | name               | Quantity | KVA | Total power KVA |
|---------------|--------------------|----------|-----|-----------------|
| 1             | Trolley palletizing unit | 1        | 1.2 | 1.2             |
| 2             | AGV charging station  | 1        | 0.5 | 0.5             |
| 3             | other               | 1        | 1   | 1               |
| 4             | total               |          |     | 2.7             |

7. Conclusion

An intelligent warehouse management system is designed, which mainly completes a variety of tasks such as storage (incoming inspection), delivery (picking), moving (replenishing), inventory, and various inventory reports according to needs. Realize the system user information management and authority allocation and management. The system database management logs the identified information into the database and verifies the information from the extracted database.

References

[1] J. van der Geer, J.A.J. Hanraads, R.A. Lupton, The art of writing a scientific article, J. Sci. Commun. 163 (2000) 51-59.
[2] Long Guishan, Liu Lei, Liu Ying, et al. Research on auto-verification and intelligent storage system for smart watt-hour meter [J]. Electrical Measurement & Instrumentation, 2013, 50 (5): 95-100.
[3] Qu Jingzhi, Liu WeiPeng, Wu Guorui, Yu Shasha. Automatic verification pipeline and intelligent storage system of based on the semi-active RFID power meter [J]. Electrical Measurement & Instrumentation, 2018, 55 (12): 104-107.
[4] Wang Libin, Wang Hongying, Zhang Chao. Research on the optimal maintenance frequency of change back meter automatic verification pipeline equipment [J]. Electrical Measurement & Instrumentation, 2017, 54 (8): 89-92.
[5] Yang Dongsheng, Lu Guanna, Ding Hengchun, Yuan Ruiming, Lv Yanguo.
[6] A fuzzy expert system for fault diagnosis of auto-verification line for electricity meters [J]. Electrical Measurement & Instrumentation, 2017, 54 (7): 94-96+102.
[7] Zhai Xiaohui, Liu Hongguo. Design and Realization of Automatic Verification Pipeline System for Intelligent Change back meters [J]. Shandong Electric Power, 2014, 41 (6): 36-38.