

Construction of daily management platform for intelligent building facilities based on BIM / RFID Technology

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Abstract: Traditional construction equipment usually needs to spend a lot of time and money to repair and maintain. According to statistics, the cost consumption of operation and maintenance in the later period reaches 75%, which belongs to the consumption of non value-added work, and with the increase of the number of intelligent building equipment, this consumption is also gradually increasing. Therefore, it is particularly important to build the equipment management system based on BIM and RFID technology for the daily maintenance management of intelligent building equipment.

1. Introduction

Construction equipment management is an important part of operation and maintenance. In the maintenance of traditional building equipment, the information related to relevant equipment, including drawings, manuals and equipment maintenance records, should be inquired in advance. Most of the information is presented in paper form, so it is difficult to timely and effectively update the information. A lot of time in the process of maintenance management is spent on information query and verification. According to statistics, the cost of operation and maintenance in the later stage of the project reaches 75%, which belongs to the consumption of non value-added work, and with the increase of the number of intelligent building equipment, this consumption is also gradually increasing. The Ministry of housing and urban rural development of the people's Republic of China issued the "2016-2020 outline for the development of construction informatization", which raised Bim and Internet of things technology to the level of national development strategy. The innovation of production and management mode based on BIM and Internet of things technology and the improvement of informatization level have become the inevitable trend of the development of construction industry. In terms of maintenance, quality control and debugging, the support rate of BIM application points is more than 65%, and the support rate of maintenance is close to 80%. These application points are the main content of equipment management. At present, domestic BIM applications are mainly concentrated in the design and construction stage, and few cases extend to the later operation and maintenance. It is very important to build the equipment management system based on BIM and RFID technology for the daily maintenance and management of intelligent building facilities.

2. Functional requirements of equipment management system

2.1 User permission operation function.

Equipment management involves multiple departments, and personnel of different departments need to perform their own duties. They have different operation permissions for the equipment management system. Therefore, the account numbers of the management system are required to be classified according to the permissions to facilitate the actual operation of personnel of different departments.

2.2 Information integration and query function.

A lot of basic information and process information will be generated in the whole life cycle of equipment from purchase to scrap. The equipment management system based on BIM and RFID technology should first integrate and store all the information related to the equipment,

Through BIM integrated equipment and equipment information from RFID technology, a complete equipment information database can be established and queried.

2.3 Real time dynamic management function.

The information such as use, repair, maintenance, location, ownership and so on in the process of equipment operation and maintenance belong to dynamic information, which needs to be scanned in real time by RFID technology to dynamically record the relevant information in the process of operation and maintenance into BIM for real-time dynamic management of equipment information.

2.4 Three dimensional visualization function.

BIM provides technical support for 3D visualization of buildings. BIM including equipment model can integrate equipment with buildings and display them in 3D visualization, so as to understand the information related to equipment and the relationship and spatial position between equipment and buildings more intuitively.

2.5 Automatic prompt and early warning function.

Through the equipment inspection, maintenance, repair, application processing and other related information input and process settings, the system automatically counts the workload of the day, displays the task list details, provides data support for the manager's workload arrangement of the day, and improves the efficiency and quality of equipment management.

3. Information requirement of equipment management system

3.1 Basic attribute information

In the equipment management system, the equipment information includes the basic attribute information when purchasing the equipment and the operation and maintenance information in the process of using the equipment. The basic attribute information includes the system name, device name, user department and unique ID number of the device. The basic attribute information is generated based on the device individual, and can be determined after the device is purchased in the database, which has the characteristics of individual. The basic properties of the device exist in the form of a desk card, and written into the RFID tag of the device and attached to the device, which is convenient for the on-site manager to check and update at any time. The ID number is the identity symbol of the device, which is determined by the device category and spatial location information.

3.2 Operation and maintenance information

Equipment operation and maintenance information is constantly updated in the life cycle, which is the focus of equipment management. In the operation and maintenance stage, the equipment from the initial purchase and storage to the final scrap, including the repair and repair of the equipment, planned maintenance, periodic inspection, early warning, change processing, application for scrap and other related work.

4. System framework construction

The precondition of scientific research and decision management is to manage and utilize all kinds of information resources effectively in the information society. The system framework (as shown in Figure 1) enables effective data exchange among RFID devices, BIM models and databases. BIM model can store the attributes of each component, such as material type, quantity, etc. However, the operation and maintenance period of the project is very long, which may reach 50

years. The amount of information stored in the model is very large. Therefore, it is necessary to establish a database to store a large amount of data. In addition, each facility attached to RFID tag in BIM model has a unique RFID tag ID, which is also stored in the database. In addition, each facility attached to RFID tag in BIM model has a unique RFID tag ID, which is also stored in the database. The purpose of the module matching algorithm is to determine that the reference label (attached to the facility or wall, known location label) and the day label (attached to the facility, unknown location label) have the same signal module.

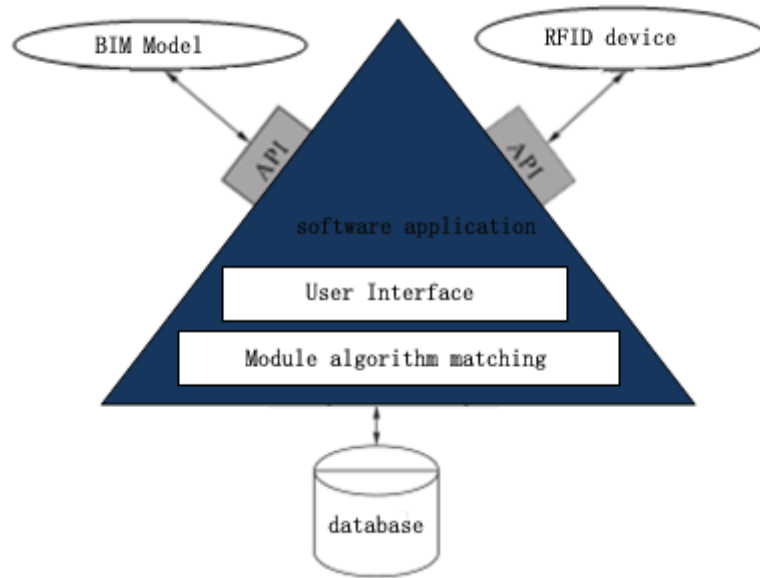


Fig.1 Frames of BIN and FRID

In the data layer, BIM information mainly provides the environment information of the device. The information entered by the client includes the historical information and process information generated in the device management. The information provided by RFID tag is the basic attribute information such as the ID, brand, model, life of the device, as well as real-time information such as maintenance, location and status. In the BIM database, all data generated in the process of architectural design and construction are stored, such as architectural drawings, 3D models, geometric and non geometric information of components and equipment, construction process information, etc. It is expected to obtain valuable information for equipment management from BIM database, so it is necessary to select the information in BIM database instead of inheriting it completely. For example, the process data in construction stage has less application value in equipment management and can be filtered.

User application layer is the source of client data, similar to the concept of portal in OA system. It provides corresponding operation function keys for users with different permissions, and makes centralized display and reminder for all kinds of important information, instructions and queries of information to be processed. For example, general users can only browse the 3D model of the device, query the basic attribute information and apply for repair; In addition to the operation authority of general users, management personnel can also approve or dispatch work. The management mode with clear responsibilities and authorities can better manage equipment operation and make maintenance plan.

In addition, the system also involves the function layer. Function layer is the embodiment of user management task target object, including model management, information management, operation and maintenance management. Model management is mainly to create, update and delete operations the model based on its actual situation. At the same time, it can feedback information to master the actual operation of the equipment, and realize the linkage management of the equipment model and the entity itself by observing the real-time state of the model. Information management mainly to record, update and improve the relevant information generated in the whole life cycle of the operation and management equipment through the client. It can be used by managers at any time

and provide data reference for operation and maintenance managers to make decisions. Model management and information management are two-way, closely linked with each other, one of the changes will be linked to the other party's data changes. Each stage of operation and maintenance management includes application, approval, plan arrangement, actual operation, result acceptance and confirmation, process information recording and other links. The actual operation of each link combines two parts of management tasks: system application and on-site operation. The two parts are interdependent, the management objects and objectives are consistent, and they are carried out at the same time, which improves the effectiveness of the work on the basis of improving the workflow.

4.1 Design of system function realization

Construction equipment maintenance managers need to manage all kinds of equipment information effectively according to the system database (the database has the query function), and scan and check the equipment management information regularly, on this basis, the information in the database is updated in time. The data is directed to access database to form the initial database of operation and maintenance management by using the interconnection function of open database in BIM. After the module design is completed according to the system requirements analysis, the system database uses the access database tool to complete the structure design, and the management of basic information (equipment number, name, manufacturer, etc.) and equipment operation and maintenance information (maintenance personnel, time, cost, existing problems, etc.) is the main function module of the database, You can query, add, modify and delete the equipment maintenance information. Then create relevant data table, maintain and manage equipment operation, according to the equipment information table (including supplier information table, department information table, maintenance information summary table, maintenance information table, etc.).

4.2 Design of RFID subsystem

In order to extend the powerful database function of PC to embedded devices, a relational database (SQL Server Mobile, as a sub database of intelligent building equipment maintenance management system) is integrated into RFID reader (handheld), which completes the efficient management and operation of data in embedded devices. Equipment maintenance and management personnel can access the information in the database, paste the RFID tag on the equipment components (as the storage medium), and store the subset information of the system database (for equipment maintenance, management personnel and users to access). The information stored on the tag is shown in Table 1.

Table 1 Label integration data

Storage contents	ID	Specifications	status	process data	historical data	environmental data ↵
Describe	Unique	Basic	condition	Operation	Maintenance	Environment↵
	characteristic	information	Excellent Good, pass, available, inoperable	and maintenance process↵ ↵	record	around↵ components ↵

The RFID system can read the data stored on the RFID tag at different distances, and can also read the relevant information of some concealed engineering components. Due to the limitation of label memory, the data subset on the label needs to select the stored information according to the actual needs, and update the relevant data in time. The specific process of system database—RFID tag—Information exchange is shown in Figure 2.

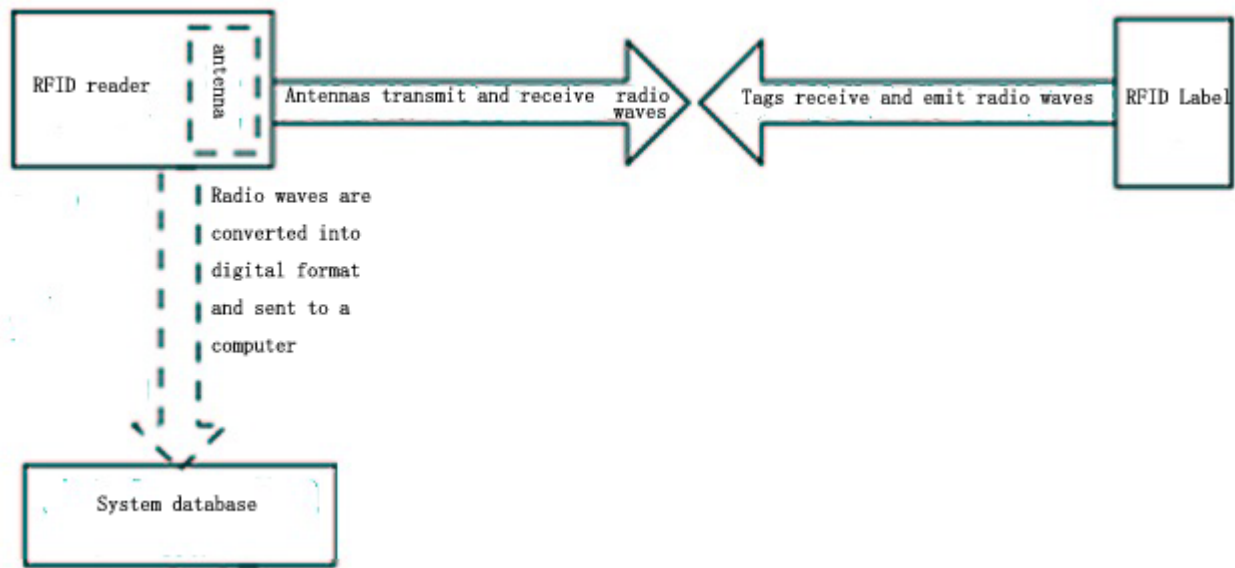


Fig.2 Reader, Label, PC information exchange process

Using ActiveSyne program to establish the communication connection between RFID and PC, receiving tag ID of RFID reader through PC (used to perform database query). Through the automatic information interaction system, the information flow automatic interaction process (query, retrieval, input and output) from specific objects to BIM elements is realized, which improves the maintenance and management efficiency and reduces the labor cost

5. Implementation of maintenance management system platform

After the establishment of equipment maintenance management database based on BIM model on PC side, export the equipment related information (maintenance list, etc.) through the database, assign maintenance management tasks accordingly, complete the equipment inspection work, scan the equipment tag through the use of RFID reader, record the maintenance situation after the work, and update the tag information and mobile terminal database information synchronously, so as to complete the central database information update. In the operation stage, the equipment components include a variety of operation states (which can be divided into good, good, qualified, available and non operational). It is necessary to carry out regular maintenance and inspection on the relevant components, update the status in time based on the actual inspection results, and carry out relevant treatment (including recycling, reuse, disposal, etc.) on the relevant equipment in combination with the economic life of the product. The updating process of the status data on a component tag can be realized by RFID scanning. The implementation architecture of the construction equipment maintenance management system is shown in Figure 3.

In the maintenance management system platform, regular inspection and maintenance and management of equipment, and make detailed records, the main process is as follows:

(1) Management personnel, mainly responsible for equipment accounting, management of database, development of maintenance plan, maintenance process and cost management, allocation and implementation of specific tasks.

(2) Maintenance personnel responsible for the inspection of certain type of equipment in a certain area (such as 1F air conditioning equipment), according to the task allocation and system operation and maintenance tips, scanning and reading the instruction information in the reader through RFID. Reader to device tag information. Through the ID to complete the query, with the open equipment related operation and maintenance database for information exchange, so as to better complete the maintenance work; After the completion of the work, the maintenance information (such as maintenance personnel, date, cost, situation before and after repair, record certificate number, etc.) will be recorded in the reader database, and the relevant label information

will be updated at the same time. The final results will be fed back to the management personnel, and the management personnel will complete the update of the database of the construction equipment maintenance management system accordingly.

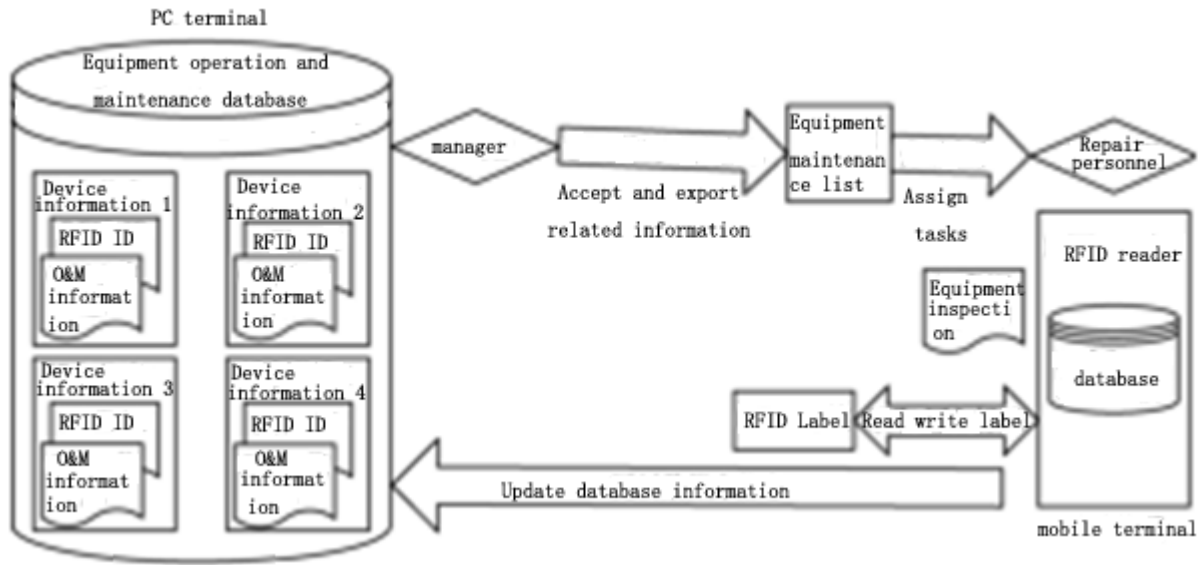


Fig.3 Equipment operation and maintenance management

6. System platform operation and maintenance management test

6.1 Construction of system platform

In order to test the practicability of the intelligent building equipment maintenance and management system platform designed in this paper, the system platform is put into trial operation in a building, and the air conditioning equipment in a room on the middle floor is selected as the test object after being labeled with RFID. The BIM model is built by using Autodesk Revit architecture, the BIM database is built by using Microsoft Access, and the RFID development kit (atidtechnology company) including hand-held reader (atid570 RFID) and tag (epcg2) is used. On this basis, the integrated Bim and RFID environment is built, Similarly, the building model is established through autodeskrevit architecture, and then the air-conditioning equipment model is integrated into the building model through Au todesk Revit MEP.

6.2 Result analysis

Input the relevant attribute information of equipment maintenance management into the air conditioning equipment, and export the access database of equipment maintenance management. In the process of operation and maintenance management, generate relevant information reports according to the actual needs, the work efficiency of the operation and maintenance staff is significantly improved. The device ID can be obtained by scanning the RFID tag. According to the relevant data records and operation guidance provided by the system, the maintenance management content can be determined quickly and accurately. The process of maintenance information update and statistical summary is simple and easy to operate. There is evidence to carry out various maintenance management work, and it can effectively guide the operation. In the integrated information environment, the efficiency of staff retrieval and query can be significantly improved, It can effectively meet the needs of large-scale construction equipment maintenance and management, and has high application value.

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