Building Elevator Safety Monitoring System Based on the BIM Technology

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Building Elevator Safety Monitoring System Based on the BIM Technology

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Abstract. There are many problems in traditional elevator industry, such as, poor maintenance, unclear elevator operation information and single supervision platform. In this paper, a smart elevator management system based on "BIM + IOT" is proposed. This system combines BIM Technology, Internet technology, embedded technology and software management technology with elevator intelligent management system. It realizes the video monitoring of the whole equipment, equipment status monitoring, multi-party joint rescue and multiplatform information sharing of Government, Enterprise, Property and Maintenance. The system is composed of hardware and software, which realizes the functional coupling between elevator safety and intelligent building, and provides a research direction for Intelligent Building.

1. Introduction

Along with the rapid building construction development, elevators become a vertical travelling vehicle for people, and the Elevator-safety has become important issue, so elevator failure prediction is a researching hotspot for the public security at home and abroad. The elevator failure predication system was constructed by the artificial intelligence algorithm, but the monitoring-cloud platform is failed to complete based on the operating data [1-3]. A 3D+Time visualized model was built by the Building Information and Internet of Things, but the monitoring system was insufficient [4]. The BIM system with vertical transport of high-rise buildings was constructed by big data and artificial intelligence technology, good working of the system is depended on accumulation of data set [5,6]. Considering the monitoring-could platform, a visualized temperature-monitoring platform is based on BIM and SQL-SERVER, which was complex, inconvenient with the increasing construction information [7]. In a word, the real-time system combined BIM with IOT technology is not constructed.

In this paper, a C/S monitoring platform of the elevator is constructed by Internet of Things and cloud computing, ensuring visual management of elevator equipment, on-demand maintenance and accident emergency management, the state data of the elevator are collected, such as and information is effectively shared to solve "islanding effect".

2. System construction

2.1. Hardware system

Safety of elevator is closely related to consummate maintenance. In accordance with the "on-demand maintenance" principle, the most suitable maintenance time is determined by the health state of each elevator part. The maintenance evaluation model mainly concerns elevator use environment, temperature, load, operation times, operation speed, equipment service time and maintenance times. Hardware of the system is mainly composed of data acquisition, site monitoring and other equipment. As shown in Table 1, sensors are employed to collect input data, and mainly include the load cell, the speed sensor and the vibration sensor. The field-monitoring system is composed of the camera and the video capture card. And the hardware structure of elevator monitoring system is shown in Figure 1.

Table 1. Partial equipment list

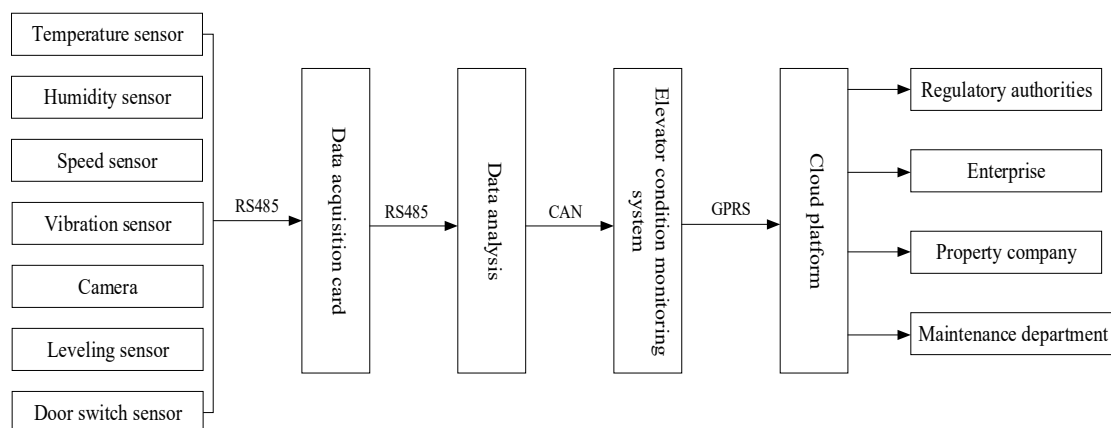| Name	Model
Temperature sensor	WRNKL-130/WRNKL-230K
Humidity sensor	GWSD100/100
Speed sensor	GSC200
Vibration sensor	ADIS16445BMLZ
Load cell	LUDWIG LW-PB
Camera	HCV iDS-2DF5220s-D4
Video capture card	HCV DS-40008HS
Data acquisition card	ADVANTECH PCI-1716

Figure 1. Hardware structure of elevator monitoring system

In this paper, information of the elevator is collected from multiple sources, such as the safety monitoring system, the fire-fighting system, the communication system and the office system. And then, information is successively obtained by means of RS485/CAN communication, to the cloud system for data storage. As see from Figure 2, the hardware framework of elevator is set up by BIM and IOT system.
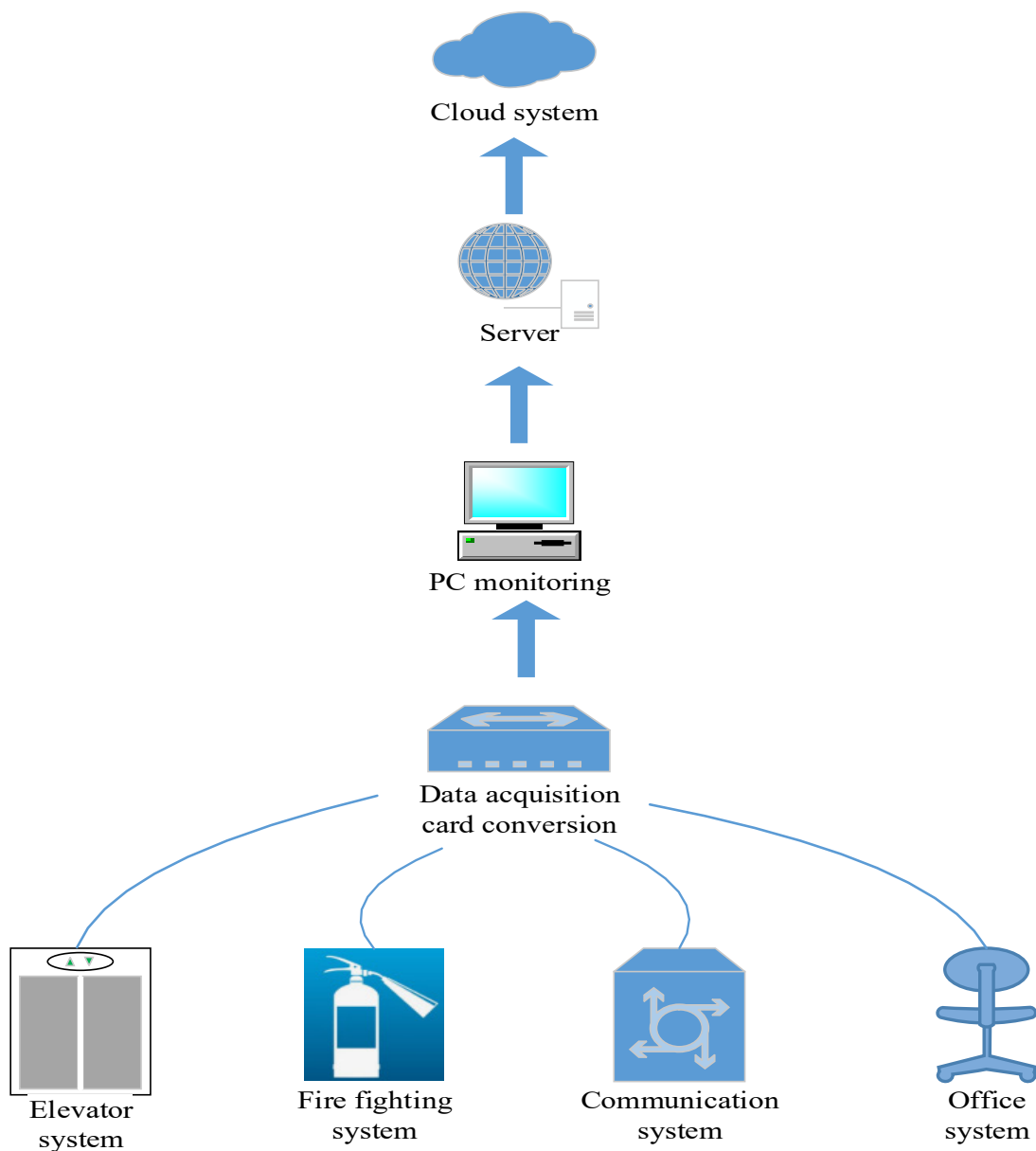
Figure 2. Hardware framework of elevator safety monitoring based on BIM system

2.2. Software system

This system is based on software such as Revit, MPs, Autodesk Navisworks, etc., to realize 3D simulation and information management of elevator safety supervision system. Based on the successful implementation of BIM in the construction industry, this system combines BIM with elevator supervision to solve related problems and finally realize elevator safety monitoring. In terms of operating system configuration, this system selects win 10 education version; database management system selects MySQL 8.0; Web server selects lightweight Tomcat 8.5 with free Open-Source code; client browser selects EI 8 64 bit.

The BIM elevator safety monitoring system is deployed in the intelligent building. Managers connect through the private network or the communication system for remote real-time control. The BIM elevator video monitoring system and its subsystems realize the interconnection and sharing of

elevator internal image, fire-alarm, ventilation and the lighting control, events and other types of information through video transmission protocol (Ethernet Protocol). Based on the BIM digital model, the shared database structure is determined to complete the functions of elevator state perception, feature identification, emergency assessment and early warning, decision management and control. Based on the analysis of objectives and requirements, this platform selects a multi-layer architecture mode, which is the perception layer, the communication layer, the data layer, the service layer, the business layer and the application layer according to the trend of data. In order to ensure the stable operation of the platform, the system of information security support, the protection includes industry standards and relevant laws. The software system framework is shown in Figure 3.
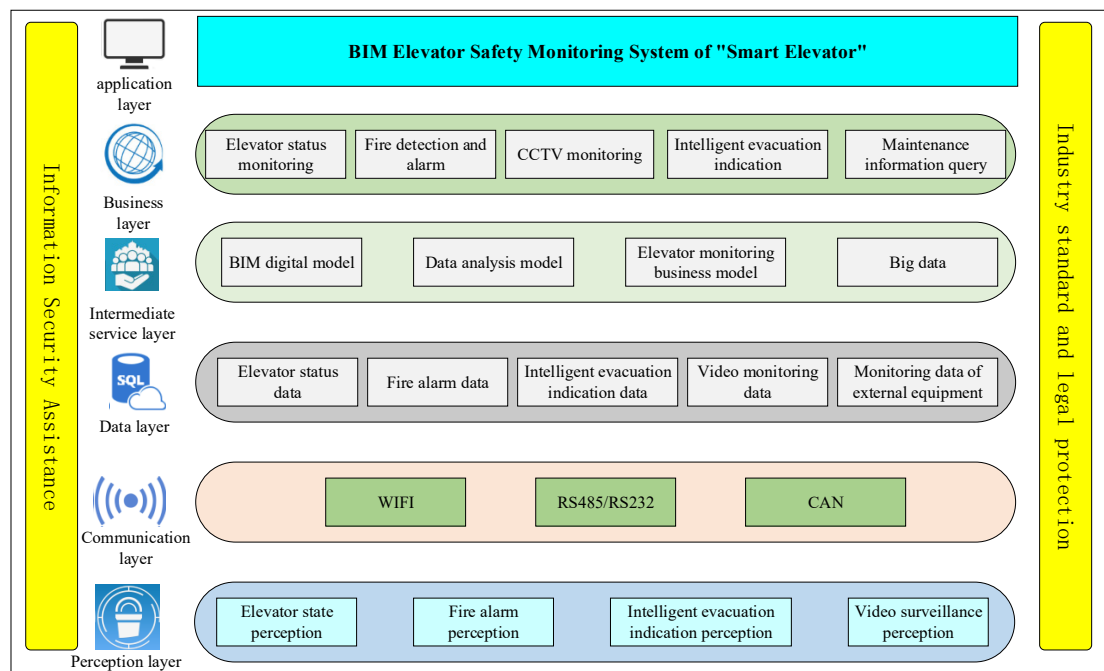

Figure 3. Safety monitoring system of BIM elevator of "Smart Elevator"

The storage and invocation of multi-source heterogeneous data were supported in the storage framework of this system, which was a guarantee for the high throughput at data processing, especially for the rapid query and display of the data platform. The BIM modeling was built by the Revit software, and the BIM data of the elevator was transferred by the open database connectivity function of. The type of the data structure was normalized by the third normal form (3NF) method, the dynamic data of the elevator was stored by means of OPC SERVER interface. As shown in Figure 4, the building space information and the operating data of the elevator were interchanged in the data platform, and the information was demonstrated in the software interface when the equipment was clicked with a computer mouse.

The storage system of this platform supports the storage and transfer of multi-source heterogeneous data, and also ensures the stable query and display of platform data when processing amounts of data. The data of the system is exported through open database connectivity in Revit software. The dynamic data of equipment operation is connected with structured data through the OPC server interface. The data structure type is determined to the method of 3NF, and the data is classified and stored in different sets, such as file repository module and the database module. Dynamic information and static information are combined to realize the interaction and view of elevator equipment status information. The transmission process of platform data is shown in Figure 4.
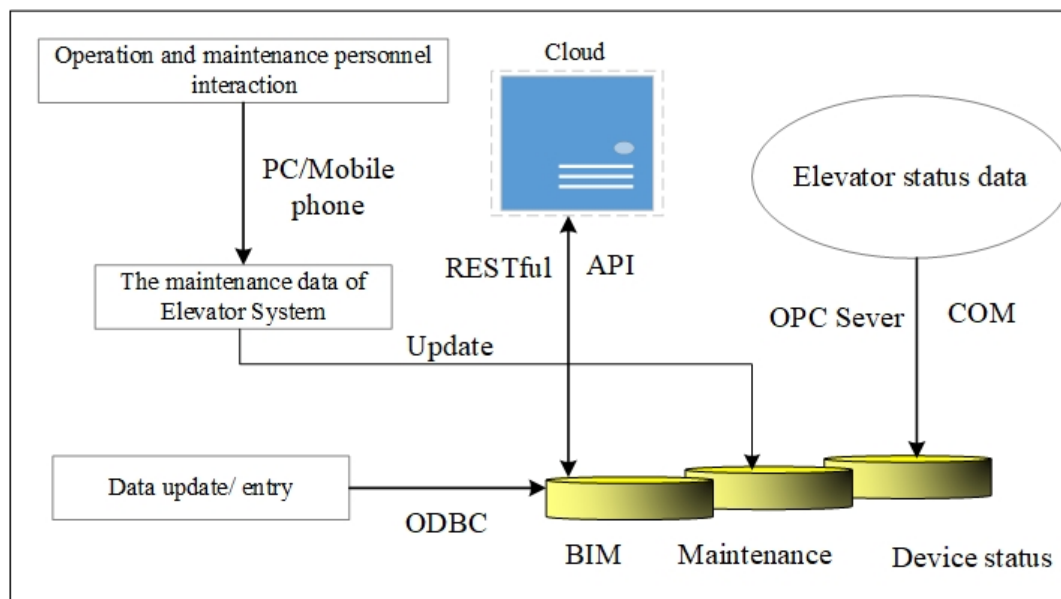
Figure 4. Platform data transmission process

As the BIM safety monitoring system of the intelligent elevator, the platform has been developed based on win10 system and Visual Basic6.0, and the block diagram was shown in Figure 5. The user interface was programed and commissioned by Visual Basic6.0, and the algorithm was realized through python language. There was a few changed in underlying code, meanwhile, coming with concise interface and the multi-function displaying rea. The Active X Data Objects (ADO) provided by VB6.0 is easy to use and rapidly access the database, especially for SQL-serve and Oracle database. In this work, SQL-serve database was connected with connections property of the connection object, which was a component of Microsoft ActiveX Data Object 2.6 library.
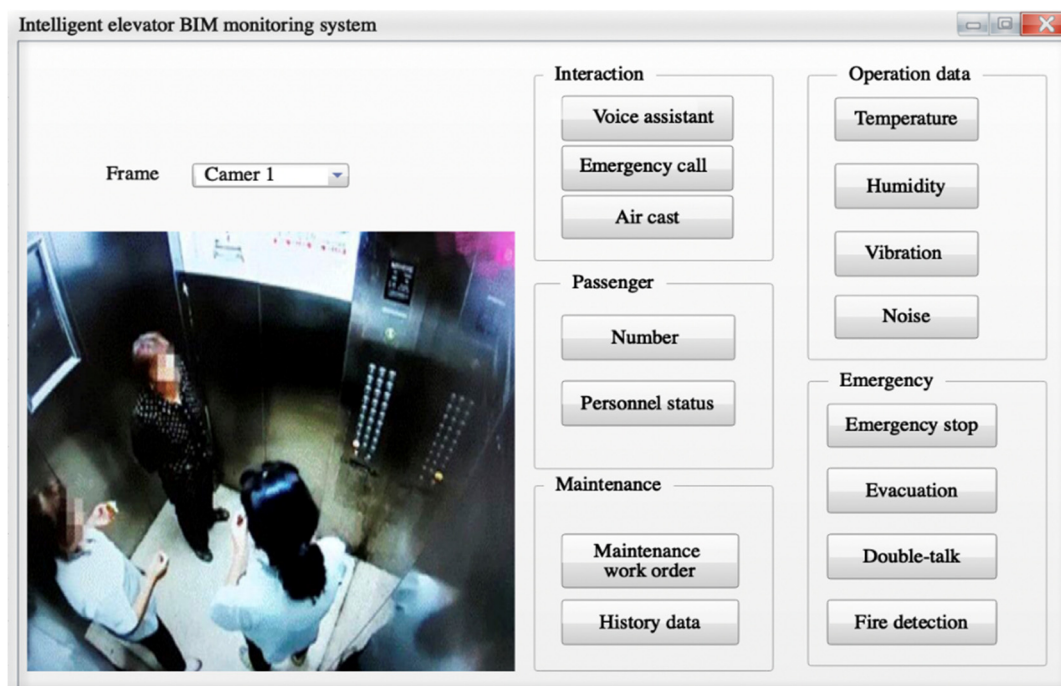

Figure 5. Real-time BIM monitoring interface of an intelligent elevator

3. Conclusion

In this paper, the safety monitoring system of the elevator was accomplished by BIM and IOT technology, the fire fighting and accident rescue information integrate in the platform, thus the "islanding effect" was solved. The system passed testing and got good effects, it has been a significant improvement in the management and efficiency of the building elevator. At the same time, the failure possibility was marked reduced, accompanied with low maintenance costs.

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