Establishment of Fire Control Management System in Building Information Modeling Environment

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Abstract. Fire control is an significant topic for building construction. It directly affects the safety of residents. The fire control has been integrated with ICT to accurately monitor related fire information. This study constructed the sensor and monitor locations in Building Information Modeling (BIM) based on 3D model. When the sensor is activated, the system can instantly show floor and the room plan of fire point in the 3D model and connect to monitors which are assigned to watch the suspected fire area to determine the authenticity of fire alarm. Through the video display, correctness of fire alarms can be carefully judged to prevent panics and disturbances brought about by false alarms.

Keywords: Fire Control Management System, Building Information Modeling, Fire Control Equipments

1 Introduction

Since Taiwan is an island country, there are many tall buildings being built in major cities to increase living space. Fire has not only leaded progress and civilization for our society, but also caused disaster and suffering or calamity. [1] If any fire in these tall buildings, it would cause tremendous loss of human life and damage to property. The traditional method for people to access previous fire control and disaster relief data archive files is both inefficient and time-consuming. [2] The development of information technologies has been so rapid, integrating fire control and computer information became a trend.

With the high demand of fire control in spacious buildings, computer vision is playing a more important role. [3] Integrating fire facilities with different functions into one single platform can help user accurately judge fire disaster as well as improve rescue efficiency and accuracy with current information and communication network technologies. Previous fire control software was typically designed in 2D environment. If BIM can be integrated with fire control systems, more details information can be provided so the rescue and data accessing time can be significantly reduced to improve disaster control results. A network construction model of underground transportation hub safety monitoring center is proposed by Wang according to the disadvantages of present management mode in underground

transportation hub. [4]

1.1 Fire Control System

First responders to a major incident include many different agencies. [5] Kuligowski presented a discussion of the features of protected elevator systems that can provide safe and reliable operation both for fire service access and for occupant egress during fires. [6] The monitoring scope of a building includes access control, carbon dioxide, electricity, air conditioner, and fire control. Fire control system is separated from other monitoring systems in the building and form an unique system. When fire sensors are activated, alarms and sprinklers will be concurrently started. The administration proceeds to inform the fire department and broadcast to public for evacuation and other activities. Usually a fire control system consists of a huge amount of equipment which are connected as a sensing network linked with the server. This sensing network is also connected to other fire control facilities such as fire alarm, rolling fire door, sprinkling system and smoke exhaust system and so on.

With the development of information technology, the fire safety assessment of whole structure or region based on the computer simulation has become a hot topic. [7] Monitoring system mainly achieves archives of fire, security, warehouse temperature and humidity and so on, one-stop monitoring and management. [8]. Zuo presented the design solution and framework of software which implemented the integrated management and data sharing of building automation, gating, fire safety, monitor control and material management. [9]

1.2 Building Information Modeling

Proponents claim that the adoption of BIM will lead to greater efficiencies through increased collaboration. [10] The BIM has been adopted by a growing number of countries. There are many cases presenting results after implementation of the BIM in construction projects. Access to accurate building information is often limited and inefficient due to the lack of preservation of building documentation and inability to communicate with building systems.

Currently the academic and industrial sectors of the world have proactively implemented the BIM and its research. The BIM can be applied to several stages including planning, design, construction, and operation of the whole life cycle for a building. In the life cycle of a building, design and construction stages could take about 2 to 5 years, but operation and maintenance of the building could take 30 years or even 50 years. If BIM can extend its application to the maintenance and management of the building, its value will be more prominent. The setup of the fire prevention monitoring system in this research is categorized as an application in the operation stage of a building. So if BIM is implemented in the design stage, it will be meaningful for subsequent operating functions. Completed construction buildings can also apply BIM during the operation stage for the purposes of repair, maintenance and management.

2. Establishment of Building Model

2.1 Establishment of Sample Building

This study uses the College of Architecture and Planning in Chung Hua University to create a BIM model according to the actual dimensions of the building. The main function of BIM is to create and use internal common access to project related information in the life cycle of a building. In this integrated digital environment, the information entered by the former can be fetched by others for subsequent use. This will help to improve project quality, save time, reduce costs and prevent errors. The drawings created in BIM environment can be linked and fetched through ODBC to extract related building information and construct management database. The management software can be used to reduce the inconvenience of maintenance, avoid errors, and achieve an efficient fire control administration. BIM, ER Model, ASP.net, database and Windows environment are used to develop "Fire Control Management System" in this study.

2.2 Creation of Database

In this research, ER/Studio has been used for the creation of E-R Model in conjunction with the BIM development tool Revit Architecture to import various parameter values and unit data table into the database system using ODBC.

The featured BIM is essentially a joint database; all 3D models created using the BIM are constructed from the data in the corresponding attribute tables, which are interrelated. This explains why changes to data would be propagated to other related data in real time for users to easily extract the required data. There are two type of database conversions presented in this research: one involved the use of ER-Model for the conversion of logic module to physical module before data is transferred from ODBC to MS SQL and the other would be Revit. Data conversion processes include data table conversion and conversion to relational database.

3 Functional Analysis of the System

The project plans and categorizes into four major categories including Building Fire Control Monitoring, Fire Control Equipment, Space Operation and Common Data Operation.

3.1 Building Fire Control Monitoring

This module is the core module of the system, which includes "3D BIM", "Alarm location data", "User contact data", "Floor monitor location diagram", etc., and is

shown in Fig. 1. When the system receives signal from the sensor, the space number, area and assigned monitors will be listed on the display. When the data is selected, the related contact user data can be checked to display the detail information of the user. The "Open" link can be selected to display the monitor video in that space to recognize actual situation of that space (as shown on small display in Fig. 1). If the fire signal is correct, informing the people in that area to evacuate and other related fire accident informing activities will be performed immediately, including informing the rescue group.

Fig. 1. Building fire control display and monitor video display

3.2 Fire Control Equipment

The fire control equipment data module is mainly for providing the functions of maintenance and query of fire control equipment and it includes "Equipment Data Query" and "Maintenance Record Query".

A. Equipment Data Query

This page is separated into two main portions including defining sorting criteria and data display of the query results. Sorting criteria defining can screen the data being queried by different conditions such as floor, area, room, equipment, equipment type, etc. This pull-down menu designed in this research can follow the mentioned design structure to automatically list out all the details of the lower-layer data that belongs to the upper-layer defined data. For example, as shown in Fig. 2, after selecting 3F of Building A, all the areas belonging to 3F will be automatically summarized and listed in the menu for selection. After selecting Area A3F0, all the room numbers belonging to that area will be automatically listed and so forth for other selections. In addition, each selection will come with a checkbox. If that selection is checked, its selected value will be listed as the expression of sorting, whereas those not selected will not be taken into consideration. If multiple items are selected, it will be an "and" relation, and the data matching all sorting conditions will be listed as shown in Fig. 3.

B. Maintenance Record Query

This page provides maintenance and query of the equipment maintenance including

numbering, date, equipment supplier, equipment name, and room number.

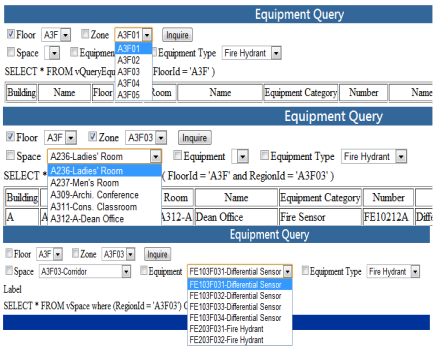

Fig. 2. Correlated pull-down menu display

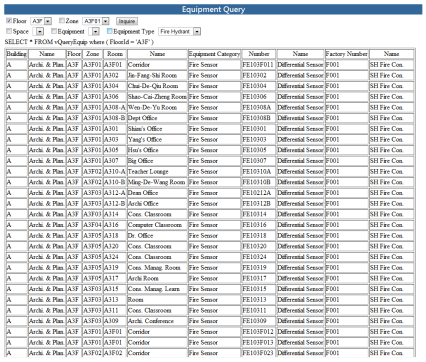

Fig. 2. Equipment data query display

3.3 Space Operation

This module includes "Space Data Maintenance" and "User Data Maintenance" pages. Space Data Maintenance page can maintain data of each space including numbering, name, floor, area, etc., (as shown in Fig. 4). User Data Maintenance page provides maintenance and query of related user data including name, college and department, extension number, cell phone number, email, etc., (as shown in Fig. 5).

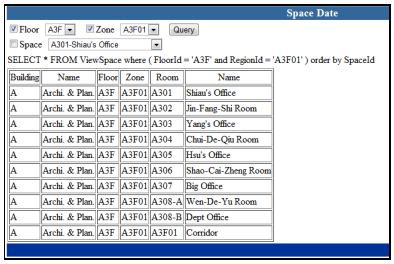

Fig. 4. Space data query display

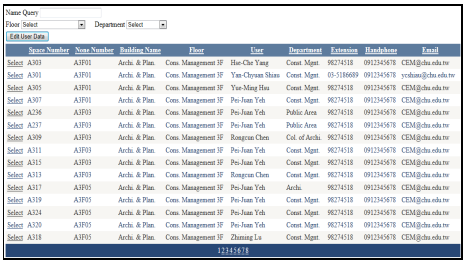

Fig. 5. User data query view

3.4 Common Data Operation

This module includes "Staff Data Maintenance", "System Log Data" and "Firefighting Department Data" pages. Staff Data Maintenance page provides maintenance of staff data. System Log Data page provides maintenance and query of the events handling records. Firefighting Department Data page provides maintenance and query of the related data of the rescue units administrated by the firefighting department and their contact information.

4. Conclusions

This study uses BIM environment to create building model and uses MS Visual Studio to develop Fire Control Management System. This article draws the following conclusions:

A. Buildings integrate the equipment with ICT to perform automated control of the facilities in the buildings provide a convenient, comfortable and safe living environment.
B. Building component data in BIM can be imported into database to avoid data duplication caused by human error.
C. This study built a BIM for a building and established Fire Control Management System to integrate fire control equipment with building spaces. When sensors are activated, monitor video display can be instantly inspected. Through the video display, correctness of fire alarms can be carefully judged to prevent panics and disturbances brought about by false alarms.

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