

Research on Integration System of Construction and Safety Monitoring Based on BIM and RFID

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Abstract. The research aims at the complicated construction environment and difficulties in monitoring workers' behaviors. By analyzing construction safety norms and accident investigation and analysis, the thesis has carried out the definition, identification and classification to the danger zone of construction site. Then through the BIM, RFID and Internet integration technology, the construction site was proposed based on BIM and RFID workers' real-time positioning and early security warning system model, including BIM module, positioning module, data processing module, data transmission module and warning module, to expect to improve the efficiency of safety management of construction site workers, reduce the accident rate in construction industry.

Keywords: Construction management, Safety monitoring, BIM, RFID.

1. Introduction

Security management is always the key point of the construction engineering and construction site management. Frequent safety accidents greatly affected the benefit and efficiency of the engineering construction. But due to the construction site numerous participants, fluidity construction personnel, complicated working environment and the large and difficult safety monitoring factors. Traditional way of safety monitoring such as visual, artificial detection cannot be found in time or prevent the occurrence of safety accidents. With the development of science and technology, construction site safety monitoring start to apply the advanced technology, such as GPS, video monitoring, etc. Application of these new technologies, to some extent, alleviates the pressure of construction site safety management work and raises the working efficiency. But judgment upon safety monitoring of the state still has to rely on the management experience, security monitoring information feedback timely, subjectivity is bigger, the efficiency is low. Therefore, improving the efficiency of construction site safety monitoring and effect, achieving the real-time, automation has become a direction for the future development of the construction site safety management. RFID is a kind of instant information gathering tools, being able to store the information collected with high degree of automation. As the informatization construction of advanced technology with functions such as visualization, collaborative operation, BIM has made rapid development in the field of construction and application. Integration of the two made information acquisition automatically and visualization can be displayed by BIM technology, then analyze the data acquisition and situation of site safety management. In this way, BIM can transmit warning signal to workers in unsafe area. Referring to the existing research results at home and abroad, the thesis integrates the RFID technology with BIM technology, builds safety monitoring system in construction which is used to solve dilemma such as construction site safety monitoring is not timely and low degree of automation, improves the efficiency of site safety monitoring in construction.

2. The construction site safety monitoring system architecture

Construction site safety monitoring system is consisted of four parts which respectively are BIM module, positioning module, warning module, the data transmission module. Built by information model, BIM module is able to reflect the information about environment and the progress in the

construction site and achieve the mobile management of construction site. Positioning module is used to get the position of the object, and to be reflected in BIM module. Data processing module collected data based on the analysis of data to distinguish whether workers are in danger environment. Early warning module can send alarm information to workers in dangerous environment. Based on BIM and RFID integration construction site safety monitoring system architecture is shown in Figure 1:

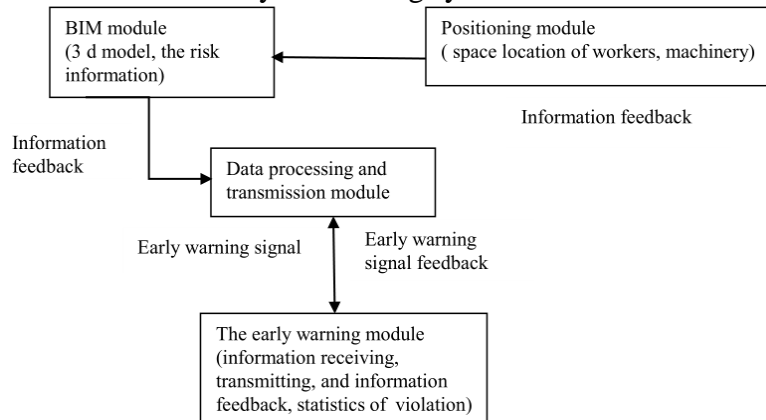


Fig.1 The architecture of construction site safety monitoring

2.1 BIM module

BIM module needs to collect 3d model and information of risk factors in construction site. BIM module, therefore, it should reach the danger zone for effective identification, and update project environmental information in the environment according to the progress of engineering and change of the environment.

Identification of the danger zone. After analyzing common safety accident in the construction site, construction site danger zone can be divided into two classes: One is related to the structure itself, such as the mouth of the cave. When these areas are not set protective facilities or protective facilities set are not standard, it will form the danger zone. Another danger zone is related to mechanical equipment, such as cranes, elevators, etc., this kind of accident is usually falling objects and mechanical collision, etc. Falling objects are mainly caused by crane when transporting goods to fall, so the tower crane corresponding danger zone, centered on “placement for workers reaction distance as the radius of the prototype area. “Point position by position of tower crane, crane arm Angle and the horizontal distance to the center line of the tower control. Tower crane location in a certain construction period is fixed, so you can directly in BIM corresponding placed in virtual environment construction tower crane model. Mechanical collision attack is mainly mechanical collisions with one blow. According to the form, safety standards in BIM models centered on mechanical position safe distance as the radius of circular dangerous area.

Update of environment information construction site. Due to the advancement of engineering construction, the construction site environment is also in constant change. In order to do well in the construction site safety monitoring, first of all, update of environmental information construction site should be ensured. In the concrete construction practice, the engineer updates BIM model according to the actual schedule every day and adds the security check information, as the basis of the next day the danger zone identification data. Therefore, in the BIM module can update the construction site environment information according to the actual project progress.

2.2 Positioning module

Positioning technology. BIM module builds and identifies the danger construction site area, but the construction site safety monitoring also need to determine whether the workers in danger zone, therefore, it needs to get worker's position information in the space. In addition, because of the danger zone identification is also related to the position of mechanical equipment, so the positioning module also locates mechanical equipment.

The mainly location technologies are GPS, A - GPS, RFID, ultrasonic, infrared ray. Through the comparison of characteristics of several types of the positioning technology, RFID localization accuracy is moderate with anti-interference ability and good extensibility. Therefore, in the security

monitoring system, I use RFID technology to locate workers and positioning of the equipment. RFID technology is made of labels, speaking, reading and writing and computer communication network. Stored in the tag information of the object, after read and write device to identify the sent to the computer. When RFID system is at work, signal is transmitted by reader-writer, label activates after receiving the signal activation and feedbacks the information to reader-writer later, reader-writer devices the received information and sent to the computer processing, finally, computer decodes the label position.

Application of RFID technology. In the construction site, it can install the labels on the helmet, and position workers. To locate the site, Antenna is installed in the red border points which is used to determine the scope of the construction site area. And it builds antenna in each layer to position and to make sure workers and equipment's in vertical position. Each layer is equipped with a set of reader-writer to obtain the label's position. In the construction site to build three-dimensional coordinates, through the information feedback by the label, identify the position of workers and machines, so as to realize the function of positioning.

2.3 Warning module

Early warning module includes information receiving, launch, information feedback, statistics. Reception is the label feedback data processed by computer, found that workers' distance from the dangerous area border is 0, then send the early warning module tag information, early warning module receives the information immediately after the launch. Refers to the early warning information launch module after receiving the dangerous information, to fire alarm information, the corresponding label tags (such as a prompt response and workers can be perceived. Information feedback is refers to the workers after receive the alarm information is out of the danger zone. If workers leave the danger zone, the alarm signal to stop early warning module, and conversely to launch this information to managers, for management personnel to the scene to check the processing. Violations statistics refers to the workers received alarm information failed to timely leave the danger zone, were recorded in violation of a, so that managers manage the workers, to understand the safety awareness of workers on the construction site, targeted to the implementation of the safety education.

2.4 The data transmission module

Within the system, the four modules need for data transmission between them. Due to the construction site's responsible area is larger, so the wireless transmission system. Data transmission require fast and accuracy, and can be adjusted with the change of venue for timely. Transmission objects to coordinate information and information transmission capacity requirements is not high. In the current study, ZigBee, as a system of data transmission medium, ZigBee is used to locate managing workers data transmission in the construction site. Therefore, in this system, ZigBee can be used as data transmission media, can meet the requirements of the monitoring system of data transmission.

3. Workers to the construction site safety monitoring system of workflow

The working process of the construction site worker safety monitoring system, as shown in Figure 2. Work at the beginning of each day, system start, first of all the previous day's progress update information and safety inspection records, the information input into BIM module, BIM model to engineering and environmental information updates, and reflect on the day when the engineering and environmental conditions. BIM module according to the information received in the model in recognition and classification of hazardous area, and the data processing module to the danger zone information analysis processing, calculate the dangerous border area. Location information of space positioning module will field workers through the data transmission module to the data processing module, data processing module based on the analysis of working space position and dangerous border area, to calculate the distance the workers and the danger zone. If the distance is zero, then the system will start the early warning module, warning messages.

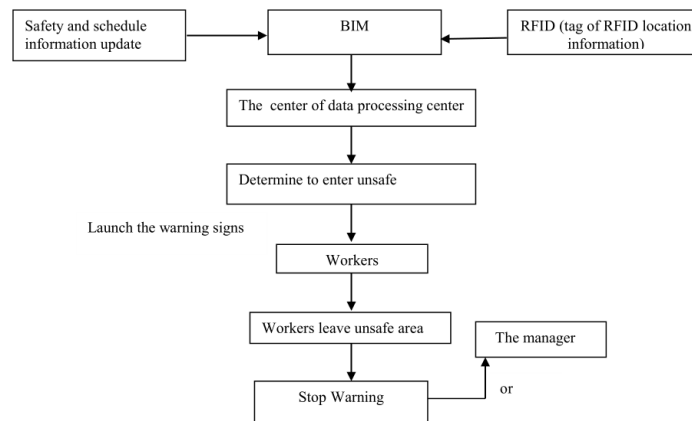


Fig.2 The workflow of construction site worker safety monitoring system

4. Conclusions

This study proposed the construction site integrated BIM and RFID technology applied in construction safety monitoring, to break the current construction of the construction site safety monitoring manual entry paper transfer, one party leading, from experience management, information to deliver timely communication not smooth monitoring the status quo, such as automatic data acquisition, information updates automatically, monitor the participating, monitoring throughout the entire implementation of construction safety automation, informationization, visualization, the effective monitoring of the paperless. This system on the one hand able to alert the danger area of workers, reduce the construction site safety accidents; On the other hand can record the performance of the workers in the construction site, understand the number of construction site workers enter the danger zone, has targeted to help site management personnel to carry out safety training. In a follow-up study, can be clearer in the system identification of dangerous area, in order to improve the effect of the construction site safety monitoring.

Acknowledgements

College Students Open Experiments, Southwest Petroleum University

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