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BIM-Based Indoor-Emergency-Navigation-System for Complex Buildings

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Abstract: The imminence of terrorist activities and the necessity of the maximum possible disaster preparedness in the sense of indoor-navigation support have been brought to evidence by several catastrophes, e.g., the fire at Istanbul Airport in May 2006 or the terror attacks on the London Underground on July 7, 2005. Since 2001 ten terror attacks have been thwarted only in Great Britain. For that reason the aim of the presented research project is to develop a solution for response and recovery to support rescuers in finding the shortest way within a public building and provide them with important information in their particular spatial context. Existing building information models (BIM) are used for displaying plans on mobile devices and for routing purposes. The indoor navigation system is based on wireless LAN (WLAN), ultra-wide-band (UWB), and radio frequency identification (RFID). These technologies are described in detail and an overview on data formats which are used to retrieve building data out of the BIM for generating routing networks is given.

Key words: indoor positioning; RFID; UWB; WLAN; disaster preparedness; response and recovery; BIM

Introduction

In order to save human lives and material assets complex buildings like airports are equipped with different safety and security systems. To save people and buildings from fire the prevention and detection of fire are very important. For that reason the Frankfurt Airport has about 50 000 automatic fire detectors. These are connected to alerting lines. If a fire detector triggers, the fire brigade is informed. To find the detector the rescuers take the arrival instruction for that alerting line and immediately start for the building in which the alarm has been activated. The arrival instruction contains only few information about the building. Usually only the building number, the number of the fire detection line, and the way to the fire brigade terminal are drawn on a small map. Once the respective building is reached a central fire alarm station displays the fire detection line and the exact fire detector that has caused the alarm. At these terminals building maps are available printed on paper (route cards) (see Fig. 1).

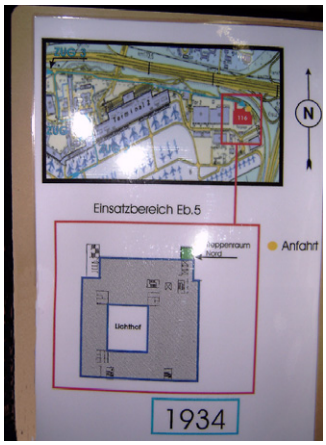

Fig. 1 Fire brigade route card

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Using these route cards the fire brigade can find the fire detector. Figure 2 shows the operating sequence.

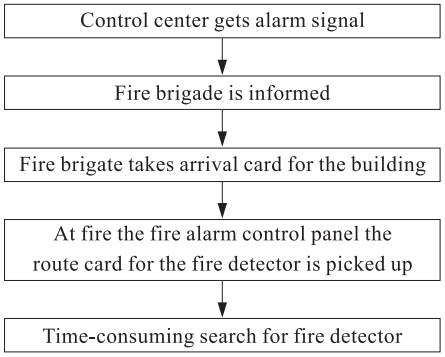

Fig. 2 Work sequence of fire brigade

In complex buildings it is very difficult to find the exact fire detector because of insufficient orientation. Due to changes in usage, especially, airports often undergo reconstruction work. It takes enormous efforts to keep these building maps on an up-to-date level and to distribute them to the different central fire alarm stations. In alarm cases at least six fire-fighters are involved for 30 to 45 minutes only to locate the fire detector and to return to the fire station. Most alarms are so-called false alarms (triggered by a detection failure: e.g., pressure fluctuation in a sprinkler system). The fire brigade of the Frankfurt Airport has about 5000 alarms per year. 95% of them are false alarms but in each case concentrated efforts of the fire brigade are necessary: Fire detectors and extinguishing systems have to be checked immediately. The current situation is not only time consuming. In cases of real fire the orientation within a building and information about the direct way to the fire detector, the exact position of the fire detector, and the areas where passengers and employees are located are very important to save human lives. For the officer in charge it is nearly impossible to keep track of all activities and the particular positions of the rescuers within the building.

In this research project "Context sensitive indoor-emergency-navigation-system for complex buildings"— funded by the German Federal Ministry of Transport, Building and Urban Affairs and in cooperation with the Frankfurt Airport (Fraport) Fire Brigade and a fire protection engineering office — different methods and technologies for indoor position sensing and a BIM-data-export are developed to enable indoor navigation (positioning and route calculation). Such a support improves the orientation and safety for rescuers in buildings in general. The basic of the new system is the multi-method-approach for indoor real-time location systems (RTLS) in connection with routing networks generated from the building-information model (BIM). Besides this the overall system architecture is presented in this paper.

1 BIM-Based Indoor-Emergency-Navigation-System

The aim of the presented research is to improve disaster preparedness by providing a better orientation within a complex building in general. Therefore, the development of a new reliable indoor positioning system for fire-fighters is of central interest. Especially, important building information within the spatial context of the rescuer will be provided by the system, e.g., gas pipes or high voltage panels. These aspects are of high interest of the project partner, Fraport Fire Brigade.

The approach envisages that each rescuer will use a mobile device (PDA or other mobile computer) which will be equipped with indoor positioning, routing, and important building information that will be displayed in the spatial context of the rescuer. Therefore, information of the BIM is exported and prepared for the use on mobile devices.

1.1 Multi-method-approach

As satellite based navigation systems such as GPS or Galileo (in future) do not allow position sensing inside of buildings[1], different methods and technologies are needed. However, technologies like WLAN, radio frequency identification (RFID), infrared and ultra-wideband allow position sensing inside buildings but each system has its own application range for usage.

A survey and analysis of the different indoor positioning technologies is given in Ref. [2]. Based on this analysis the Institute of Numerical Methods and Informatics in Civil Engineering developed a multi-method-approach (see Fig. 3) to integrate different position sensing methods and technologies which are appropriate for all different environments of the Frankfurt Airport.