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An Intelligent IoT Based People Evacuation Guidance Model for Fire Hazard

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Abstract**: With the development of science and technology, the design of modern architecture is becoming more and more attractive. The large-scale public buildings such as shopping malls, office buildings, Research centres and education centres are increasing dramatically. In case of sudden disasters and the overloaded electricity may easily cause fire and the fire smoke, fire in large buildings spread over a wide range of areas and produces physical damages, several hazard to life and property and atmospheric pollution. This paper proposes An Intelligent IOT based People Evacuation Guidance Model for Fire Hazard to guide the people by constructing the evacuation path dynamically based on the real time situation to reach the safety exit quickly in large public buildings using their Personal Digital Assistant like mobile phone, tabs etc. Whenever a fire breaks out, IOT module alerts the people to find the safety exit. Thus, the proposed system minimizes danger and economic losses by guiding the optimized evacuation path. The performance of the proposed system will be compared with the existing system and the result of improvement will be shown.

Keywords: Fire Detection, Internet of Things, Optimal Path, Safety Exit, Mobile Terminal.

I. INTRODUCTION

Nowadays the drastic improvement of science and technology in the modern architecture is more complicated, and the large-scale public buildings such as office buildings, shopping malls, science and education centers are increasing and densely populated. The creative and innovative idea makes the building structure complicated [1].Incase of sudden disasters like fire, gas leakage and earthquake etc., the evacuation of people is inefficient because of ineffective evacuation guidance and anxiety conditions of people when they are under stress their behaviors can be unpredictable.

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In addition, the people health status and average age which may affect the crowd dynamic movement also considered. On the other hand, large public buildings usually occupy a larger internal space and their structural design is relatively complex.

The overloaded electricity may cause fire at any time [3].Building fire may cause incredible life and more property loss. Evacuating the people from the large public building in a reasonable amount of time is a challenging task. This paper proposes dynamic planning to enhance the safety of people, Items destroyed by fire, however, is gone forever. An uncontrolled fire can destroy an entire room's contents within a few minutes and completely burn out a building in a couple of hours. Serve the emergency management for urban disaster prevention and also mitigation, a spatial model for that will be established and used for an emergency evacuation platform is designed based on IOT technology.

i. Motivation

The complexity and variability of the internal environment of public buildings prompt to think about how to protect people in the fire and quickly reach the safe area.

ii. Scope

The scope of this project is to guide the people by constructing the evacuation path dynamically based on the real time situation to reach the safety exit quickly in large public buildings using their Personal Digital Assistant like mobile phone, tabs etc.

iii. Objective

1. To propose an intelligent people evacuation guidance model for fire hazard in large buildings.
2. To protect the safety of life and property in large public buildings under fire conditions.
3. To propose an optimal path to reach the safety exit quickly.

II. LITERATURE SURVEY

The study of fire evacuation requires considering the integrity of function, personnel behaviors, the rationality of the deployment of firefighting equipment and the form of the fire site, the building structure and other factors. Some of the study should be taken to develop that fire evacuation model.

In 2019, Huixian Jiang introduced fire evacuation model to guide the people by constructing evacuation path dynamically based on the real time situation to reach the safety exit using all possible paths in large public buildings with the help of their Personal Digital Assistant like mobile phone, tabs etc.

In order to increase the safety evacuation in public places, using the Ant Colony Algorithm is used [4].

Pejman Kamkarian and Henry Hex moor proposed the method for Predicting Evacuation Capacity in Public Buildings and demonstrated a solution for analyzing public space evacuation rates.

For evacuating from a building in a reasonable amount of time and to increase the safety evacuation in public spaces, the Bayesian Belief Network method was developed [2]. That methodology utilized physical Environment and Crowd Properties, Physical Properties, Crowd Properties and Network topology to construct Bayesian Belief Network. The limitation of this paper is for the complex building structure, the process is very difficult and time consuming.

In 2017, Swaranadeep Majumder introduced the IoT based fire emergency monitoring and evacuation system that can be used as a smart fire defense guidance system.

The goal is to inform occupants and emergency services of the location of the fire and provide a real time safe path of evacuation. To achieve the safe system, the Heuristic algorithm of the Capacity constrained Route Planner (CCRP) Methodology is utilized [5]. Jianyong Shi [6] proposed agent technology to simulate and analyze the process of occupant's evacuation under fire expansion. As a real time, example, they have simulated their model in indoor stadium where 2008 Beijing Olympic Games is conducted. Also expressed a methodology to study the mutual relationship between people safety and fire hazard.

Yinchuan [7] analyzed that evacuation time is increased as the number of occupants, obstacle on the stair on each floor is increases and studied the performance on double-flight staircase compared with staircase of bifurcated type. sprinkler system activation modes is investigated by using CFD simulation software FDS in large commercial building and it was found that combustible materials, combustion rate play result in a prolonged evacuation time and affect the safety level of people in such buildings [8].

Adjiski proposed a prototype model based on fire risk assessment, fire detection, safety situation awareness, and effective system for evacuation. The application program interfaces for solving the problems of building the effective fire safety system is deployed on smartphone device that utilizes the two-way communication and 3D visualization with evacuation guidance [9].

III. PROPOSED SYSTEM

The proposed fire evacuation system produces the navigation routes using Wi-Fi. Temperature sensor is used to sense the presence of fire in buildings. The navigation routes can be monitored by peoples using webpage.

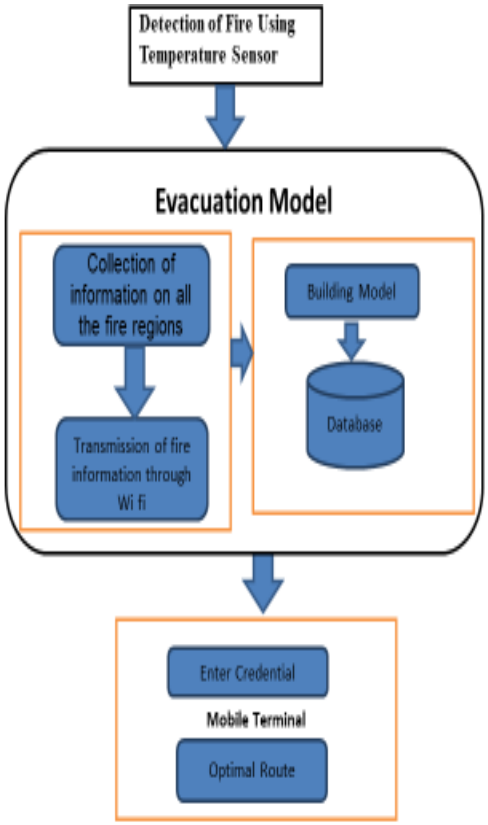

Fig.1. System Architecture

Entire system will be controlled by using PIC microcontroller. Wireless transceiver is used for communication between floors. When fire is detected in any of the floors safer exit path will be displayed in webpage. Peoples can follow that path and can be move from fire region. The architecture of the proposed system is shown in Fig.1.

IV. HARDWARE COMPONENTS

A. Pic Microcontroller

Microcontroller is a single chip that contains Processor, Non-Volatile memory, Volatile memory, I/O Control unit and clock. Billions of microcontroller units are embedded in large number of products. PIC microcontroller chip is the world's smallest microcontroller. Peripheral Interface Controller (PIC)was designed by General Instruments. The main reason for using PIC is Low Power, Reasonable Size, Convenient Packaging and Surface Mount. It has High Performance RISC CPU with high operating speed and Interrupt capability. In addition, it also has Power-on Reset (POR), Power-up Timer (PWRT), Oscillator Start-up Timer (OST), and Brown-out Reset (BOR) with software control option. Microcontroller provides Programmable code protection. The ADC is used to convert Analog to digital signal.

B. Wireless Transceiver

A transceiver is a device comprises both a transmitter and a receiver. It shares a common circuitry. The device is a transmitter-receiver when no circuitry is common between transmit and receive functions.

C. Switched Mode Power Supply

Switched Mode Power Supply (SMPS) is a power supply which uses a switching regulator to control then stabilize the output voltage by switching on and off the current load.

D. Wifi Module(Esp8266)

ESP8266 which is suitable for adding Wi-Fi functionality to microcontroller via UART. The module can be reprogrammed to act as a standalone Wi-Fi connected device. It has 8 pins, which has 4 in the row of 2. These are the pins for communication. Controller or USB to serial converters work at 5V.

E. Temperature Sensor

The lm35 is an integrated circuit sensor which is used to measure the temperature with an electrical output propositional to the temperature. Output voltage is linearly propositional to the Celsius temperature. The given formulae are used to convert the Celsius into voltage.

At 25°C

$$Vout = \frac{X_2}{X_1 + X_2} yV = \frac{1000}{10000 + 1000} y12V = 1.09V$$

At 100°C

$$Vout = \frac{X_2}{X_1 + X_2} yV = \frac{1000}{100 + 1000} = y12V = 10.9V$$

Vout is the Negative Temperature Coefficient. Let the conductor having resistance of X2 at 1000'C and x1 at T'C respectively. The 12V is the output of SMPS module.

F. Liquid Crystal Display

A **16x2 LCD** displays 16 characters per line and there are two such lines. In this each character is displayed in 5x7 pixel matrix. This LCD has 2 registers that are Command and Data. The command register holds the command instructions given to the LCD to do a predefined task like initializing it, clearing etc.

V. HARDWARE IMPLEMENTATION

The 230V AC Power supply is converted to 12V DC through SMPS. In SMPS the input Voltage is passed to the bridge rectifier which converts the ac input to dc, the output from bridge rectifier is stored in the capacitor, the flow is passed to the resistor to ignore the reverse back voltage. The Pulse set transformer or step-down transformer receives the input and convert it into 12V DC supply. Zener diode is used to maintain the consistency of voltage. The 12V DC is given as input to the 7805 regulator which converts the input into 5V DC. The LM35 is a temperature sensor which operates over a −55˚ to +150˚C temperature range, while the LM35C is rated for a −40˚ to +110˚C range (−10˚ with improved accuracy). The LM35 sense the temperature and displays the degree of temperature in LCD. In LCD the sensed temperature information is stored in data registers. When the value exceeds the threshold limit then abnormal status is updated via LCD. The transceiver placed in the controller is used to transmit and receive information between floors. The Wi-Fi module works with 3.3V, the TTL (Transmitter-Transmitter Logic) helps to convert the required voltage. The output of Wi-Fi module is given to the webserver for generating the safety path.

VI. SOFTWARE IMPLEMENTATION

The compiler has built in functions to access the PIC microcontroller hardware such as READ_ADC to read a value from the A/D converter. The CCS Compiler is used to program the PIC microcontroller. The Visual studio IDE (integrated development environment) is used for creating the webpage. The safety path is generated by placing the building map in the database. During the execution of the program the building map is retrieved by using SQL (Structured Query Language).

VII. WORKFLOW

Temperature sensor is used to sense the presence of fire in buildings and that information send to microcontroller unit. Microcontroller unit controls the entire system. When the temperature exceeds the threshold limit it notifies the presence of fire through LCD. RFM transceiver is used to transmit and receive the information form Floor1 and Floor 2 microcontroller unit. Fire hazard information is updated in web server via Wi-Fi. The block diagram is shown in fig.2.

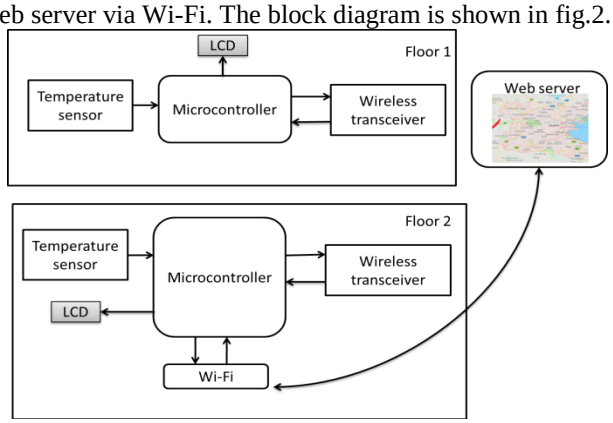

Fig.2. Block Diagram

VIII. ESTABLISHMENT OF EVACUATION MODEL

The internal structure of the building is shown in figure 3. and the floor plan is shown in figure.4. According to the actual floor structure, the shopping mall, the floor plan of the shopping mall is divided into 5 areas are shown in fig. 4. There are too many areas in the floor plan they are A1, A2, A3, A4 and A5. We consider only the A1 areas. The A1 area contains two floors they are floor 1 and floor 2. The evacuation path is generated based on the fire region in the floors.

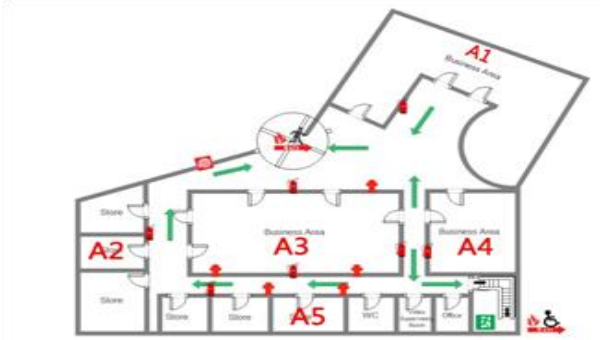

Fig.3. Building Plan

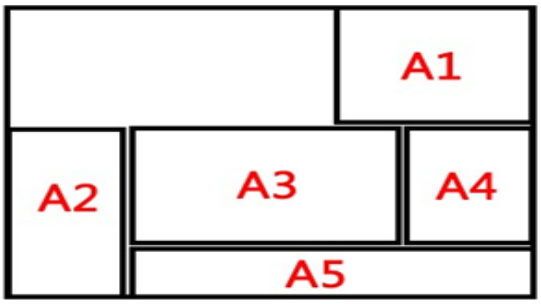

Fig.4. Plan Zoning Map

IX. DESIGN OF MOBILE TERMINAL

The mobile terminal of intelligent fire evacuation prototype system for large public buildings is implemented based on the construction of indoor maps. In order to display the layered building map in a window as large as possible on the mobile terminal, the menu bar is arranged in the form of sideslip. The buttons set in the menu bar mainly include nearby environment, optimal route. The function of the system relates the routine operation of layered map, such as zooming, translation and so on. The Layout of the Login Page, Dashboard and safety path shown in Fig.5, Fig.5.1, Fig.5.2 respectively.

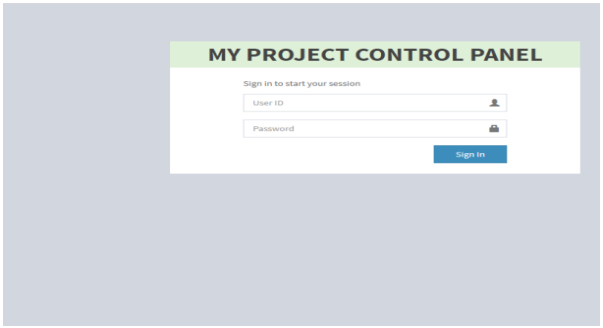

Fig.5. Login Page

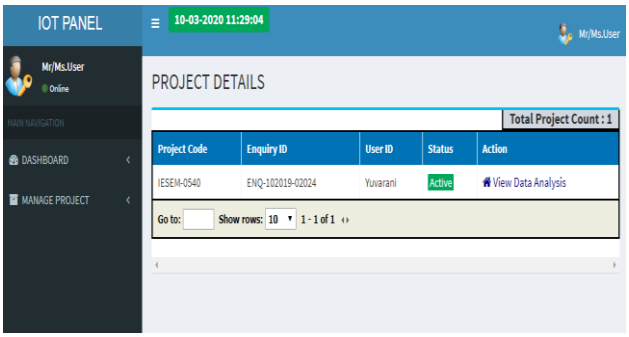

Fig.5.1. .Dashboard

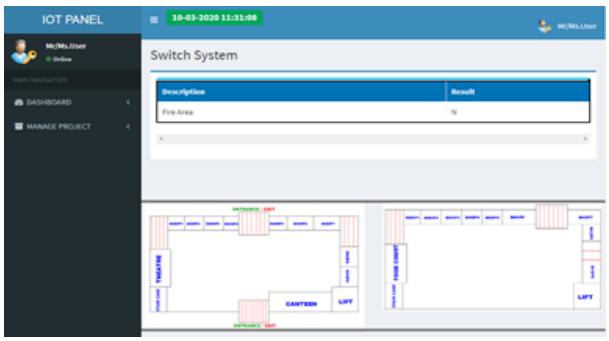

Fig.5.2. Safety Path

X. RESULTS AND DISCUSSION

Consider the building plan in fig.3. The fire in the way to reach the exit, the webpage shows the optimized path to reach the safer exit. Even fire in the optimized path the web page shows the alternate path. In fig.6 shows the building route map for path 1 and fig.7 shows the average path rate of path 1. In fig.8. Shows the building route map for path 2 and fig.9. Shows the average path rate of path 2.

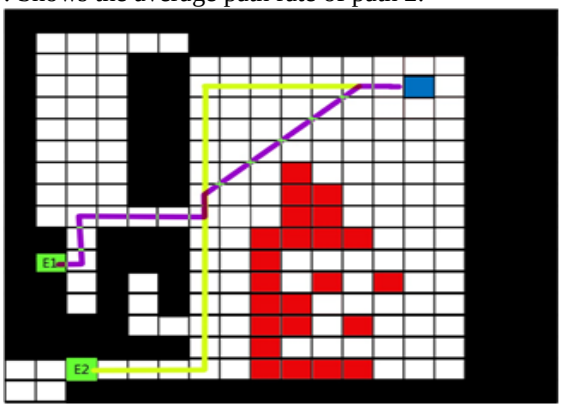

Fig.6. Building Route Map (Path 1)

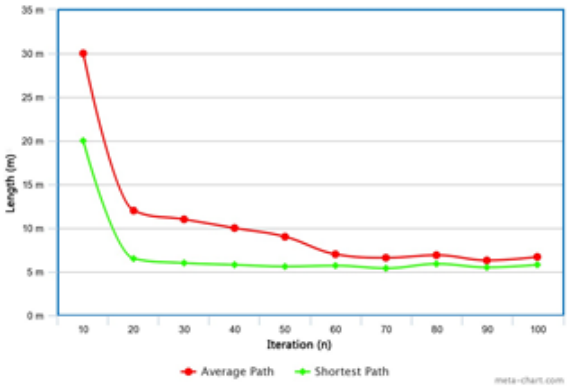

Fig.7.Average path rate (Path 1)

Consider the building route map in fig.6 the red coloured region shows the fire location. E1 and E2 are the safety exit. When fire breaks out in any of the floors, based on the fire location the path is generated to reach the nearest safety exit. In other case, if fire occurs in both the floors, obtain the fire location and generate the optimised path to reach the safety exit.

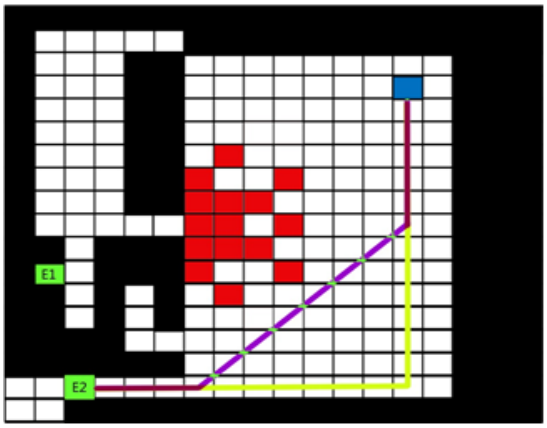

Fig.8. Building Ro *Journal Website: www.ijrte.org*
ute Map (Path 2)

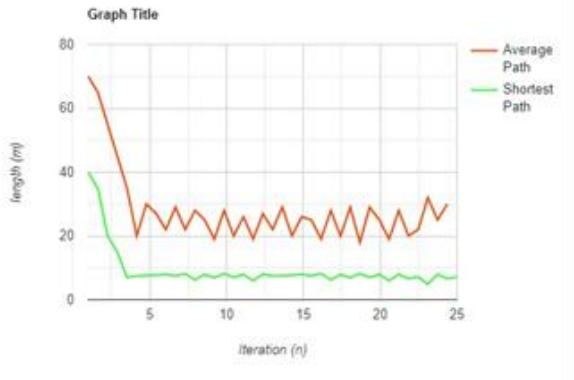

Fig.9. Average path rate (Path 2)

The time taken to reach the safety path is very less when the fire breaks out in any of the floors. When fire occurs, the distance to reach the safety exit is large when compared with the actual distance to reach the safety exit.

XI. CONCLUSION

The proposed system is used to reduce the number of deaths in fire hazards by introducing IOT. In this project, temperature sensor is used to sense the presence of fire in floor 1 and floor 2 that information will be updated in web server via Wi-Fi. When fire is detected in any of the floors safer exit path will be displayed in webpage.

FUTURE SCOPE

The Evacuation System can be further enhanced to provide the Mobile Application to the user who already installed in their mobile Terminal instead of entering the URLs of the website to get the safety path.

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