IoT based Emergency Evacuation System

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***Abstract* --- With the increase in the number of complex high rise buildings, ensuring safety is a primary requisite. In the event of an emergency such as an earthquake or a fire, the protocol followed is exiting the building as soon as possible. But in such modern day complex buildings, evacuation becomes slightly more complicated as they have multiple levels, limited exits and house larger number of people. This calls for a system that evacuates people efficiently. The Emergency Evacuation System (EES) based on Internet of Things (IoTs) aims to achieve an effective evacuation process that ensures safety and minimum casualties using sensors for early detection and monitoring, an alarm for warning about the casualty and application for evacuee guidance and easy navigation. In the occurrence of an emergency, the EES detects it, alerts the civilians in the building and provides guidance through an application.Keywords-Emergency, Evacuation, Internet of Things, Guidance Routing, Fire, Earthquake**.

I. INTRODUCTION

Internet of Things (IoT) is an environment in which physical objects are provided with the ability to transfer data over a network eliminating human-to-human or human-to-computer interaction. IOT refers to a network of comprehensively linking things through sensors and communication equipment, including linking among things and linking between people and things [7]. Research works are dealing with technologies that enable the so-called things to communicate among them and with users in order to provide data and/or accomplish tasks [6].

An emergency is a serious, unexpected and usually dangerous crisis that requires prompt attention. Early Warning Systems (EWS) are increasingly applied to mitigate the risks posed by natural hazards and to give an early warning [5].

Fire and earthquake are the most common emergency scenarios arising in indoor environment. A surveillance system is needed to monitor the area [10]. The occupants of the building need to be equipped with a system that shows them the route to the nearest and the safest exit route. It is very important to select an optimum evacuation route and give evacuation training to each evacuee [8].

In the event of an emergency, the time taken to detect, assess and evacuate people should be lesser than the physical propagation time of the critical event which makes the Time-critical sensor data exchange an essential requirement of the evacuation system. Using IoT will help optimize the evacuation task [1].

Frequently reported threatening events show that there is little time to react and it is highly difficult to identify a safe zone in the lack of accurate and timely information. To compensate the need of accurate information, practice drills take place in public places, such as schools and public offices. In cases of fire or earthquake, all occupants may be required to vacate the zone under threat as a general safety rule. Therefore, evacuation is the common measure in these scenarios. The underlying assumption is that there is an evacuation path and this path is safe [2]. During a fire, uniform evacuation guidance is inadequate because existing emergency guides do not consider the location of the fire and merely direct people to the nearest exit which could be fatal if the fire has occurred at that exit [3].

The availability of cheap credit card sized single board computer such as the Raspberry Pi has enabled the creation of numerous automated and monitoring systems that has low power consumption, faster processing ability at a lower cost [4].

The Emergency Evacuation System (EES) based on Internet of Things (IoTs) aims to achieve an effective evacuation process that ensures safety and minimum casualties. The sensors connected to the arduino mega sense the temperature, humidity and the vibration values. If either of these values exceeds the threshold value, the LED turns on as a warning. The occupants of the building receive an alert message on their mobile phones. Furthermore, the application guides them to the nearest safest exit route indicating directions, based on their location. Information about direction of escape helps people find proper evacuation routes [9]. Thus, the Emergency Evacuation System not only warms but also detects, monitors, warns and provides guidance routing to the occupants.

II. SYSTEM ARCHITECTURE

Figure 1 shows the system architecture of the proposed system. The structure of the Emergency Evacuation system consists of six components - Arduino Mega, sensors (Accelerometer, temperature/humidity sensor and gas sensor) for sensing, LED to give a warning when the threshold value is exceeded, server to process sensor data, an application to provide guidance routing and the GSM module to send an alert message.

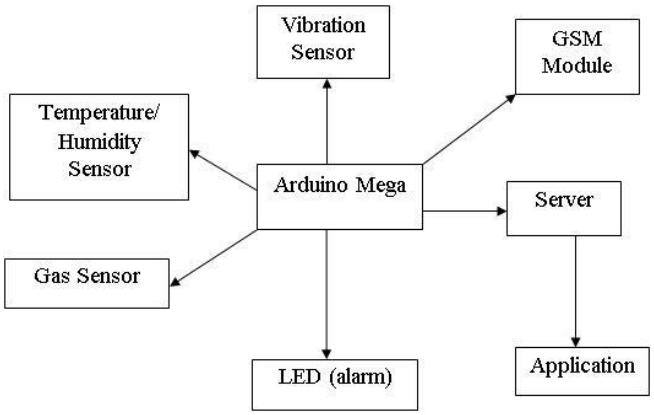

Fig.1. System design of the Emergency Evacuation System

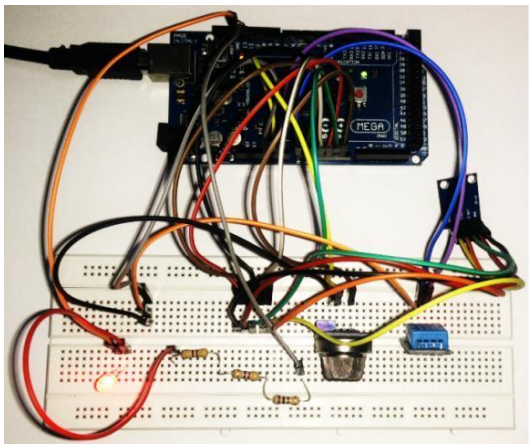

Fig.2. Hardware connections

III. METHODOLOGY

A. Arduino Mega

The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. It is simply connected to a computer with a USB cable or powered with an AC-to-DC adapter or battery to get started. It is flexible, easy to use and inexpensive.

B. Sensors

The emergency evacuation system uses three sensors to determine if a situation qualifies as an emergency or not. DHT11 is a temperature and humidity sensor which is used for detecting the temperature and humidity of the surroundings. It is inexpensive and has simple connections. MQ2 flying fish is a gas sensor which is used to detect the presence of harmful gases in the surrounds. It is highly sensitive to harmful gases like propane, LPG, H2 and also to smoke. This sensor also has fast response time which enables in taking measurements quickly. ADXL 335 is a small, low power, complete 3 axis accelerometer with a signal conditioned voltage output. This sensor has high sensitivity to vibrations.

C. Hardware connections

The Arduino Mega 2560 is connected to the PC using a USB cable. The three sensors namely DHT11, MQ2 and ADXL 335 are connected to the Arduino mega. The analog output signal from the sensor is processed by Arduino Mega. DHT11 has 3 pins – Vcc, Data and Ground which are connected to the 5V, A0 and GND ports respectively. The MQ2 gas sensor has 4 pins, out of which 3 pins are used. Vcc, GND and A0 are connected to 5V, GND and A6 pins respectively. The accelerometer has 5 pins – Vcc, X-out, Y-out, Z-out and GND which are connected to ports A5, A3, A2, A1 and A4 respectively.

IV. SYSTEM DESCRIPTION

The working of the Emergency Evacuation system is shown in Fig 3. The proposed emergency evacuation system uses Arduino Mega to read the sensor values. If the threshold value of any of the sensors is exceeded, the alarm is activated. The value of the output voltage of the sensor circuitry varies linearly with the resistivity of the sensor. So any change in the resistivity of the sensor changes the output voltage.

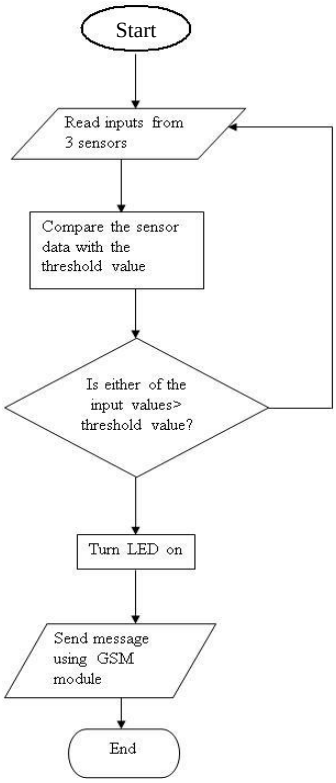

Fig.3. Working of the emergency evacuation system

Once the circuit is done and Arduino is connected to the PC, the program starts executing and the sensor values are displayed on the serial monitor. Values from each sensor are compared with the threshold value and if any of the value exceeds the threshold value, the LED glows. Next, the Arduino Mega generates an SMS and sends it using the GSM module.

When the user receives an alert on his phone, he makes use of the application and selects his current location. The evacuation route to be followed to exit the building is shown from the selected location to the nearest and safest exit. If the threshold value is not crossed, Arduino mega continues to read the analog signals from the sensors and monitors the sensor data.

Figure 4 shows the working of the application which guides the occupants towards the exit. The floor map is stored in the application. Once the occupant opens the application and inputs the current location, the exit path from the current location to the most feasible exit is displayed.

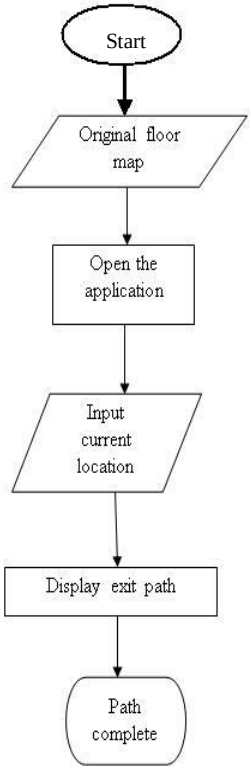

Fig.4. Working of the application

V. RESULTS AND DISCUSSION

The sensors connected to the Arduino Mega display the temperature, humidity and the vibrations along the x, y and z axis as shown in Fig 5.

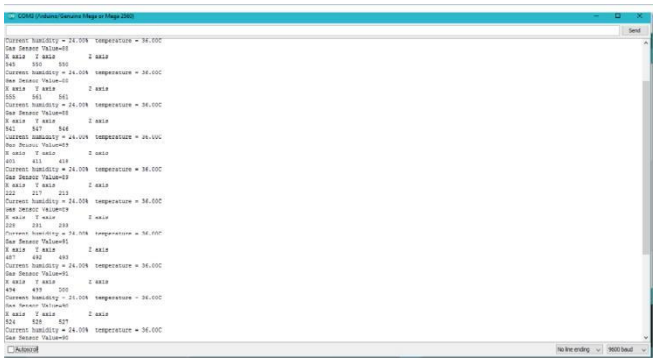

Fig.5. Sensor data values displayed on the screen

Under normal circumstances, the system monitors the sensor data. But in cases where the values exceed the threshold, the LED turns on and an alert message is sent using the GSM module as shown in Fig 6.

Fig.6. Alert message

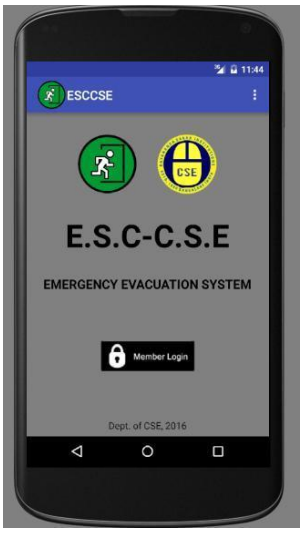

Fig.7. Main Page of the Application

The application called E.S.C-C.S.E is opened for guidance routing. Fig 7 shows the main page of the application which is followed by the user login which is shown in Fig 8.

Fig.8. User Login

The user makes use of the application to input his current location from the list of options provided. This is shown in Fig 9. After the user provides the information about his current location, the application guides him to the exit through the floor maps.

Fig.9. List of current locations in the application.

The application provides the exit route using the floor map and the input

VI. CONCLUSIONS AND FUTURE ENHANCEMENTS

In this paper, a framework for efficient and effective evacuation route guidance for the occupants in an indoor environment which is threatened by earthquake or fire is proposed. The sensors connected to the Arduino mega sense the temperature, humidity and the vibration values. If either of these values exceeds the threshold value, the LED turns on as a warning. The occupants of the building receive an alert message on their mobile phones as a notification. Furthermore, the application guides them to the nearest safest exit route indicating directions, based on their location. Thus, the Emergency Evacuation System detects, monitors, warns and also provides guidance routing to the occupants.

In our future work, we will consider the case when there are a large number of occupants which might lead to areas or exits being blocked by conglomeration of evacuating occupants. The Emergency Evacuation System can also be used for evacuation in case of a fire in an ocean vessel.

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