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IOT-Based Indoor Sensing for Occupancy Detection

Preksha Mogra, Prof. S.G Raghavendra Prasad

Abstract— **In the current generation, Internet of Things (IOT) has an important role to play in each and every area. There are many applications of IOT. One of the most important and efficient applications is in Home Automation. Consider a scenario of a building caught on fire, where one need to evacuate people from an emergency exit. Here, the problem is that one does not know how many people are present inside the building in order to evacuate them. In such cases, home automation plays a very important role. Occupancy Detection is one such area where one can sense the presence of a people in a room or a building. One of the ways of achieving Occupancy Detection is by Indoor Sensing. This paper proposes how to attain count of people present inside a room or a building at particular instant of time with the help of Infrared (IR) Sensors, finds out current temperature of a room or a building using Temperature Sensor and also activates an alarm when the room is caught on fire with the usage of Smoke Sensor and Buzzer.**

Index Terms—**Internet of Things, Indoor Sensing, Occupancy Detection, Infrared Sensor, Temperature Sensor, Smoke Sensor, Buzzer**

I. INTRODUCTION

Occupancy is an act of acquiring area in a room or building. Occupancy detection can be achieved by making use of sensors [1]. Occupancy sensors are indoor motion detecting devices which are used to detect presence of a person [2]. Based on occupancy in a room or building, innumerable decisions can be made such as controlling lights, calculating head count, automatic door control and AC control.

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Preksha Mogra, M.Tech. Software Engineering, RV College of Engineering®, Bengaluru -59
Email: prekshamogra.sse17@rvce.edu.in

Prof. S.G Raghavendra Prasad, Assistant Professor Department.of ISE, RV College of Engineering®, Bengaluru -59

Therefore, indoor occupancy measurement focuses on energy conservation, security, occupancy pattern studying. The main intention of occupancy detection is to detect people coming in and going out of the building using two motion sensors [3].

The motion sensors is of IR (Active Infrared) type.IR sensors act as a transceiver, that is, it emits light from the transmitter end and when an obstacle is detected, the reflected light to detected by the receiver end. To detect current temperature, temperature sensor is used. If the temperature goes beyond threshold value, then the alarm is activated indicating high temperature than expected. When the room is caught on fire, the gas/smoke sensor detects smoke and finally activates an alarm.

II. RELATED WORK

Occupancy monitoring can be done by Camera, Wi-Fi and Sensor-Networks. Depending on types of detection, occupancy can be classified as Terminal and Non-Terminal Methods. Terminal methods include RFID, Wi-Fi and Bluetooth, Wearables whereas Non-Terminal methods include Camera, Smart meters and Environmental Sensors. Using Occupancy monitoring, energy wasted in buildings can be reduced using HVAC control [4].

Occupancy monitoring enables to find out patterns of occupancy of old age people. Thereby helps to check their health status. The paper uses ZigBee Technology. Infrared sensors are wall mounted so that tracking of old age people becomes easy [5]. There has been lot of research going on to reduce wastage of energy in buildings through light, fans, AC. To reduce energy consumption, Self-error Correction Occupancy Counting Algorithm (SOCA) is used by using Cyber Physical Systems. Hence lighting energy management system is developed to make light adaptive to dimming system [6]. HVAC systems can also be controlled in an inexpensive way by making use of 8X8 IR array. These sensors are deployed at doorways and [7].

III. PROPOSED SYSTEM ARCHITECTURE

The proposed system provides people count at particular instant of time. This people count is useful when there is a need for emergency exit, which is detected from smoke sensor.

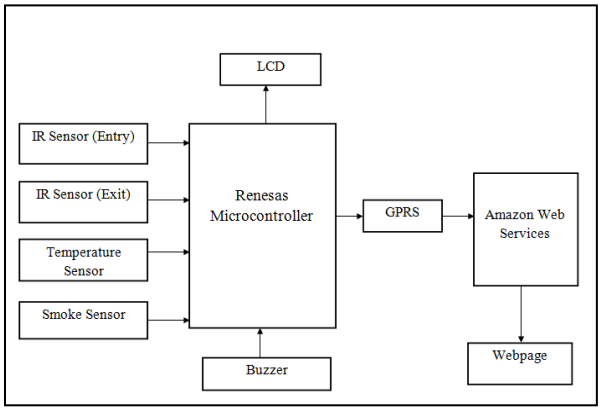

Fig. 1: Proposed system architecture

The system makes use of Renesas Microcontroller and sensors such as IR Sensors, Temperature Sensor, Smoke Sensor and a Buzzer for occupancy detection. Liquid Crystal Display (LCD) is integrated to Renesas Microcontroller. The data collected from sensors are displayed in LCD. Later, the collected data is stored on Amazon Web Services (AWS) cloud. Data is transferred to cloud with the help of Global System for Mobile (GSM) Modem through General Packet Radio Services (GPRS). The serial communication is carried out by a protocol called Universal Asynchronous Receiver Transmitter (UART). This enables transmission and receiving of data from one end to another.

IV. METHODOLOGY

Methodology tells about functionality of how all hardwares are integrated to each other.

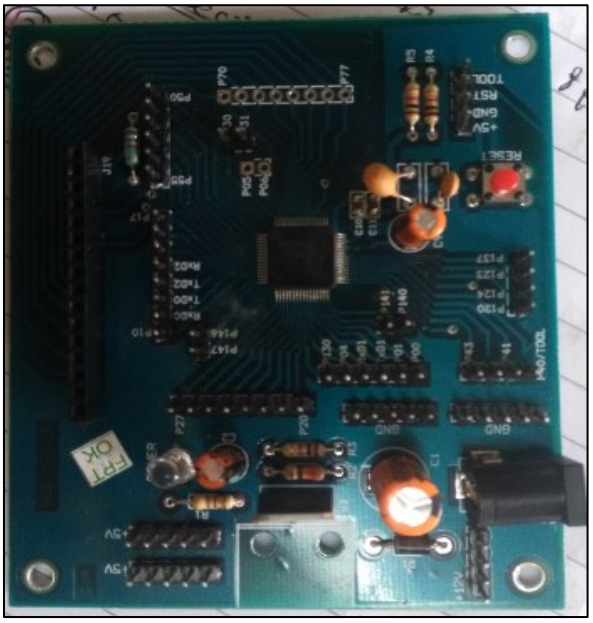

Fig. 2: Renesas Microcontroller

As depicted in the Figure 2, Renesas is a 16 bit microcontroller which belongs to RL78 family. It has 64 pins out of which 58 are GPIO pins and 6 are reserved pins. The input voltage required is 12V and operating voltage is 5V. The protocol used for serial communication in Renesas is Universal Asynchronous Receiver-Transmitter. The code required is written on IDE called Cube Suite Plus and is dumped into microcontroller using Renesas Flash Programmer software.

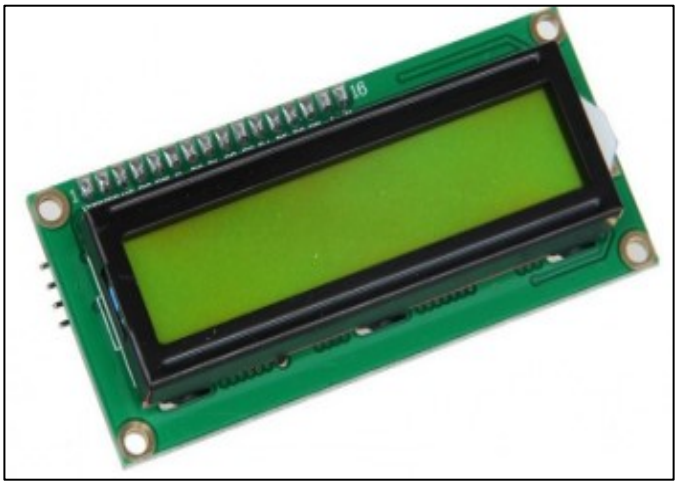

Fig. 3: Liquid Crystal Display (LCD)

The 6 pins in Renesas are reserved for 16X2 LCD. 16 and 2 represents number of columns and rows respectively. LCD is used to display data detected from sensors.

Fig. 4: Infrared Sensors

It is an active sensor. It contains two elements where one acts as an emitter and other acts as a receiver. The emitted light gets reflected back from people entering in/out of the

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building and is absorbed by the receiver. Proposed system uses two IR sensors which are used to detect people entering into the building and going out of the building. These sensors are deployed at doorways; Based on these detections, total count of people inside building is calculated and displayed on LCD

Fig. 5: Smoke Sensor

Smoke Sensor is useful when the building is caught on fire. When smoke is detected and threshold value is crossed, the buzzer is alarmed so that necessary actions can be taken for evacuation

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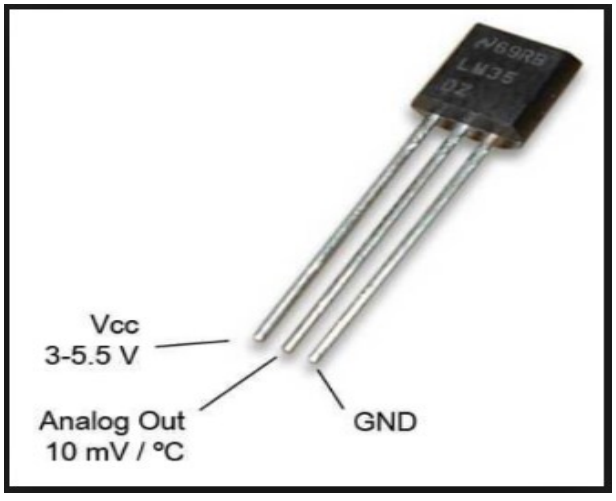

Fig. 6: Temperature Sensor

In figure 6, temperature sensor is used to detect current room temperature. When room temperature crosses threshold value, buzzer is alarmed indicating increase in room temperature.

V. EXPERIMENTAL SETUP

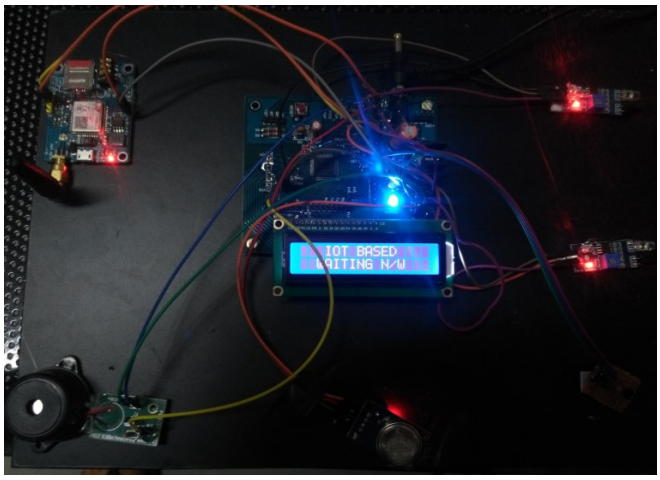

Fig. 7: Experimental Setup

The figure 7 shows experimental setup of how people count is going to be generated. All sensors are integrated with microcontroller along with GSM modem. All devices are initialized when the input voltage of 12V is provided to the setup. All devices operate at 5V. A voltage regulator is present in microcontroller which converts 12V supply to 5V.

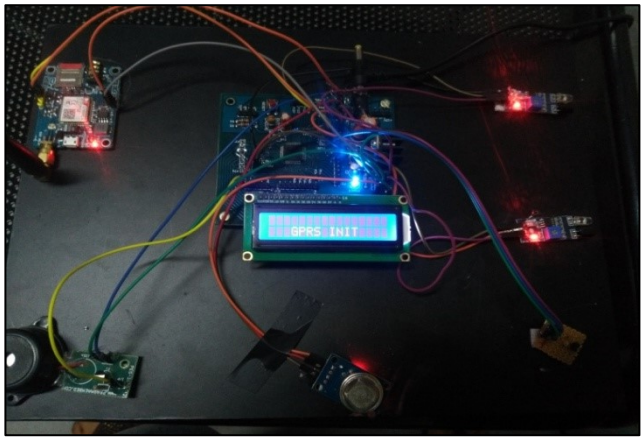

Fig 8: GPRS Initialization

The figure 8 shows GPRS initialization. When GPRS is first initialized, values are sent to AWS cloud and it gets displayed on webpage as shown in figure 9.

VI. RESULTS

The result is displayed on the webpage of AWS. It contains certain attributes such as date, time, temperature, smoke, IN, OUT, TOTAL. The data that has detected by sensors are updated at periodic interval of time on AWS webpage thorough GPRS. When smoke is detected and

temperature is above the threshold value, buzzer is alarmed and data is sent immediately to cloud. Thus, suggesting people inside the building to immediately evacuate during emergency exit.

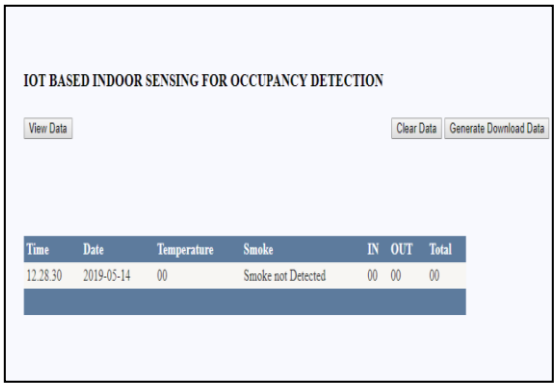

Fig. 9: Display of Initialized Values

Initial values of Temperature, Smoke, In, Out, Total In are displayed along with date and time as shown in figure 9.

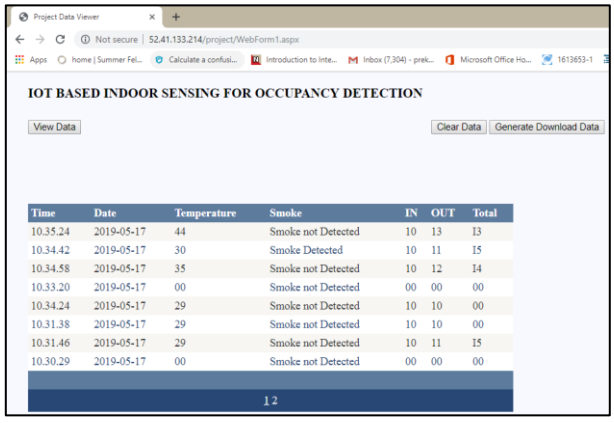

Fig 10: Data Displayed on AWS

Figure 10 shows the data displayed on webpage. Temperature threshold is set to 40 degree Celsius. If it reaches above threshold, then buzzer is alarmed indicating temperature is high. In the same way, the threshold value of smoke is set to 80 parts per million (ppm). If smoke value is greater than 80, then "Smoke Detected" message is displayed along with the buzzer in setup. People count is displayed and finally total count of people present inside a build is also displayed.

VII. APPLICATIONS

By knowing the count of people present inside the building:
1) Necessary action can be taken to evacuate people during emergency exit. 2) It is possible to find out amount of energy being used inside buildings on daily, weekly, monthly and yearly basis. Hence, one can focus towards energy conservation.

VIII. CONCLUSION AND FUTURE WORK

Occupancy Detection helps to find out number of people present inside a room or building. By making use of smoke and temperature sensors, it is possible to take security measures in advance to evacuate people during event of fire with the help of buzzer alarm.
In future work, by knowing count of people present inside a building, power utilization can be analyzed. Therefore, certain measures can be taken towards energy conservation.

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