Chapter 30
IoT Based Home Security for Housing Areas

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Abstract Internet of things (IoT) refers to the infrastructure of connected physical devices which is growing at a rapid rate as a huge number of devices and objects are getting associated with the Internet. Home security is one of the useful applications of IoT. This paper describes a project for a home security system. The system will inform the owner about any unauthorized entry or whenever the door is opened or if there is any gas leakage by sending the notification to the user through a smartphone. The system consists of an Arduino Uno as the main microcontroller, a PIR sensor to detect human movement, a buzzer to sound an alarm, an MQ-6 gas sensor to detect gas leakage, and an ESP8266 Wi-Fi module or NodeMCU to connect to the Internet. The main advantages of the system are ease of use, lower cost, and low maintenance.

Keywords Internet of things · Home security · ESP8266 Wifi module · PIR sensors · And MQ-6 sensors

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30.1 Introduction

Everyone wants to be as much safe as possible that is why security is a prime concern in our day-to-day life. Home security systems are sensible in cost and can be added to practically any house or building. There are a few significant motivations to consider getting a home security system. To start with, when criminals break into a house, they are not liable to be worried about the individual well-being of anybody in the house. The internet of thing (IoT) based home security system can be embraced at home or office as it has different sorts of sensors. This project was utilized to identify two things (intrusion and fire). The reason why fire detection is used is that based on research, most of the fire cases that occur in Malaysia in a year started with gas leakage. Usually, when the police/firefighter arrives, it is too late, and the damage has been done.

This project is easy to use as it can be operated wirelessly to turn it ON or OFF via a web app. Any intrusion or gas leakage will promptly be notified to the user via web app and all the info will be stored inside the database for future reference and analysis. If there is either an intrusion or gas leakage, the alarm will go off indicating there is danger, that way the neighbor can somehow be notified about it which maybe can save the user home with quick action. By detecting the intrusion and sounding an alarm, a security system also will often scare an intruder away.

Several works have been proposed for home security systems. Work by [1] proposed two approaches for home security. The first approach depends on GSM innovation, and the second one uses a web camera to detect an intruder. For the first approach, the smart home prototype was designed using various sensors such as infrared (IR), temperature, gas, and light-dependent resistor sensor. LED lights and fans were also included in the design to make it more resemble actual home appliances. The proposed system is controlled by an Atmega644p microcontroller. It collects information from the sensors, makes decisions, and sends an SMS notification to the corresponding number or homeowner by using a GSM modem. Some examples of a message being sent to the homeowner are “Fire at home” and “Gas leakage.” These two messages will be sent if the temperature is higher than the set threshold value or if the gas sensor is activated. As for intruder detection, the security system uses the Yawcam (Yet Another WebCAM Software) software to interface with the web camera. Yawcam is a Multilingual Java software for viewing and transferring images or videos from a webcam. The system detects the motion of the intruder, sounds an alarm, and sends an email to the homeowner.

The second work is described in [2]. The prototype system is also designed to detect an intruder. When an intruder is detected, the system will send a voice call notification to the home owner’s smartphone. Unlike the previous approach, the alarm activation is optional and is based on homeowner discretion. In addition, the provision for sending alert messages to concerned security personnel in case of critical situations is also built into the prototype system. In the case of the owner identifies that the person entering his house is not an intruder but an unexpected guest, the user/owner can make arrangements such as opening the door or switching

on various appliances inside the house by using his/her smartphone. This system is designed using TI CC3200 LaunchPad as the main controller, PIR motion detector sensor, alarm, relays for connecting home appliances, electromagnetically controlled doors or windows, smartphone phone to receive Voice Call and Energia software.

Another work is described in [3]. This paper describes the development of a home security system comprising of two different sensors, a passive infrared sensor, and an infrared sensor to monitor the home condition, in this case, motion, ESPresso Lite V2.0 to connect all the sensors and act as the main controller, Blynk application as the main interface with the smartphone and FAVORIOT platform to receive the data sent from the ESPresso Lite V2.0. Sarkar et al. [4] proposed an android based home security system using IoT and firebase. The system used two types of sensors, PIR sensors and flame sensors. Whenever the sensors get triggered, a notification will be sent to an Android app installed on a smartphone.

30.2 Methodology

30.2.1 Hardware Setup

The main block diagram is as shown in Fig. 30.1. Based on Fig. 30.1, the main components are NodeMCU ESP8266, web application, MQ 6 gas sensor, infrared passive sensor (PIR) sensor, a buzzer, and a Firebase database. NodeMCU is a microcontroller board that comes together with a Wi-Fi module. In this project, NodeMCU is the main controller which acts as a communication hub for sending and receiving

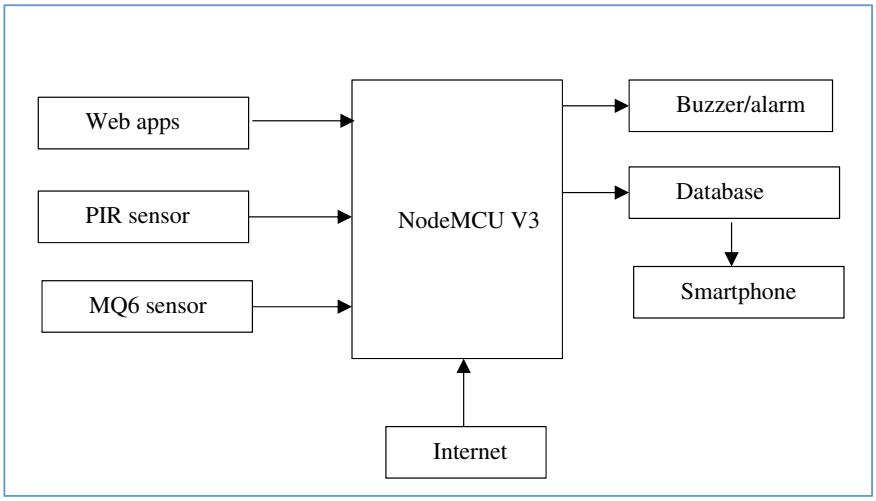


Fig. 30.1 System block diagram

data over the Internet and relaying it to the rest of the module accordingly. Arduino IDE software is used to provide the necessary coding to ensure the NodeMCU can interact with all connected sensors, the firebase database, and the web application [5]. A sample code is shown in Fig. 30.2.

The PIR sensor stands for infrared passive sensor. It is a low-cost sensor, capable of detecting human or animal activity by detecting infrared radiation emitted from objects with a temperature above zero. As the name implies, the MQ-6 gas sensor is a gas sensor. It was chosen for this project because the sensor can detect or measure common household gases such as LPG and butane. The type of buzzer used is an active passive buzzer. It is a small yet efficient component to add sound features to our project/system. In this case, to provide an alarm for the home security system.

This project will be using Firebase [6] as the database to store and send the information needed to the components or web application. Firebase also provides a

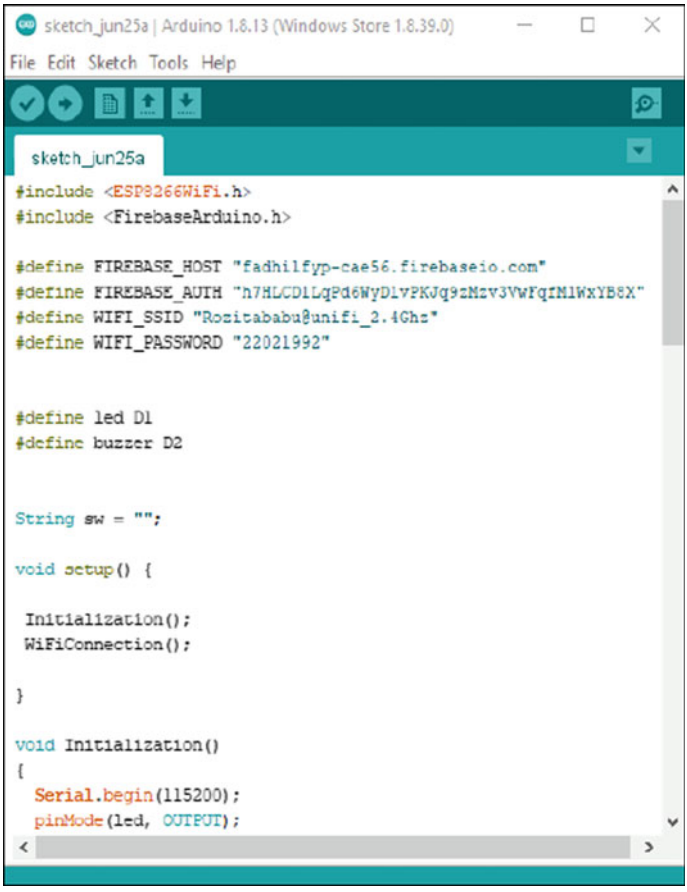


Fig. 30.2 Sample of an Arduino sketch

real-time database and back-end services which makes it very good to be used in an IoT project like this. Firebase is free to use, and it is also one of the easier databases to operate which makes it the database of choice in this project.

Like any other IoT-based home security system, the system also comes with a web application. In this project, 000webhost is used to create a working website which is the web application to monitor the state of the system. 000webhost is a free website hosting solution that provides a variety of features, including a website builder and WordPress support, all of them without any ads. Users can upgrade to a paid plan to get even more features and support, but based on the reviews, 000webhost is the best free web hosting solution for those who are truly on a budget. The HTML and JavaScript codes in the development of the web application are written using the Notepad++ editor.

To convert the web application to an android application for smartphones, a software called MIT App Inventor is used [7]. The software lets the user develop their application for Androids smartphone by using a web browser or either a connected phone or emulator. The software server will store the user's work and helps to keep track of the project. This software will convert the URL of the web application received from 000webhost into the apk file which can be downloaded and installed on any Android smartphone or device.

30.2.2 Circuit Diagram

The circuit connection for the system is as shown in Fig. 30.3. Firstly, for the PIR sensor, the output pin (orange) is connected to the D0 pin of the NodeMCU while the VCC (red) and GND (black) pin is connected to the ground and 3.3 V pin of the NodeMCU, respectively. Next, the gas sensor analog pin (yellow) is connected to the A0 pin on the NodeMCU, and similar to the PIR sensor connection; the GND and VCC pin on the gas sensor is connected to the ground and 3.3 V of the NodeMCU. The LED anode (blue) is connected to the D1 pin on the NodeMCU and the cathode is connected to the ground. Lastly for the buzzer, its positive pin is connected to the D2 pin of NodeMCU, and its negative pin is connected to the ground.

30.2.3 Flow Chart

Next, Fig. 30.4 shows the flow chart for the system. Based on the figure, the system starts with the home security system web application in the smartphone is open. Initially, the system will be in an idle state in which it will wait until either the infrared passive sensor (PIR) sensor or the MQ-6 sensor detect something or is activated. If any of the sensors is triggered, the buzzer will go off and information will be sent to the database. At the same time, a notification will be sent to the user

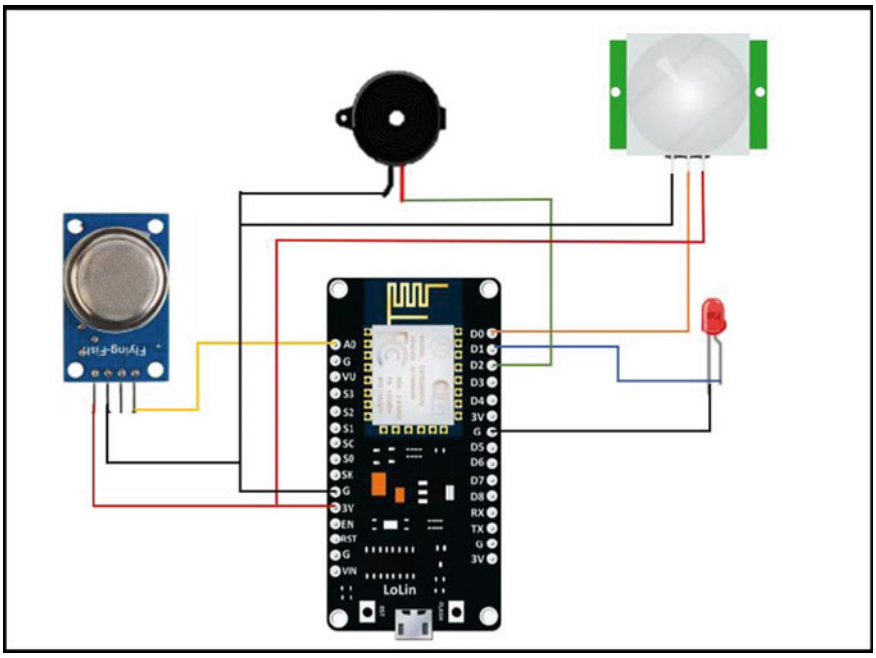


Fig. 30.3 Circuit diagram

or homeowner through the web application indicating either an intruder or a gas leakage is detected, depending on which sensor is triggered.

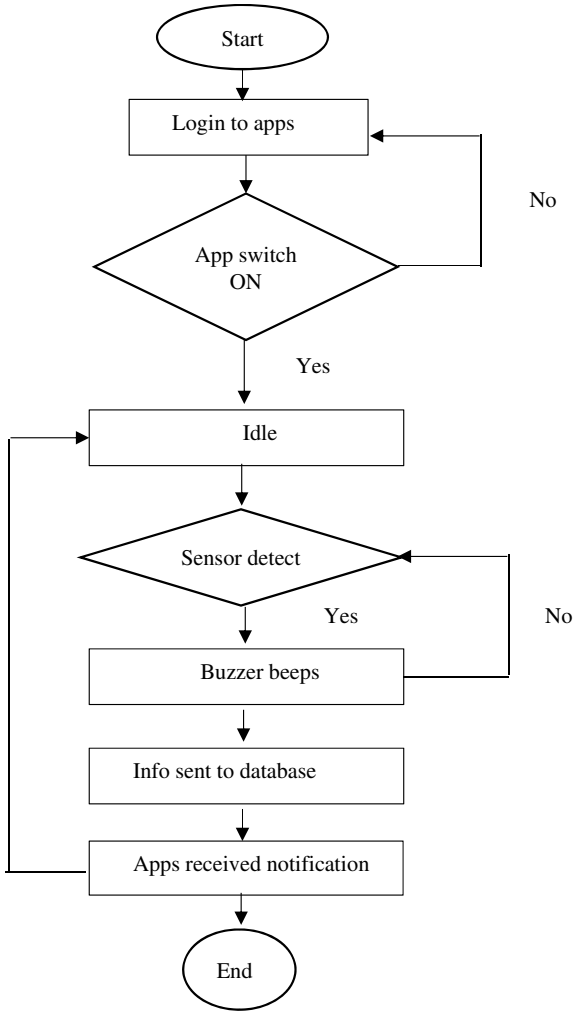
30.3 Results and Discussion

Figure 30.5 and 30.6 show the completed hardware and web interface, respectively. The Android app installed on an Android smartphone also looks the same as the web interface and it works the same as the web version. This project is designed in two modes of operation. The first is the user or homeowner view and the second mode is the administrative or admin view. Admin in this context can be the guard in the guardhouse or even the administrative people at a condominium. It refers to the people who have to watch over the user's house in a housing area.

30.3.1 User View Mode

To start using the system, a user need to sign in by entering their username and password. This way the system is made secure against unauthorized access. Upon

Fig. 30.4 Flow chart



entering the correct username and password, access will be granted and a user monitoring page will appear. To activate the system, the button SWITCH must be turned "ON." The page will display the status of the PIR sensor and the MQ-6 gas sensor in real-time. Supposedly when there is an intrusion or gas leakage, the sensor will be triggered and a notification will be sent to the web application and the android application. At the same time, an alarm will also be activated. Sample of notification received by the applications is as shown in Fig. 30.7.

In addition, the system is also able to generate a status report for both the PIR and the gas sensors. This report will be generated when a user pushes the "Click to see PIR sensor report" button for the PIR sensor and the "Click to see Gas sensor report" button for the gas sensor. A sample of the PIR report is as shown in Fig. 30.8. As

Fig. 30.5 Completed system hardware

shown in Fig. 30.8, there should be a time and date for the movement in the house detected recorded in the "Detachment history." The reading value will indicate the component parameter, if it is "1" then the sensors/components are currently activated and if the value is "0," then they are idle.

30.3.2 Administrative Mode

To enter the administrative mode, the admin needs to click on the "Log in as Admin" button and the page will be redirected to the admin login page as seen in Fig. 30.9. After inserting the right password, the admin can then proceed to the admin monitor by clicking the "Proceed to monitor" button. As seen in Fig. 30.10, the admin monitor can view the state of many houses. Similar to user view, the admin will get a notification if the house is breached or there is a gas leakage (refer to Fig. 30.11). The admin view however does not has the option to see the report of either gas leakage or intruder detection.

30.4 Conclusion

This paper described a development for a home security system for a housing area. The system incorporates PIR sensors to detect an intruder and an MQ-6 sensor to detect gas leakage. If any sensors are triggered, a notification will be sent to the homeowner and security personal. A log report of the event can also be generated

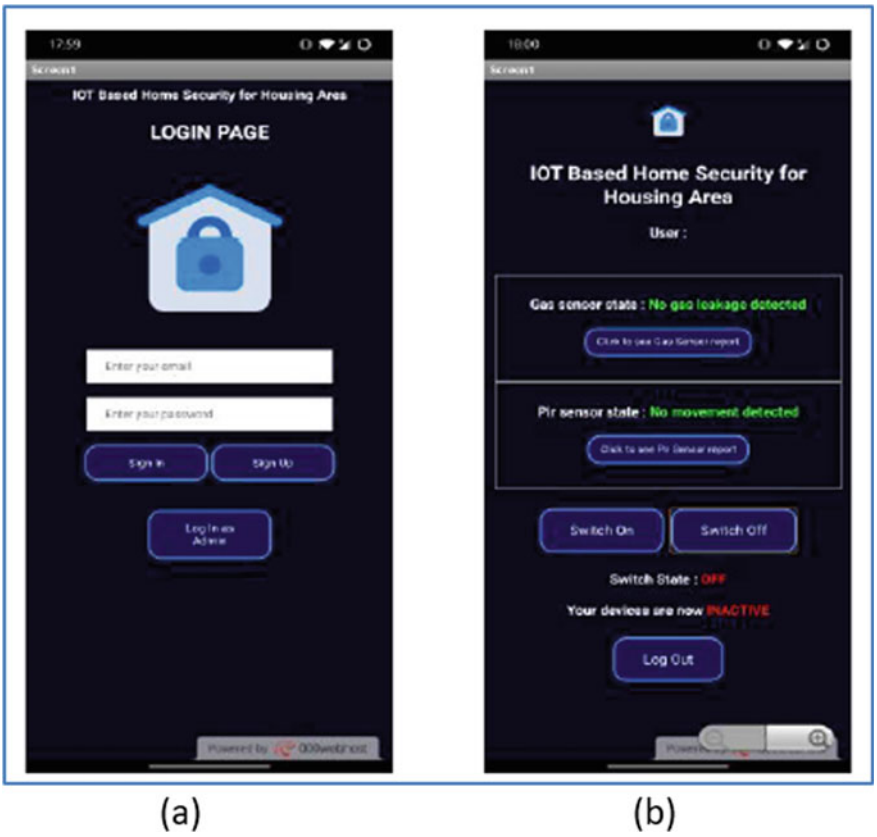


Fig. 30.6 Android app interface. **a** User login page, **b** User monitoring page

upon request. For ease of use, a web interface application was also designed. Although the system is shown to be working as expected, further improvement can still be made to the system.

Other monitoring devices such as a camera can be added to the system. This way users can identify the intruder as the real intruder or simply an unexpected guest. Another improvement concerned the fact that the system is highly dependent on the Wi-Fi connection. Network latency will affect the system performance. The time taken to transfer data to NodeMCU and then to firebase will be increased as the network latency increased. The system must also have a way to notify the user that the Wi-Fi at their home is down as the system just won't work if there is no internet connection.

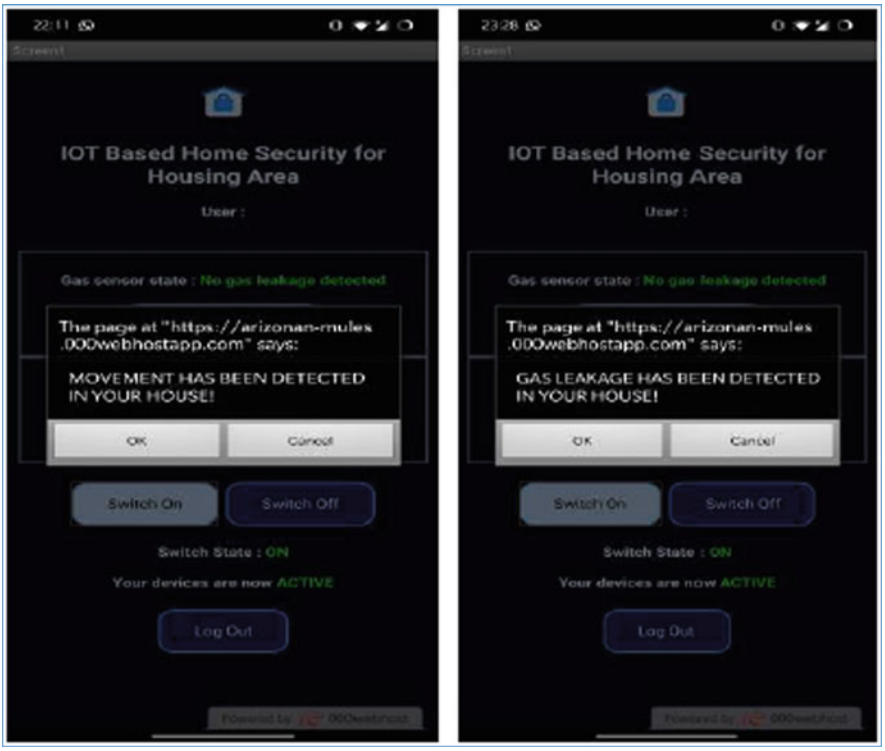


Fig. 30.7 Sample of notification sent to the app

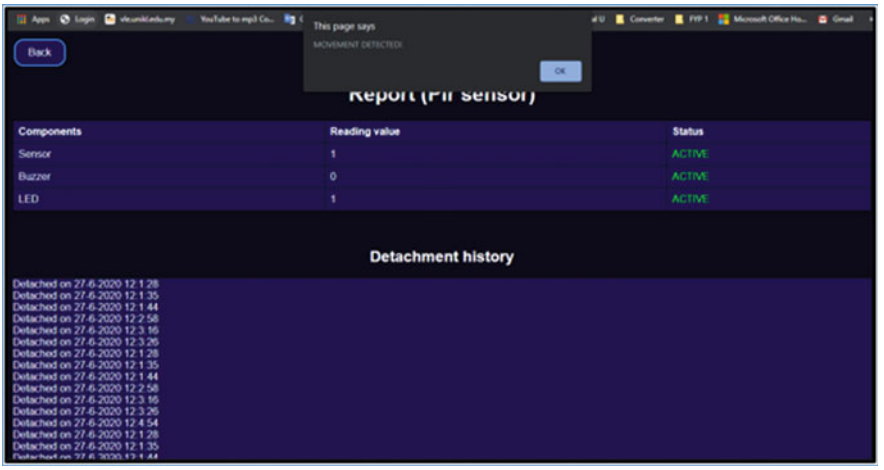


Fig. 30.8 Sample of PIR sensor report

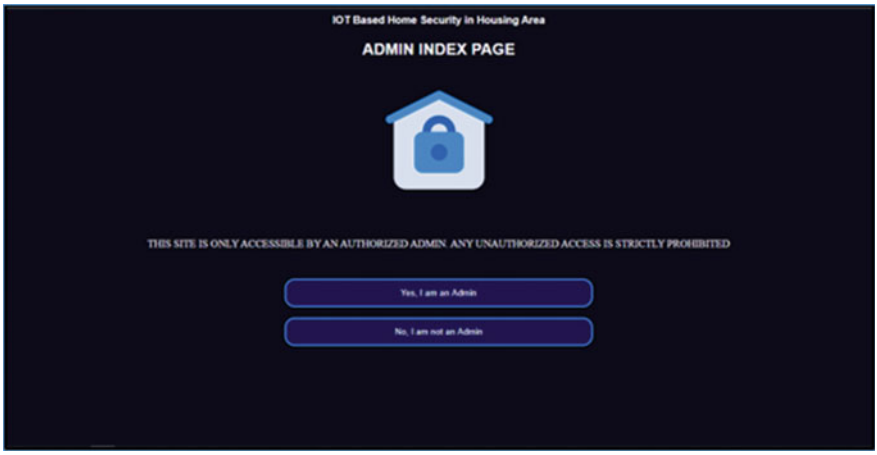


Fig. 30.9 Admin main page

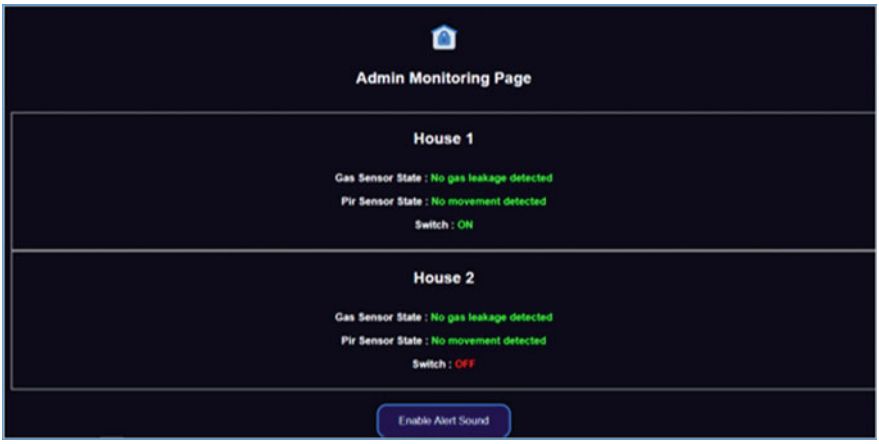


Fig. 30.10 Admin monitoring Page

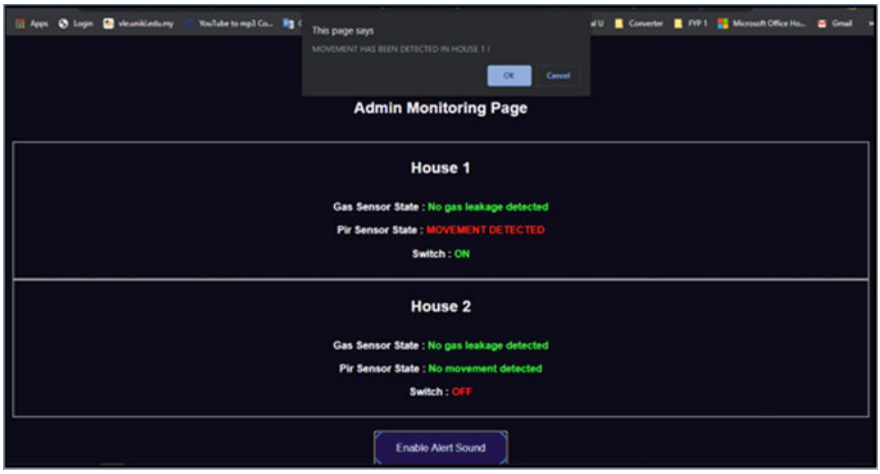


Fig. 30.11 Sample of admin alert notification

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