

S.M.A.R.T Home - Security Monitoring Automation Remote Technology Home

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(1404211)

A Report

SUBMITTED TO

University Tunku Abdul Rahman

In partial fulfillment of the requirements

For the degree of

**BACHELOR OF INFORMATION TECHNOLOGY (HONS) COMPUTER
ENGINEERING**

Faculty of Information and Communication Technology

Department of Computer and Communication Technology

AUG 2017

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I declare that this report entitled “**S.M.A.R.T Home - Security Monitoring Automation Remote Technology Home**” is my own work except as cited in the references. The report has not been accepted for any degree and is not being submitted concurrently in candidature for any degree or other award.

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I would like to express my sincere thanks and appreciation to my supervisors, Mr Teoh Shen Khang who has given me this bright opportunity to engage in an embedded system design project. It is my first step to establish a career in embedded system design field. A million thanks to you.

ABSTRACT

This project is about constructing a Smart Home System using an Arduino Mega (a microcontroller) and Raspberry Pi (a small single-board computers). The Smart Home System is built according to automation, security and monitoring perspective. In other words, the system not only specifically works for automation, security and monitoring each of them but it integrate three function and operate together. The main purpose of this system is to assist who are frequently outstation which lead to having difficulty on managing and monitoring their house. Other than that, the system also provide security against stealing case and monitoring the surrounding and condition of home which lead to a safety and comfortable environment. By using this system, user can monitor and control some of the household appliances via internet by using their own smartphone or laptop.

Furthermore, the system enable user need to log in designate website and perform some task such as switching on or off the light remotely, opening the gate of garage when user want to park their car in raining day, checking the room temperature, protecting the house from thieves, water leaking checking in kitchen and area outside the bathroom, gas leaking checking in kitchen and checking the happening of vibration.

Besides, whenever the gas content in air exceed the unsafe point which mean the gas leakage situation happened, the system will trigger the alarm and inform the user through an email. In another situation, when there are some suspicious movement around the home, the system would trigger the alarm and notify user to take any appropriate action. In order to continuously monitor the home's status, an Arduino, namely, Arduino Mega, is chosen as the main microcontroller to collect data from the sensors and subsequently, send it to Raspberry Pi, which in turn, hosts a website and uploads the data obtained from Arduino, into the database. Besides that, sensors such as LM35 temperature sensor, MQ-2 gas sensor, Relay, LCD display, PIR motion sensor, water detection sensor, vibration sensor are also required to make sure that the system functions optimally. Other than that, keypad and servo motor are also required.

Lastly, the design methodology adopted in this project is prototyping model under the category of Embedded Development Life Cycle (EDSC) which is a good idea for complicated and large system. The work of building this smart home system is divided into two part which are the circuit construction part (which not include the Raspberry Pi) and the part include webpage design and combining the microcontroller with the Raspberry Pi.

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List of Abbreviations

<i>IOT</i>	Internet of Things
<i>EDSC</i>	Embedded Development Life Cycle
<i>PHP</i>	Hypertext Preprocessor
<i>SQL</i>	Structured Query Language
<i>ECHO IV</i>	Electronic Computing Home Operator IV
<i>ARPAnet</i>	Advanced Research Projects Agency Network
<i>APK</i>	Android Package Kit
<i>Wi-Fi</i>	Wireless Fidelity
<i>GSM</i>	Global System for Mobile Communication
<i>PIR</i>	Passive Infrared Sensor
<i>SMS</i>	Short Message Services
<i>SSID</i>	Service Set Identifier
<i>HTML</i>	Hypertext Markup Language
<i>CSS</i>	Cascading Style Sheets
<i>GHAS</i>	GSM Home Automation System
<i>et.al</i>	And other

Chapter 1: Introduction

Chapter 1: Introduction

1.1 Problem Statement

It is inevitable that smart home can bring so much advantage for us, but there is nothing perfect in the world, there are many smart home systems available in the market nowadays still have lacking in several functions or features as listed in the following:

- Some of the smart home systems are not IOT (Internet of Thing) - based systems.
- Some of the smart home systems are not user-friendly.
- Some of the smart home systems are unaffordable.
- Some of the smart home systems can be easily to be hacked which are not secured by a password.
- Some of the smart home systems some need to be maintain frequently in order make sure it work properly.
- Some of the functionality of smart home is not comprehensive and not overall which mean it just focus on a specific function.

Chapter 1: Introduction

1.2 Background information

In this sophisticated era, the "Internet of things" (IOT) is becoming an increasingly growing topic of conversation both in the workplace and outside of it. It is an idea that not only has the potential to impact how we live but also how we work. But what exactly is the "Internet of things" and what impact is it going to have on people's life?

Let's start with understanding a few things. Nowadays, the internet is becoming more and more widely available, the cost of connecting is decreasing, more devices are being created with Wi-Fi capabilities and sensors built into them, the cost of technology are becoming cheaper, and smartphone penetration is skyrocketing. Hence, all of these things are creating a "perfect platform" for the IOT.

The concept of IOT basically connect any device with an on and off switch to the Internet (and/or to each other). This includes everything from smartphones, television, washing machines, headphones, fans, wearable devices and almost anything. Moreover, this also applies to components of machines, for example a jet engine of an airplane or the drill of an oil rig. As mentioned above, if any device has an on and off switch then it has a chance can be a part of the IOT. The analyst firm Gartner says that by 2020, there will be over 26 billion connected devices, so that is a lot of connections (some even estimate this number to be much higher, over 100 billion). Besides, the IOT is a big network of connected "things" which also includes people. The relationship of this network will encompasses between people-people, people-things, and things-things.

Regarding to the advantages of IOT, the concept can be applied to things like transportation networks: "smart cities" in figure 1.2.1 which can help us reduce waste and improve efficiency for things such as energy usage, so this helping us understand and improve our standard of living. The image of smart cities is stated as below:

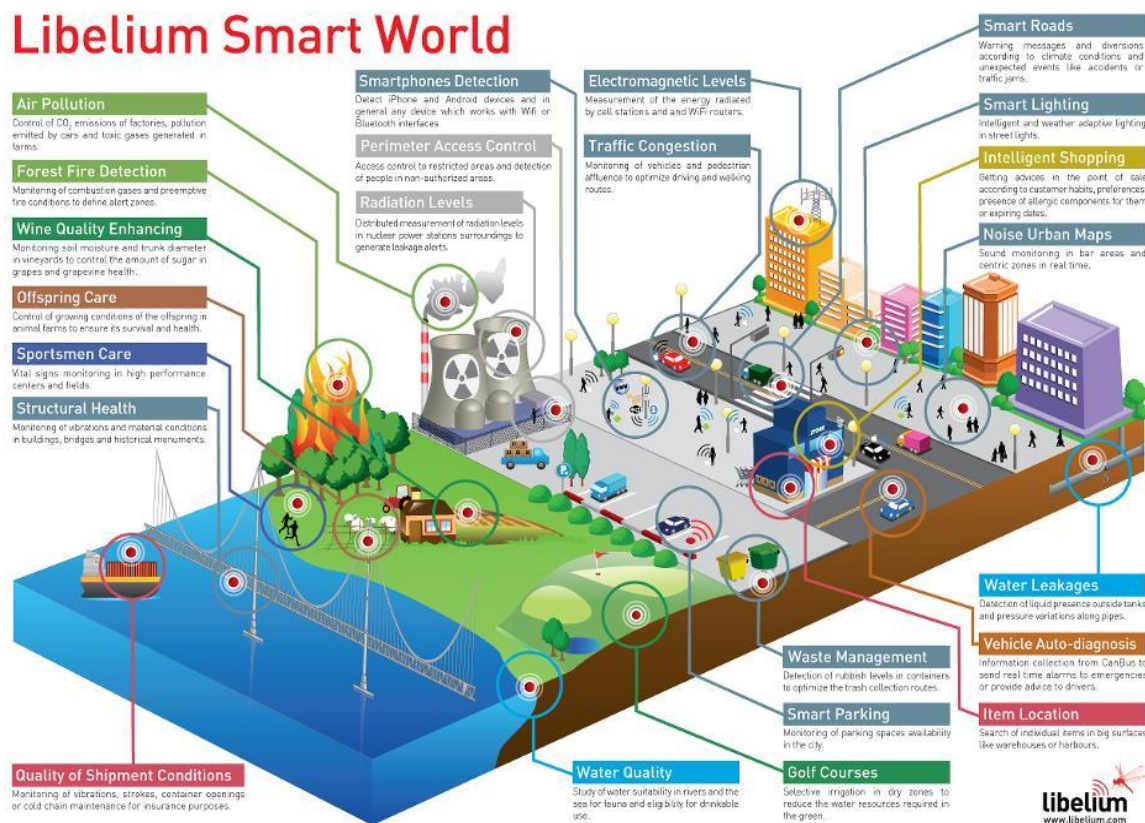


Figure 1.2.1 Smart City

In this project, smart home system has been constructed base on the concept of IOT. There are some brief history of smart home stated as below.

If you think smart home system is a new invention, you are only partially correct. It is because that the idea and concept of smart home can be traced back to the 70's. In 1785, Nikola Tesla(a Serbian-American inventor) invented the first remote control to remotely control a boat ,so this prove that the idea of remotely control have been existed in 70's. During the period of Industrial Revolution, invention of home appliance had been came out such as washing machine, clothes dryer, home refrigerator, electric dishwasher, garbage disposal .Although all of this home appliance still could not be smart enough to turn into remotely control, but at that time, the idea and imagination of remote control were there already .By 1930s, inventor had already turned their imagination to home automation. Although the technology still not so sophisticated, but many people already fascinated by this things.

Chapter 1: Introduction

After a few centuries, after the invention of computer chip, mini computer and computer monitor had been invented, the first home automation system which is ECHO IV (Electronic Computing Home Operator) was invented by Jim Sutherland .After a few year, the introduces of ARPAnet and invention of wireless technology accelerate the development of internet technology and the home automation becomes commonplace after 90's.

Nowadays, the technology of smart home is become more and more popular and sophisticated and also grab a lot of people attention.

Chapter 1: Introduction

1.3 Motivation

The major motivation of my project which is a smart home system comes from the limitation of some smart home nowadays which is available in the market, but there also some motivations come from the original purpose of smart home which is leading people to more convenient, secure and safety life. The technology of smart home not only merely about regularly monitoring the security of home and your children from your workplace, but it is all about convenience and safety. It is about take advantage of the latest technology which has been offer and about saving energy significantly thus contributing to the greener earth. For an instance, a person cannot know if his/her house is on fire or leakage of gas in kitchen immediately without a smart house, hence, all of this can benefit to energy saving.

First of all, the biggest motivation of smart home is convenience. Nowadays, due to the heavy daily expanse, people need to work from day until night in order to sustain their live. So, in another words, time is money for them, and convenience is really another way of saying “time saver”. Furthermore, most of the technology today is also built based on convenience such as car, smartphone, computer etc. Smart home play a main role to save time or provide a lot of convenience because user will not need to walk around the home to switch off the light, instead of just pressing a button on smartphone in order to save a little bit of extra time. In raining day, they just need to press a button in car to open the gate of garage to prevent wet by rain.

Security is also another important perspective toward smart home. There a lot of cime happening nowadays, so security is a big issue concerned by people. There are a lot of security system on market available and in use today but integrating the security system into smart home system can strengthen the security system at home. The smart home system also can inform user remotely if the sensor detected any person approaching the house for security purpose.

Thus, another reason for motivation is connectivity. The concept of connectivity is that having things connected in results to communication or the transfer of information. By connecting everything in the home, so everything can talk to each other, information about the home is easily attained. There are also many advantages to increase the amount of available information.

Beside, some of the motivation also comes from the limitation of some smart home nowadays which stated as below:

Chapter 1: Introduction

Regarding to some smart home system with not user-friendly and having a complicated user interface, some of the elder people who are not computer literate may find difficulty when using it .The interface of smart home should be design by some powerful webpage design software such as using PHP (Hypertext Preprocessor) which can produce a simple and easier interfaces for user to use it.

Moreover, according to the smart home which is not IOT based systems, the only communication between the controller and the user device interface is Bluetooth or other range constraint connection which is not practical for long distance communication. Hence, the smart home should be an IOT based system in order to optimize its performance since internet is popular nowadays.

Furthermore, some of the smart home systems are unaffordable which it implemented by some costly controller and some of the function of controller are unnecessary. Hence, choosing a suitable controller is an important criteria to build a smart home. Arduino Mega has been chosen as the main microcontroller in this project which is more than enough and cheaper to build a smart home system.

Lastly, some of the functionality of smart home is not comprehensive and not overall, so only a little and specific performance can be done. The smart home should be comprehensive and covering many other function which meets to market demand. It is also necessary for a smart home to encrypt with strong password to prevent intrusion of hacker.

Chapter 1: Introduction

1.4 Project Objective

The Objectives of this project are stated below:

- To develop a smart home system which can bring more safe, comfort and convenient life to user.
- To develop a smart home system can update the information get from all the sensor or device to user through a website in anytime.
- To develop a smart home system that is able to alert user during some emergency case such as water, gas leakage case and earthquake.
- To develop a smart home system that can combine the functionality of security, monitoring and automation.
- To develop a smart home system that user-friendly which can be easily understood and operated by non-technical users easily without the requirement for any advanced technical knowledge.

Chapter 2: Literature Review

2.1 Discussion of strengths and weakness of existing product

Based on the research, there are some of the similar products related to this current project. One of the products which known as “**Remote Monitoring of an Arduino Based Home Automation Security System**” develop by (David et.al, 2016).

This Product is a model for a home remote monitoring system using Arduino microcontroller with an OPNET simulated wireless network system. OPNET is a tool to simulate the behaviour and performance of any type of network. In this system, it use various sensors such as motion and proximity sensor, gas sensor and camera. The job of microcontroller is to monitor the security of the environment and send the results to a remote system over the internet. The wireless network system consists of the local and remote location to the Arduino. Besides, the WLAN is responsible for connecting various modules on the Arduino to the internet and the remote network.

Furthermore, in this smart home system, the home automation system was designed with security features using the Bluetooth and Wi-Fi technologies. The system uses the Arduino-Mega microcontroller to interface with the Bluetooth and Wi-Fi shield of the Arduino. Hence, the microcontroller will able to provide both technology as media for communication and control and using Wi-Fi to remotely monitor the system.

The circuit diagram in figure 2.1.1 showing the connection of all components which are Arduino microcontroller, Bluetooth module, Wi-Fi shield, alarm module, internet protocol camera, motion and proximity sensor, gas sensor and relay. The relay is used to switch on or off the devices with voltages above 5 volts. In the circuit diagram, the Wi-Fi shield is stacked on the Arduino and the Bluetooth module is setup on the breadboard.

Chapter 2: Literature Review

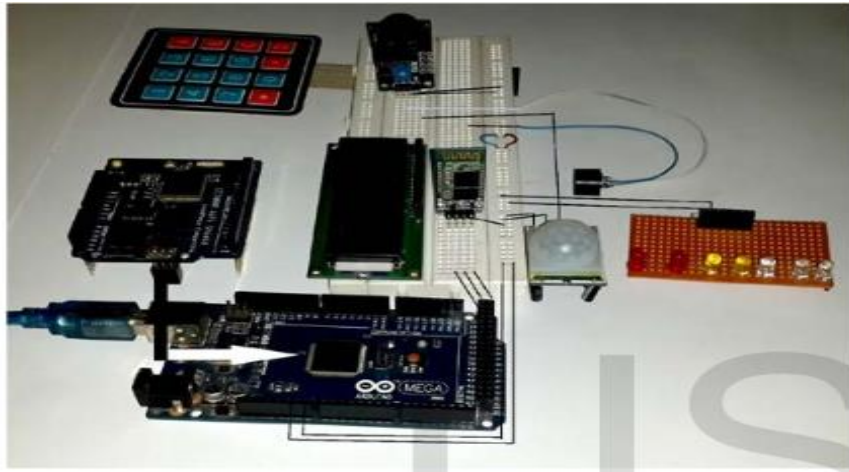


Figure 2.1.1 Circuit Diagram of Basic Components for the Remote Monitoring Security System

Regarding to the webpage of this product, the web interface is designed in HTML format in the Arduino IDE through the 'client' command. An example of a simple led blink can be found in the Arduino examples under Wi-Fi. The block of code which shown in figure 2.1.2 can fit to any network and also requires only addition of the network SSID and password of the user in the code sketch. The web interface for this project consist of an HTML page which collects data from the sensors and alerts any remotely connected host when it is necessary. Access also can be granted remotely if need to be from the web interface. Figure 2.1.3 shows the simple web page for this project which can be accessed through 192.168.43.143 from any wireless devices on the same LAN. On the sidebar, the microcontroller will upload all readings from sensors to the webserver (the Wi-Fi shield) and there is a button on the web page which used to activate the IP cam-era then streams the video feeds to the page.

```
20
21 #include <SPI.h>
22 #include <WiFi.h>
23
24
25 char ssid[] = "SMARTHOME"; // your network SSID (name)
26 char pass[] = "henry123"; // your network password
27 int keyIndex = 0; // your network key Index
28
29 int status = WL_IDLE_STATUS;
30
31 WiFiServer server(80);
32
```

Figure 2.1.2 Access point configuration in the Arduino IDE

Chapter 2: Literature Review

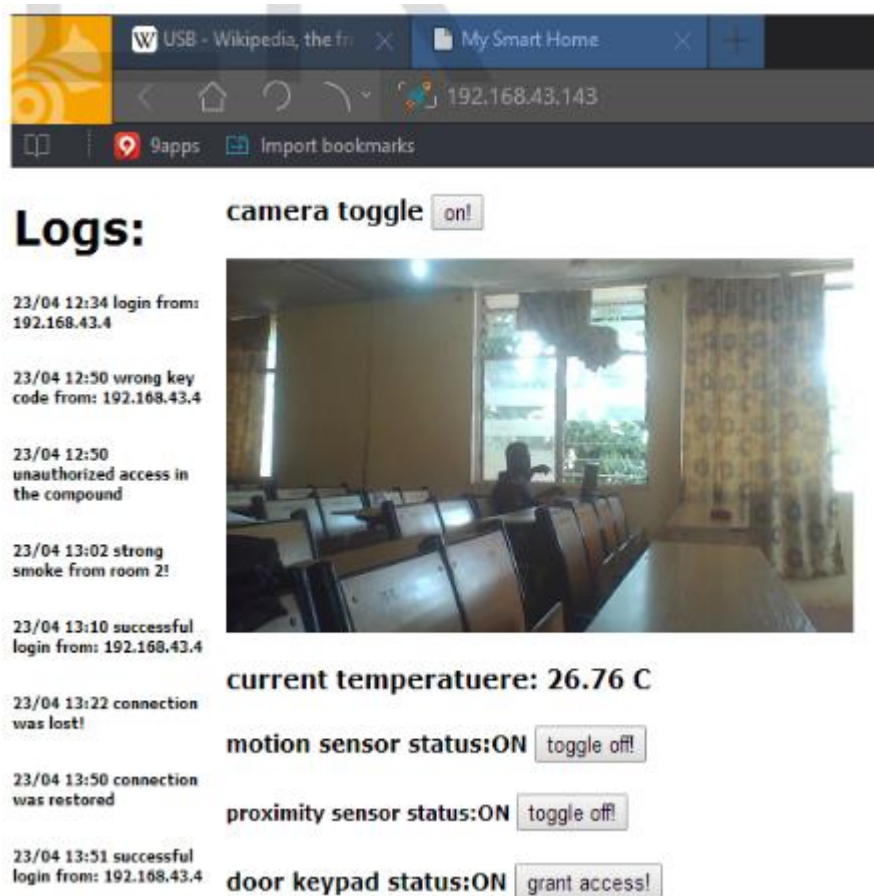


Figure 2.1.3 Webpage of Product (1)

After analyzing on their product, found that there have a few strengths and weakness on their product. In this product, they have two module which are Bluetooth and Wi-Fi shield for Arduino microcontroller to connect to user. The first one is Bluetooth which can be connected through smartphone and second one is Wi-Fi which can be connected through a web page in the smartphone or PC. Hence, this will benefits to the situation when there is not internet connect cause by internet service provider. Another strengths of this product is it has an internet protocol camera to view the status of the house, this really significantly enhance the system.

However, there are some **weaknesses** exist in this product. The minimum requirement for the speed of internet connection of that house is 2Mbps, or the otherwise the video captured will be delay. The slower the internet speed, the longer the delay.

Furthermore, there is another research related to this project, which is “**Design of a Home Automation system Using Arduino**” by (Nathanet.al, 2015).

Chapter 2: Literature Review

This product presents a cheaper and flexible home control and environmental monitoring system. It hosts an embedded micro web server in Arduino Mega 2560 microcontroller, with IP connectivity for accessing and controlling some devices or household appliances remotely. Hence, some of the devices or household appliance can be controlled through a web application or via Bluetooth Android based Smart phone application. To demonstrate the feasibility and effectiveness of this system, devices such as light switches, power plug, temperature sensor, gas sensor and motion sensors have been integrated with the proposed home control system.

Besides, the basic block diagram of the smart home system is shown in figure 2.1.4. The microcontroller of this system is used to obtain data of physical conditions through sensors connected to it. These integrated sensors such as the temperature sensor will read the temperature values, the gas sensor will detect smoke and gas to avoid fire outbreak. The automatic switching on and off of the light is controlled by the Light Dependent Resistor (LDR) which determines the day light intensity. Furthermore, this system also incorporates security in its design, a motion detector is integrated using Passive Infrared Sensor (PIR) to detect movement in the home when the security system is turned on. A relay switch is used to send control signals from the micro-controller to the electronic device used to achieve the switching on and off action. A webpage is designed with a one factor authentication system (username and password) to check the authenticity of the home user. It acts as an input device to control the home appliances and also acts as an output device to read the values of the physical conditions. Lastly, the mobile application also utilizes this same step to act as an input and output device in this system.

Chapter 2: Literature Review

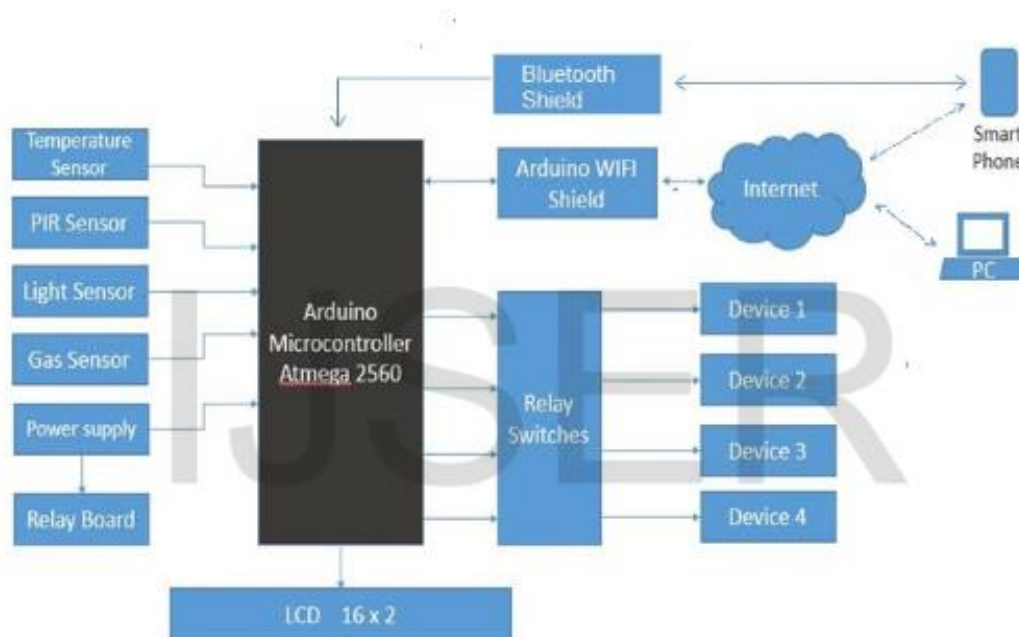


Figure 2.1.4 Block Diagram of System (1)

In regard with the strengths of this product, they use Adobe Dreamweaver, Hypertext Pre-Processor (PHP) and also Javascript as their web application language which shown in figure 2.1.5. Hence, the web pages will become so powerful and user friendliness and also has a colorful display of web item. This system also uses Google speech recognition engine to eliminate the need for external voice recognition module, so only the particular user can log in to the system for security purpose.

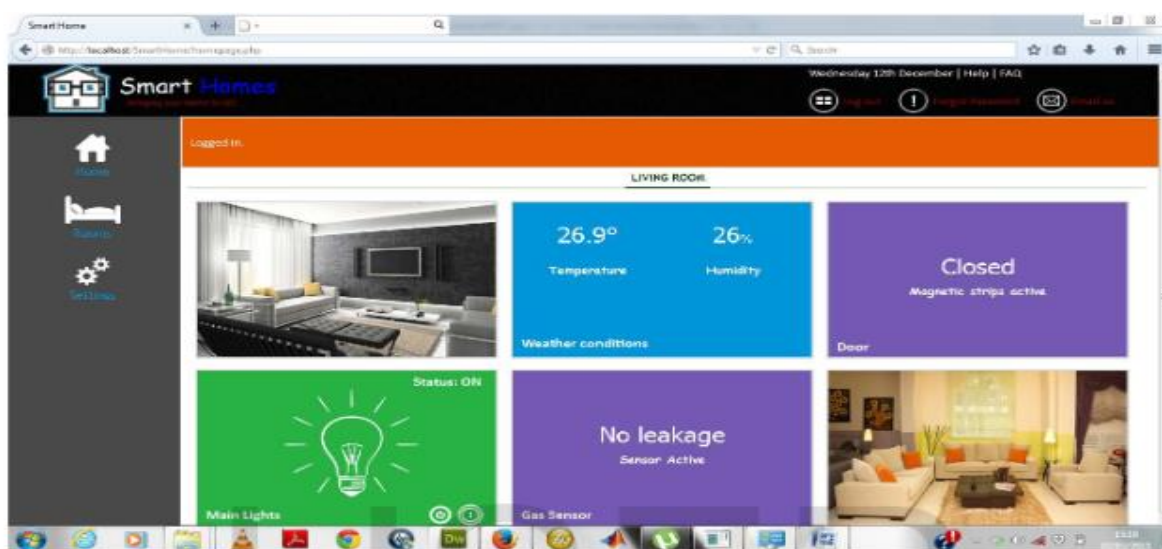


Figure 2.1.5 Webpage of Product (2)

Chapter 2: Literature Review

On other hand, there are some **weaknesses** exist in this product. The Bluetooth module connection between smartpone of this connection can be connected within the range of house only, as we know the distance of Bluetooth connection cannot be too long. In this project, the Bluetooth module is not going to add because the user still can use the mobile cellular such as 3G or 4G to access the system even though there is not internet provider outside the home.

Another research related to this project is “**Improving Home Automation Security; Integrating Device Fingerprinting into Smart Home**” develop by (ArUNET.al, 2016).

In this product, the writer explains about the importance of accessing modern smart homes over the internet and highlights various security issues associated with it. This paper also explain the evolution of Device Fingerprinting concept over time, and discusses various pitfalls in existing device fingerprinting approaches. In this system, it propose a two stage verification process for smart homes, using Device Fingerprints and Login Credentials which shown in figure 2.1.6. The system verifies the user device as well as the user accessing the home over the internet. Unlike any other approaches, the Device Fingerprinting algorithm in this system considers a device’s geographical location while computing its fingerprint. In this device identification experiment, the writer were able to successfully identify 97.93% of the devices that visited our webpage using JavaScript, Flash and Geolocation.

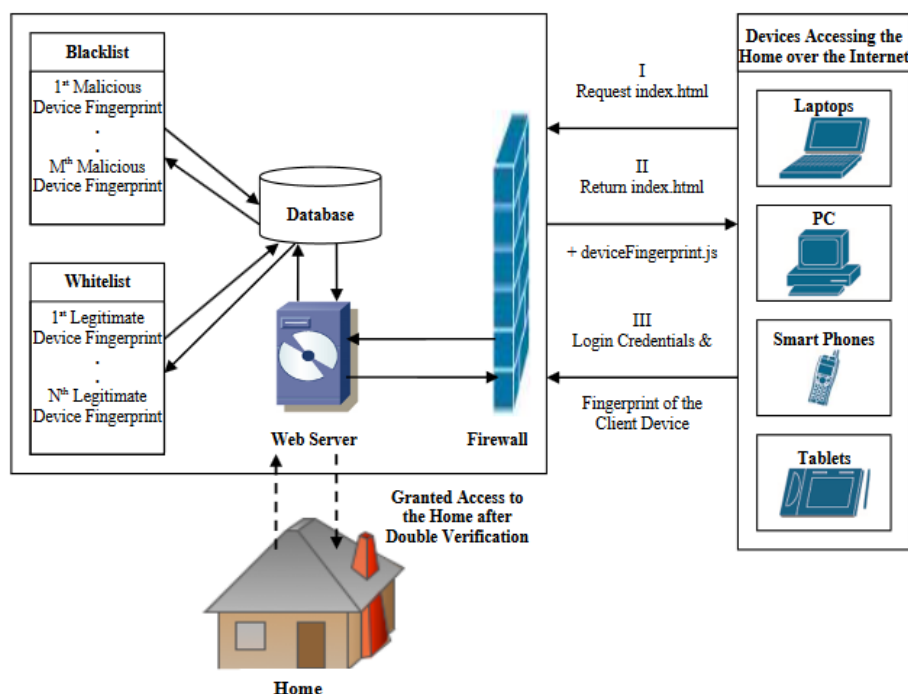


Figure 2.1.6 Logical Diagram of System

Chapter 2: Literature Review

In this product, the strengths of this system is, it have double layer of security: username and password as well as fingerprinting technique for protection purpose. User will not log in to the system either fail in any one of this layer of security. However, the weakness is the cost of this product is too expensive and this system also include complex fingerprint algorithm which required more knowledge to install, so the project will not consider this technique.

Thus, another research related to this project is “**Home Automation System Using Android and Arduino Board**” develop by (Poonam B. et.al, 2016).

In this product, this system makes use of existing GSM architecture to control the home appliance. Four different devices are controlled through Android APK. The Initially designed APK is installed on Smartphone and the messaging is done through SMS service which uses GSM architecture. The SMS is received by GSM modem which is interfaced to Arduino board. In accordance with SMS specific, the device will be switches ON or OFF through relay board. Moreover, the preface of the Global System for Mobile Communication (GSM) is mainly for the usage of cellular phones got the novelty of distance communication at remote location. This system makes use of this ability for remote control of instruments and appliances. In an example, a person on a drive within his car all of a sudden memorizes that he left the Cooler, ON actually it should be OFF. The usual circumstance is to drive back and switch OFF. But with the Android mobile phone in the hand equipped with GHAS (GSM Home Automation System) Application, one looks on how the same could be used to result control at any point, anywhere and time without worrying geographical locations. The block diagram in this system shown in figure 2.1.7.

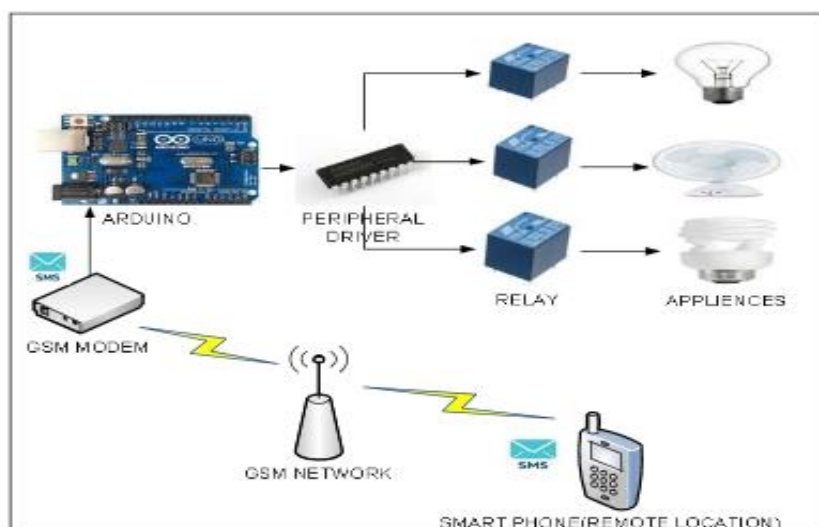


Figure 2.1.7 Block Diagram of System (2)

Chapter 2: Literature Review

In this product, this system make use of existing GSM architecture to control the home appliance. The initially designed APK is install on Smartphone and messaging is done through sms services with Arduino board. The strengths of this system is the usage of GSM network, with this type of network, user can control the home appliance by sending a SMS and not even use a smartphone but a normal hand phone So ,This will benefit to some elder, handicap and old people who do not know how to use a smartphone to surf internet. Thus, this system is very easy to use because the user just need to send a message through SMS to switch on or off a fan and after a few second, user will receive a massage to inform him that following operation has been done.

On other hand, some **weaknesses** exist in this product are sending the SMS message via GSM require some money and also require to have an extra GSM Model to operate with the microcontroller. Furthermore, the disadvantage of using GSM that is multiple users share with the same bandwidth. The transmission of GSM can be encountered interference if it shared with enough users. Another disadvantage of GSM is that it can interfere some electronics, such as pace makers and hearing aids. Such interference is because that GSM uses a pulse-transmission technology, so many locations such as hospitals and airplanes require hand phones to be turned off.

Moreover, another research related to this project is “**Smart Home Control by using Raspberry Pi & Arduino UNO**” develop by (Hamid et.al).

This product presents an inexpensive and a flexible home control and monitoring system by utilizing network based on Raspberry Pi and using Arduino Microcontroller. The interface between the Access Point and switches with IP connectivity for accessing some devices and the remotely controlling will be made by using Android based smartphone application or server computer. The switch node in this system connected to electrical devices which can be controlled using sensor and remotely controlled through an access point. The Smart Switch in this system for Smart Home development consists of two major parts that are smart switch device and the access point. Furthermore, the main hardware of this system consist of: Raspberry Pi, Arduino Microcontroller, nRF24L0+Wireless Transceiver, Relay Modules, LAMPS, Gang Switches, Plugs, Sensors and Wire Set. The expected outcomes from this system: programming by using Python that comes built-in with Raspbian, wireless module adapter to make connections between the Arduino Microcontroller and nRF24L0+ Wireless Transceiver.

Chapter 2: Literature Review

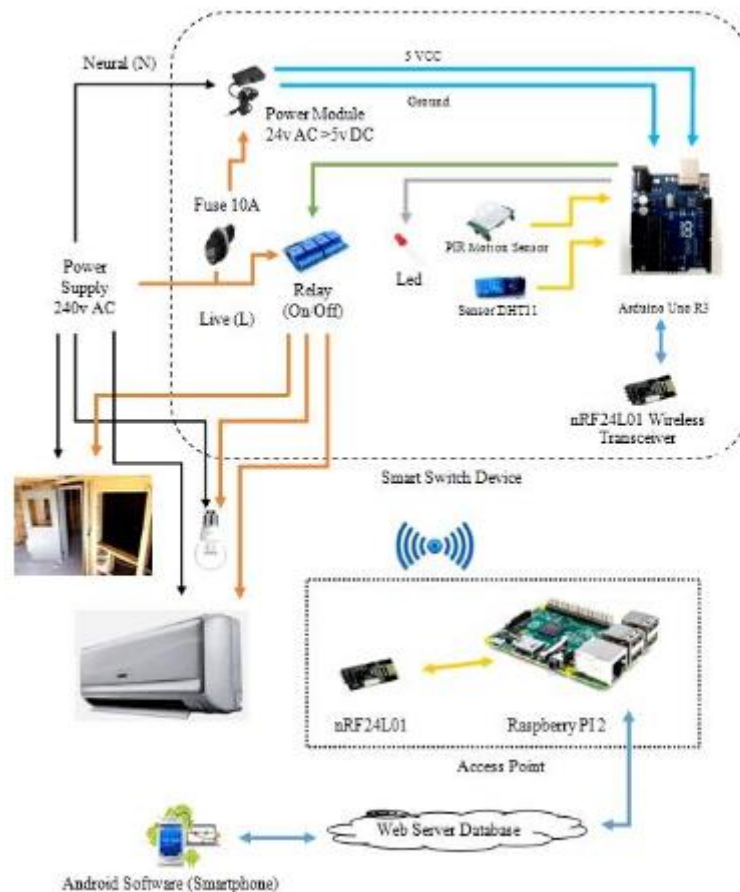


Figure 2.1.8 Block Diagram of System (3)

Regarding to the strengths of this system, it take advantages of the usage of nRF24L0+1 Wireless Transceiver as an access point between Arduino UNO and Raspberry Pi. Hence, no wire is needed for connection between Arduino UNO and Raspberry Pi, and the Raspberry Pi can take way from Arduino UNO about the range between 100 meters which benefit for better wire management.

On other hand, some **weaknesses** exist in this system are the mobile application design for smart home system is too simple and not attractive. In addition, this system also has some drawback which is lacking of sensors and less functionality. This is because that there are only one sensor which is temperature and humidity sensor implemented in this system and lead to insufficient of functionality.

Chapter 2: Literature Review

Similar Products related to this Project	Strengthness of Similar Products	Product of this project
Remote Monitoring Of An Arduino Based Home Automation Security System	<ol style="list-style-type: none"> 1. Two module which are Bluetooth and Wi-Fi shield for Arduino microcontroller to connect to interface of user devices. 2. An internet protocol camera to view the status of the house. 	<ol style="list-style-type: none"> 1. Only one module which is Wi-Fi shield for Arduino microcontroller to connect to interface of user devices. 2. A camera module connected to Raspberry PI to view the status of the house.
Design of a Home Automation system Using Arduino	<ol style="list-style-type: none"> 1. Adobe Dreamweaver, Hypertext Pre-Processor (PHP) and also JavaScript as web application language. 2. Google speech recognition for security log in. 	<ol style="list-style-type: none"> 1. Hypertext Pre-Processor (PHP) as web application. 2. Password for security log in.
Improving Home Automation Security;Integrating Device Fingerprinting Into Smart Home	<ol style="list-style-type: none"> 1. Double layer of security: username and password as well as fingerprinting technique for protection purpose. 	<ol style="list-style-type: none"> 1. Only one layer of security which is password encrypted.
Home Automation System Using Android and Arduino Board	<ol style="list-style-type: none"> 1. GSM architecture to control the home appliance. 	<ol style="list-style-type: none"> 2. Wi-Fi architecture to control the home appliance.
Smart Home Control by using Raspberry Pi &arduino UNO	<ol style="list-style-type: none"> 1. Usage of nRF24L0+1 Wireless Transceiver as an access point 	<ol style="list-style-type: none"> 2. Usage of Arduino Ethernet Sheid as an access point between

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	between Arduino UNO and Raspberry Pi	Arduino UNO and Raspberry Pi
--	--------------------------------------	------------------------------

Table 2.1.1 Differences between Similar Products and Product of this Project

Chapter3: System Design

3.1 Full System Diagram

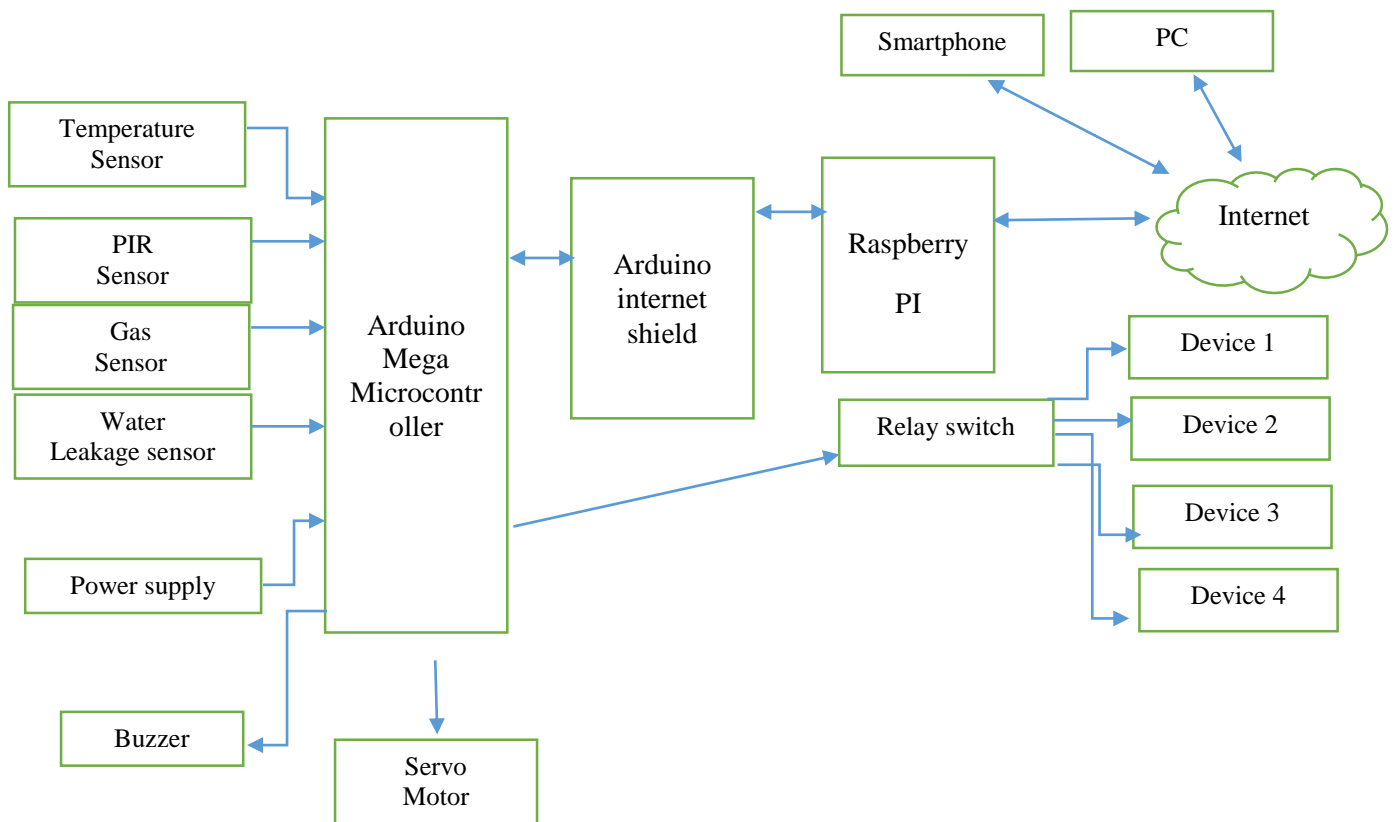
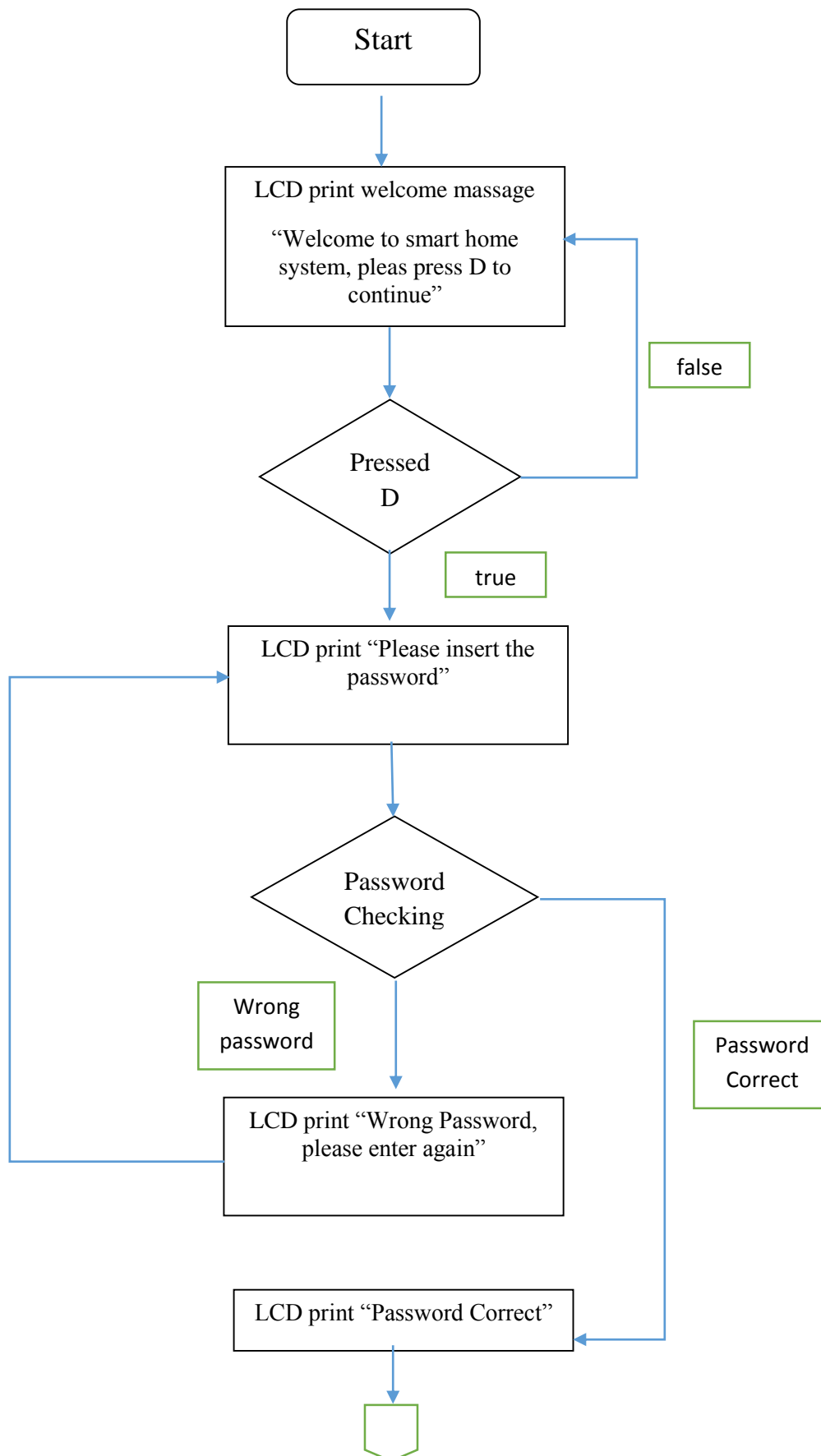


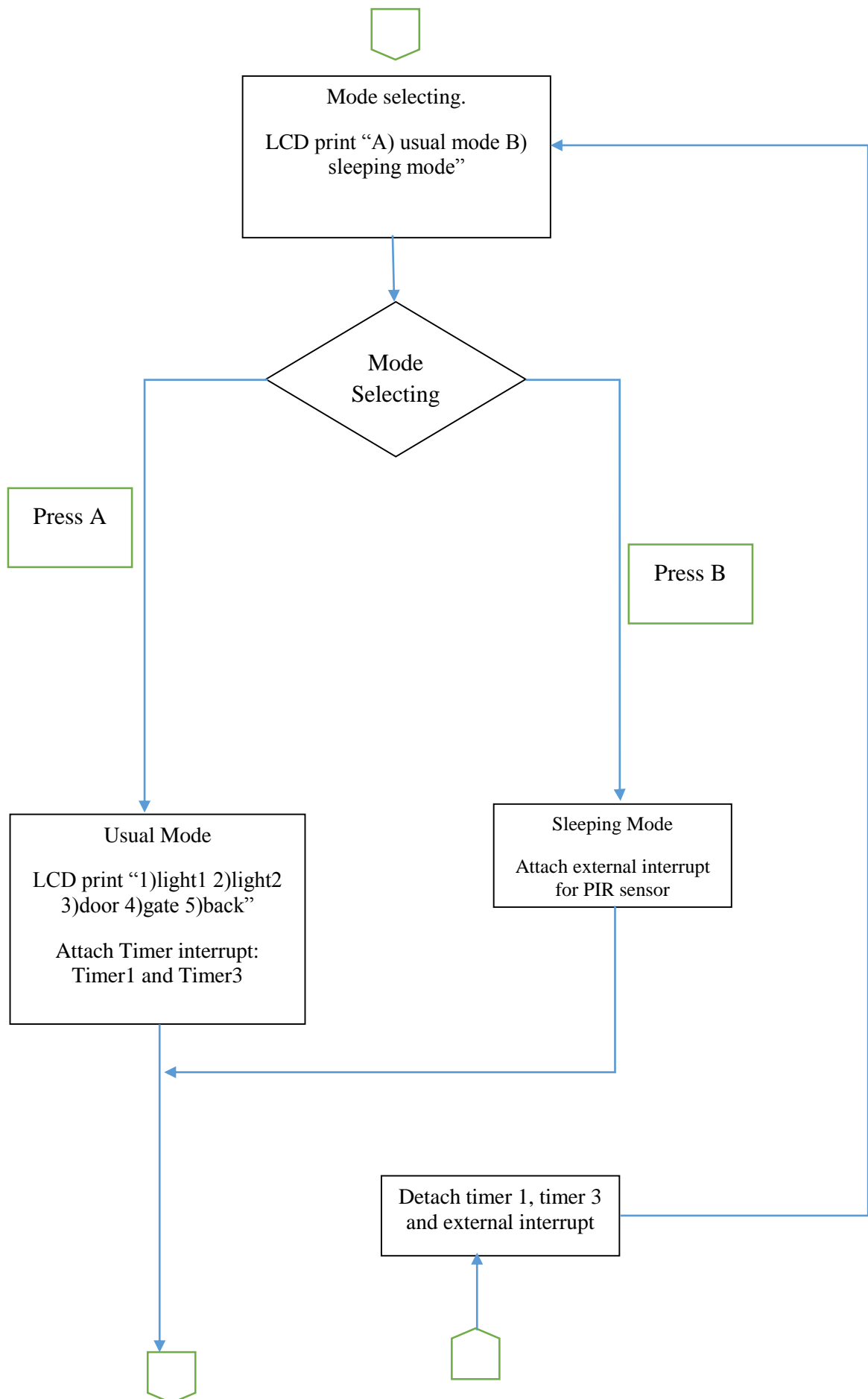
Figure 3.1.1 Full System Diagram

In this project, the Arduino Mega will be the main microcontroller to control all the sensor, servo motor and relay switch. Arduino internet shield is stacked up on the top of the Arduino Mega and it plays an important role to let the Arduino Mega connects to the internet so it can send data out to the server hosting by Raspberry Pi. There are four databases reside in the server which is Raspberry in this case, so all the data get from the server will save into the databases respectively. There is also a web page hosted by Raspberry Pi to display out all the data in the database. Besides, regarding to the automation, the Arduino Mega need to be plugged in to the USB slot of the Raspberry Pi by using a USB cable. This because that, the web page which hosts by Raspberry Pi will send a signal through the serial connection (which is USB wire connection) in order to do the operation of automation.

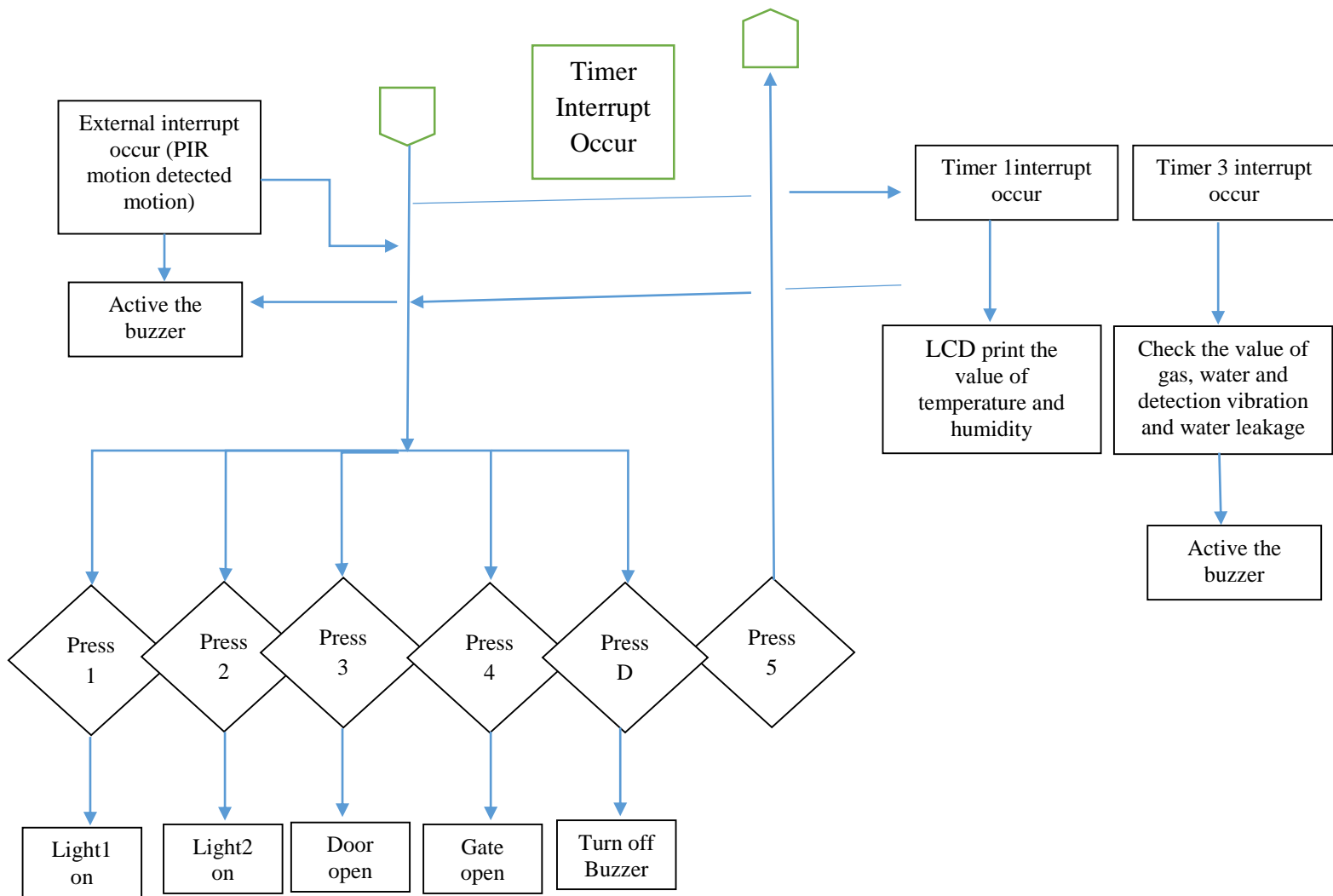
3.2 Flow Chart of Hardware Part



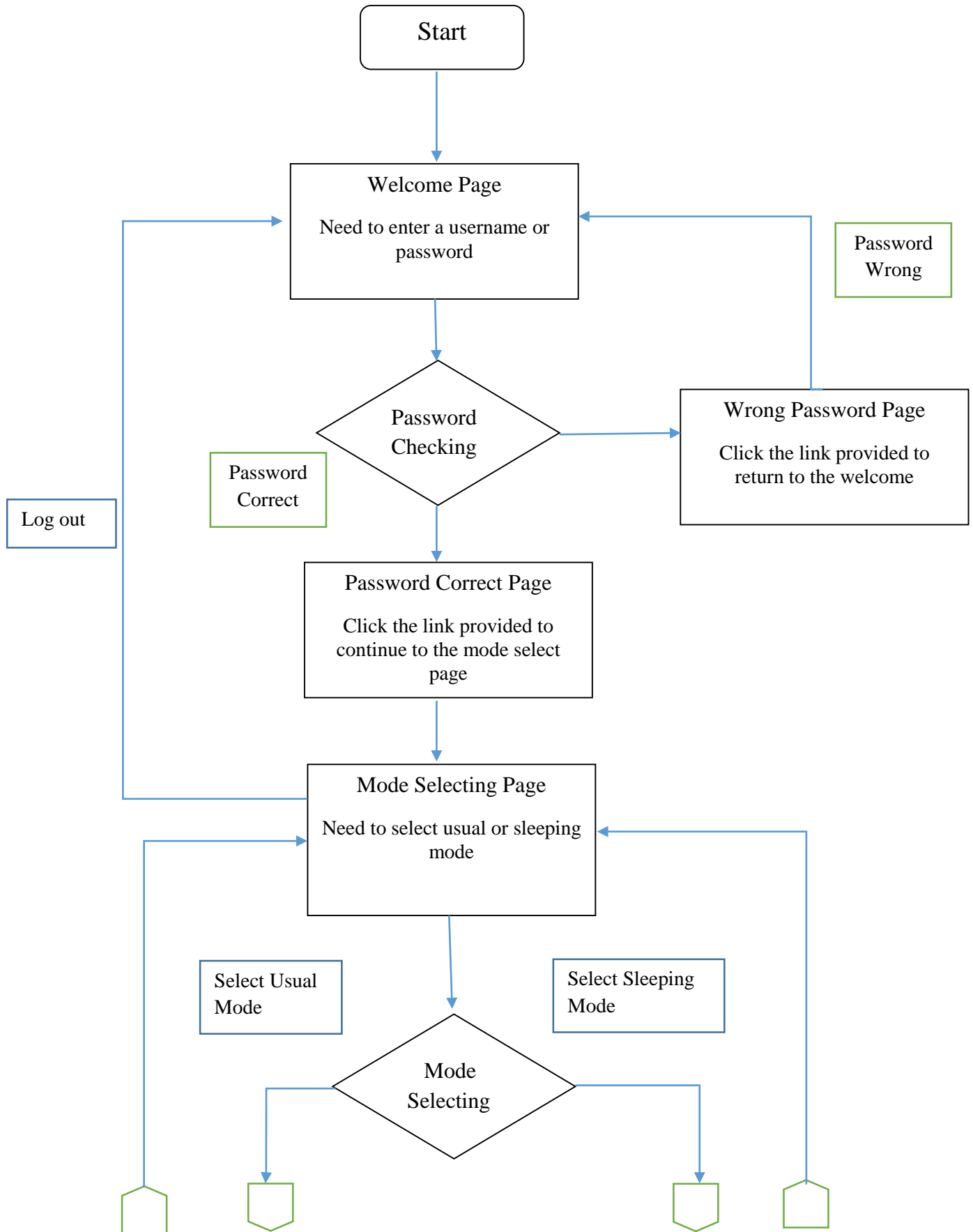
Chapter 3: System Design



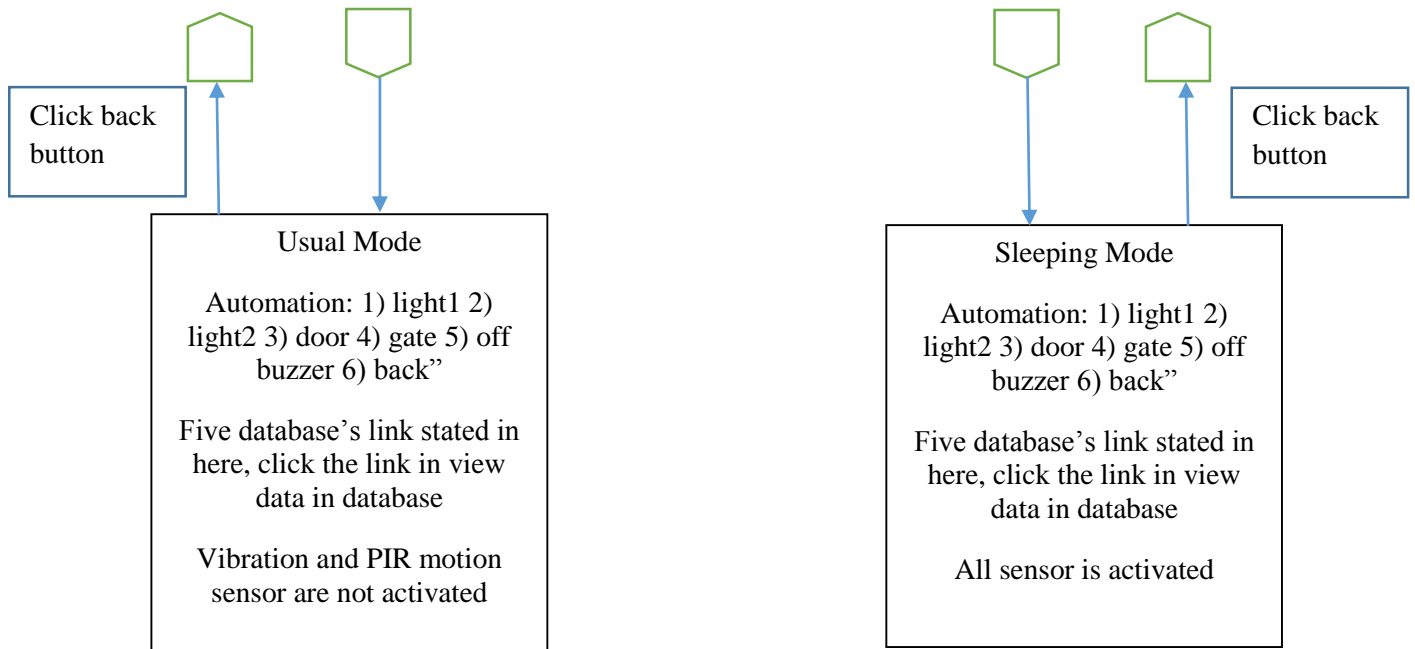
Chapter 3: System Design



3.3 Flow Chart of Software Part



Chapter 3: System Design



3.4 System Flow Diagram (both software and hardware)

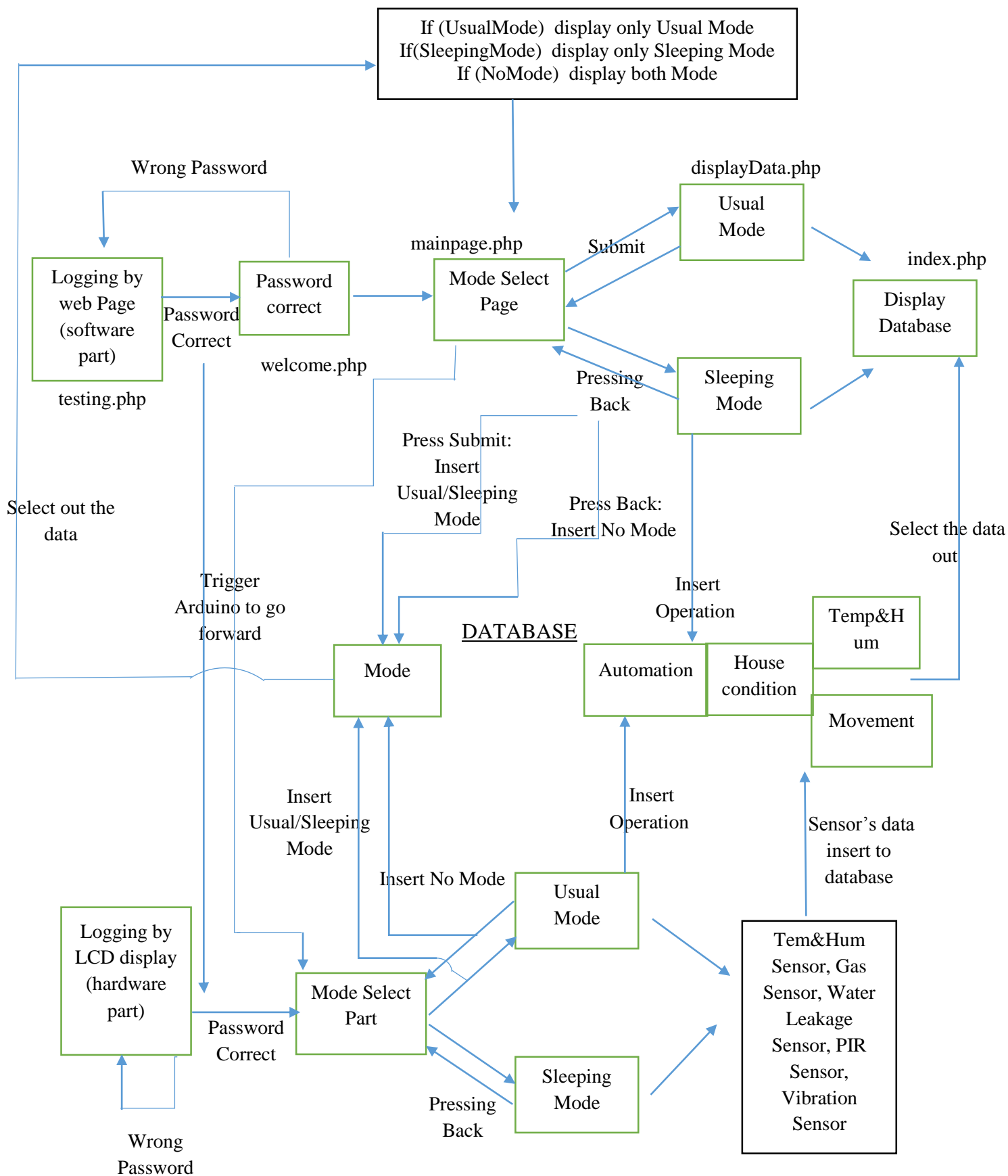


Figure 3.4.1 System Flow Diagram

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In the system flow diagram which shown as figure 3.4.1, user can either login to the smart home system by using a designated web page or LCD display and keypad (two user interfaces). The flow of web page is synchronized to the hardware part of the system which mean the flow of web page needs to work with the hardware part in order to run properly. For instance, if a user successfully login and move to the mode select page, it will also trigger the hardware part to move to the mode select part. In contrast, the hardware part of the system is not synchronized to the flow of web page which mean it can run individually.

In the software part, user need to provide a correct username and password in order to enter to the mode select page. At this movement, the system will trigger the hardware part to move the mode select part as well. Besides, the user will be lead back to the login page when entering a wrong password.

In the mode select page, there are three scenarios which the page only display usual or sleeping mode, or both of mode in the option of the form. Usually, there will be two mode for user to select, but the case of one mode is due to fact that user has been logging to one of mode in the hardware part. Hence, in the case of one mode, the mode select page will display only a mode which is the mode that user has already selected in the hardware part. This method is used to avoid difference login between two user interfaces.

After selecting a mode, the Arduino will also be trigger to one mode among the usual or sleeping mode and activated all the sensors and devices. The data of sensor also will be saved into database for displaying at the web page. The only difference between usual and sleeping mode is the PIR motion sensor and vibration sensor is only on at the sleeping mode.

In the hardware part, the user also needs to login to system with the same step with the software part.

Further explanation of the flow of web page will be discuss in sub-chapter 3.9 Web Page Design of This Project.

3.5 NOOBS installation on Raspberry Pi

First of all, in order to operate with Raspberry Pi, an operating system is necessary. There are two main operating system available in the Raspberry Pi website (www.raspberrypi.org) which is Raspbian and NOOBS. Raspbian is the Foundation's official supported operating system by Raspberry Pi while NOOBS is an easy operating system installer which contains Raspbian. It also can provide a selection of alternative operating systems which are then downloaded from the internet and installed. Hence, NOOBS is recommended to install in Raspberry Pi due to its simplicity and diversity. The step of installation is stated as below:

- 1) **Download the NOOBS operating system:** NOOBS is available for download on the Raspberry Pi website: raspberrypi.org/downloads which shown as figure 3.5.1. The zip file is recommended to download than torrent if the user is not familiar with torrenting.

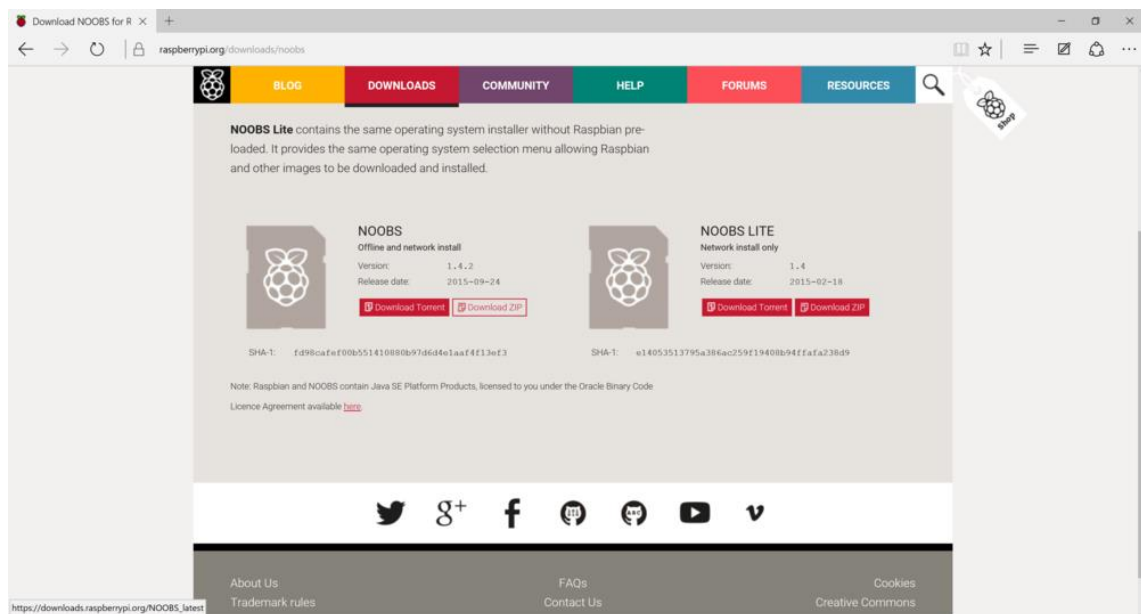


Figure 3.5.1 Download Website of NOOBS

- 2) **Transferring NOOBS on an SD card:** Once the NOOBS zip file is downloaded, the contents are needed to be unzipped and copied to a formatted SD card. To format a SD card, visit the SD Association's website and download SD Formatter 4.0 for either Windows or Mac and follow the instructions to format the SD card. Once the SD card has been formatted, drag all the files in the extracted NOOBS folder and drop them

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onto the SD card drive. So, the necessary files will then be transferred to your SD card. When this process has finished, safely remove the SD card and insert it into Raspberry Pi.

3) Booting the Raspberry Pi: Once SD Card has been inserted into Raspberry Pi and then plug with a power source, mouse and keyboard. The Raspberry Pi will be booted once the power source is plugged, and a window will appear with a list of different operating systems which shown as figure 3.5.2 that can be installed. It is recommended to use Raspbian by ticking the box next to Raspbian and click on install.

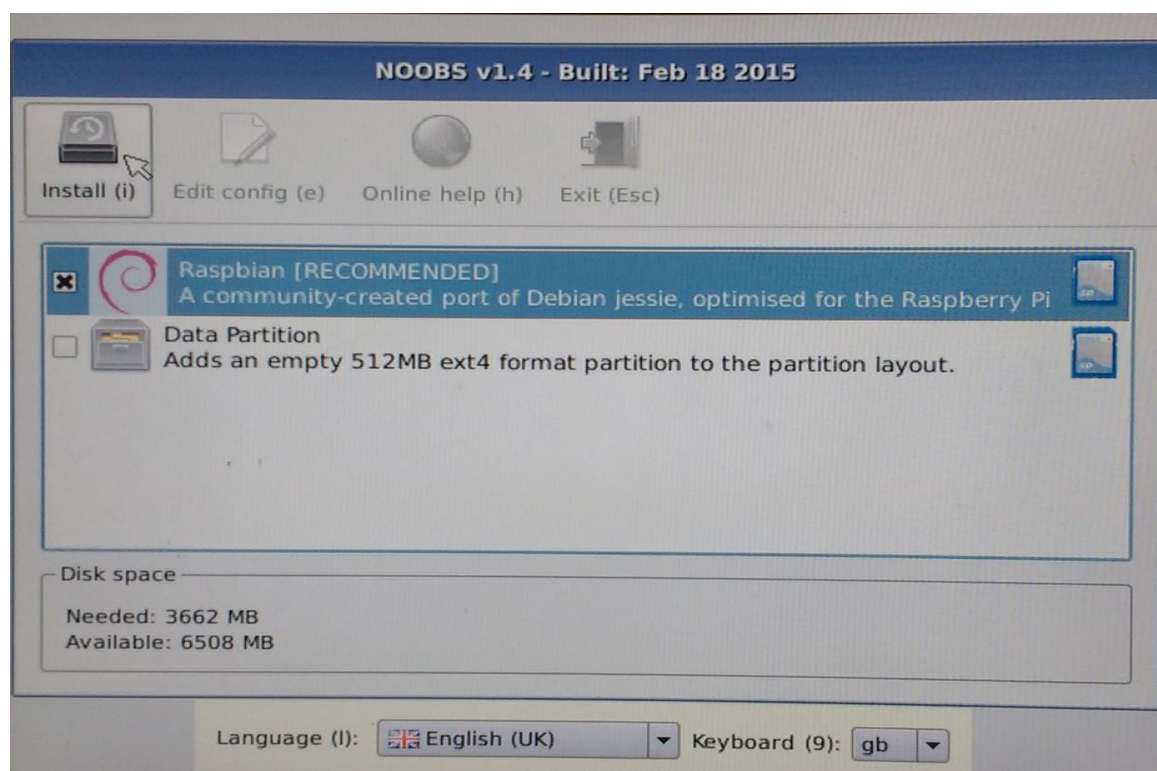


Figure 3.5.2 Selection of NOOBS Operating System

4) Logging in and accessing the graphical user interface: The default login for Raspbian is username `pi` with the password `raspberrypi`. To load the graphical user interface, type `startx` and press **Enter**.

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3.6 LAMP installation on Raspberry pi

The LAMP is a group of open source software that used to make web server run on user computer. The abbreviation of LAMP stands for Linux, Apache, PHP and MySQL. Hence, the installation of LAMP will include the installation of Apache, PHP and MySQL. The step of installation is stated as below:

Step 1) Install Apache:

- 1) First install the apache2 package by typing the following command in to the Terminal:

```
sudo apt-get install apache2
```

- 2) Testing the web server by browsing to `http://localhost/` or the IP address of the Raspberry Pi from another computer on the same network. To find the IP address of Raspberry Pi, type `ip address` in the command line.
- 3) Browse to the default web page either on the Raspberry Pi or from another computer on the same network and the default web page which shown as figure 3.6.1 will be popped up. Hence, this mean that the Apache web server is working.

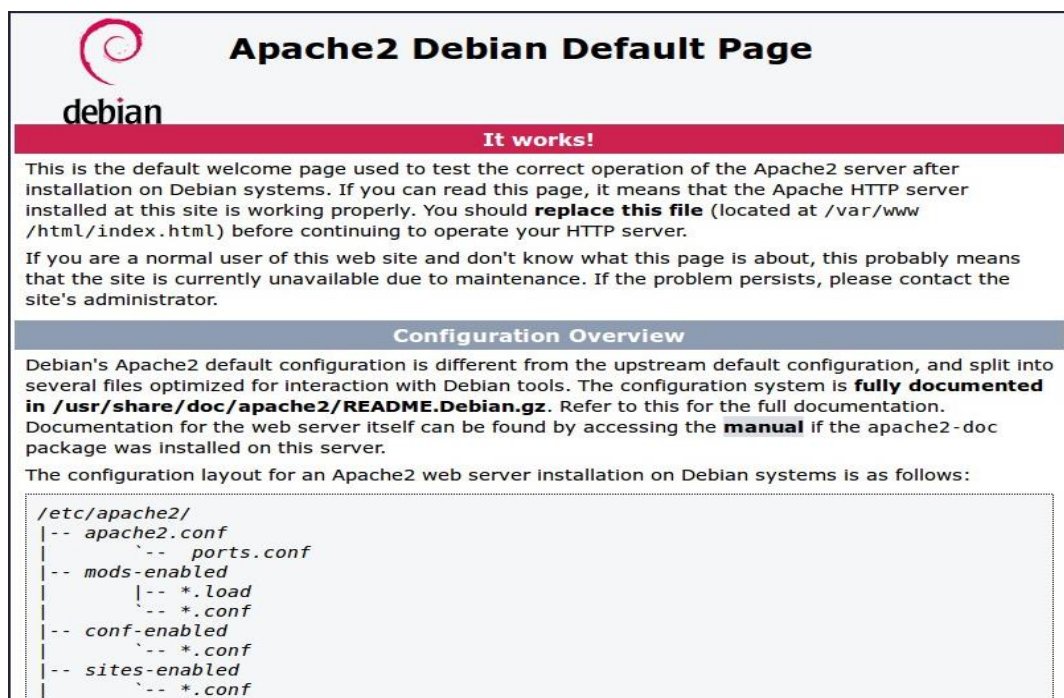


Figure 3.6.1 Default Page of Apache2

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- 4) Change the default web page by navigating to the directory shown below in a terminal window:

```
cd /var/www/html
ls -al
```

This is because that the default web page is just a HTML file on the file system. It is located at `/var/www/html/index.html`. Please **note that the directory was `/var/www` in Raspbian Wheezy but is now `/var/www/html` in Raspbian Jessie.**

- 5) After typing in the command in terminal, the following file will be shown as below:

```
total 12
drwxr-xr-x 2 root root 4096 Jan  8 01:29 .
drwxr-xr-x 12 root root 4096 Jan  8 01:28 ..
-rw-r--r-- 1 root root 177 Jan  8 01:29 index.html
```

This shows that by default there is one file in `/var/www/html/` called `index.html` and it is owned by the `root` user (as is the enclosing folder). In order to edit the file, it is necessary to change its ownership to the user's own username. Change the owner of the file (the default `pi` user is assumed here) using `sudo chown pi: index.html`. Lastly, the user can try to edit his own HTML page and view his page in the web browser.

Step 2) Install PHP:

- 1) In order to allow the Apache server to process PHP files, it is required to install PHP5 and the PHP5 module for Apache. Type the following command to install these:

```
sudo apt-get install php5 libapache2-mod-php5 -y
```

- 2) Now remove the `index.html` file by typing `sudo rm index.html` and create a php file `index.php` by typing `sudo nano index.php`.

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- 3) Put some PHP content in it :`<?php echo "hello world"; ?>`. Now save and refresh the browser. The “hello world” word should pop up in the web page. This is not dynamic but still served by PHP. Try something dynamic by typing in the following command:

```
<?php echo date('Y-m-d H:i:s'); ?>
or
<?php phpinfo(); ?>// this will pop up the page as figure 3.6.2
```



PHP Version 5.2.3-1ubuntu6.3	
System	Linux grenadine 2.6.18-xenU #3 SMP Thu Jan 10 15:56:11 CET 2008 i686
Build Date	Jan 10 2008 09:24:13
Server API	Apache 2.0 Handler
Virtual Directory Support	disabled
Configuration File (php.ini) Path	/etc/php5/apache2
Loaded Configuration File	/etc/php5/apache2/php.ini
Scan this dir for additional .ini files	/etc/php5/apache2/conf.d
additional .ini files parsed	/etc/php5/apache2/conf.d/curl.ini, /etc/php5/apache2/conf.d/gd.ini, /etc/php5/apache2/conf.d/mysql.ini, /etc/php5/apache2/conf.d/mysqli.ini, /etc/php5/apache2/conf.d/pdo.ini, /etc/php5/apache2/conf.d/pdo_mysql.ini, /etc/php5/apache2/conf.d/pspell.ini, /etc/php5/apache2/conf.d/ldap.ini
PHP API	20041225
PHP Extension	20060613
Zend Extension	220060519
Debug Build	no
Thread Safety	disabled
Zend Memory Manager	enabled
IPv6 Support	enabled

Figure 3.6.2 PHP Information Page

Step 3) Install MySQL:

- 1) Install MySQL by entering the following commands:

```
$ sudo apt-get install mysql-server
```

When prompted the figure 3.6.3 as stated below, enter a password for the MySQL root account. This is different to your root account for the Raspberry Pi. This password is specifically for the MySQL root user. The MySQL root user has special privileges so that this user can create, delete and manipulate databases.

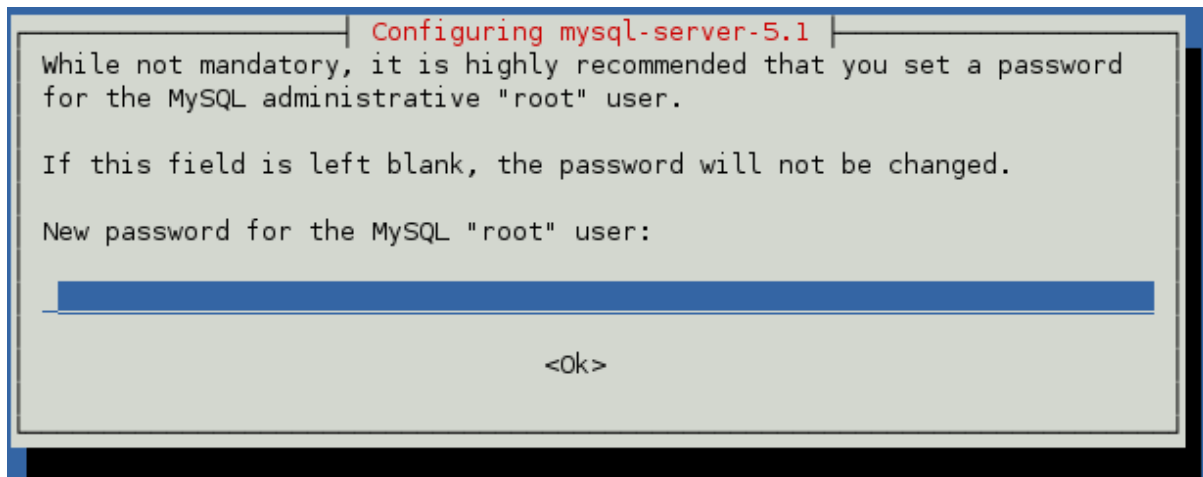


Figure 3.6.3 Password Request Page of MySQL

- 2) When the installation is complete, user need to log into the MySQL shell in order to access the database. This will be used to communicate and issue commands to the MySQL server. At the terminal enter the following command:

```
mysql -u root -p
```

This command starts the MySQL client with the user of root and will prompt you to enter your MySQL root password which shown as figure 3.6.4.

```
root@debian:/home/cynic# mysql -u root -p
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 41
Server version: 5.1.73-1 (Debian)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> █
```

Figure 3.6.4 Login Terminal of MySQL

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- 3) The above screen shot is the MySQL monitor interface. It will be used to connect, create, delete and modify databases and tables within MySQL. There are alternatives to the command line and one of these is called PHPMysqlAdmin.

3.7 How Arduino Save Data to Database and Display It on Web Page

The objective of this topic is to use Arduino to read data from sensor and send the values to the internet, the data stored in a Web Server and displayed it on a particular webpage. With this way, the data get from the sensor can be monitoring easily and also enable user to get the historic information. It also allows user to capture data from multiple data input devices and display them when and how user want. Even though this could also be done with a dedicated web page which hosting by Arduino itself, it is easier to store it to a database and create a web page (or user interface) that reads data from the database. The following steps are states below:

Step1) Connect Arduino to the Local Area Network:

- 1) Stack the Ethernet shield on Arduino like the image shown in figure 3.7.1 so the Arduino will able to connect to internet.

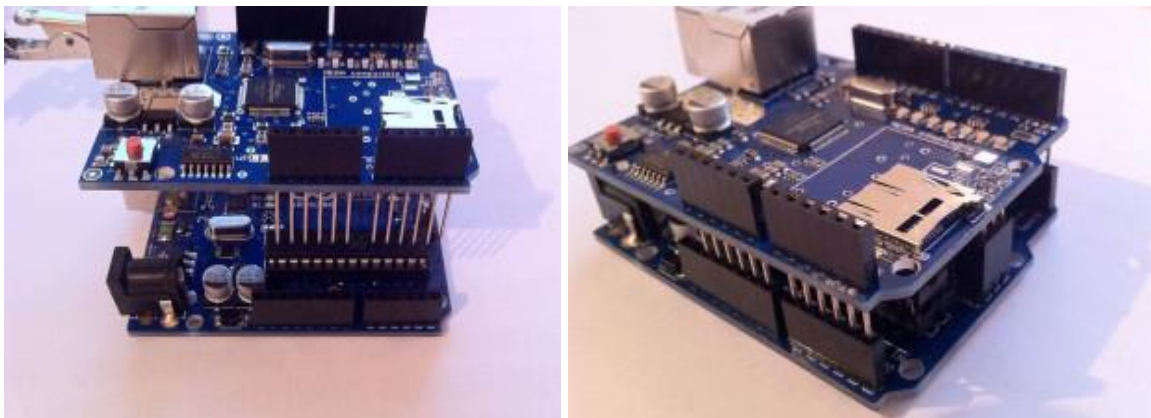


Figure 3.7.1 Connection between Arduino and Arduino Ethernet Shield

- 2) Connect USB and network Ethernet cable – USB goes into Arduino, and network cable into the Shield stacked on top of Arduino as image shown below. If everything is ok, Shield LEDs and Ethernet port will light up which shown in figure 3.7.2.

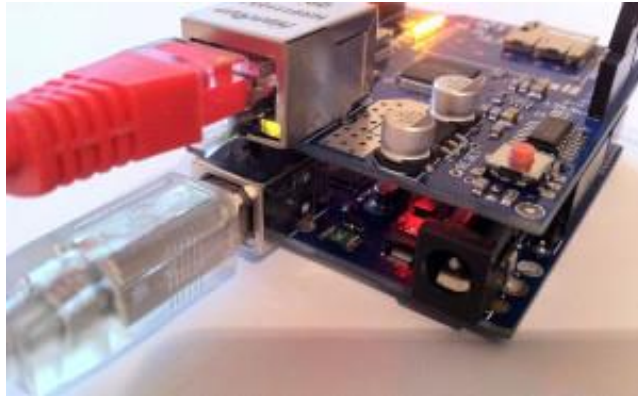


Figure 3.7.2 LED Light Up Image in Arduino Ethernet Shield

Step2) Prepare the database:

- 1) Login to database with command in terminal:

```
mysql -u root -p
```

Enter the password with the root user.

- 2) Creating the database with the following command:

```
CREATE DATABASE test;
```

- 3) The database has been created but now user need to work on that database. This is done by issuing the USE command. Enter the following.

```
mysql> USE test;
```

The user will receive a confirmation that the database has changed. All future commands will be performed on the test database.

Rather than use the MySQL root account to access each database, it is far more secure to create a user with less privileges. This is because that it limits any changes to this database only. The following command will do just that as image shown in figure 3.7.3. The user will be called gamer and it is this user's job to maintain the test database.

```
mysql> CREATE USER 'gamer'@'localhost' IDENTIFIED BY 'password';
```



```
mysql> CREATE USER 'gamer'@'localhost' IDENTIFIED BY 'password';  
Query OK, 0 rows affected (0.00 sec)
```

Figure 3.7.3 Creating User in MySQL Terminal

- 4) This creates the user called 'game@localhost' with the password of password. Next, it is required to setup the actions that this user can perform.

```
mysql> GRANT ALL PRIVILEGES ON test.* TO 'gamer'@'localhost';
```

This allows all actions to be performed on the test database for the gamer@localhost user.

- 5) The next command refreshes the database with the new privileges that user have just created and informs mysql to update its internal data with the new user privileges.

```
mysql> FLUSH PRIVILEGES;
```

If user do not issue the FLUSH PRIVILEGES command then he will not be able to login using the game user unless by rebooting the Raspberry Pi.

- 6) Hence, at this movement, the user can create tables in this particular database under the username of gamer by the following command:

```
CREATE TABLE tempLog (  
    timeStamp TIMESTAMP NOT NULL PRIMARY KEY,  
    temperature int(11) NOT NULL,  
    humidity int(11) NOT NULL,  
);
```

- 7) The database is used obviously to store the readings get from temperature and humidity sensor, so that they can be accessed later. It's a very simple database, with just one table with 3 columns. It stores the time stamp and the corresponding temperature and humidity values.

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Step3) Create files that will capture data sent from Arduino and write it to database:

- 1) The easiest way to get data from Arduino to the database is to use PHP and HTTP POST request method. It is because that the Information sent with the POST method is invisible to others (all names/values are embedded within the body of the HTTP request) and has no limits on the amount of information to send.
- 2) Create a PHP file that connect to the database with the database name, password and table. In this project, the name of PHP file is *connect.php* which uses to connect to the database as image shown in figure 3.7.4:

```
1 <?php
2
3 function Connection(){
4     $server="server";
5     $user="user";
6     $pass="pass";
7     $db="database";
8
9     $connection = mysql_connect($server, $user, $pass);
10
11     if (!$connection) {
12         die('MySQL ERROR: ' . mysql_error());
13     }
14
15     mysql_select_db($db) or die( 'MySQL ERROR: ' . mysql_error() );
16
17     return $connection;
18 }
19 ?>
```

Figure 3.7.4 File of *connect.php*

The *connect.php* is writing in term of function because it is convenient for other PHP file to call it when there are multiple PHP files.

- 3) Create a PHP file that will write the data get from Arduino to the database. In this project, the name of this PHP file is *add.php* which uses to write data to the database as image shown in figure 3.7.5:

```
1 <?php
2     include("connect.php");
3
4     $link=Connection();//call the function inside the connect.php
5
6     $temp1=$_POST["temp1"]; //get data from Arduino
7     $hum1=$_POST["hum1"];
8
9
10
11     $query = "INSERT INTO `tempLog` (`temperature`, `humidity`) //insert data to the database
12     VALUES ('".$temp1."','".$hum1."')";
13
14     mysql_query($query,$link);
15     mysql_close($link);
16
17     header("Location: index.php");
18 ?>
19
```

Figure 3.7.5 File of *add.php*

Step4) Write an Arduino code to send the data get from the sensor:

- 1) When the database is already created and the PHP file that writes data to database also is ready, the task of Arduino code is to send the current reading data get from sensor. In this project, the available sensors are temperature and humidity sensor, water leakage sensor, gas sensor, vibration sensor and PIR motion sensor.

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2) The Arduino code is shown in:

```
#include <DHT.h>
#include <Ethernet.h>
#include <SPI.h>

byte mac[] = { 0x00, 0xAA, 0xBB, 0xCC, 0xDE, 0x01 }; // RESERVED MAC ADDRESS
EthernetClient client;

#define DHTPIN 2 // SENSOR PIN
#define DHTTYPE DHT11 // SENSOR TYPE - THE ADAFRUIT LIBRARY OFFERS SUPPORT FOR MORE MODELS
DHT dht(DHTPIN, DHTTYPE);

long previousMillis = 0;
unsigned long currentMillis = 0;
long interval = 250000; // READING INTERVAL

int t = 0; // TEMPERATURE VAR
int h = 0; // HUMIDITY VAR
String data;

void setup() {
  Serial.begin(115200);

  if (Ethernet.begin(mac) == 0) {
    Serial.println("Failed to configure Ethernet using DHCP");
  }

  dht.begin();
  delay(10000); // GIVE THE SENSOR SOME TIME TO START

  h = (int) dht.readHumidity();
  t = (int) dht.readTemperature();

  data = "";
}

void loop(){
  currentMillis = millis();
  if(currentMillis - previousMillis > interval) { // READ ONLY ONCE PER INTERVAL
    previousMillis = currentMillis;
    h = (int) dht.readHumidity();
    t = (int) dht.readTemperature();
  }

  data = "temp1=" + t + "&hum1=" + h;

  if (client.connect("www.*****.*****.com",80)) { // REPLACE WITH YOUR SERVER ADDRESS
    client.println("POST /add.php HTTP/1.1");
    client.println("Host: *****.*****.com"); // SERVER ADDRESS HERE TOO
    client.println("Content-Type: application/x-www-form-urlencoded");
    client.print("Content-Length: ");
    client.println(data.length());
    client.println();
    client.print(data);
  }

  if (client.connected()) {
```

Figure 3.7.6 Arduino Code to Send Data to Server

The code which drawn by the box is main code to send data to the file *add.php* which host by Raspberry Pi server. Some part of the Arduino code need to replace with the Arduino MAC address and server IP address.

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Step5) Display the data to the web page:

- 1) To display data in the database, it is easiest to make a PHP webpage that will read data from database and refresh every few seconds.
- 2) Creating the php file that will read data from database. In this project, the name of this PHP file is *index.php* which uses to display data from database to the web page as image shown below:

```
1 <?php
2
3     include("connect.php");
4
5     $link=Connection(); // connect to the database
6
7     $result=mysql_query("SELECT * FROM `tempLog` ORDER BY `timeStamp` DESC",$link); //select the data out from database
8 ?>
9
10 <html>
11 <head>
12     <title>Sensor Data</title>
13 </head>
14 <body>
15 <h1>Temperature / moisture sensor readings</h1>
16
17 <table border="1" cellspacing="1" cellpadding="1">
18     <tr>
19         <td>&nbsp;Timestamp&nbsp;</td>
20         <td>&nbsp;Temperature 1&nbsp;</td>
21         <td>&nbsp;Moisture 1&nbsp;</td>
22     </tr>
23
24     <?php
25         if($result!=FALSE){
26             while($row = mysql_fetch_array($result)) {
27                 printf("<tr><td> &nbsp;%s </td><td> &nbsp;%s&nbsp;</td><td> &nbsp;%s&nbsp;</td></tr>",
28                     $row["timeStamp"], $row["temperature"], $row["humidity"]); //Display the data
29             }
30             mysql_free_result($result);
31             mysql_close();
32         }
33     ?>
34
35 </table>
36 </body>
37 </html>
38
```

Figure 3.7.7 File of *index.php*

The file of *index.php* contain both PHP and HTML language which PHP works as extract data from database and HTML works as describing the basic structure of a webpage.

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- 3) Hence, if everything worked as planned, when the user open the page *index.php*, he should get the data that wrote in database from the sensor as the image shown in figure 3.7.8:

Temperature / moisture sensor readings

Timestamp	Temperature	Moisture
2014-07-06 17:16:15	26	54
2014-07-06 17:11:14	26	54
2014-07-06 17:06:14	26	54
2014-07-06 17:01:13	26	54
2014-07-06 16:56:12	26	54
2014-07-06 16:51:11	26	55
2014-07-06 16:46:11	26	55
2014-07-06 16:41:10	26	55
2014-07-06 16:36:09	26	55
2014-07-06 16:31:08	26	55
2014-07-06 16:26:07	26	55
2014-07-06 16:21:06	26	55
2014-07-06 16:16:06	26	55
2014-07-06 16:11:05	26	55
2014-07-06 16:06:04	26	55
2014-07-06 16:01:03	26	55
2014-07-06 15:56:03	26	55
2014-07-06 15:51:02	26	55
2014-07-06 15:46:01	26	55
2014-07-06 15:41:00	26	54
2014-07-06 15:35:59	26	55
2014-07-06 15:30:59	26	54
2014-07-06 15:25:58	26	55
2014-07-06 15:20:57	26	55
2014-07-06 15:15:56	26	55
2014-07-06 15:10:56	26	55
2014-07-06 15:05:55	26	55
2014-07-06 15:00:54	26	56
2014-07-06 14:55:53	26	56
2014-07-06 14:50:52	26	55

Figure 3.7.8 Temperature and Moisture Sensor Readings

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3.8 How PHP Controls Arduino

This topic is about how automation happen in this project. The automation actually mean user can switch on some of the household appliance by just clicking the designate button ready on the website. This topic assume reader has been finished the installation of NOOBS and LAMP on Raspberry Pi. The following step stated below show how PHP can transmit a signal from Raspberry Pi to Arduino.

Step1) Using the serial port in PHP:

- 1) The core of this technique is using the fopen() command. This is normally used for opening a document to edit within the code (like if user wrote a script to make a text file with some information in it and save it). Instead, this technique exploits how Linux views files and use it on a port. Initially, the Arduino IDE need to be installed from the Raspberry Pi. Thus, kindly plug in the Arduino cable into the USB port of Raspberry Pi and open the Arduino IDE window. The device name will be indicated under the ports menu. It will probably be /dev/ttyUSB0 or something similar.
- 2) The code stated in figure 3.8.1 show that the opening of some port as a file and write the numbers 2 to 11 based on what button is pressed:

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```
22 <?php
23
24
25 $verz="1.0";
26 $comPort = "/dev/ttyACM0"; /*change to correct com port */
27
28 if (isset($_POST["rcmd"])) {
29     $rcmd = $_POST["rcmd"];
30     switch ($rcmd) {
31         case on:
32             $fp =fopen($comPort, "w");
33             fwrite($fp, 2); /* this is the number that it will write */
34             fclose($fp);
35             break;
36         case off:
37             $fp =fopen($comPort, "w");
38             fwrite($fp, 3); /* this is the number that it will write */
39             fclose($fp);
40             break;
41         case on2:
42             $fp =fopen($comPort, "w");
43             fwrite($fp, 4); /* this is the number that it will write */
44             fclose($fp);
45             break;
46         case off2:
47             $fp =fopen($comPort, "w");
48             fwrite($fp, 5); /* this is the number that it will write */
49             fclose($fp);
50             break;
51         case open:
52             $fp =fopen($comPort, "w");
53             fwrite($fp, 6); /* this is the number that it will write */
54             fclose($fp);
55             break;
56         case close:
57             $fp =fopen($comPort, "w");
58             fwrite($fp, 7); /* this is the number that it will write */
59             fclose($fp);
60             break;
61         case back:
62             $fp =fopen($comPort, "w");
63
64
65
66
67
68
69
70
71
72
73
74 |default:
75     die('Crap, something went wrong. The page just puked.');
```

Figure 3.8.1 Code of File Opening In Port

Step2) How Arduino reads the signal send from Raspberry Pi:

- 1) Each time a button on the page is pressed, the case statement happens and the "file" (really the port) is opened, put into write mode, a single ASCII number is written, and then it's closed. The ports need to close it each time or else it won't work.
- 2) On the Arduino side, simply read in from the serial port by using Serial.read() in the loop(). The code indicates the usage of if statement to check for each ASCII number, so if 1 is sent, then do one thing, if 2 is sent, do another thing, etc. Since PHP server is running once Raspberry Pi is on, the user can access the page on the server from anywhere in the world and it will control the Arduino. Here's some example Arduino code which stated in figure 3.8.2 that used to control some of the household appliances:

```
void loop() { //main loop
  if (Serial.available() > 0) { //if there is anything on the serial port, read it
    usbnumber = Serial.read(); //store it in the usbnumber variable
    Serial.println(usbnumber);
  }

  if(key || usbnumber){
    if (key == '1'&& lightCount1==0 || usbnumber==50) { // $fp=2
      //when '1' is pressed allow the user to input a key.

      Serial.println("light1 on");
      digitalWrite(ledPin1, HIGH);
      usbnumber=0;
    }
    else if(key == '1'&& lightCount1==1 || usbnumber==51){ // $fp=3
      Serial.println("light1 off");
      digitalWrite(ledPin1, LOW);
      usbnumber=0;
    }
  }
  else if (key == '2'&& lightCount2==0 || usbnumber==52) { // $fp=4
    //when '2' is pressed allow the user to input a key.

    Serial.println("light2 on");
    digitalWrite(ledPin2, HIGH);
    usbnumber=0;
  }
  else if(key == '2'&& lightCount2==1 || usbnumber==53){ // $fp=5
    Serial.println("light2 off");
    digitalWrite(ledPin2, LOW);
    usbnumber=0;
  }
}
else if (key == '3'&& servoCount==0 || usbnumber==54) { // $fp=6
  //when '2' is pressed allow the user to input a key.

  Serial.println("door open");
  Servo1.write(90);
  usbnumber=0;
}
```

Figure 3.8.2 Arduino Code to Receive Number on Serial Port

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The codes which drawn by a yellow rectangular indicate the number that written into the port with it usbnnumber respectively.

3.9 Web Page Design of This Project

The website of this project is mainly built by PHP and HTML scripting language. The PHP plays a very important role to collect form data, do some modification on database and control user-access while HMTL is used for describing the structure of web page and building some blocks of the HTML page. Furthermore, this system is designed into two way controls which mean user can login or control to the smart home system by using keypad or webpage. The process of web page design in this project is stated as below:

First of all, user needs to access to the designated website by typing the server's IP address in the browser, for example the IP address is 192.168.1.5 in this case. Thus, user will be asked to log into the smart home system by entering his username and password into the log in page which shown in figure 3.9.1. The back button in this browser has been disable to avoid any historical records save in this browser.

The login page is done by using form method in PHP which the username and password of user will be stored in two variable which name as name and password and sent to the page *welcome.php* which shown in figure 3.9.2. In the *welcome.php*, the name and password variable are retrieved by using POST method and it will go through the checking process in the if-else statement to determine its correntness. A file which written with corresponding ASCII number will be opened in the ACM0 port (in this case) to signal the Arduino to proceed to the next step if the username and password is correct. The following code is shown in figure 3.9.2.

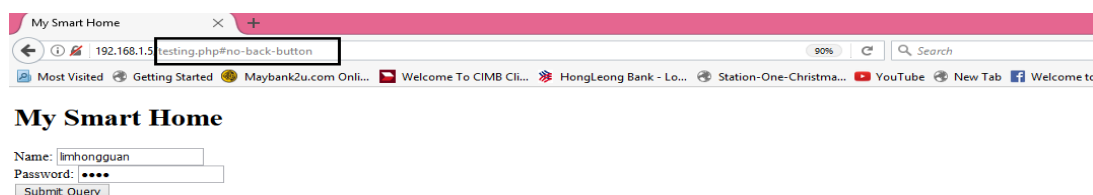


Figure 3.9.1 My Smart Home Login Page

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```
22
23
24 <form action="welcome.php" method="post">
25
26 Name: <input type="text" name="name"><br>
27 Password: <input type="password" name="password"><br>
28
29 <input type="submit">
30
31 </form>
32
33
```

Figure 3.9.2 Code of Form Method in PHP

```
7
8 <?php
9
10 $comPort = "/dev/ttyACM0"; /*change to correct com port */
11
12 $name = $_POST["name"];
13 $password = $_POST["password"];
14
15
16
17 if ($name == "limhongguan" && $password == "1234") {
18     echo "Password Correct";
19     echo "<a href=mainpage.php>Click Here</a>";
20
21     $fp = fopen($comPort, "w");
22     fwrite($fp, 2); |
23     fclose($fp);
24 }
25 else {
26     echo "Password Wrong";
27     echo "<a href=testing.php>Click Here</a>";
28
29 }
30
31
32
33 ?>
34
```

Figure 3.9.3 PHP Code to Signal Arduino

The *Password Correct* words which shown in figure 3.9.4 will be indicated if user entering the correct password, in contrast , user will received a *Password Wrong* webpage which shown in figure 3.9.5 if entering a wrong password. Hence, user needs to press the *Click Here* link in the password correct page to proceed to the following mode select page. However, user will be returned to the login page if clicking the *Click Here* link in the password wrong page.

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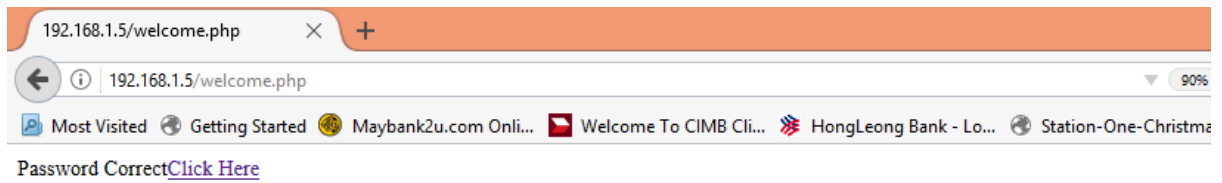


Figure 3.9.4 Password Correct Page

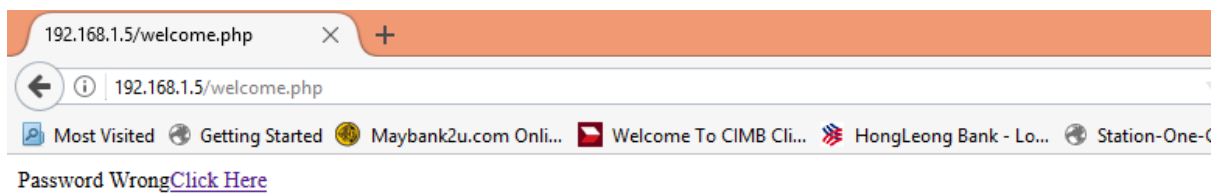


Figure 3.9.5 Password Wrong Page

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Moreover, after entering the correct password, the Arduino will be also triggered to the mode select in serial monitor which shown in figure 3.9.6.

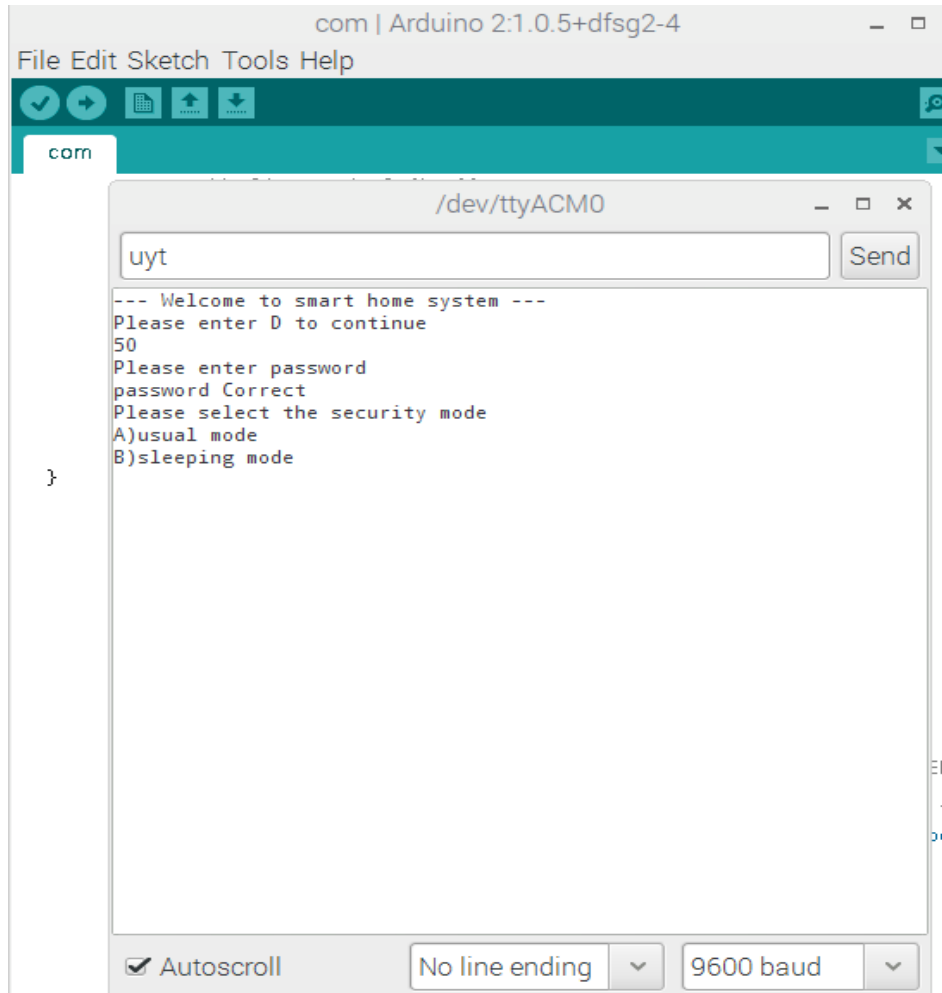


Figure 3.9.6 Mode Selecting Page in Serial Monitor

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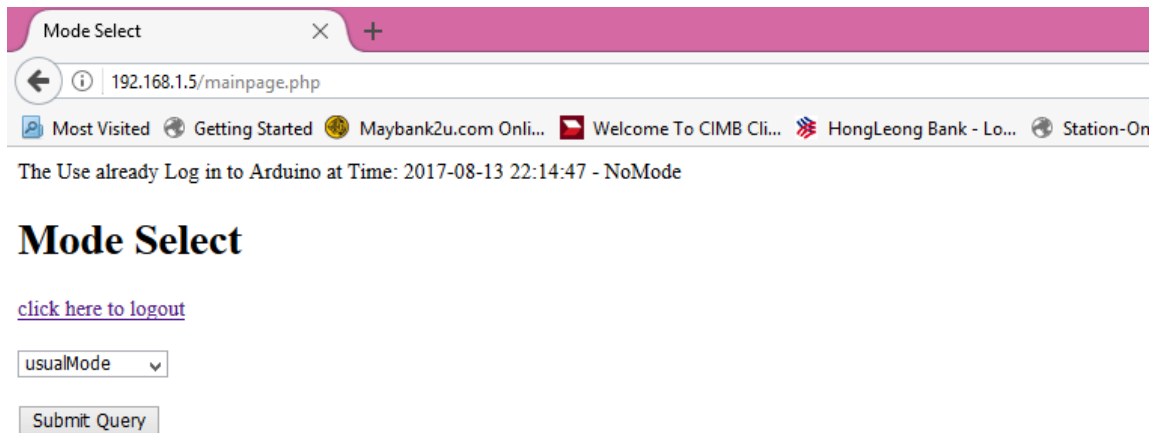


Figure 3.9.7 Mode Selecting Page

In the mode select page which shown in 3.9.7, user can either choose usual mode or sleeping mode. In the usual mode, the PIR motion sensor and vibration sensor are purposely turning off but turning on at sleeping mode. After finish selecting the mode, user need to press the submit button to continue to the following page. In some scenario, there is only one option in the mode select page, this is due to the fact that the user has been logging to one of the mode in the system by using keypad. So, the user can only log in to one of the mode at the same time.

The mode select page is also done by using form and file opening method in figure 3.9.9 which are same with the login page. However, a record of selecting mode will be save into the database which will use for comparing with the next mode selecting section which shown in figure 3.9.8. Hence, this technique will avoid any difference of mode selecting by multiple users.

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```
62
63 <?php if ($mode1=="UsualMode") { ?>
64
65 <form action="<?php echo $PHP_SELF;?>" method="post">
66     <select name="cars">
67         <option value="usualMode">usualMode</option>
68     </select>
69     <br><br>
70     <input type="submit">
71 </form>
72
73 <?php } if($mode1=="SleepingMode") { ?>
74
75 <form action="<?php echo $PHP_SELF;?>" method="post">
76     <select name="cars">
77         <option value="sleepingMode">sleepingMode</option>
78     </select>
79     <br><br>
80     <input type="submit">
81 </form>
82
83 <?php } if($mode1=="NoMode") { ?>
84
85 <form action="<?php echo $PHP_SELF;?>" method="post">
86     <select name="cars">
87         <option value="usualMode">usualMode</option>
88         <option value="sleepingMode">sleepingMode</option>
89     </select>
90     <br><br>
91     <input type="submit">
92 </form>
93
94 <?php } ?>
95
96 <br/>
```

Figure 3.9.8 Code of PHP form in Mode Selecting Page

```
101
102 <?php
103 $comPort = "/dev/ttyACM0"; /*change to correct com port */
104 $mode= $_POST["cars"];
105
106
107
108 if ($mode == "usualMode") {
109     echo "Please click here to usual mode <br>";
110     echo "<a href= displayData.php?data4=usualMode>Click Here</a>";
111 };
112
113
114     $fp =fopen($comPort, "w");
115     fwrite($fp, 9); /* this is the number that it will write */
116     fclose($fp);
117 }
118 else if ($mode == "sleepingMode") {
119     echo "Please click here to sleeping Mode<br>";
120     echo "<a href= displayData.php?data4=SleepingMode>Click Here</a>";
121 };
122
123     $fp=fopen($comPort, "w");
124     fwrite($fp, 10); /* this is the number that it will write */
125     fclose($fp);
126 }
127
128
129
130 ?>
131
```

Figure 3.9.9 Code of File Opening at Port in Mode Selecting Page

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In the usual mode or sleeping mode page which shown in figure 3.9.10 and 3.9.11, user can automate some of the household appliance such as switching on the light and opening the door and also can monitoring the temperature and humidity, house situation and home security condition. In the section of home situation, a message will be display to the page that indicate whether there are any occurrence of gas leaking, water leaking or vibration with the following time. Besides, the message of suspicious movement happening will also be display at home security condition's section with the time recorded as well. Furthermore, the user also can check any history of temperature and humidity, home situation, home security condition or automation by viewing the database. The only difference between usual and sleeping mode is the condition of PIR sensor and vibration sensor. The PIR sensor and vibration sensor will be turned on only at sleeping mode. Moreover, the user also can view all the same information in the web page by opening the serial monitor.

Regarding to code running behind, all the button of automation section are done by using PHP form which shown in figure 3.9.12. So, when user press a particular button, the value of button will be saved into a \$rcmd variable and uses to decide what operation need to be done in term of automation. The technique of automation is also done by using file opening in the port in order to send a signal to inform the Arduino which shown at figure 3.9.13. Furthermore, in regard to the part of database, a select statement which shown at figure 3.9.14 is used to extract out all the data which is stored in the database and display on the respective webpage. The webpage to display data in database is shown in figure 10.9.15 to 10.9.18.

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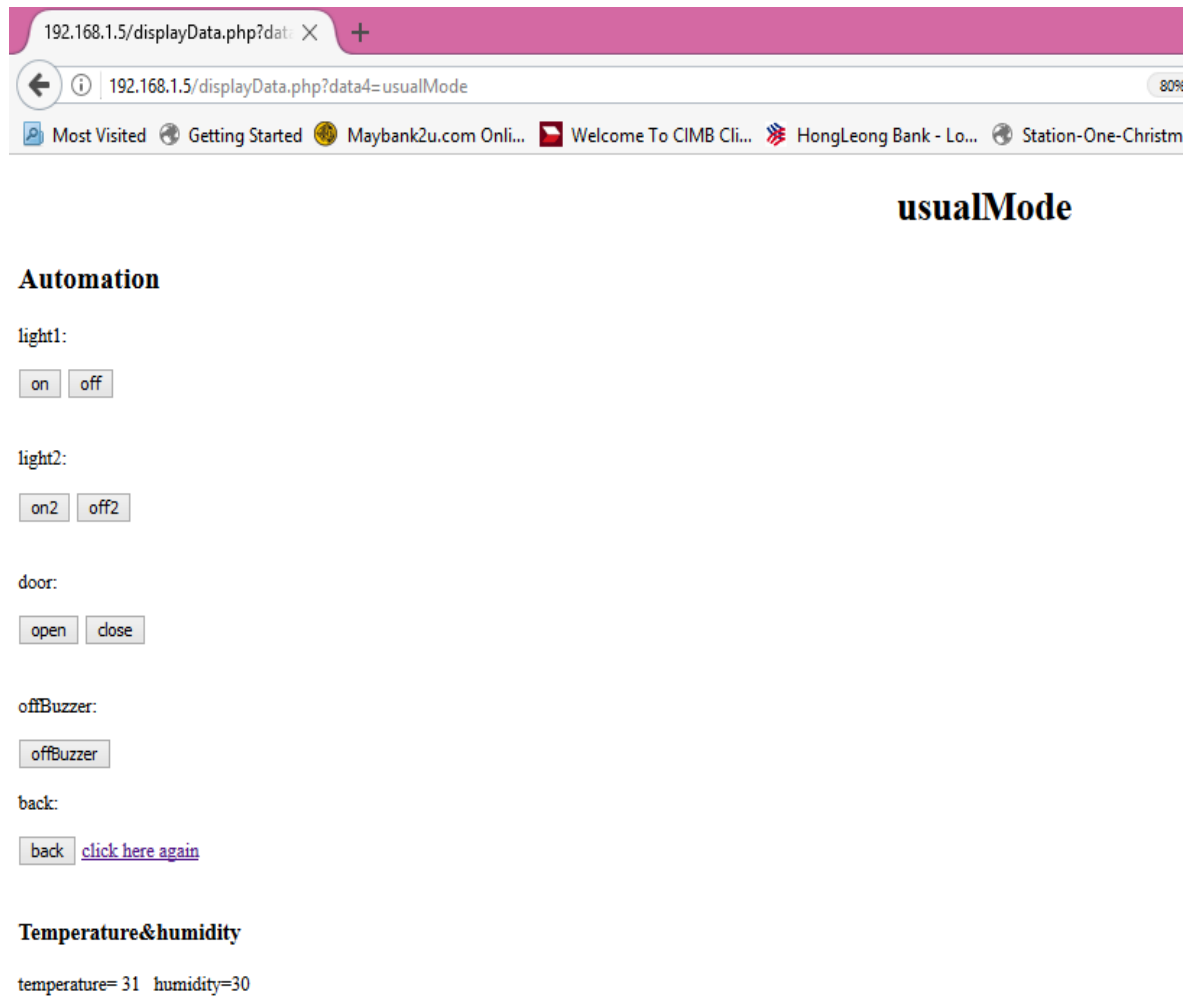


Figure 3.9.10 Usual Mode Page

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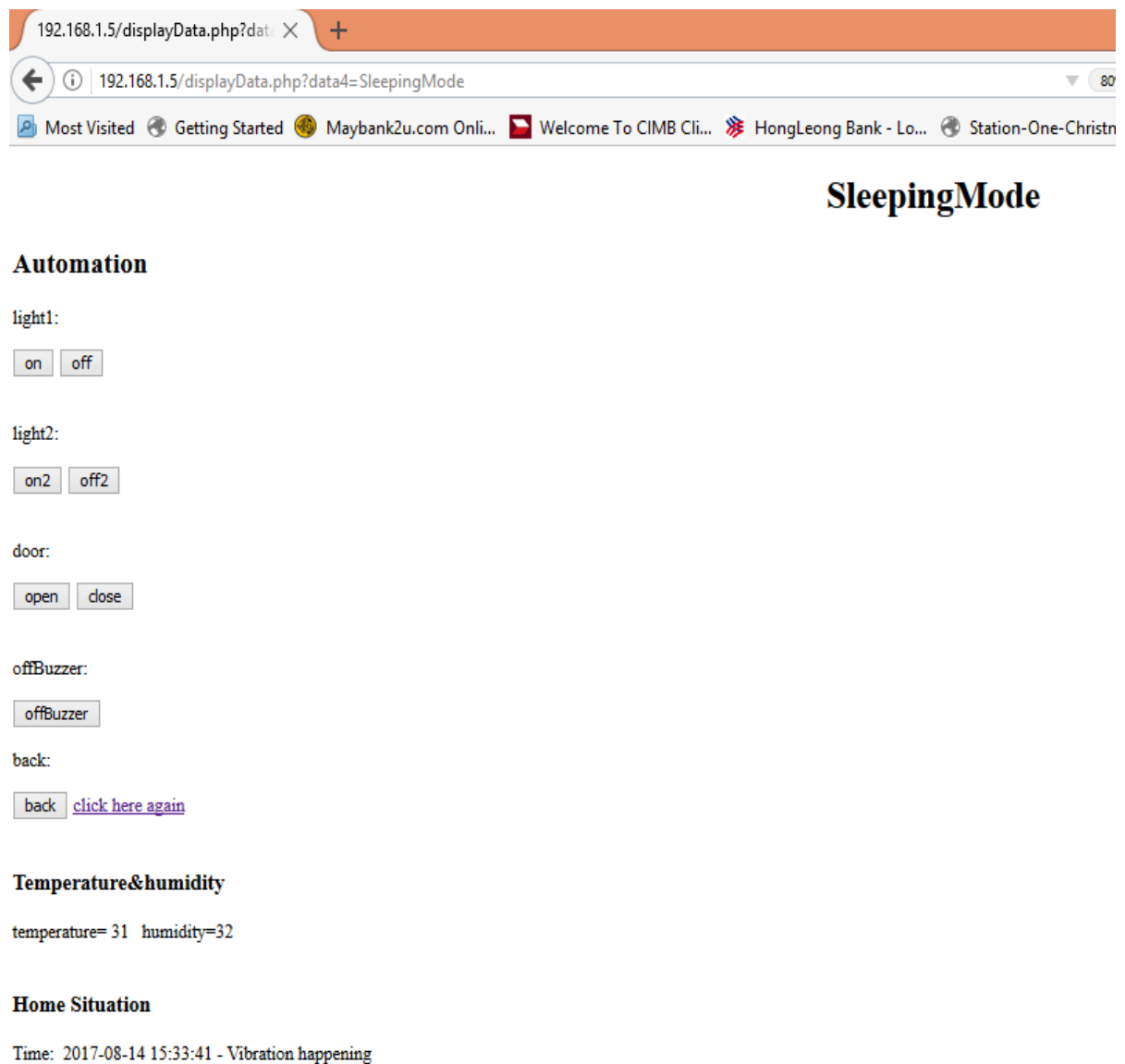


Figure 3.9.11 Sleeping Mode Page

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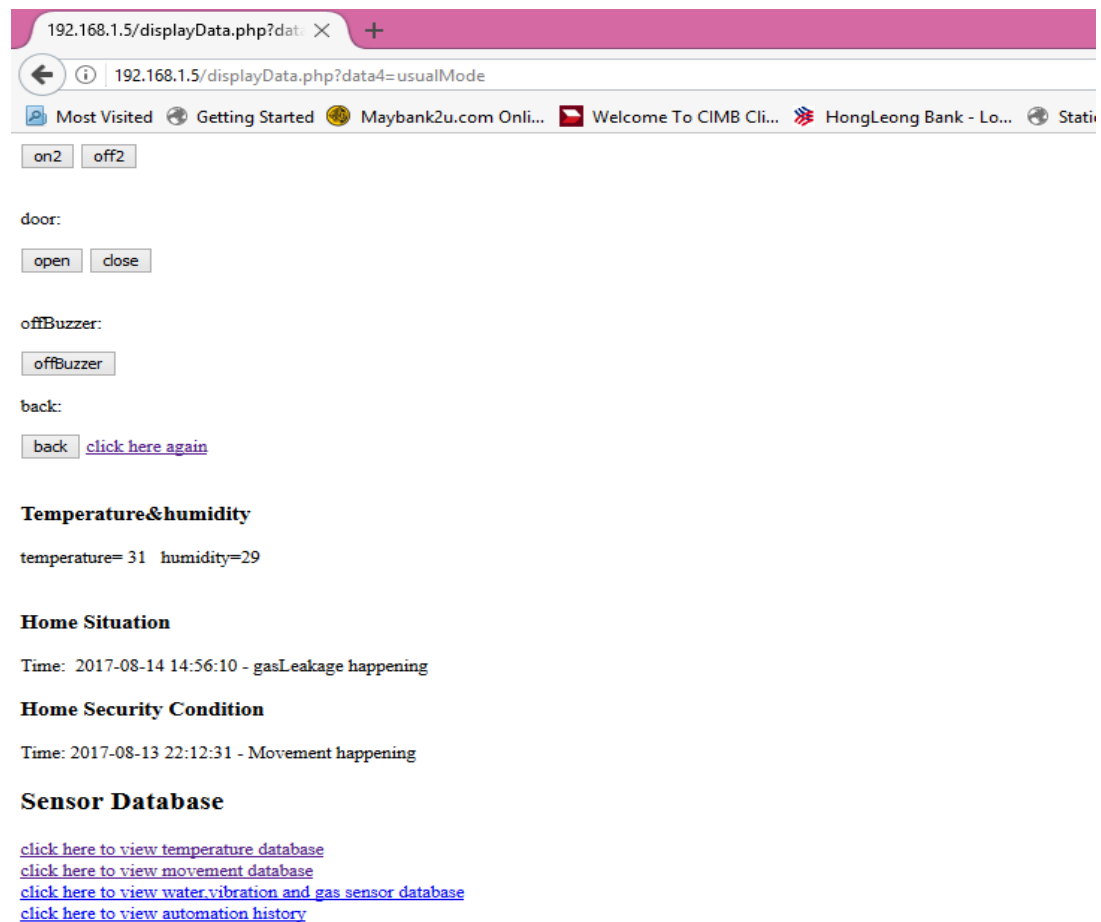


Figure 3.9.11 Sleeping Mode Page

```
<form method="post" action="<?php echo $PHP_SELF;?>">
  <p>light1:</p><input type="submit" value="on" name="rcmd">
  <input type="submit" value="off" name="rcmd"><br/>
  <br/>
  <p>light2:</p><input type="submit" value="on2" name="rcmd">
  <input type="submit" value="off2" name="rcmd"><br/>
  <br />
  <p>door:</p><input type="submit" value="open" name="rcmd">
  <input type="submit" value="close" name="rcmd"><br/>
  <br />
  <p>offBuzzer:</p>
  <input type="submit" value="offBuzzer" name="rcmd">
  <br />
  <p>back:</p>
  <input type="submit" value="back" name="rcmd">
</form>
```

Figure 3.9.12 Code of PHP Form to Determine Operation of Automation

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```
22 <?php
23 $comPort = "/dev/ttyACM0"; /*change to correct com port */
24
25 if (isset($_POST["rcmd"])) {
26     $rcmd = $_POST["rcmd"];
27     switch ($rcmd) {
28         case on:
29             $fp =fopen($comPort, "w");
30             fwrite($fp, 2); /* this is the number that it will write */
31             fclose($fp);
32             break;
33         case off:
34             $fp =fopen($comPort, "w");
35             fwrite($fp, 3); /* this is the number that it will write */
36             fclose($fp);
37             break;
38         case on2:
39             $fp =fopen($comPort, "w");
40             fwrite($fp, 4); /* this is the number that it will write */
41             fclose($fp);
42             break;
43         case off2:
44             $fp =fopen($comPort, "w");
45             fwrite($fp, 5); /* this is the number that it will write */
46             fclose($fp);
47             break;
48         case open:
49             $fp =fopen($comPort, "w");
50             fwrite($fp, 6); /* this is the number that it will write */
51             fclose($fp);
52             break;
53         case close:
54             $fp =fopen($comPort, "w");
55             fwrite($fp, 7); /* this is the number that it will write */
56             fclose($fp);
57             break;
58         case back:
59             $fp =fopen($comPort, "w");
60             fwrite($fp, 8); /* this is the number that it will write */
61             fclose($fp);
62             break;
63     }
64 }
```

Figure 3.9.13 Code of File Opening at Port in Automation Page

```
23 <?php
24 $servername = "localhost";
25 $username = "lim";
26 $password = "049763208";
27 $dbname = "test";
28
29 // Create connection
30 $conn = new mysqli($servername, $username, $password, $dbname);
31 // Check connection
32 if ($conn->connect_error) {
33     die("Connection failed: " . $conn->connect_error);
34 }
35
36 $sql = "SELECT * FROM MOVEMENT ORDER BY timeStamp DESC"; // select the data out
37 $result = $conn->query($sql);
38
39 if ($result->num_rows > 0) {
40     // output data of each row
41     while($row = $result->fetch_assoc()) {
42         echo "Time: " . $row["timeStamp"] . " - " . $row["movements"] . "<br>"; //display the data
43     }
44 } else {
45     echo "0 results";
46 }
47 $conn->close(); // close connection
48 ?>
49
```

Figure 3.9.14 Code to Select Data from Database

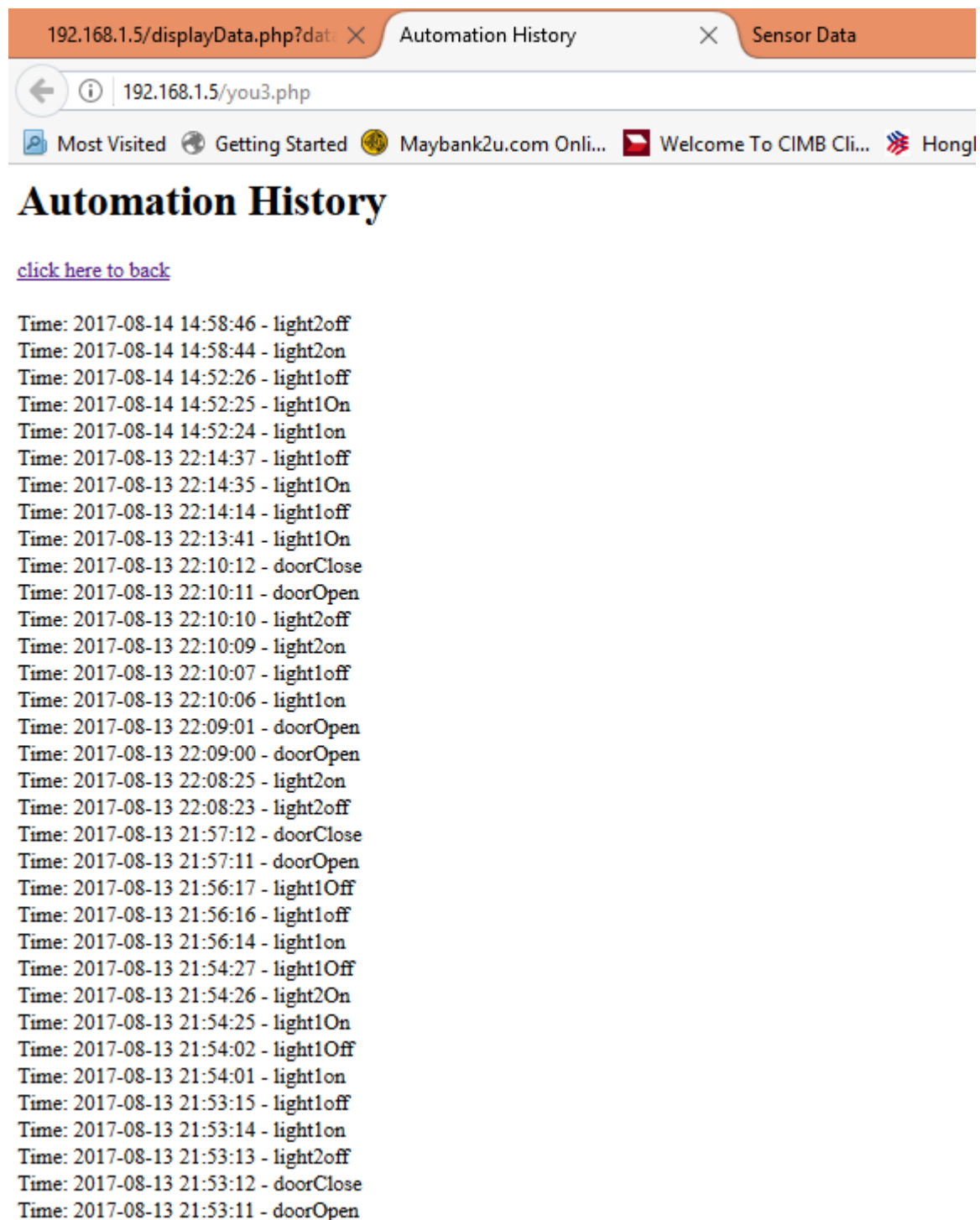


Figure 3.9.15 Database Display Page of Automation History

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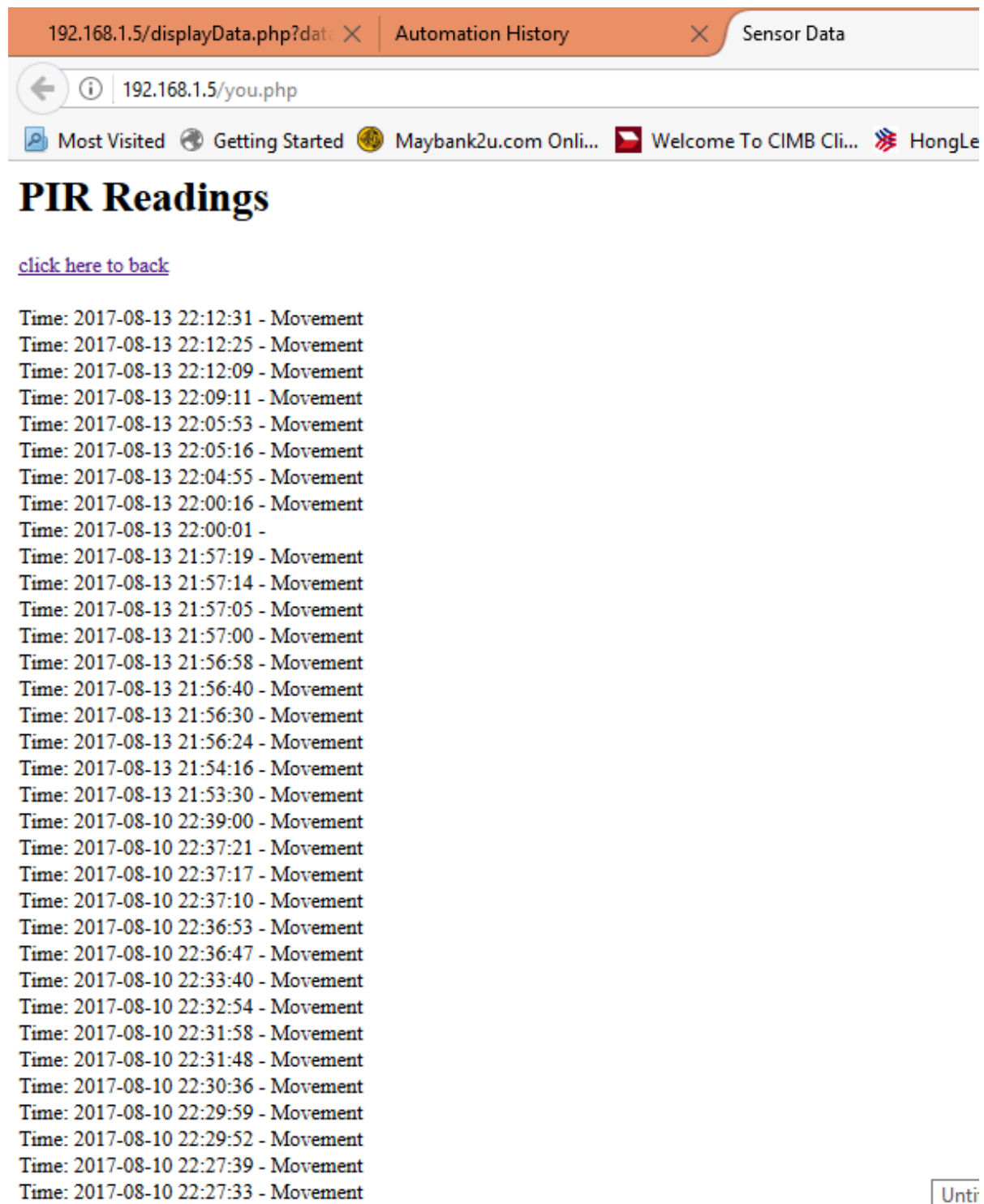
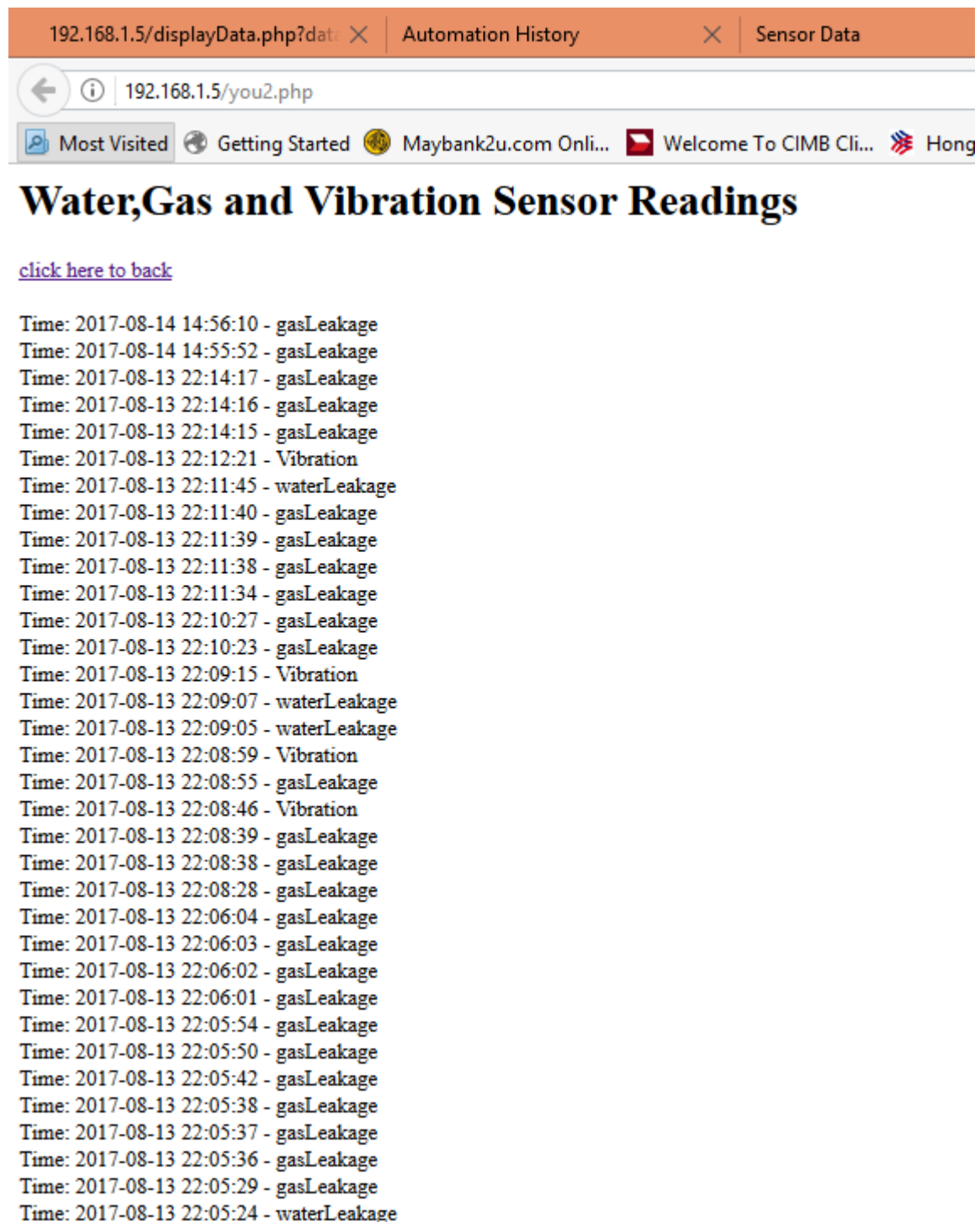


Figure 3.9.16 Database Display Page of PIR Sensor's Reading

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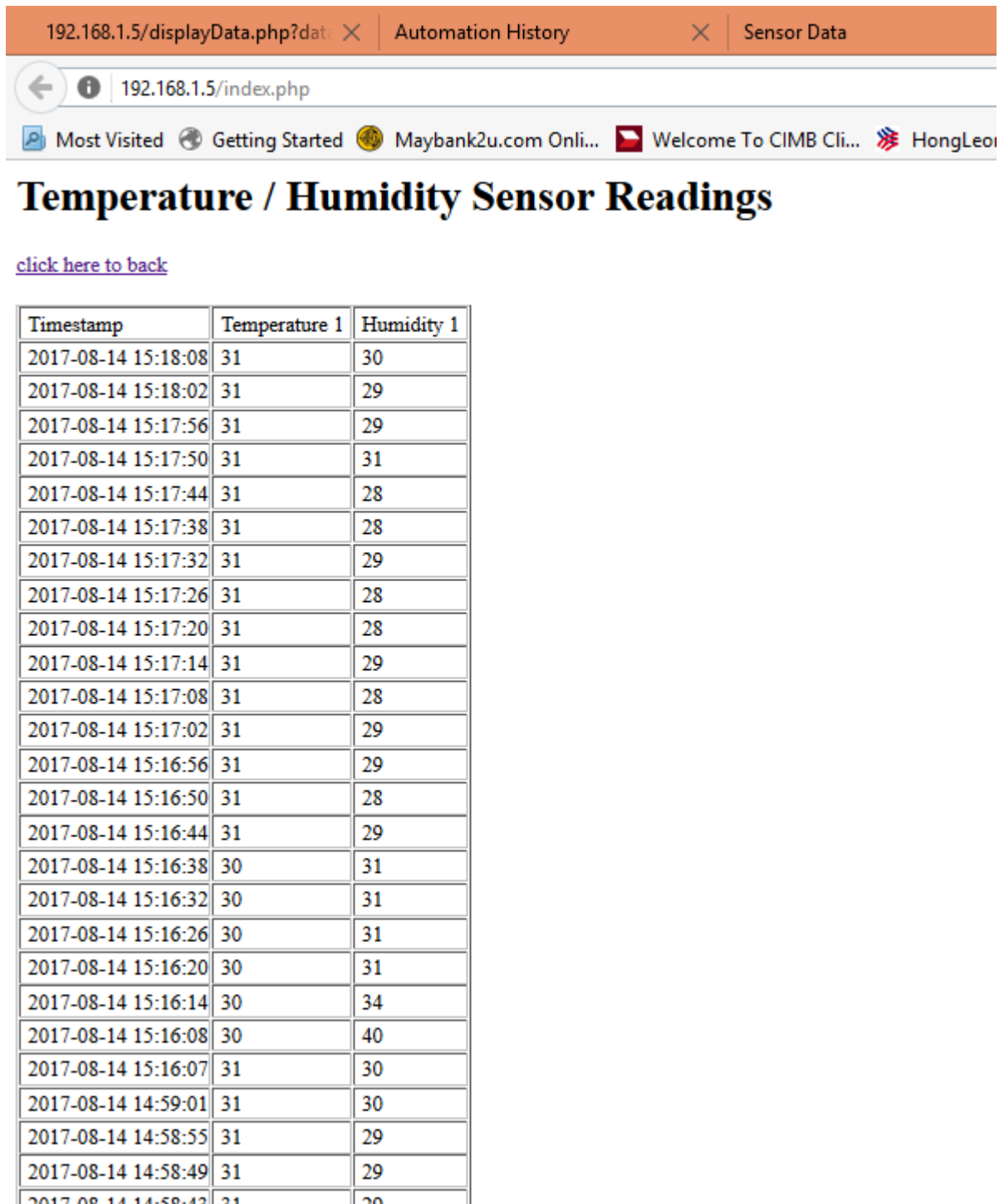
The screenshot shows a web browser window with the following elements:

- Browser tabs: 192.168.1.5/displayData.php?dat... Automation History Sensor Data
- Address bar: 192.168.1.5/you2.php
- Navigation bar: Most Visited Getting Started Maybank2u.com Onli... Welcome To CIMB Cli... Hong
- Page title: **Water, Gas and Vibration Sensor Readings**
- Link: [click here to back](#)
- Log of sensor readings:

Time: 2017-08-14 14:56:10	- gasLeakage
Time: 2017-08-14 14:55:52	- gasLeakage
Time: 2017-08-13 22:14:17	- gasLeakage
Time: 2017-08-13 22:14:16	- gasLeakage
Time: 2017-08-13 22:14:15	- gasLeakage
Time: 2017-08-13 22:12:21	- Vibration
Time: 2017-08-13 22:11:45	- waterLeakage
Time: 2017-08-13 22:11:40	- gasLeakage
Time: 2017-08-13 22:11:39	- gasLeakage
Time: 2017-08-13 22:11:38	- gasLeakage
Time: 2017-08-13 22:11:34	- gasLeakage
Time: 2017-08-13 22:10:27	- gasLeakage
Time: 2017-08-13 22:10:23	- gasLeakage
Time: 2017-08-13 22:09:15	- Vibration
Time: 2017-08-13 22:09:07	- waterLeakage
Time: 2017-08-13 22:09:05	- waterLeakage
Time: 2017-08-13 22:08:59	- Vibration
Time: 2017-08-13 22:08:55	- gasLeakage
Time: 2017-08-13 22:08:46	- Vibration
Time: 2017-08-13 22:08:39	- gasLeakage
Time: 2017-08-13 22:08:38	- gasLeakage
Time: 2017-08-13 22:08:28	- gasLeakage
Time: 2017-08-13 22:06:04	- gasLeakage
Time: 2017-08-13 22:06:03	- gasLeakage
Time: 2017-08-13 22:06:02	- gasLeakage
Time: 2017-08-13 22:06:01	- gasLeakage
Time: 2017-08-13 22:05:54	- gasLeakage
Time: 2017-08-13 22:05:50	- gasLeakage
Time: 2017-08-13 22:05:42	- gasLeakage
Time: 2017-08-13 22:05:38	- gasLeakage
Time: 2017-08-13 22:05:37	- gasLeakage
Time: 2017-08-13 22:05:36	- gasLeakage
Time: 2017-08-13 22:05:29	- gasLeakage
Time: 2017-08-13 22:05:24	- waterLeakage

Figure 3.9.17 Database Display Page of Water, Gas and Vibration Detection Sensor's Reading

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192.168.1.5/displayData.php?dat... X Automation History X Sensor Data

192.168.1.5/index.php

Most Visited Getting Started Maybank2u.com Onli... Welcome To CIMB Cli... HongLeoi

Temperature / Humidity Sensor Readings

[click here to back](#)

Timestamp	Temperature 1	Humidity 1
2017-08-14 15:18:08	31	30
2017-08-14 15:18:02	31	29
2017-08-14 15:17:56	31	29
2017-08-14 15:17:50	31	31
2017-08-14 15:17:44	31	28
2017-08-14 15:17:38	31	28
2017-08-14 15:17:32	31	29
2017-08-14 15:17:26	31	28
2017-08-14 15:17:20	31	28
2017-08-14 15:17:14	31	29
2017-08-14 15:17:08	31	28
2017-08-14 15:17:02	31	29
2017-08-14 15:16:56	31	29
2017-08-14 15:16:50	31	28
2017-08-14 15:16:44	31	29
2017-08-14 15:16:38	30	31
2017-08-14 15:16:32	30	31
2017-08-14 15:16:26	30	31
2017-08-14 15:16:20	30	31
2017-08-14 15:16:14	30	34
2017-08-14 15:16:08	30	40
2017-08-14 15:16:07	31	30
2017-08-14 14:59:01	31	30
2017-08-14 14:58:55	31	29
2017-08-14 14:58:49	31	29
2017-08-14 14:58:42	31	29

Figure 3.9.18 Database Display Page of Temperature and Humidity Sensor's Reading

3.10 Explanation, Connection and Code For Individual Sensor

1) DTH11 temperature and humidity sensor:



Figure 3.10.1 DTH11 Temperature and Humidity Sensor

There are two sensors mounted in the DTH11 which are temperature sensor and humidity sensor. Specification, feature, calculation of humidity and calculation of temperature of DTH11 are stated as below:

Specification:

Humidity measuring range: 20%-90%
Temperature measuring range: 0-50c
Humidity measuring accuracy: 5.0%RH
Temperature measurement accuracy: 2.0c
Response time: <50ms
Low power consumption

Features:

Single wire digital interface
Ultra small size
High reliability
Optimized long-term stability

Chapter 3: System Design

Calculation of Humidity:

The DHT11 measure the humidity by measuring the relative humidity (RH).Relative humidity calculates through the amount of water vapor in air divide the saturation point of water vapor in air.

The formal to calculate relative humidity :

$$RH = \left(\frac{\rho_w}{\rho_s} \right) \times 100\%$$

RH : Relative Humidity

ρ_w : Density of water vapor

ρ_s : Density of water vapor at saturation

RH is showed in percentage. At 100%RH, condensation happen, at 0%RH, mean the air is completely dry.

Calculation of Temperature:

The DHT11 measures temperature through a surface mounted which is NTC temperature sensor (thermistor) which attach into the unit. The NTC thermistor are made from a semiconducting material and compressed to form a temperature sensitive conducting material.

The thermistor circuit:

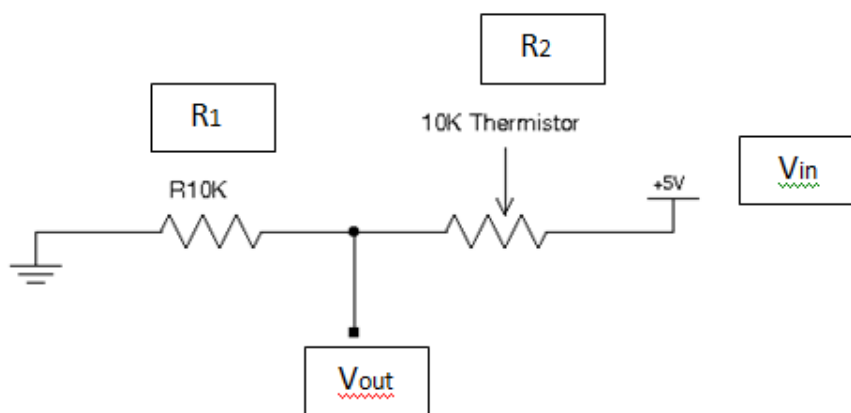


Figure 3.10.2 Circuit of Thermistor

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Calculation of Temperature:

Arduino will measure the voltage at a point (V_{out}) between the resistor (R_1) and thermistor (R_2). Hence, the equation for a voltage divider is:

$$V_{out} = V_{in} \times \left(\frac{R_2}{R_1 + R_2} \right)$$

The variables of equation stated are:

V_{out} : Voltage between thermistor and resistor

V_{in} : Vcc

R_1 : resistor value

R_2 : resistor of thermistor

Hence, the equation can be simplified become:

$$R_2 = R_1 \times \left(\frac{V_{in}}{V_{out}} - 1 \right)$$

Lastly, Steinhart-Hart equation will be used to produce the temperature value (T) by substitute R_2 into R . The A, B, C are the Steinhart-Hart which vary depending of the type of thermistor:

$$\frac{1}{T} = A + B \ln(R) + C [\ln(R)]^3$$

Chapter 3: System Design

Connection or Code of Temperature and Humidity Sensor:

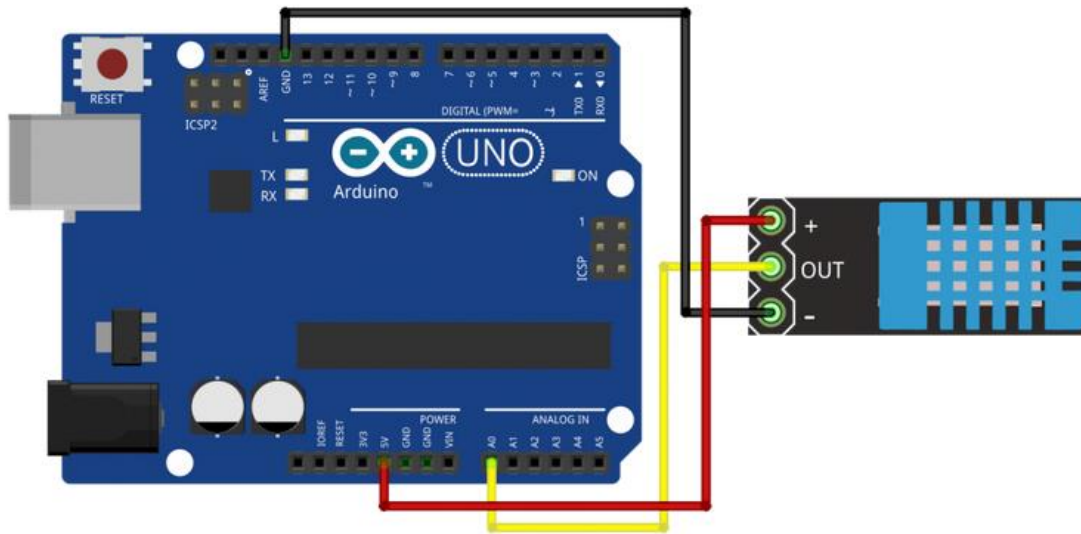


Figure 3.10.3 Connection of Temperature & Humidity Sensor to Arduino

As we can see, we only need 3 connections to the sensor. The connections are: Voltage is connected to 5V pin of Arduino, Ground is connected to ground pin of Arduino and Signal which can be connected to any Analog Pin of Arduino.

Since we will be using a Library that is available for this sensor, our code will be very short and simple. Once the library is included, just run the code stated below:

```
#include "DHT.h"
#define dht_apin A0 // Analog Pin sensor is connected to

dht DHT;

void setup() {

  Serial.begin(9600);
  delay(500); // Delay to let system boot
  Serial.println("DHT11 Humidity & temperature Sensor\n\n");
  delay(1000); // Wait before accessing Sensor

} // end "setup()"

void loop() {
  // Start of Program

  DHT.read11(dht_apin);

  Serial.print("Current humidity = ");
  Serial.print(DHT.humidity);
  Serial.print("% ");
```

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```
Serial.print("temperature = ");  
Serial.print(DHT.temperature);  
Serial.println("C  ");  
  
delay(5000); //Wait 5 seconds before accessing sensor again.  
  
//Fastest should be once every two seconds.  
  
} // end loop()
```

The result of code in the serial monitor:

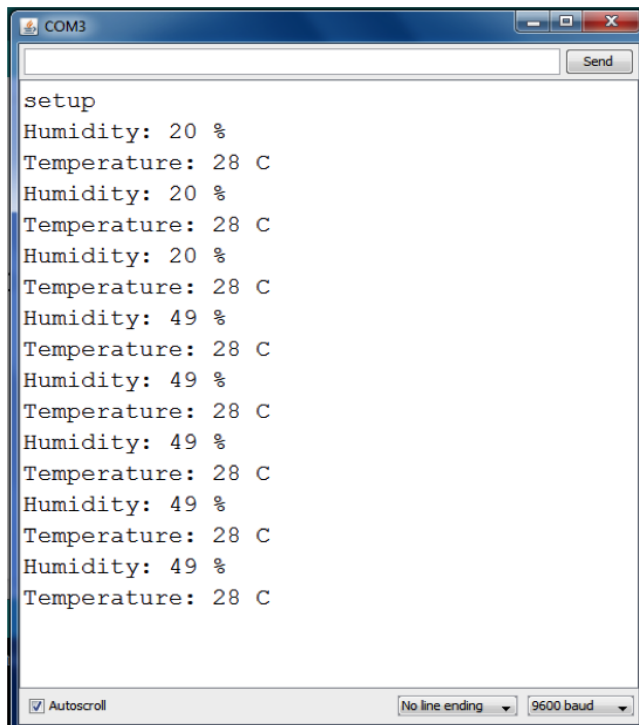


Figure 3.10.4 Result of Temperature & Humidity Value Shown in Serial Monitor

Chapter 3: System Design

2) MQ-6 gas detection sensor:



Figure 3.10.5 Gas Detection Sensor

The MQ-6 gas detection sensor is made by a sensitive material SnO₂ which has lower conductivity in clean air. Hence, the more combustible gas exist in air, the higher the conductivity in sensor. The value of gas content in air can be obtained by converting the change of conductivity of SnO₂. The specification, feature and calculation of gas content of MQ-6 gas detection sensor are stated as below:

Specification:

Working Voltage: 5V
Interface type: Analog
Pin Definition: 1-Output 2-GND 3-VCC
High sensitivity to LPG, iso-butane, propane
Small sensitivity to alcohol, smoke
Fast response
Stable and long life
Simple drive circuit
Size: 40x20mm(1.57"x0.79")

Feature:

Chapter 3: System Design

High sensitivity to LPG (liquefied petroleum gas), iso-butane, propane

Small sensitivity to alcohol, smoke

Fast response

Stable and long life

Simple drive circuit

Calculation of Gas Content:

The MQ-6 gas detection sensor calculates the gas content in air by calculating the Power of Sensitivity body (Ps) in the circuit of sensor.

The circuit of sensor:

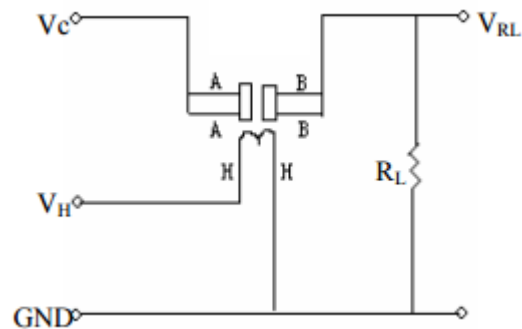


Figure 3.10.6 Circuit of MQ-6 Gas Detection Sensor

The variables of circuit stated are:

VC: test voltage, used to detect voltage (VRL) on load resistance (RL)

VH: heater voltage, used to supply certified working temperature to sensor

The equation of Power of Sensitivity body (Ps) is:

$$P_s = V_C^2 \times \left(\frac{R_s}{R_s + R_L} \right)^2$$

$$\text{Resistance of sensor } (R_s) = \frac{V_C}{V_{RL} - 1} \times R_L$$

Chapter 3: System Design

Connection of Gas Detection Sensor with Arduino:

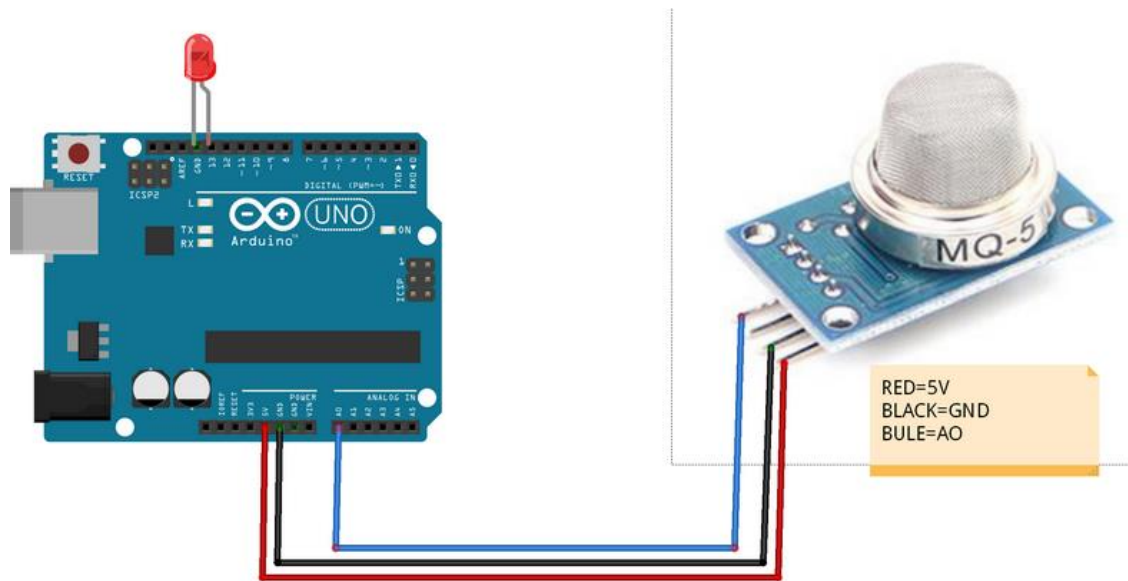


Figure 3.10.7 Connection of Gas Detection Sensor with Arduino

The connection are: Voltage is connected to 5V pin of Arduino, Ground is connected to ground pin of Arduino and the A0 pin of gas sensor can be connected to any Analog Pin of Arduino.

Arduino Code of Gas Detection Sensor:

```
void setup()
{
  Serial.begin(9600);
}

void loop()
{
  float sensorVoltage;
  float sensorValue;

  sensorValue = analogRead(A0);
  sensorVoltage = sensorValue/1024*5.0;

  Serial.print("sensor voltage = ");
  Serial.print(sensorVoltage);
  Serial.println(" V");
  delay(1000);
}
```


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The result of code in the serial monitor:

```
sensor voltage = 1.14 V
sensor voltage = 1.44 V
sensor voltage = 1.71 V
sensor voltage = 1.95 V
sensor voltage = 2.16 V
sensor voltage = 2.32 V
sensor voltage = 2.46 V
sensor voltage = 2.55 V
sensor voltage = 2.56 V
sensor voltage = 2.47 V
sensor voltage = 2.28 V
sensor voltage = 2.08 V
sensor voltage = 1.90 V
sensor voltage = 1.76 V
sensor voltage = 1.63 V
sensor voltage = 1.52 V
sensor voltage = 1.43 V
sensor voltage = 1.34 V
sensor voltage = 1.26 V
```

Figure 3.10.8 Result of Gas Detection Value Shown in Serial Monitor

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3) Rain drop detection sensor:



Figure 3.10.9 Rain drop detection Sensor

Specification:

Area: 5cm x 4cm nickel plate on side

Working voltage: 5V

Output format: Digital switching output (0 and 1) and analog voltage output AO

Small board PCB size: 3.2cm x 1.4cm

Indicators: Power indicator & Output indicator LEDs

User Control: Onboard sensitivity adjustment potentiometer

Feature:

Adopts high quality of RF-04 double sided material

Anti-oxidation, anti-conductivity, with long use time

Comparator output signal clean waveform is good, driving ability, over 15mA

Potentiometer adjust the sensitivity

With bolt holes for easy installation

Uses a wide voltage LM393 comparator

Chapter 3: System Design

The Rain drop detection sensor is used as a water detection sensor which implement in the front area of kitchen or bathroom to prevent water leakage. The rain drop detection sensor is manufactured based on the LM393 op amp structure. It can measure water via an analog output pins and provide digital output when a certain threshold is exceeded.

The Rain drop detection sensor detects the existence of water by using a path of parallel resistance that is measured via op amp. The existence of water lowers the resistance and increases the voltage output. In contrast, a dry board has a high resistance and will cause a maximum voltage on output.

Connection of Rain Drop Detection Sensor with Arduino:

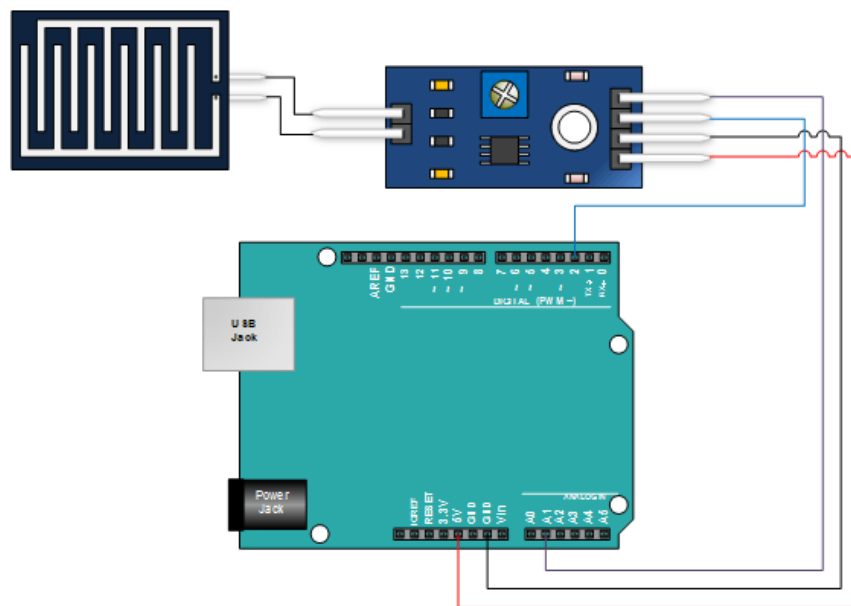


Figure 3.10.10 Connection of Rain Drop Detection Sensor with Arduino

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The connection are: Vcc is connected to 5V pin of Arduino, Ground is connected to ground pin of Arduino and the A0 pin of gas sensor can be connected to any Analog Pin of Arduino and D0 pin is not used in this case.

Arduino Code of Rain Drop Detection Sensor:

```
void setup() {
  // initialize serial communication @ 9600 baud:
  Serial.begin(9600);
}

void loop() {
  // read the sensor on analog A0:
  int sensorReading = analogRead(A0);
  // map the sensor range (four options):
  // ex: 'long int map(long int, long int, long int, long int, long
int)'
  int range = map(sensorReading, sensorMin, sensorMax, 0, 3);

  // range value:
  switch (range) {
  case 0: // Sensor getting wet
    Serial.println("Flood");
    break;
  case 1: // Sensor getting wet
    Serial.println("Rain Warning");
    break;
  case 2: // Sensor dry
    Serial.println("Not Raining");
    break;
  }
  delay(1); // delay between reads
}
```

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The result of code in the serial monitor:

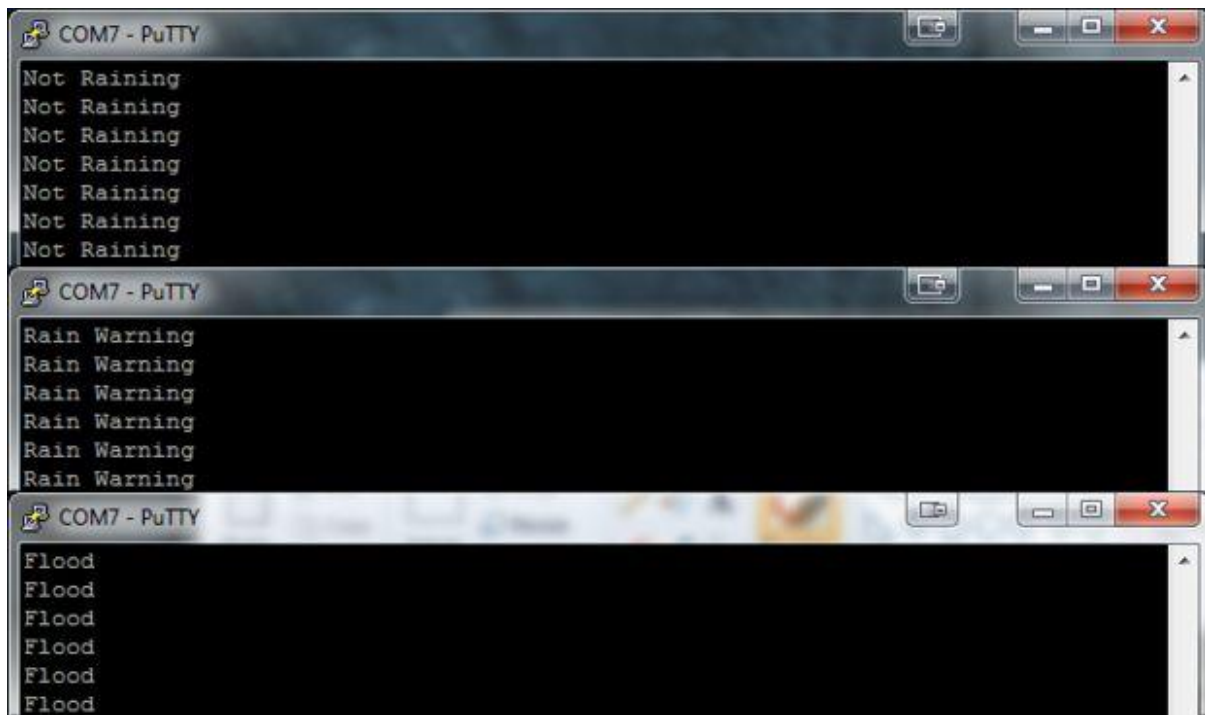


Figure 3.10.11 Result of Rain Drop Detection Value Shown in Serial Monitor

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4) PIR Motion Sensor:

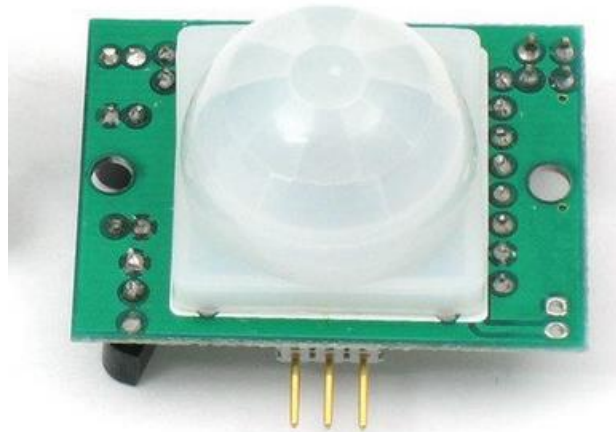


Figure 3.10.12 PIR Motion Detection Sensor

Specification and feature:

Compact size: 24*32 mm

Supply voltage: DC3.3-12V

Current drain: $\leq 30\mu\text{A}$

Delay time: 2s-80mins, adjustable

Blockade time: 2.3S

Trigger mode: Repeatable triggered

Lux: adjustable

Detecting distance: $\leq 8\text{m}$

Detecting angle: $\leq 120^\circ$

Voltage Output: 3.3V High/Low level signal or Open-Collector Output

Operation Temperature: -20°C - $+55^\circ\text{C}$

Infrared sensor: dual element, low noise, high sensitivity

The PIR motion sensor is used to detect any suspicious movement around the house during the night time and it will trigger the alarm and notify user through e-mail when detecting movement. The PIR sensor itself has two slots in it, each slot is made of a special material that is sensitive to IR. The lens used here is not really doing much so the two slots can 'see' out past some distance (basically the sensitivity of the sensor). When the sensor is idle, both slots detect the same amount of IR, the surrounding amount radiated from the room or walls or outdoors. When a warm body like a human or animal passes by, it first intercepts one half of the PIR sensor, which causes a positive differential change between the two halves. When the warm

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body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. These change pulses are what is detected.

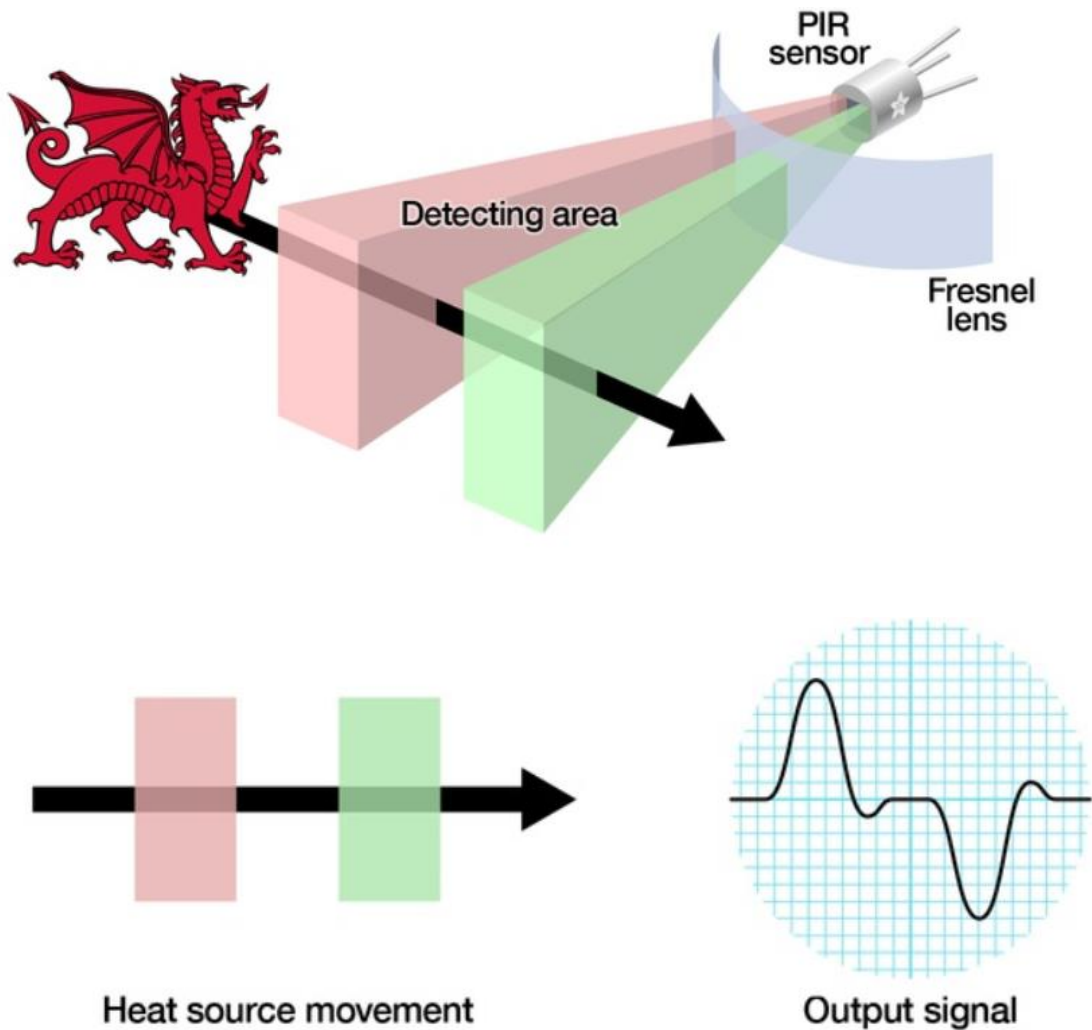


Figure 3.10.13 Working Process of PIR Sensor

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Connection of Rain Drop Detection Sensor with Arduino:

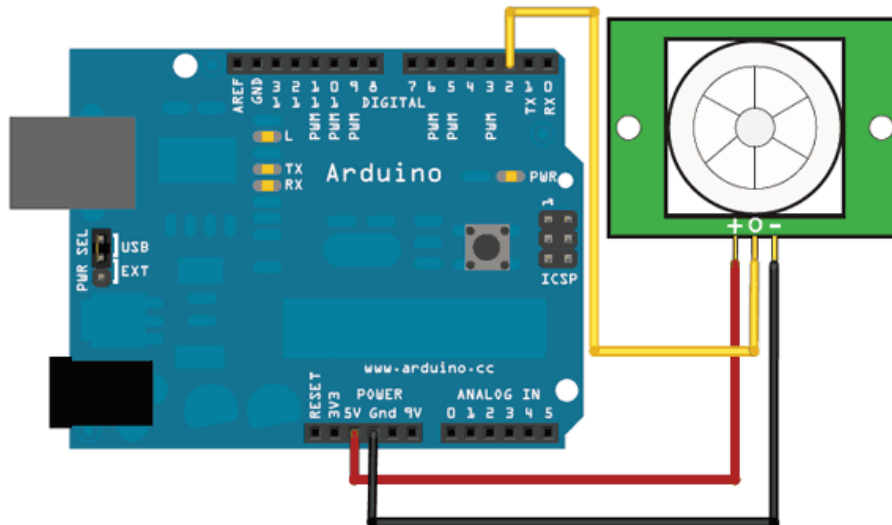


Figure 3.10.14 Connection of Rain Drop Detection Sensor with Arduino

The connection are: Vcc is connected to 5V pin of Arduino, Ground is connected to ground pin of Arduino and the A0 pin of gas sensor can be connected to any Digital Pin of Arduino.

Arduino Code of PIR Motion Detection Sensor:

```
int ledPin = 13;           // choose the pin for the LED
int inputPin = 2;         // choose the input pin (for PIR sensor)
int pirState = LOW;      // we start, assuming no motion detected
int val = 0;             // variable for reading the pin status

void setup() {
  pinMode(ledPin, OUTPUT); // declare LED as output
  pinMode(inputPin, INPUT); // declare sensor as input

  Serial.begin(9600);
}

void loop(){
  val = digitalRead(inputPin); // read input value

  if (val == HIGH) {          // check if the input is HIGH
    digitalWrite(ledPin, HIGH); // turn LED ON
    if (pirState == LOW) {
      // we have just turned on
      Serial.println("Motion detected!");
      // We only want to print on the output change, not state
      pirState = HIGH;
    }
  }
  else {
    digitalWrite(ledPin, LOW); // turn LED OFF
  }
}
```


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```
    if (pirState == HIGH){  
        // we have just turned of  
        Serial.println("Motion ended!");  
        // We only want to print on the output change, not state  
        pirState = LOW;  
    }  
}  
}
```

The result of code in the serial monitor:

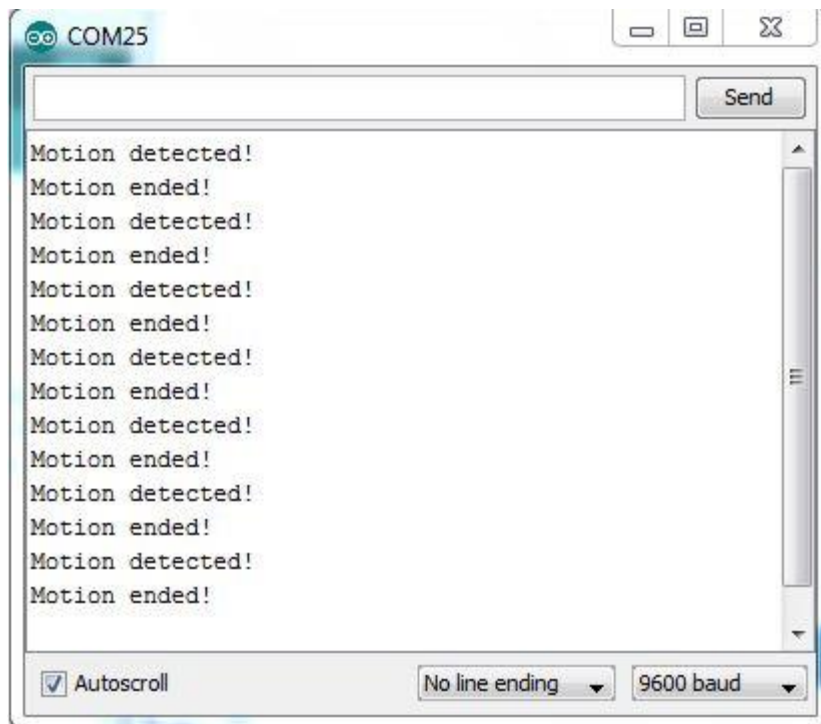


Figure 3.10.15 Result of PIR Motion Detection Value Shown in Serial Monitor

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5) Vibration Sensor:



Figure 3.10.16 Vibration Detection Sensor

Specification and feature:

The default state of the switch is close

Digital output

Supply voltage: 3.3V-5V

On-board indicator LED to show the results

On-board LM393 chip

Dimension of the board: 3.2cm x 1.4cm

The vibration sensor is installed near the door to detect any intrusion during the night time. The Vibration sensor is used originally as vibration switch because of its high sensitivity. It is also sensitive to environment vibration and generally used to detect the ambient vibration strength. When module did not reach the threshold in shock or vibration strength, DO port output gets high level and when external vibration strength exceeds the threshold, DO port output gets low level.

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Connection of Vibration Detection Sensor with Arduino:

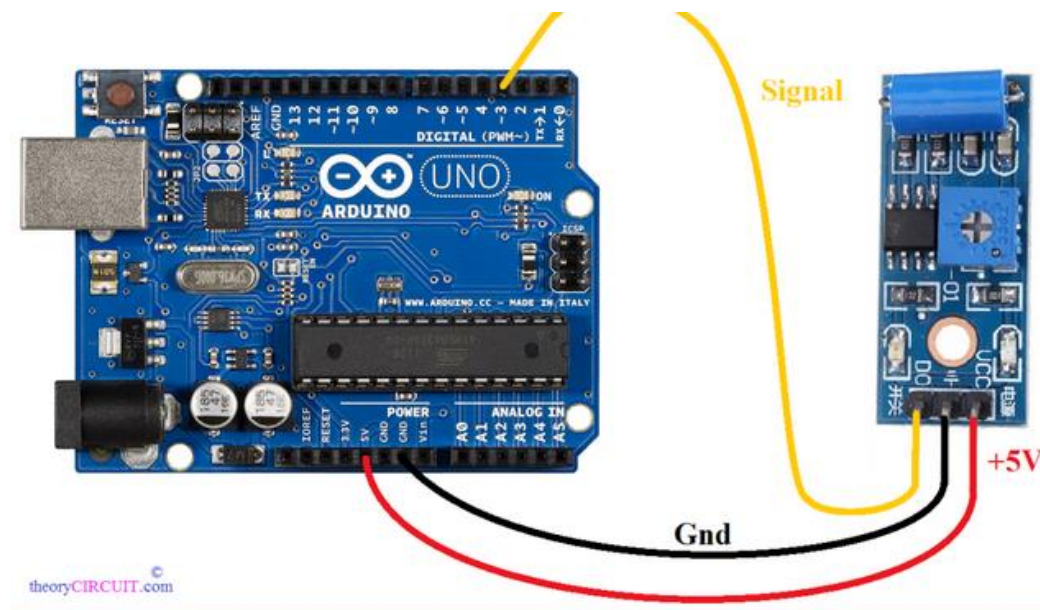


Figure 3.10.17 Connection of Vibration Detection Sensor with Arduino

The connection are: Vcc is connected to 5V pin of Arduino, Ground is connected to ground pin of Arduino and the A0 pin of gas sensor can be connected to any Digital Pin of Arduino.

Arduino Code of Vibration Detection Sensor:

```
int LED_Pin = 13;
int vibr_Pin = 3;

void setup(){
  pinMode(LED_Pin, OUTPUT);
  pinMode(vibr_Pin, INPUT); //set vibr_Pin input for measurement
  Serial.begin(9600); //init serial 9600
  // Serial.println("-----Vibration demo-----");
  -----");
}

void loop(){
  long measurement =TP_init();
  delay(50);
  // Serial.print("measurement = ");
  Serial.println(measurement);
  if (measurement > 1000){
    digitalWrite(LED_Pin, HIGH);
  }
  else{
    digitalWrite(LED_Pin, LOW);
  }
}
```

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```
long TP_init(){  
    delay(10);  
    long measurement=pulseIn (vibr_Pin, HIGH); //wait for the pin to get  
HIGH and returns measurement  
    return measurement;  
}
```

The result of code in the serial monitor:

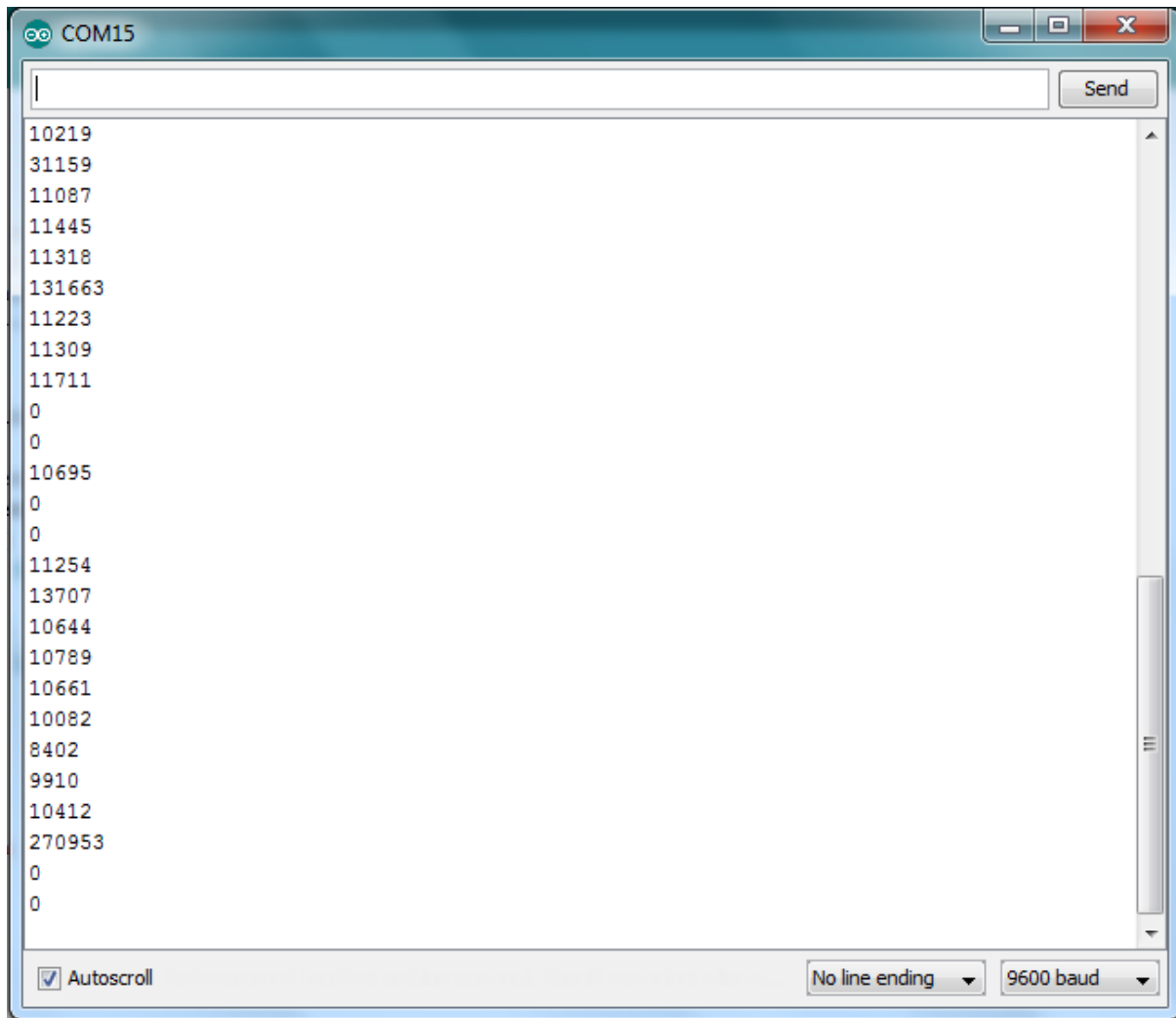


Figure 3.10.18 Result of Vibration Detection Value Shown in Serial Monitor

3.11 Arduino Email Sending

This topic is about how to use the Arduino communicate with a Python program running on the Raspberry Pi to send an email when there is a detection of sensor. The Arduino is the heart of this project. It 'listens' to the sensor and when there is a detection, it will instruct the Raspberry Pi through the USB port to send an email.

Due to the Python is pre-installed in Raspberry Pi when installing the NOOBS operating system, so we can just create a Python program. In order to do this, copy the code below into a file called “movement.py”. On the terminal of Raspberry Pi ,use the “nano” editor, on Raspberry Pi, it is probably easiest to make the file using the Python editor 'IDLE’ which is available from the Python program group on start menu.

Before running the Python program, there are some configuration changes that need to make. These are all up near the top of the file. The program assumes that the emails are being set from a Gmail account. So, a Gmail address is needed in this program. The email address next to “TO” is needed to be changed to the email that user want to receive the notifications. The email address next to “GMAIL_USER” is also needed to be changed to the email address of user’s Gmail address and alter the password on the next line to the password user to retrieve his emails. The Python code of this project is stated as figure 3.11.1 and figure 3.11.2. Besides, user can also change the subject line and text of the message to be sent, on the lines that follow. Furthermore, user will also need to set the serial port of the Arduino by editing the line below:

```
ser = serial.Serial('COM4', 9600)
```

For Windows, this will be something like “COM4” for Mac and Linux, something like “/dev/tty.usbmodem621” which shown in figure. This can be found this by opening the Arduino IDE and in the bottom right corner, it will show at the port that is connected to the Arduino.

```
1 import time
2 import serial
3 import smtplib
4
5 TO = 'limhongguan4@gmail.com'
6 GMAIL_USER = 'limhongguan4@gmail.com'
7 GMAIL_PASS = '049763208lim'
8
9 SUBJECT = 'Intrusion!!'
10 SUBJECT2 = 'Water Leakage!'
11 SUBJECT3 = 'Gas Leakage!'
12 SUBJECT4 = 'Vibration occur!'
13
14 ser = serial.Serial('/dev/ttyACM0', 9600)
15
16 TEXT = 'Your PIR sensor detected movement'
17 TEXT2 = 'Water leakage occur in your bathroom '
18 TEXT3 = 'Gas Leakage occur in your bathroom '
19 TEXT4 = 'Vibration detected in you room'
20
21
22
23 def send_email1():
24     print("Sending Email")
25     smtpserver = smtplib.SMTP("smtp.gmail.com",587)
26     smtpserver.ehlo()
27     smtpserver.starttls()
28     smtpserver.ehlo
29     smtpserver.login(GMAIL_USER, GMAIL_PASS)
30     header = 'To:' + TO + '\n' + 'From: ' + GMAIL_USER
31     header = header + '\n' + 'Subject:' + SUBJECT + '\n'
32     print header
33     msg = header + '\n' + TEXT + '\n\n'
34     smtpserver.sendmail(GMAIL_USER, TO, msg)
35     smtpserver.close()
36
37 def send_email2():
38     print("Sending Email")
39     smtpserver = smtplib.SMTP("smtp.gmail.com",587)
40     smtpserver.ehlo()
41     smtpserver.starttls()
42     smtpserver.ehlo
43     smtpserver.login(GMAIL_USER, GMAIL_PASS)
44     header = 'To:' + TO + '\n' + 'From: ' + GMAIL_USER
45     header = header + '\n' + 'Subject:' + SUBJECT2 + '\n'
46     print header
47     msg = header + '\n' + TEXT2 + '\n\n'
48     smtpserver.sendmail(GMAIL_USER, TO, msg)
```

Figure 3.11.1 Python Code to Send Email(1)

```
46     print header
47     msg = header + '\n' + TEXT2 + ' \n\n'
48     smtpserver.sendmail(GMAIL_USER, TO, msg)
49     smtpserver.close()
50
51     def send_email3():
52         print("Sending Email")
53         smtpserver = smtplib.SMTP("smtp.gmail.com",587)
54         smtpserver.ehlo()
55         smtpserver.starttls()
56         smtpserver.ehlo
57         smtpserver.login(GMAIL_USER, GMAIL_PASS)
58         header = 'To:' + TO + '\n' + 'From: ' + GMAIL_USER
59         header = header + '\n' + 'Subject:' + SUBJECT3 + '\n'
60         print header
61         msg = header + '\n' + TEXT3 + ' \n\n'
62         smtpserver.sendmail(GMAIL_USER, TO, msg)
63         smtpserver.close()
64
65     def send_email4():
66         print("Sending Email")
67         smtpserver = smtplib.SMTP("smtp.gmail.com",587)
68         smtpserver.ehlo()
69         smtpserver.starttls()
70         smtpserver.ehlo
71         smtpserver.login(GMAIL_USER, GMAIL_PASS)
72         header = 'To:' + TO + '\n' + 'From: ' + GMAIL_USER
73         header = header + '\n' + 'Subject:' + SUBJECT4 + '\n'
74         print header
75         msg = header + '\n' + TEXT4 + ' \n\n'
76         smtpserver.sendmail(GMAIL_USER, TO, msg)
77         smtpserver.close()
78
79     while True:
80         message = ser.readline()
81         print(message)
82         if message[0] == 'M' :
83             send_email1()
84         if message[0] == 'w' :
85             send_email2()
86         if message[0] == 'G' :
87             send_email3()
88         if message[0] == 'V' :
89             send_email4()
90         time.sleep(0.5)
91
```

Figure 3.11.2 Python Code to Send Email(2)

Chapter 3: System Design

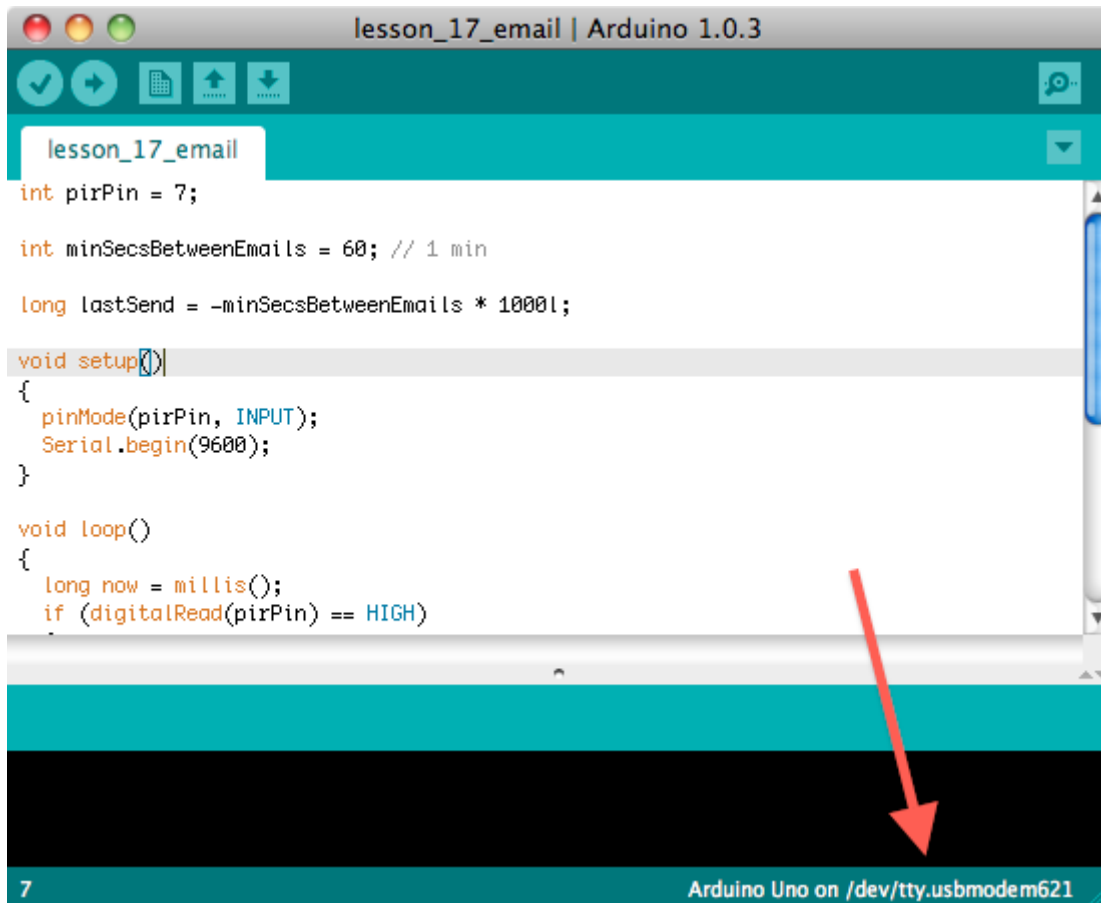


Figure 3.11.4 Port Showing in Arduino IDE

Lastly, When all the changes have been made, the program can be run from Command Prompt / Terminal with the command:

python movement.py

Chapter 4: Methodology and Tools

4.1 Design Methodology

A good and high functionalities system require a proper design methodology to be its underlying reference. Hence, the design methodology adopted in this project is prototyping model under the category of Embedded Development Life Cycle (EDSC). The main idea behind this Prototype Model is to build a prototype (an early approximation of a final system) first and experience a large work of testing and reworking until an acceptable prototype is achieved. This model do well in the scenarios when all the requirement are unknown at the beginning of the process of work.

The following step of Prototyping Model stated as below:

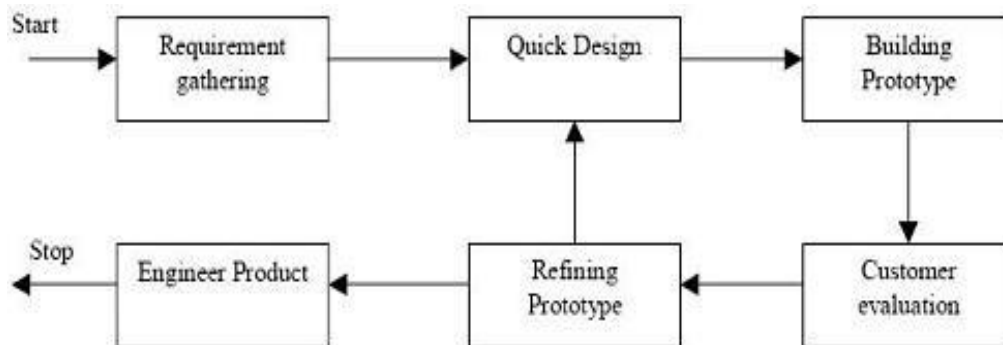


Figure 4.1.1 Prototyping Model

1. **Requirement gathering and analysis:** The requirements of new system need to be defined as much as possible at beginning.
2. **Quick design:** An initial design need to be created for the new system. In quick design state, the characteristic used in design won't not work precisely same as the real outline. But its overall features are more similar to the final development.
3. **Building prototypes:** A first prototype of new system is created from the initial design. This is actually a scaled-down system which comprises some of feature of the final product.

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4. **Customer evaluation:** After building the prototype system, the prototype will be send to clients for evaluation checking. The second prototype will be release based on the first prototype in conjunction with seeking comments of client and other professional.
5. **Refining product:** In this phase, the user iteratively evaluates the first prototype and strengthens it in the weakness portion. The user will also do the iterative evaluation as many times as possible until the clients are satisfied with final prototype.
6. **Engineer product:** After all successive feedback and positive review from the customer, the actual product is designed and developed. The system also needs to go through the process of checking and testing to prevent any failures.

In conclusion, prototyping model is a good idea for complicated and large system and for which there is no existing system to determine the pre-requirement, so I will use this model to implement into this system design. Another reason are it can make user more understand about the whole system and this model can be traced back to previous stage for troubleshooting purpose.

Chapter 4: Methodology and Tools

4.2 System Requirement

Both software and hardware is needed in Smart Home System in order for system to work properly.

For the **software** part, Arduino IDE and LAMP which included Apache Web server, PHP Hypertext Preprocessor and MySQL Structured Query Language will be used in this project. Arduino IDE is an open source software that can be used between software and hardware by writing C codes on it then upload to the ArduinoMega board. Besides, LAMP is an open source Web development platform that uses Linux as the operating system, Apache as the Web server, MySQL as the database management system and PHP as the programming scripting language. The MySQL software will be the main database to store the sensor's data which get from Arduino while the Apache software will be using in the Raspberry pi to become as a web server to upload the data which get from database to the user interface. Lastly, the PHP (Hypertext Preprocessor) is a general-purpose scripting language which used for server site website development.

For the hardware part, Arduino Mega board, Raspberry pi, Arduino Ethernet Shield, keypad, relay, LCD display, servo motor, buzzer, sensor such as temperature and humidity sensor, MQ-2 gas sensor, PIR motion sensor, water detection sensor, vibration sensor will be used in this project.

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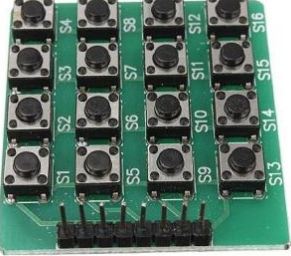
 <p>Arduino Mega: Main controller</p>	 <p>Raspberry PI : Single computer chip</p>	 <p>LCD Display: Use to display information get from microcontroller</p>
 <p>4 x 4 keypad: Use to switch on or off some household appliance</p>		

Table 3.10.1 Sensors of Smart Home

4.3 Verification Plan

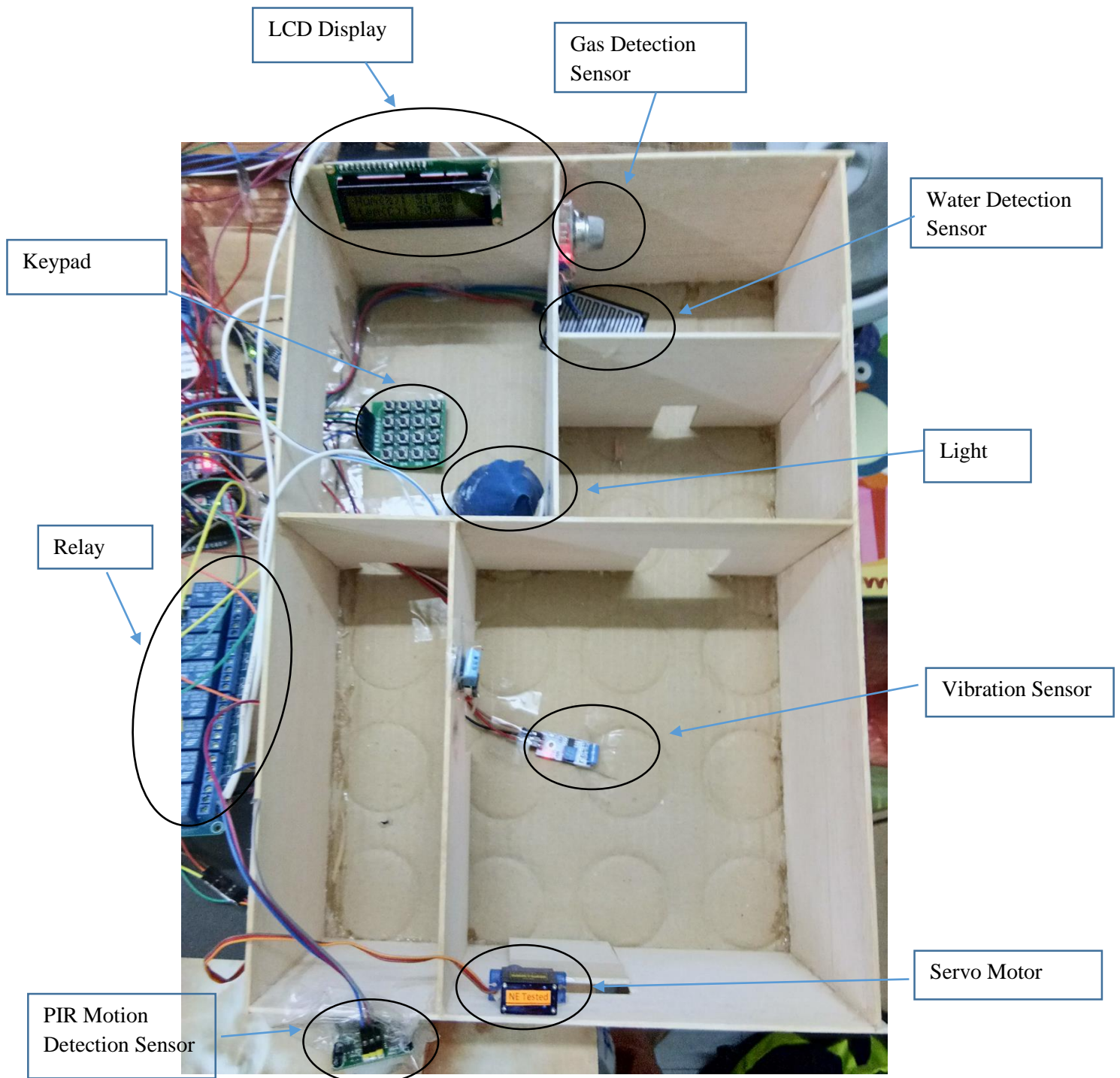


Figure 4.2.1 Full Diagram (1)

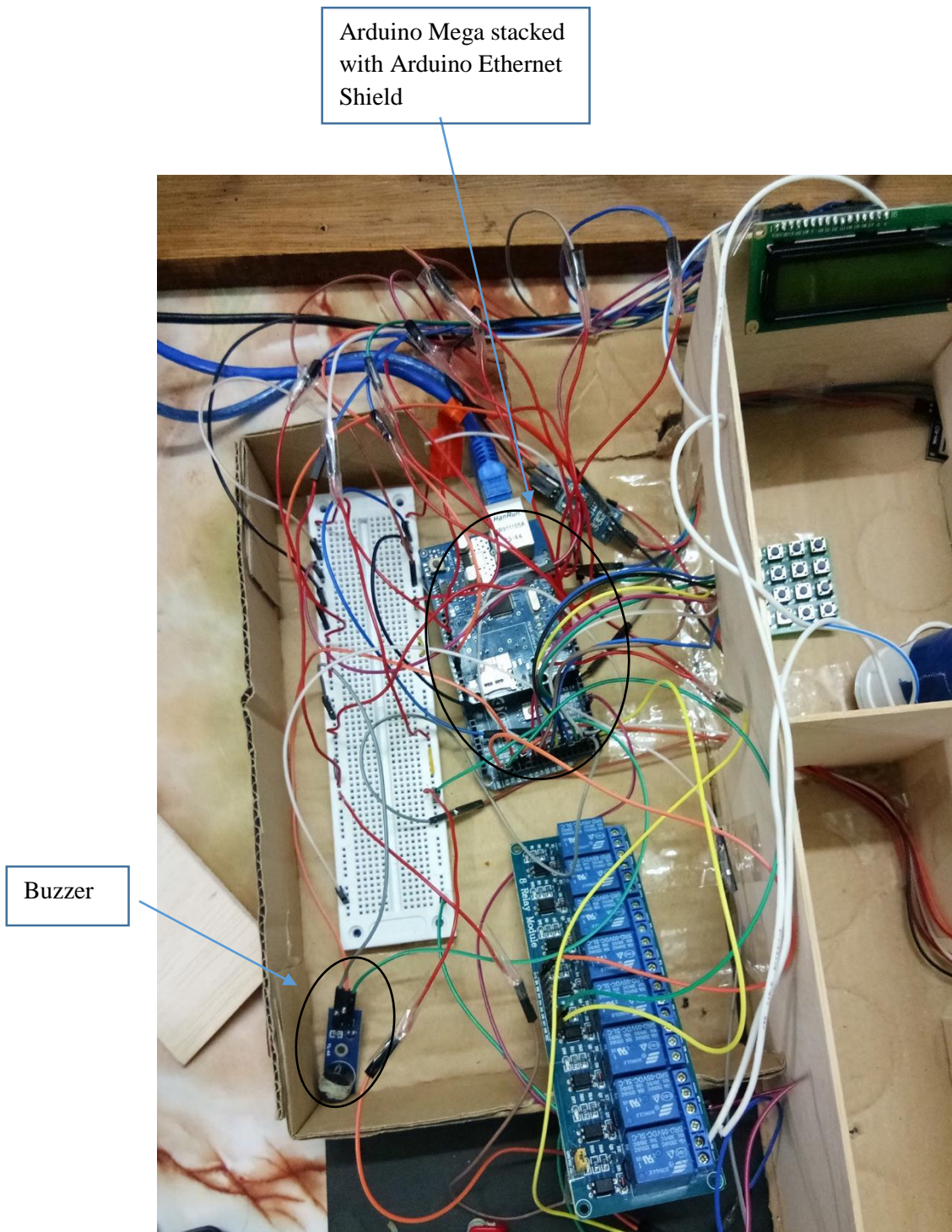


Figure 4.2.2 Full Diagram (2)

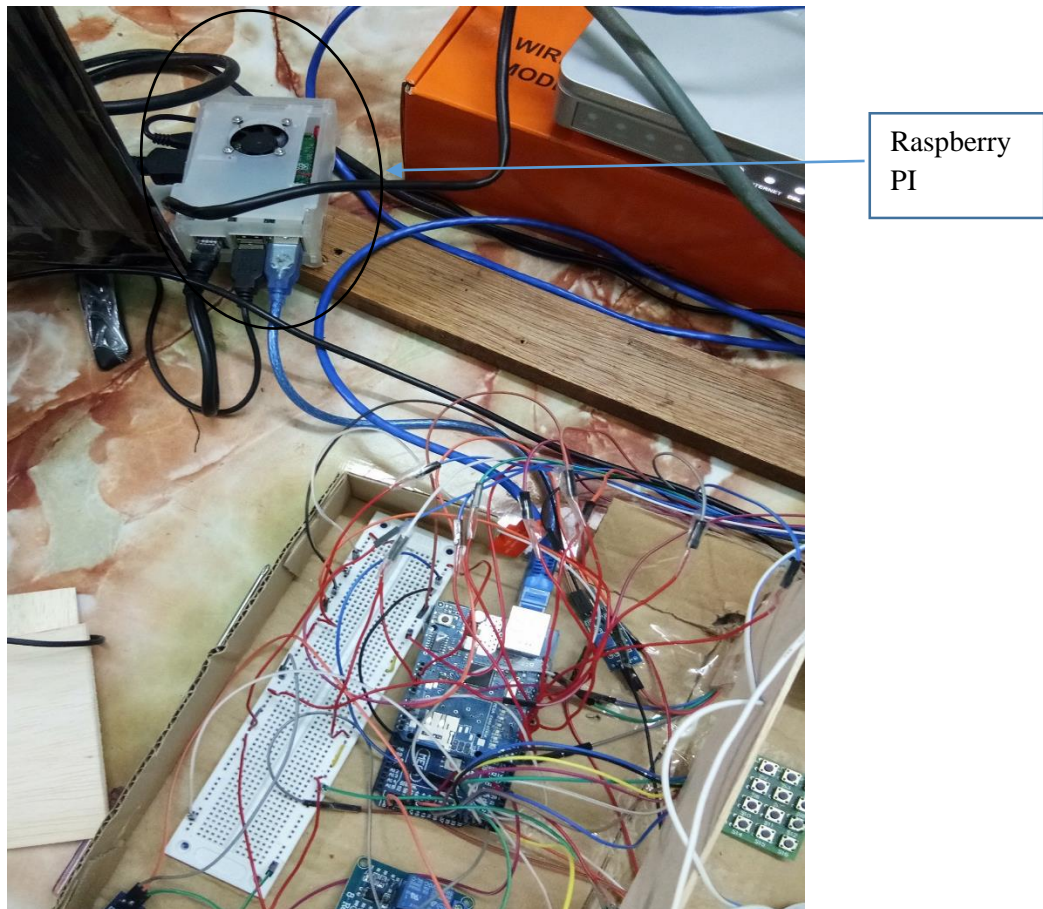


Figure 4.2.3 Full Diagram (3)

The Figure 4.2.1, Figure 4.2.2, Figure 4.2.3 are the full diagram which comprises all the sensor and component.

There are two mode in this system which are the usual mode and sleeping mode. In sleeping mode, all the sensors will be activated. In the usual mode, all sensor will be activated except PIR motion detection sensor and vibration detection sensor. User are recommended to use sleeping mode during the sleeping time in night or the outstation time so this is for the sake of security purpose. Besides, user are recommended to use usual mode during the day time when he or she is staying in the home.

The verification of the smart home's functions are stated as below:

- 1) Security part:
 - a. Verification of PIR Motion Detection Sensor: The alarm will be activated and an e-mail will also be sent to the user during the detection of suspicious

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movement around the home which shown in figure 4.2.8. Besides, the user also can view the situation through the webpage which under the section of Home Security Condition and LCD display which shown in figure 4.2.5 and 4.2.6 and check the historical record in a specific webpage which shown in figure 4.2.7.

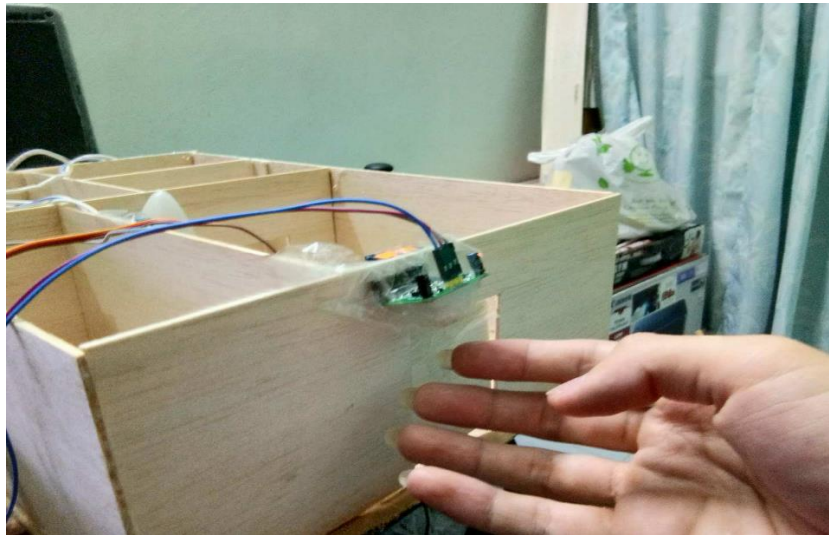


Figure 4.2.4 Testing of PIR Motion Sensor

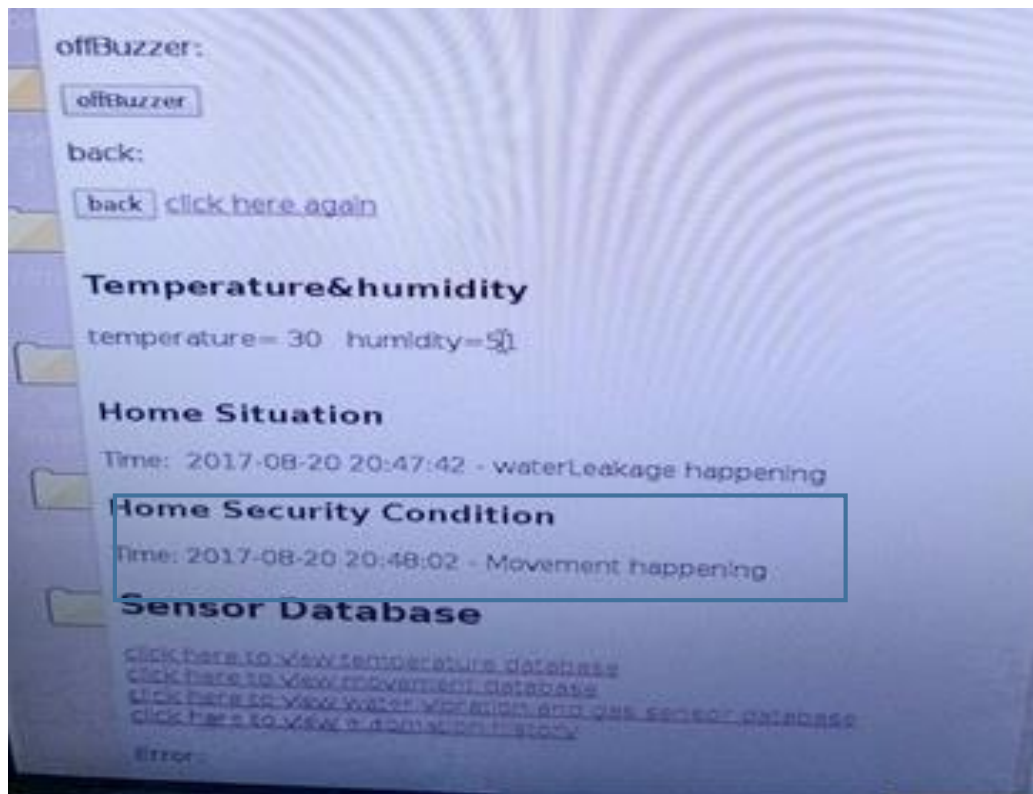


Figure 4.2.5 Display Information of Motion Detection on Webpage

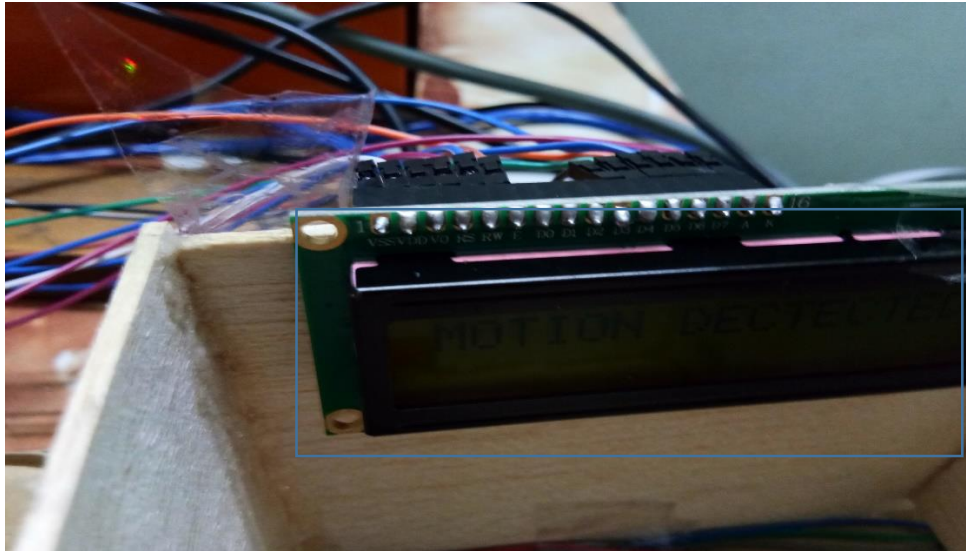


Figure 4.2.6 Display Information of Motion Detection on LCD Display

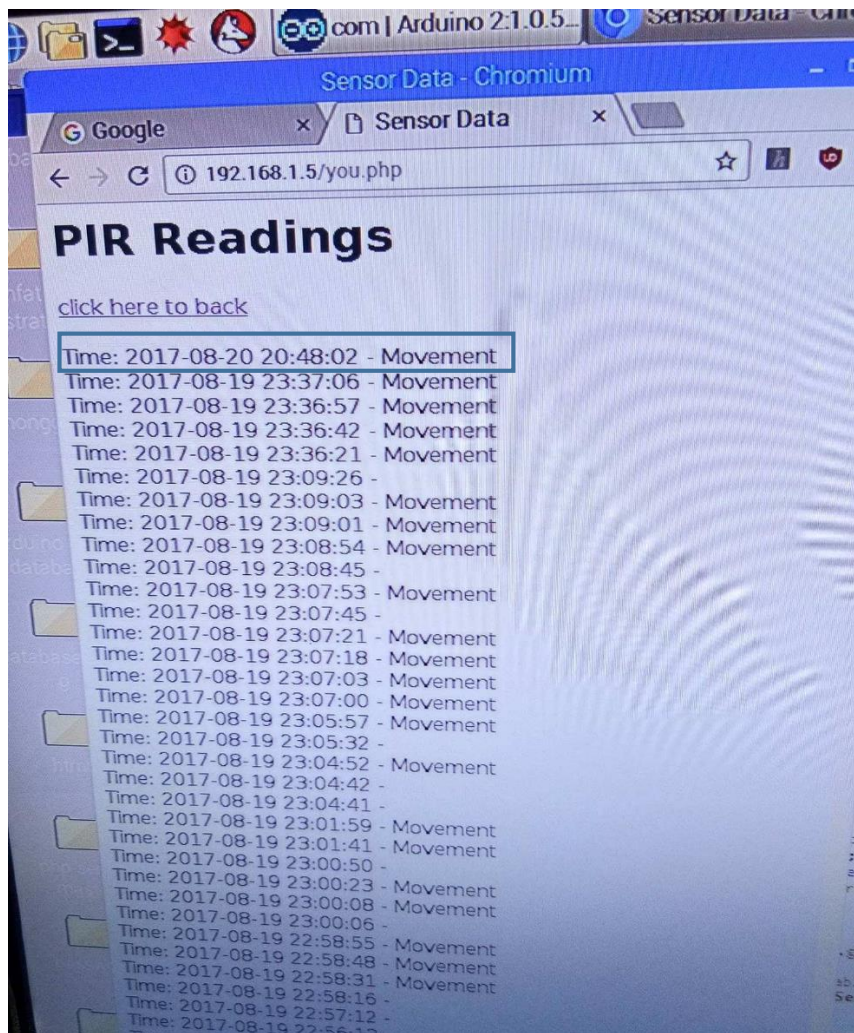


Figure 4.2.7 Historical Record of Motion Detection on Webpage

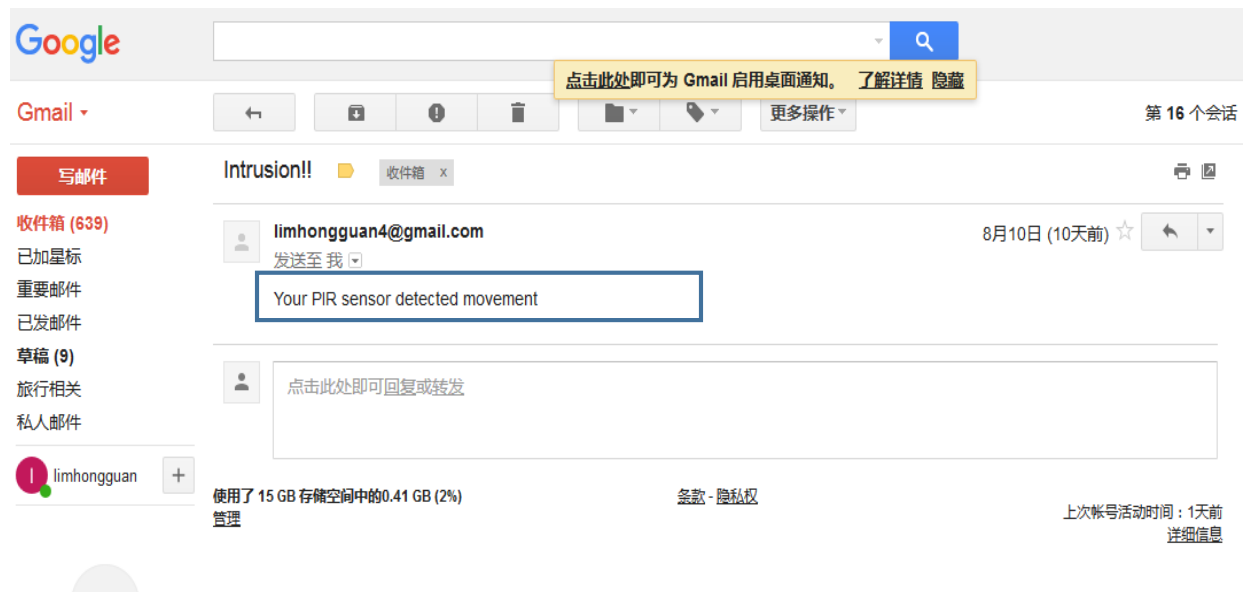


Figure 4.2.8 An Email of Motion Detection Case

- b. Verification of Vibration Detection Sensor: The alarm will be activated and an e-mail will also be sent to the user during the vibration cause by intrusion of intruder which shown in figure 4.2.13. Besides, the user also can view the situation through the webpage which under the section of Home Situation and LCD display which shown in figure 4.2.10 and 4.2.11 and check the historical record in a specific webpage which shown in figure 4.2.12.

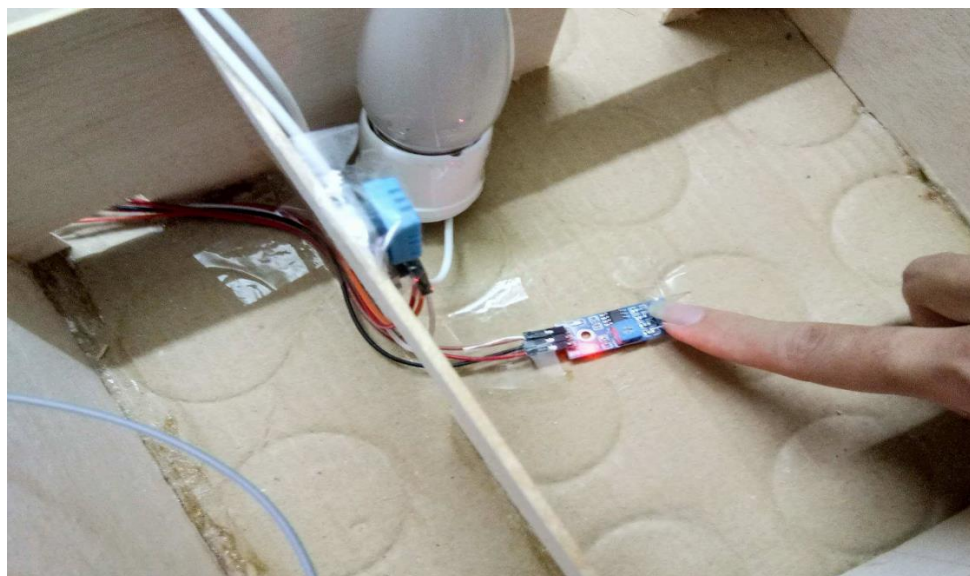


Figure 4.2.9 Testing of PIR Motion Sensor

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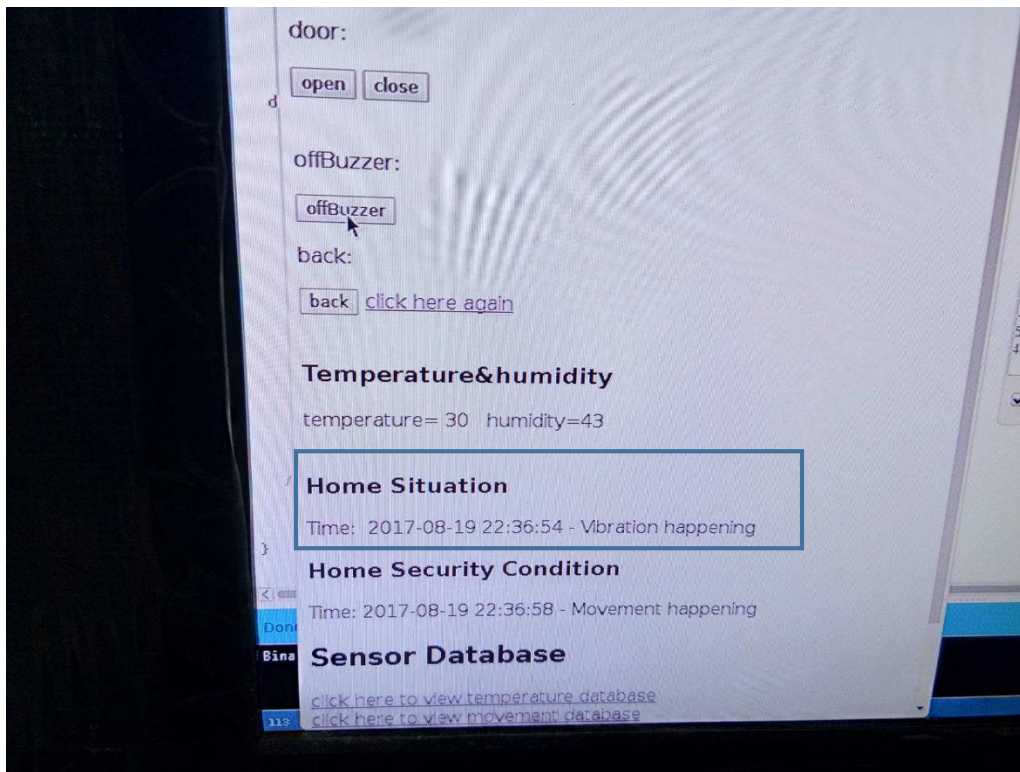


Figure 4.2.10 Display Information of Vibration Detection on Webpage

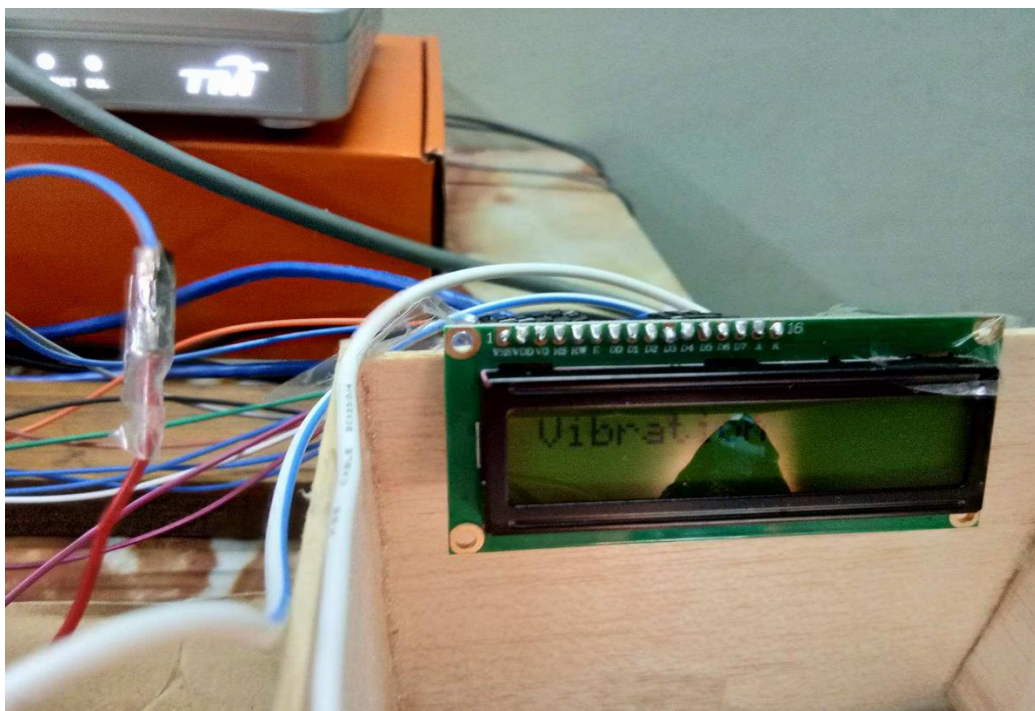


Figure 4.2.11 Display Information of Vibration Detection on LCD Display

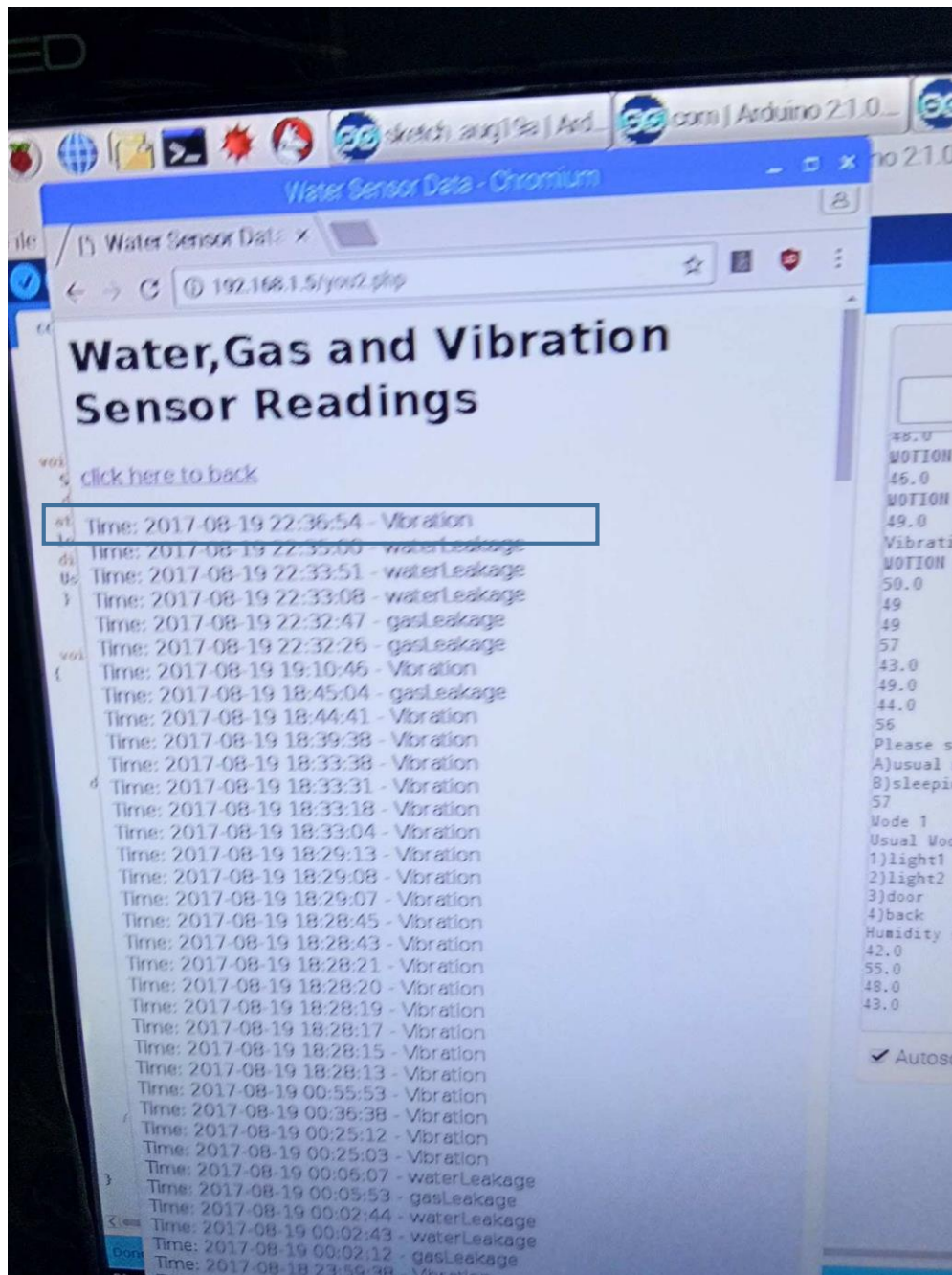


Figure 4.2.12 Historical Record of Vibration Detection on Webpage

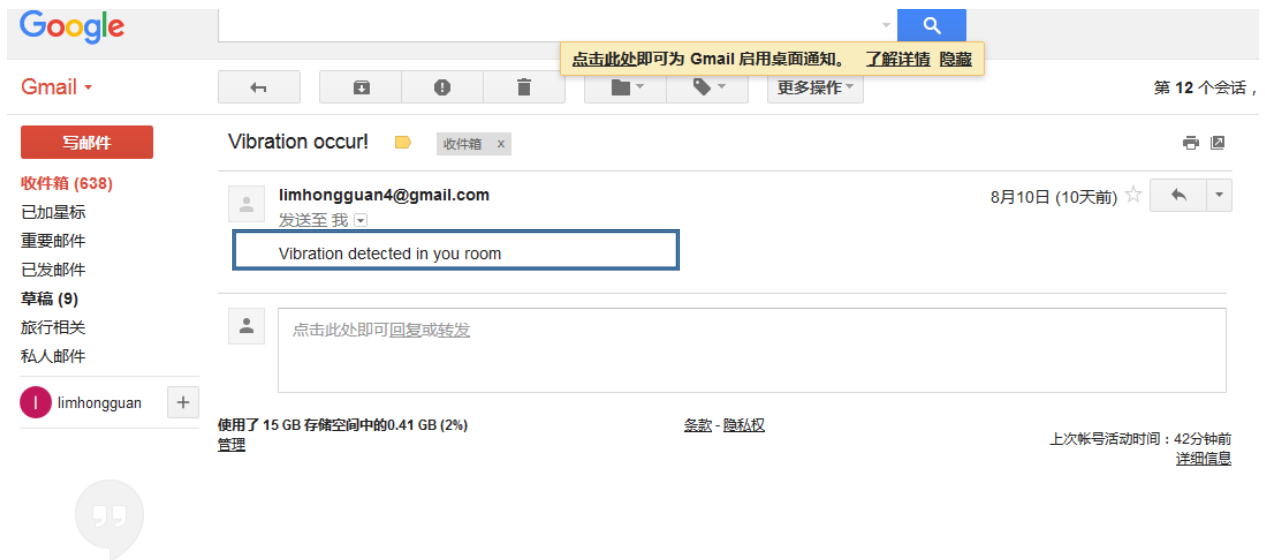


Figure 4.2.13 An Email of Vibration Case

- c. Verification of Water Detection Sensor: The alarm will be activated and an e-mail will also be sent to the user during the case of water leakage which shown in figure 4.2.18. Besides, the user also can view the situation through the webpage which under the section of Home Situation and LCD display which shown in figure 4.2.17 and 4.2.16 and check the historical record in a specific webpage which shown in figure 4.2.15.

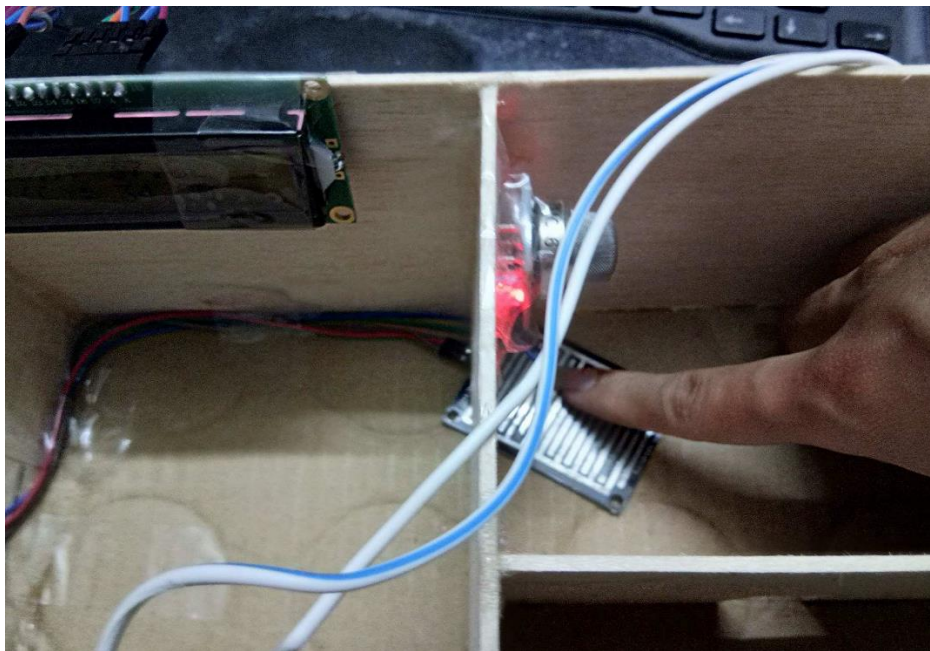


Figure 4.2.14 Testing of Water Detection Sensor

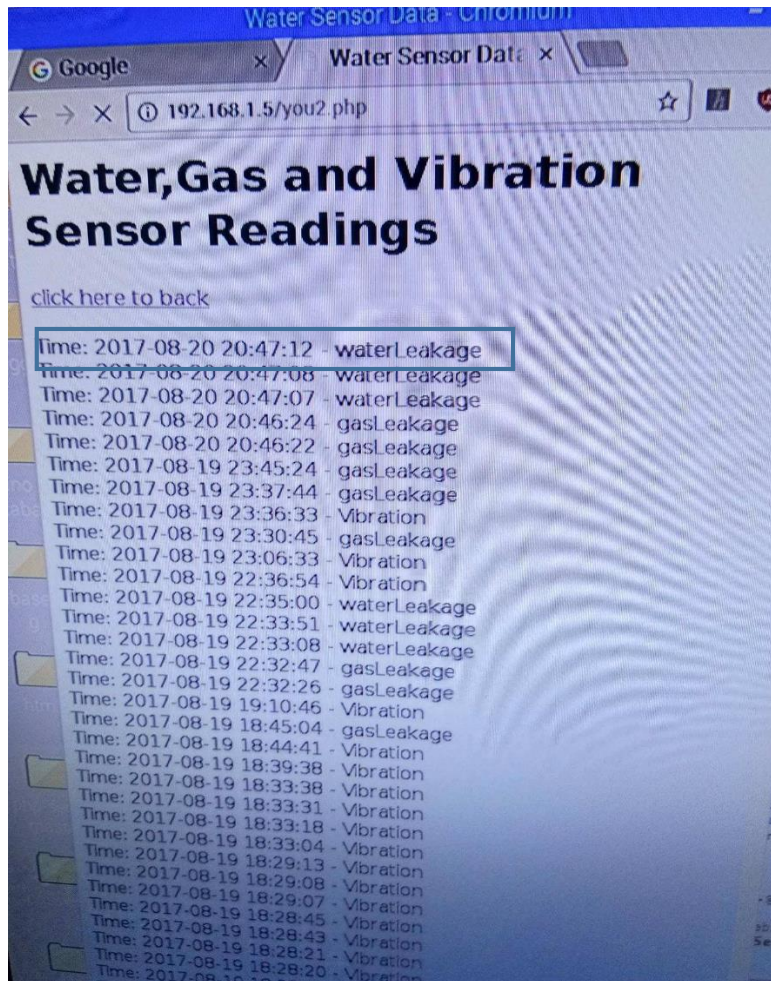


Figure 4.2.15 Historical Record of Water Detection on Webpage

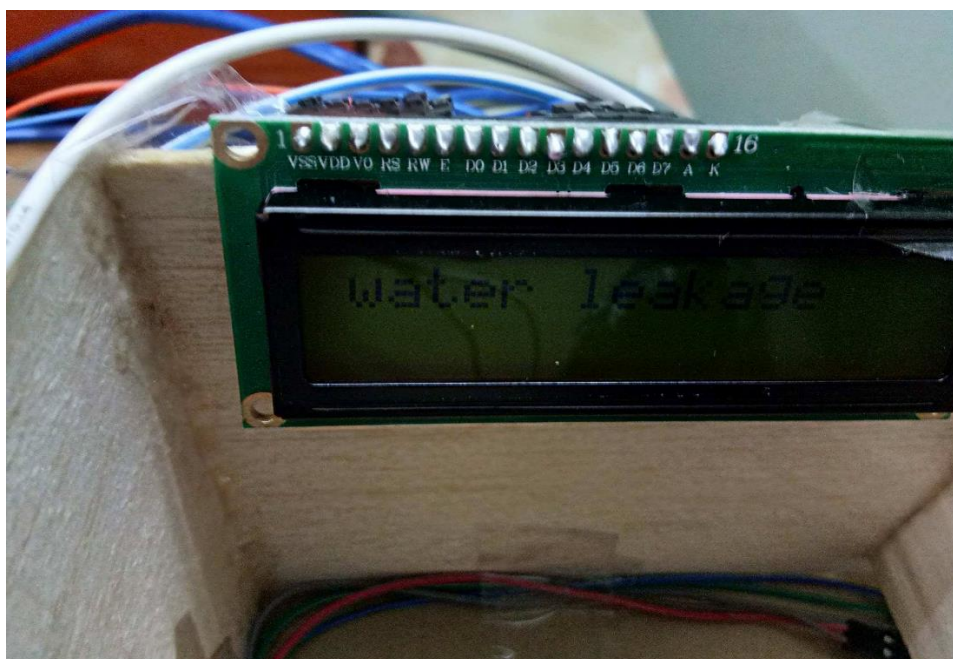


Figure 4.2.16 Display Information of Water Detection on LCD Display

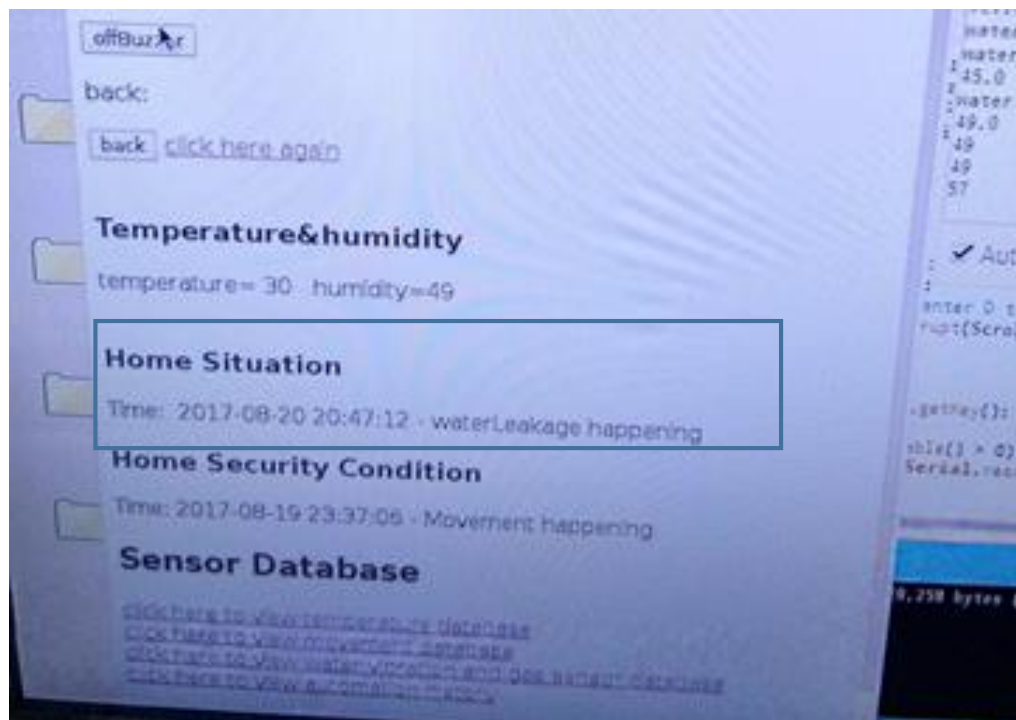


Figure 4.2.17 Display Information of Water Detection on Webpage

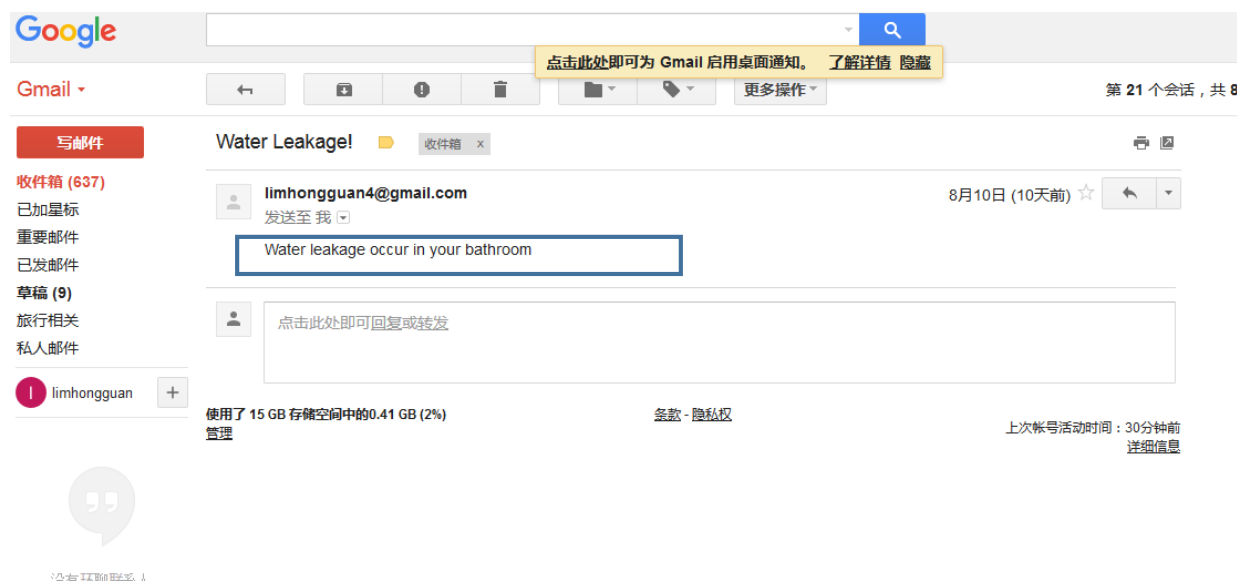


Figure 4.2.18 An Email of Water Leakage Case

- d. Verification of Gas Detection Sensor: The alarm will be activated and an e-mail will also be sent to the user during the case of gas leakage which shown in figure 4.2.23. Besides, the user also can view the situation through the webpage which under the section of Home Situation and LCD display which shown in figure 4.2.20 and 4.2.21 and check the historical record in a specific webpage which shown in figure 4.2.22.

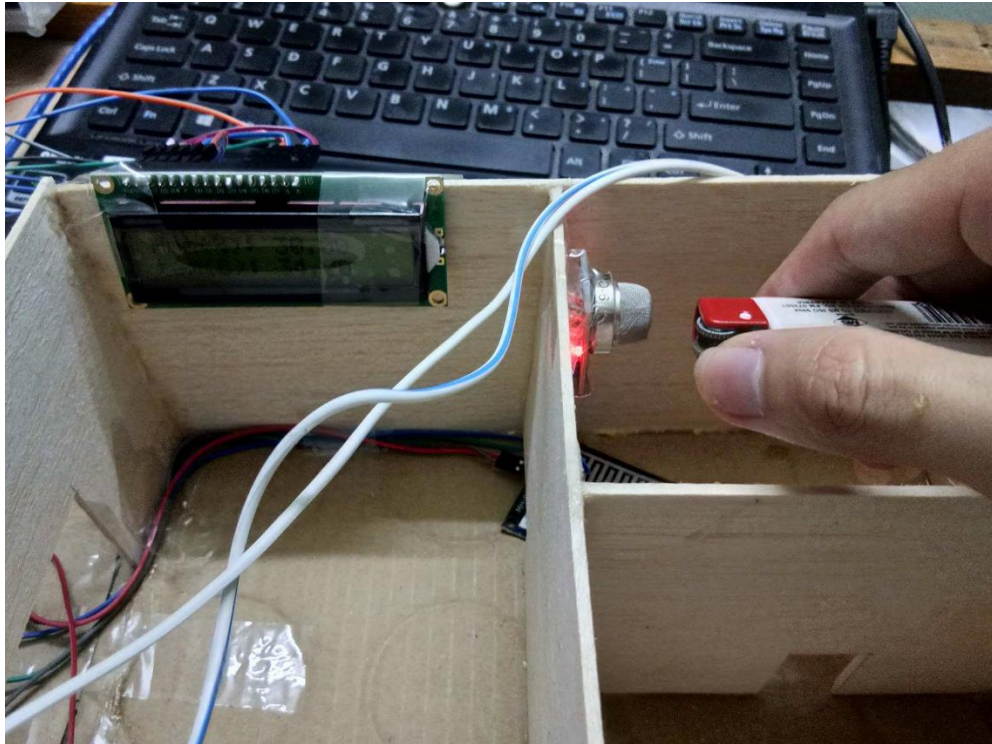


Figure 4.2.19 Testing of Gas Detection Sensor

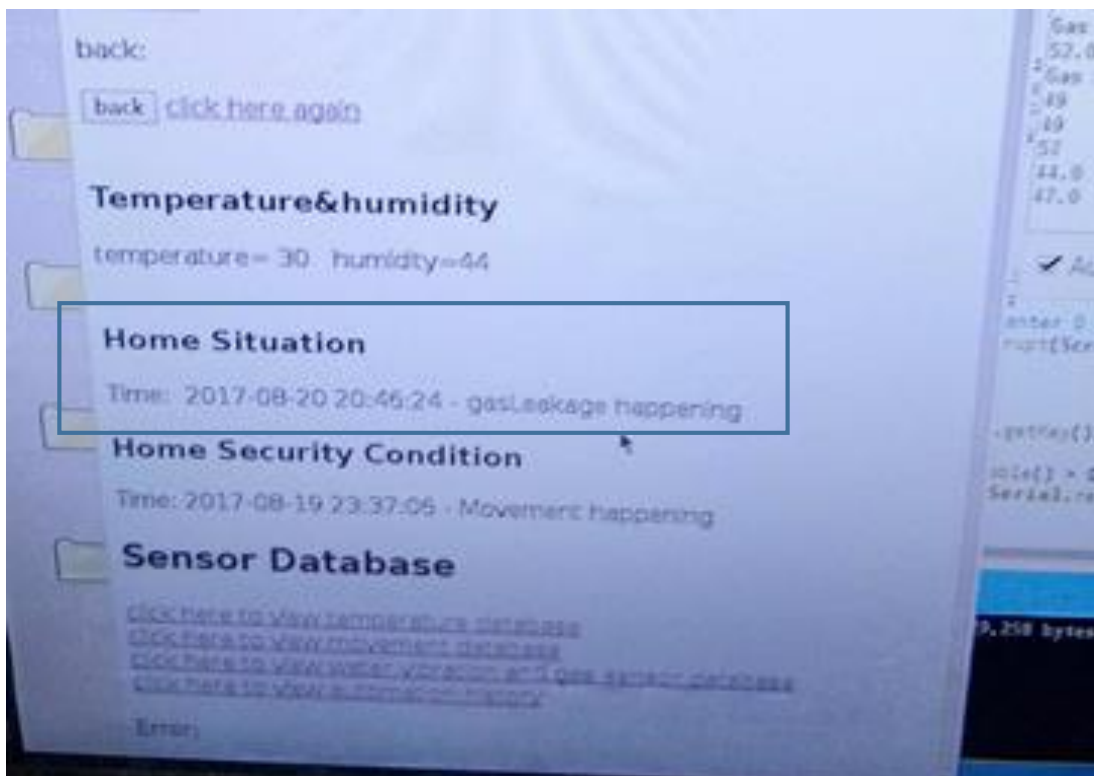


Figure 4.2.20 Display Information of Gas Detection on Webpage

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Figure 4.2.21 Display Information of Water Detection on LCD Display

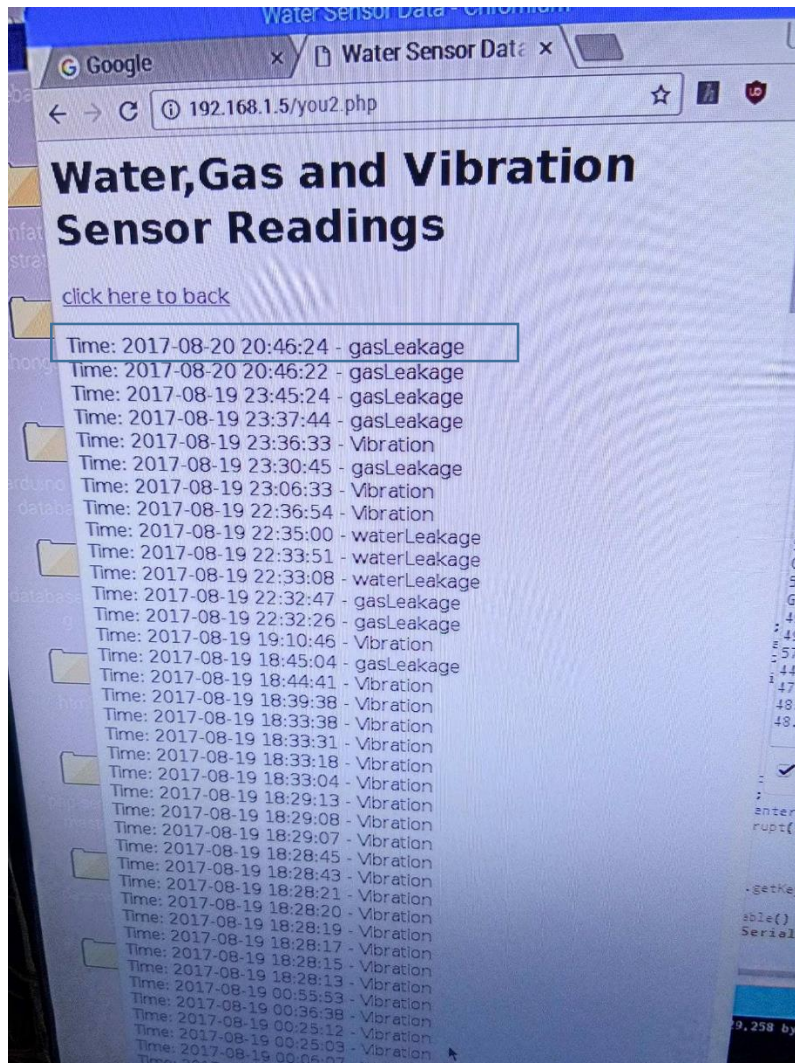


Figure 4.2.22 Historical Record of Gas Detection on Webpage

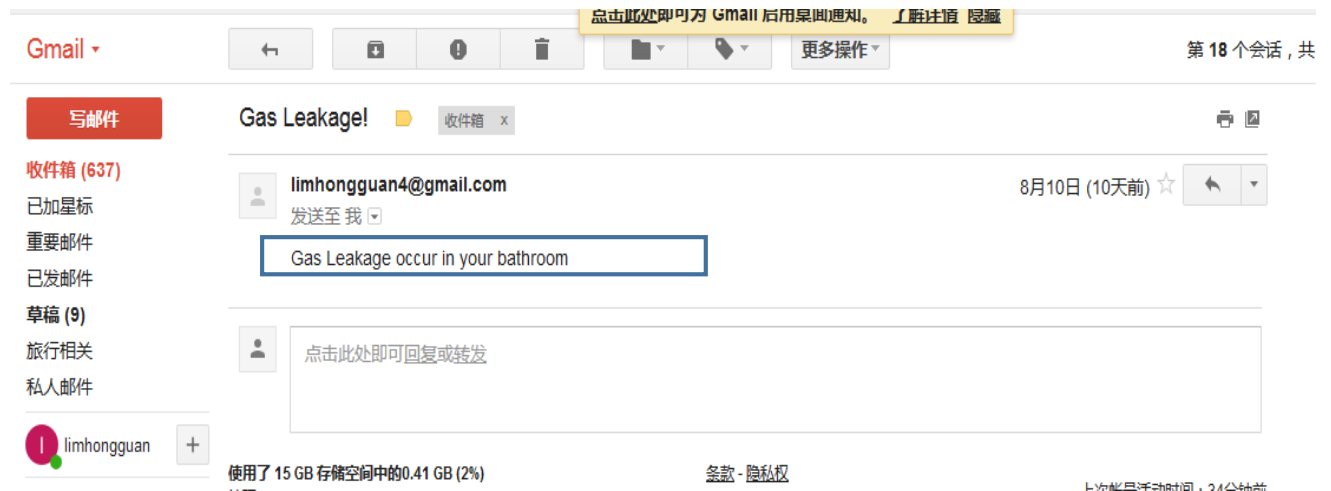


Figure 4.2.23 An Email of Gas Detection Case

2) Monitoring Part:

- a. Verification of Temperature and Humidity Sensor: User can monitor the temperature and humidity by viewing the LCD display which shown in figure 4.2.24 and the webpage which shown in figure 4.2.25.

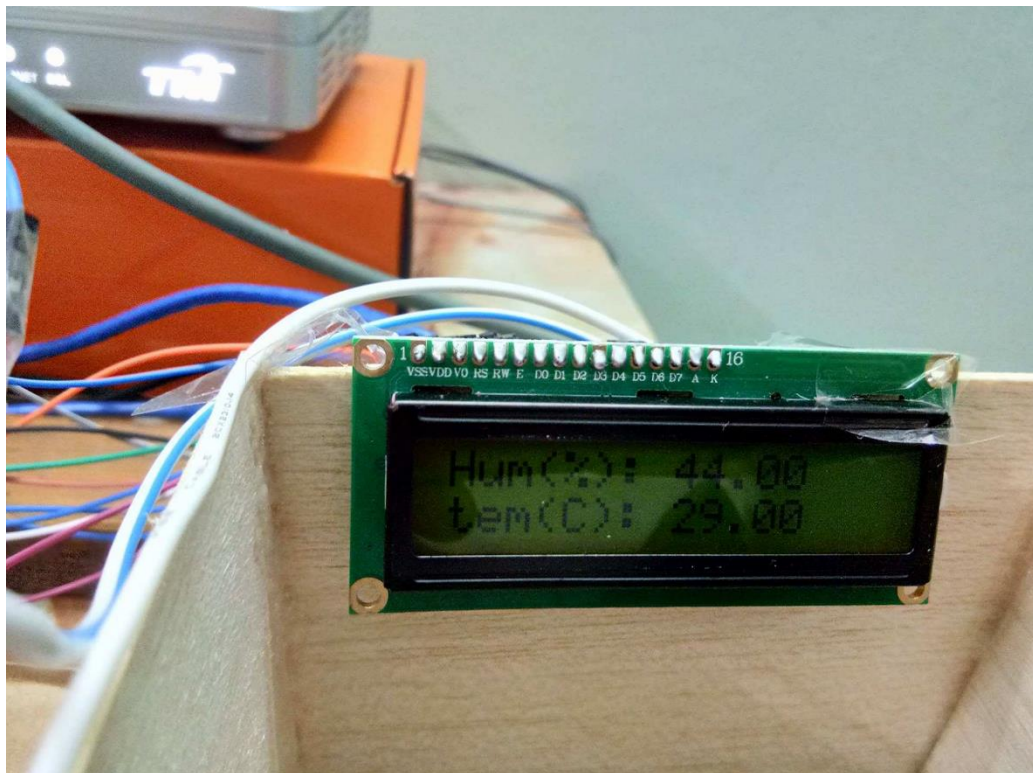


Figure 4.2.24 Display the Value of Temperature and Humidity on LCD Display

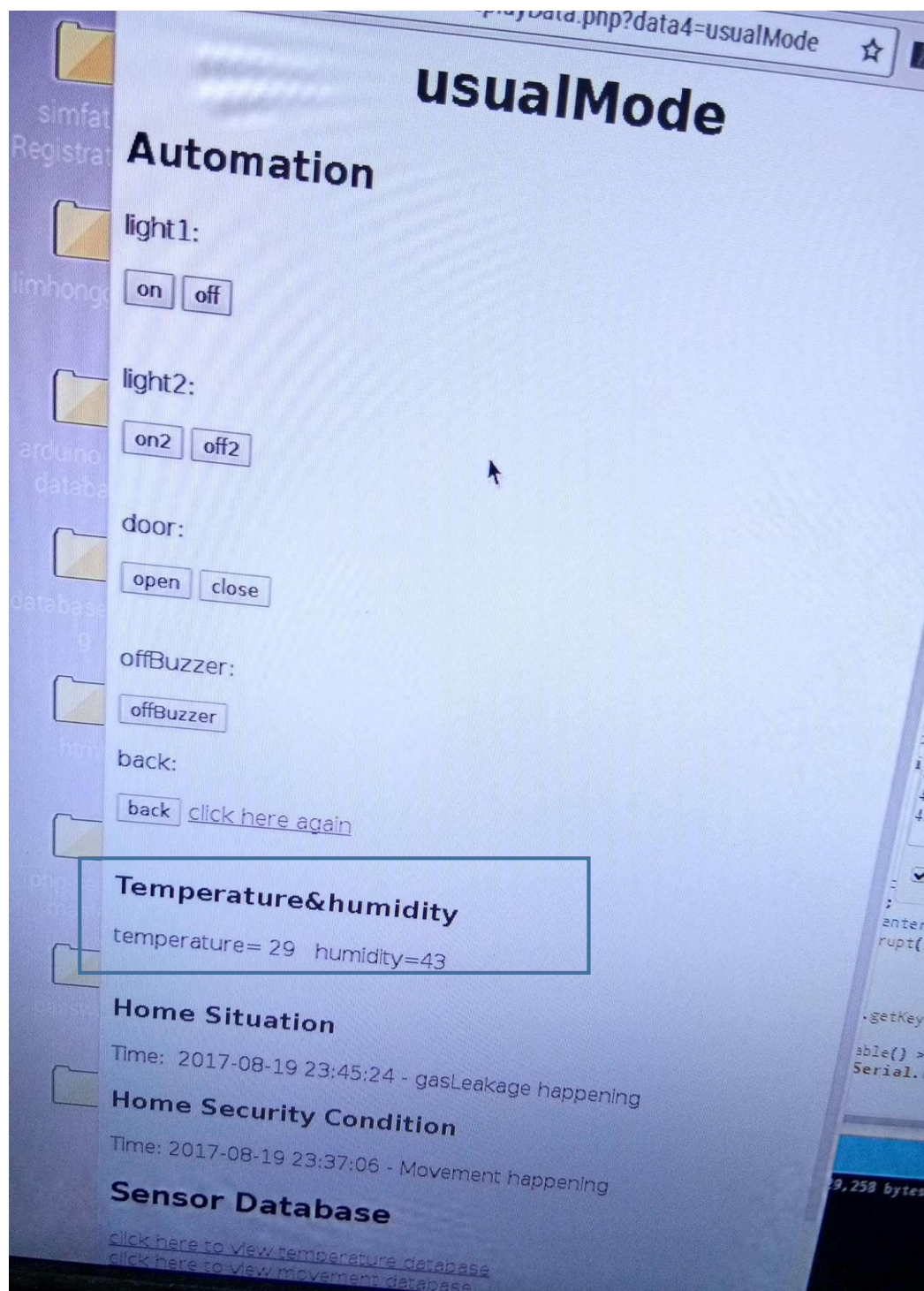
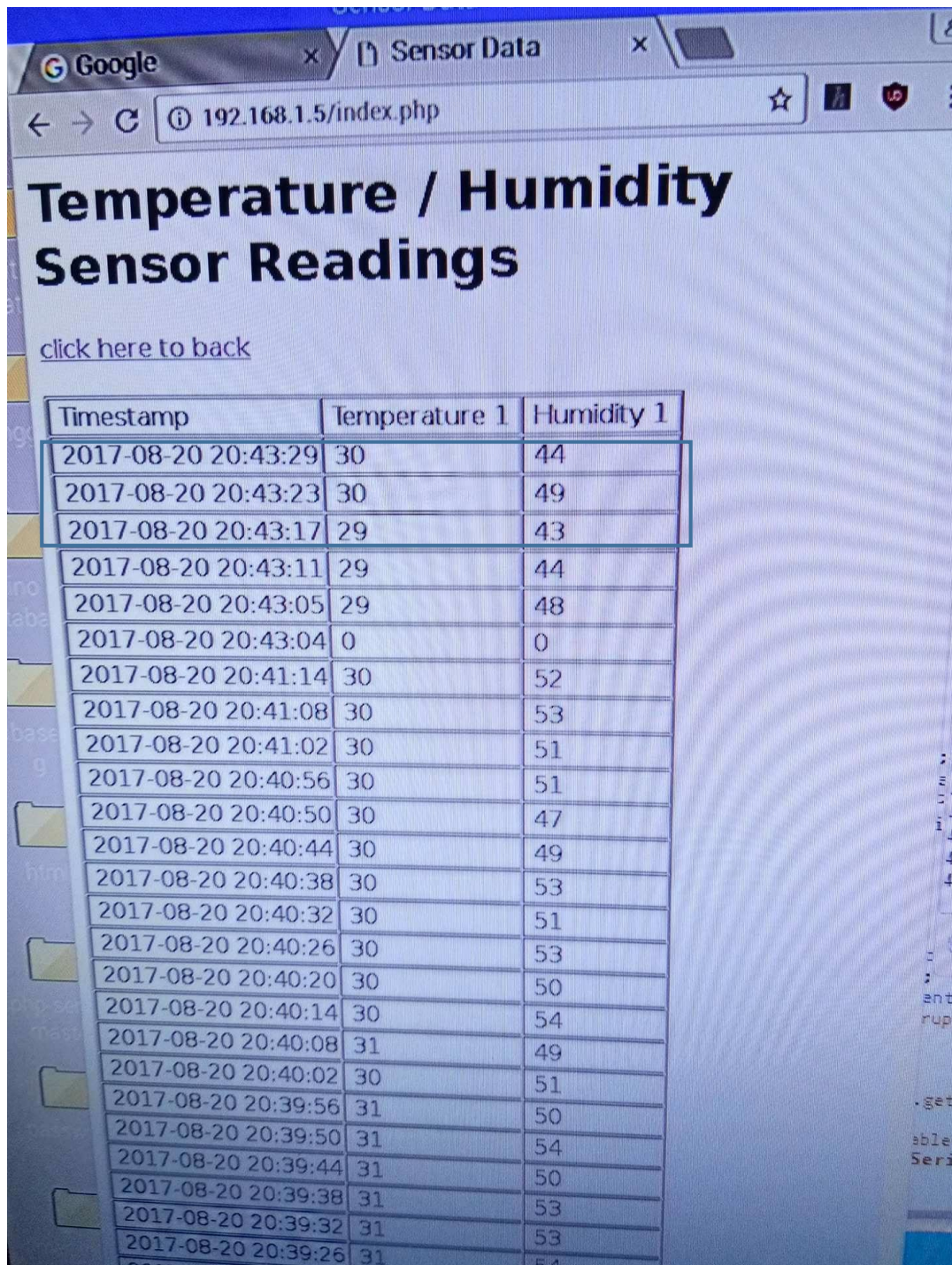


Figure 4.2.25 Display the Value of Temperature and Humidity on Webpage



The screenshot shows a web browser window with the title 'Sensor Data' and the URL '192.168.1.5/index.php'. The main heading is 'Temperature / Humidity Sensor Readings'. Below the heading is a link 'click here to back'. A table displays sensor readings with columns for 'Timestamp', 'Temperature 1', and 'Humidity 1'. The table contains 20 rows of data, with the first three rows highlighted by a blue border.

Timestamp	Temperature 1	Humidity 1
2017-08-20 20:43:29	30	44
2017-08-20 20:43:23	30	49
2017-08-20 20:43:17	29	43
2017-08-20 20:43:11	29	44
2017-08-20 20:43:05	29	48
2017-08-20 20:43:04	0	0
2017-08-20 20:41:14	30	52
2017-08-20 20:41:08	30	53
2017-08-20 20:41:02	30	51
2017-08-20 20:40:56	30	51
2017-08-20 20:40:50	30	47
2017-08-20 20:40:44	30	49
2017-08-20 20:40:38	30	53
2017-08-20 20:40:32	30	51
2017-08-20 20:40:26	30	53
2017-08-20 20:40:20	30	50
2017-08-20 20:40:14	30	54
2017-08-20 20:40:08	31	49
2017-08-20 20:40:02	30	51
2017-08-20 20:39:56	31	50
2017-08-20 20:39:50	31	54
2017-08-20 20:39:44	31	50
2017-08-20 20:39:38	31	53
2017-08-20 20:39:32	31	53
2017-08-20 20:39:26	31	54

Figure 4.2.26 Historical Record of Temperature and Humidity's Value on Webpage

- 3) Automation part: user can execute some automation through a designated webpage which is completely same with the between user and sleeping. Beside from this,

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user can do the same thing by using the keypad. All the history of automation will be save into the database and it can be viewed in the webpage.

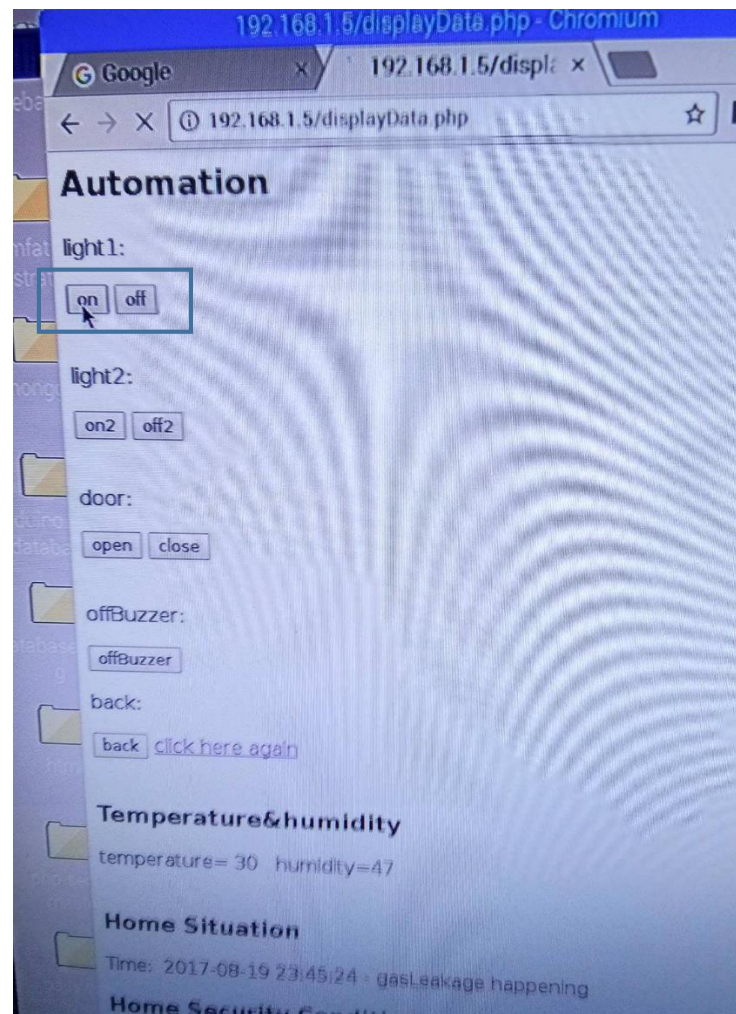


Figure 4.2.27 Light Switching on by Automation



Figure 4.2.28 Status of Light On on LCD Display

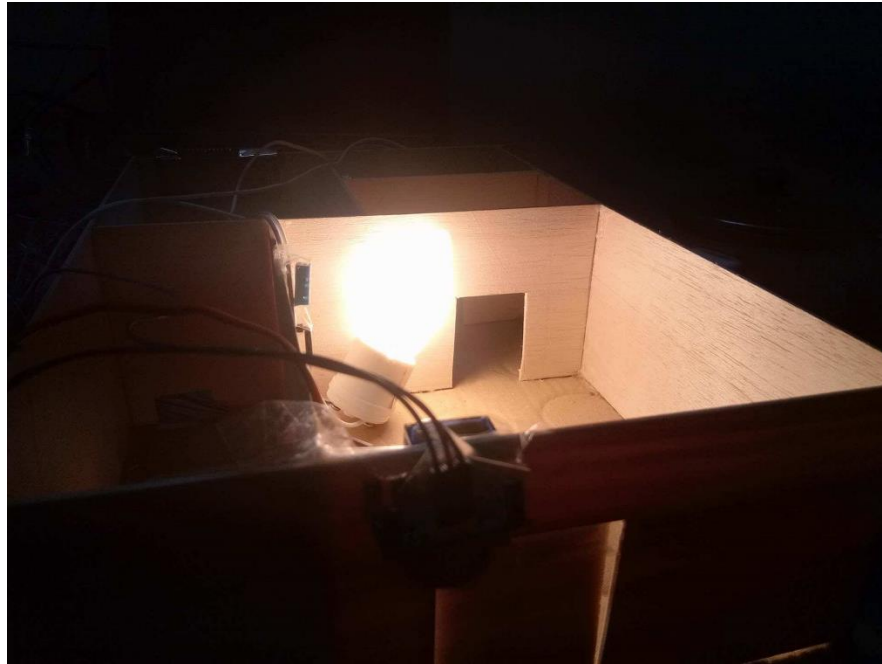


Figure 4.2.29 Light On

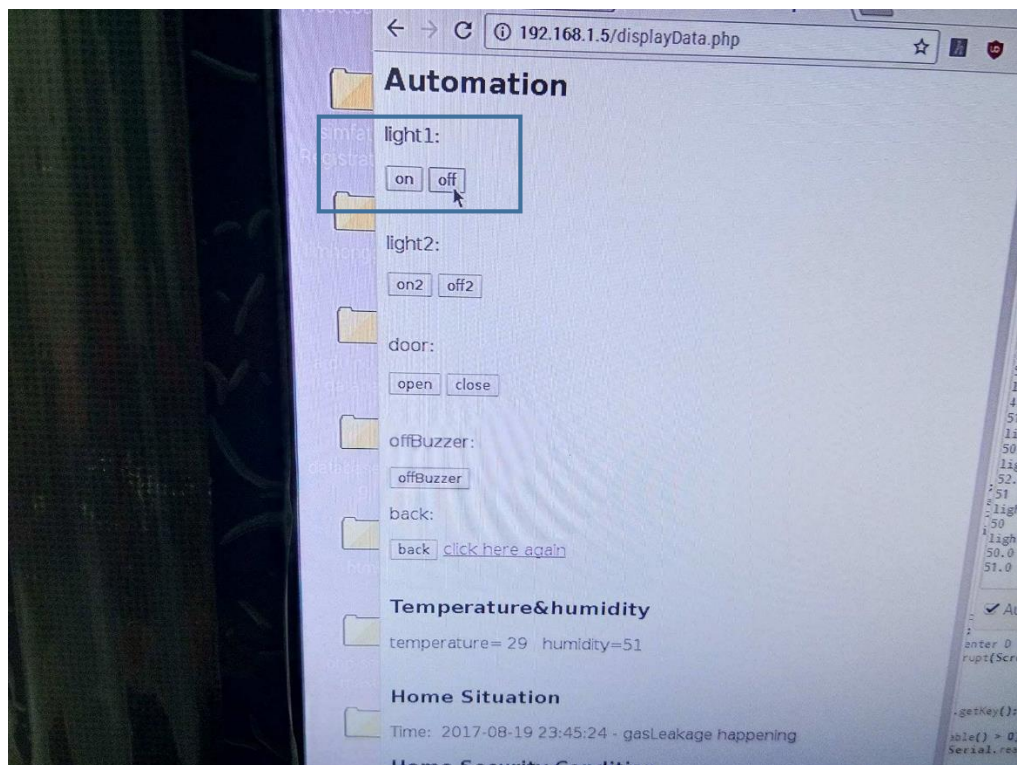


Figure 4.2.30 Light Switching Off by Automation



Figure 4.2.31 Status of Light Off on LCD Display

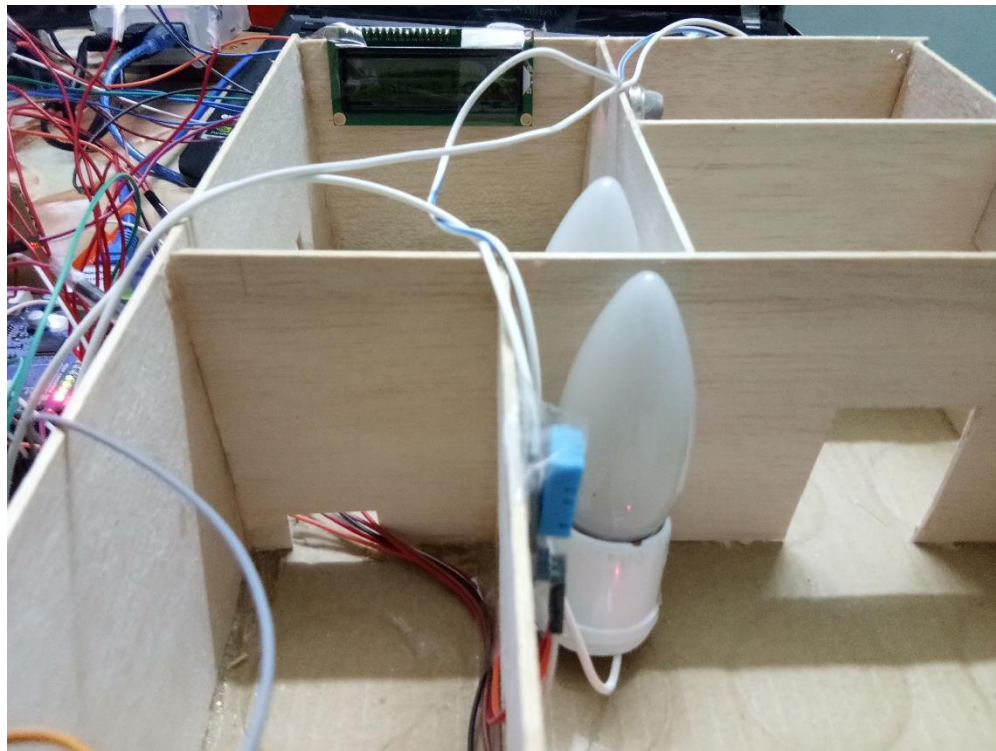


Figure 4.2.32 Light Off

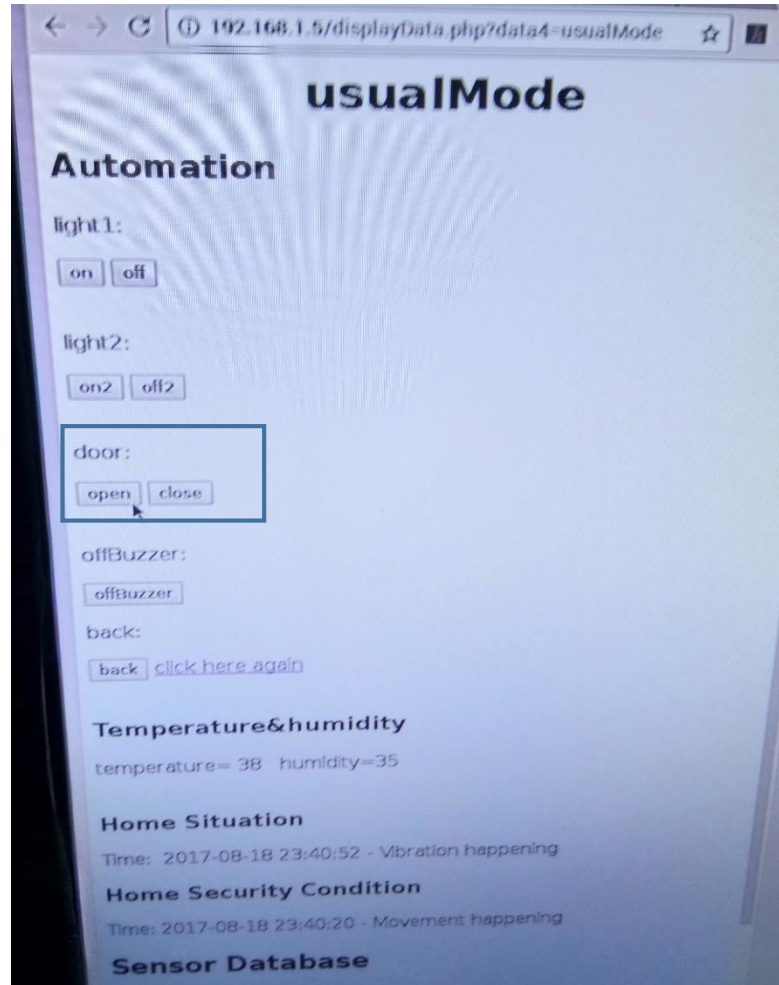


Figure 4.2.33 Door Opening by Automation



Figure 4.2.34 Status of Door Open on LCD Display

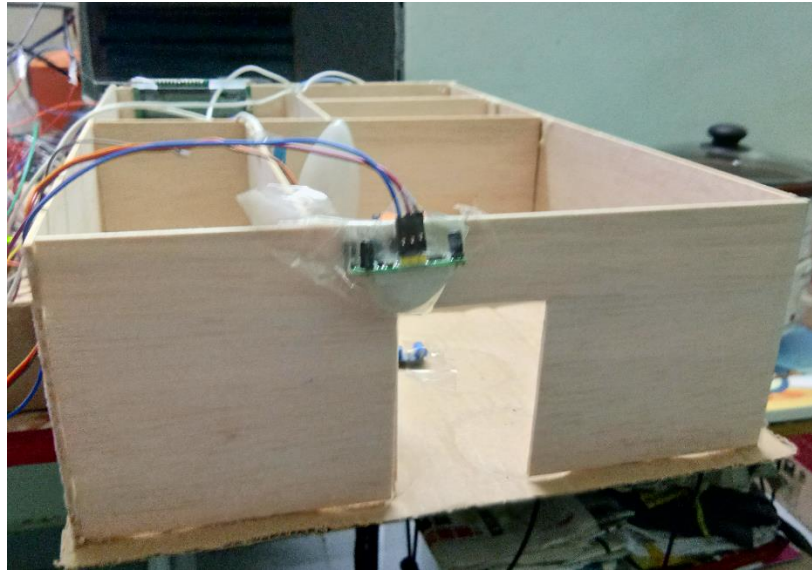


Figure 4.2.35 Door Opened

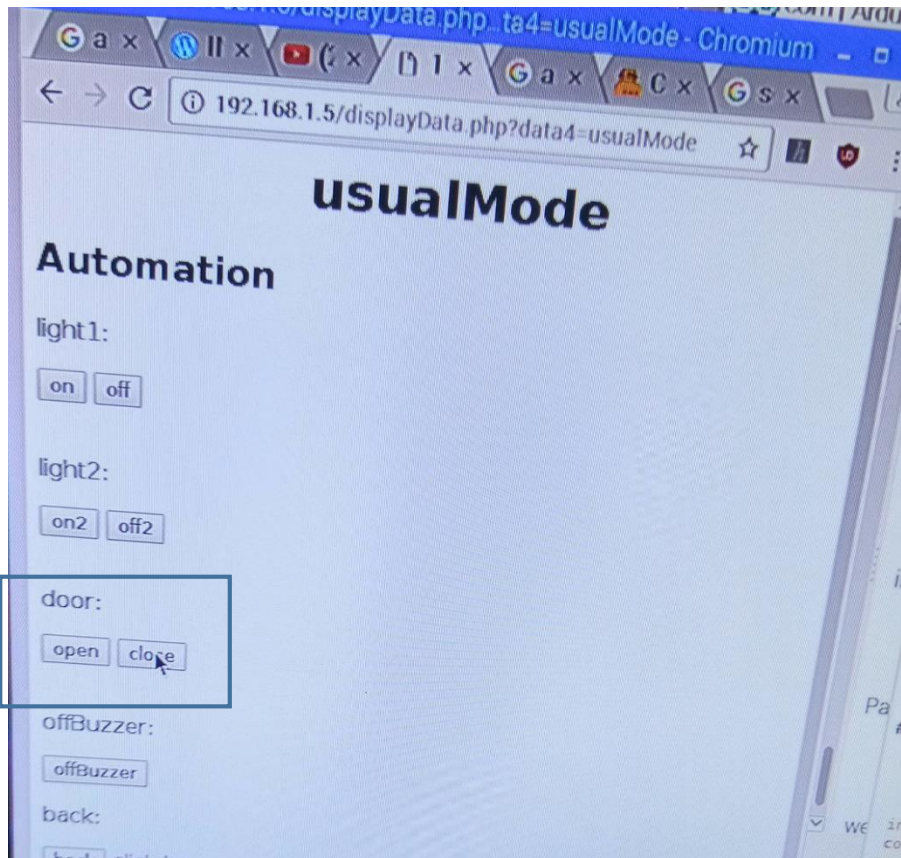


Figure 4.2.36 Door Closing by Automation



Figure 4.2.37 Status of Door Close on LCD Display

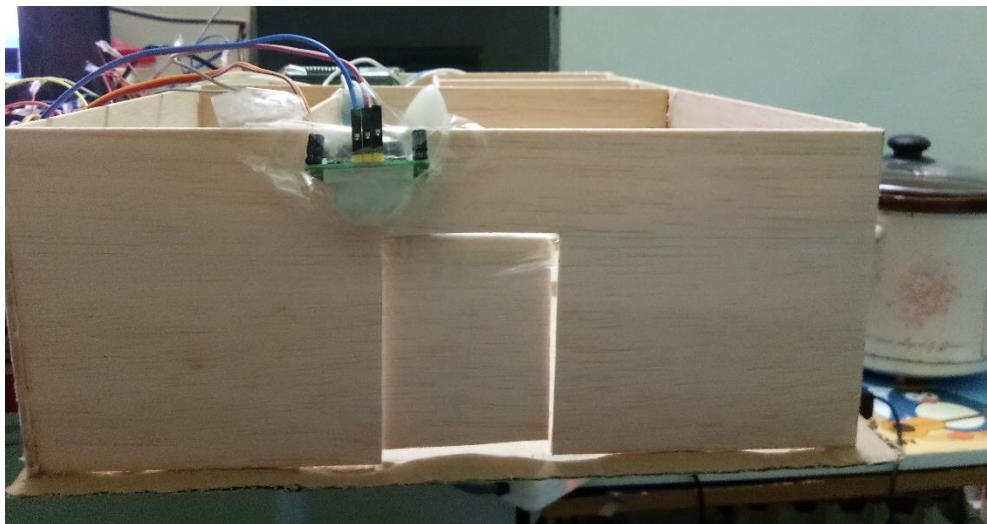


Figure 4.2.38 Door Closed

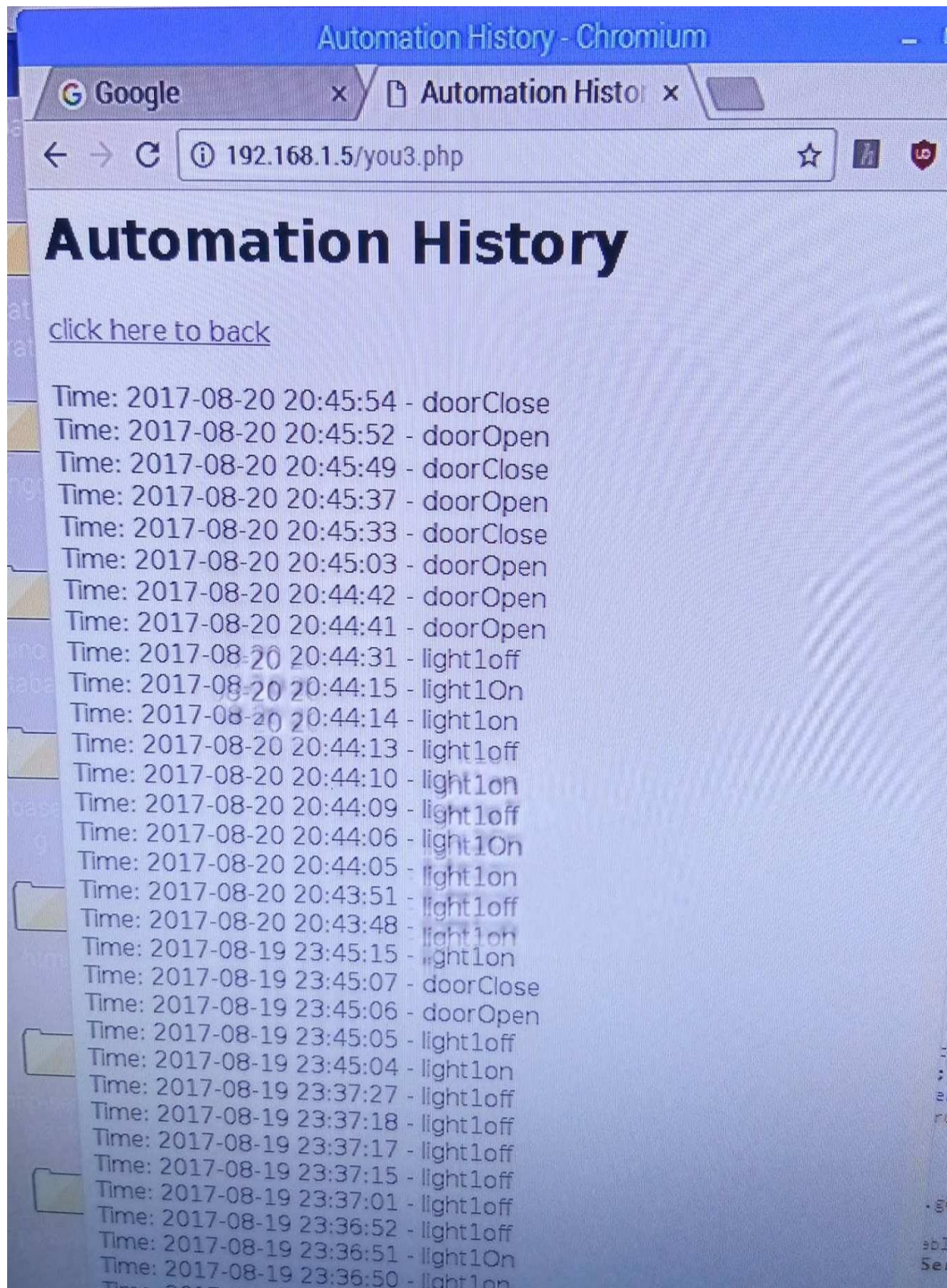


Figure 4.2.39 Historical Record of Automation's Value on Webpage

Chapter 5: Conclusion

It can be concluded that all part of this project has been successfully done although still consist of some imperfection, but like a quote say that imperfection is perfection to a beautiful perspective.

Until the end of project two, the system comprise Arduino Mega, Arduino internet shield, Raspberry Pi, keypad, relay, servo motor, buzzer, sensor such as temperature and humidity sensor, MQ-2 gas sensor, PIR motion sensor, water detection sensor, vibration sensor. Currently, this project has been successfully integrated the three main function which are automation, security and monitoring in one system. Hence, regarding to the automation, the user can automation some household appliance by clicking a button in a designated web page or pressing a keypad. In regard to security, the user will get a notification through an e-mail or a display in the web page when there is a detection of PIR motion sensor or vibration sensor. Thus, the alarm will also be activated in this circumstances. Furthermore, with regard to monitoring, user can monitor the temperature, humidity, occurrence of water leakage, gas leakage via viewing a web page or serial monitor.

Also it can be concluded that this project have met the following objective:

They are as follows:

- To develop a smart home system can update the information get from all the sensor or device to user in anytime. Currently, the system can update the temperature and humidity value at web page and LCD display anytime.
- To develop a smart home system that is able to alert user during some emergency case such as water, gas leakage case and earthquake. Currently, the system can alert the user by active the buzzer, display the message at webpage and LCD display and sending an e-mail during the emergency case.
- To develop a smart home system that can combine the functionality of security, monitoring and automation. The system has been integrated the three main function which are automation, security and monitoring in one system.
- To develop a smart home system that user-friendly which can be easily understood and operated by non-technical users easily without the requirement for any advanced

Chapter 5: Conclusion

technical knowledge. The user interface which is the webpage in this project is simple enough for user to master it.

- To develop a smart home system which can bring more safe, comfort and convenient life to user. With integrating the three main function which are automation, security and monitoring in one system, the smart home system definitely can bring a safe, comfort and convenient life to user.

Furthermore, after go through the process of this project two, there are some issues and challenges arise. The first issues is the proper connection of all the wires. Due to the big amount of sensors or devices which require wires connection, all the wires connection become so messy which lead to increase the difficulty of troubleshooting.

Besides, the PIR motion sensor is not functioning well in this project. It is so sensitive sometime but it will also become not sensitive in some period of time. Lastly, due to the insufficient knowledge of webpage design such as HTML, JavaScript and CCS, the webpage of this project is not attractive and powerful but it is simple and user-friendly.

There are some future works can be done by adding some of the artificial intelligence technique into the smart home system such as the system can automatically deal with the cases happening in the home. For instance, the system can determine the seriousness of some cases such as thief intrusion by automatically report to the police station and notify the user. Moreover, the system also can be added with CCTV to strengthen the security part of this project.

References / Bibliography

Arun Cyril Jose, Reza Malekian , Member, IEE, Ning Ye, Feb 2016,**Improving Home Automation Security;Integrating Device Fingerprinting Into Smart Home**,IEEE Access.

Apais, *PART 1 - Send Arduino Data to the Web (PHP/ MySQL/ D3.js)* from:
<<http://www.instructables.com/id/PART-1-Send-Arduino-data-to-the-Web-PHP-MySQL-D3js/>>.[2016]

Aloishis89, *Control an Arduino with PHP* from:
<<http://www.instructables.com/id/Control-an-Arduino-with-PHP/>>.[2013]

Cassie, *The History of Home Automation*,Available from:
<<https://myalarmcenter.com/blog/the-history-of-home-automation/>>.[23 JUL 2015].

Cynic, Raspberry Pi Course Week 6 – Day 2 (Understanding Databases – MySQL) from:<<http://www.suntimebox.com/raspberry-pi-tutorial-course/week-6/day-2-understanding-databases-mysql/>>.[AUG 2015].

Hamid Hussain Hadwan, Y. P. Reddy M.E. Student, Mech. Mechatronics, SCOE, Pune, India Professor in Mech, SCOE, Pune, India, April 2016, **Smart Home Control by using Raspberry Pi & Arduino UNO**, International Journal of Advanced Research in Computer and Communication Engineering Vol. 5, Issue 4.

ISTQB Exam Certification, *What is Prototyping model – advantages, disadvantages and when to use it?* Available from: <<http://istqbexamcertification.com/what-is-prototype-model-advantages-disadvantages-and-when-to-use-it/>>. [6 June 2012].

Margaret Rouse, Tech Target Search CIO, *Prototyping Model*. Available from: <<http://searchcio.techtarget.com/definition/Prototyping-Model/>>. [Aug 2005].

Nathan David, Henry Agbo, Grey Ezema, AmalachukwuAbafor, May 2016, **Remote Monitoring Of An Arduino Based Home Automation Security System**, International Journal of Scientific & Engineering Research, Volume 7, Issue 5.

Nathan David, AbaforChima, AronuUgochukwu, EdogaObinna, June 2015, **Design of a Home Automation system Using Arduino**, International Journal of Scientific & Engineering Research, Volume 6, Issue 6.

Ste Wright, *Tutorial – Install Apache, PHP and MySQL on a Raspberry Pi 2* from: <<https://www.stewright.me/2015/08/tutorial-install-apache-php-and-mysql-on-a-raspberry-pi-2/>> [Aug 2015]

Steven Beschloss, *Object of Interest: Remote Control*. Available from: <<http://www.newyorker.com/tech/elements/object-of-interest-remote-control/>>. [22 NOV 2013].

Poonam B. Patil, Rupali R. Patil, Swati V. patil, Avadhoot R Telepatil, April 2016, **Home Automation System Using Android and Arduino Board**, International Journal of Innovative Research in Science, Engineering and Technology, Volume 5, Issue 4.