Smart House
Group Number : 21

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I have read this report and approve its content.

Abstract (English)

The title of our project is called Smart House. The purpose of our project is to achieve more comfort and independence for elderly people. As you know today many of the elderly or wheelchair are dependent in their home when they are stay at home alone. For example, they couldn't turn on/off the lights and turn on/off the air-conditioner: The switches and air-conditioner remote were beyond their reach or some of them couldn't see where the switches or remote located. Naturally, people don't want anyone feel like it's their responsibility for taking care of them. So, we want to help elderly and handicapped people achieve more comfort and independence in their home to let them can take care theirself.

Our project is going to implement smart house system that have two systems in the house (lighting system and air-conditioning system). This kind of project is yet happen in every developed country and Thailand also. Even Thailand have a product like our project but we have function that they don't have, that's learning system through human behavior. We think that we have an opportunity to develop this product to come true.

Abstract (Thai)

หัวข้อโปรเจ็คของกลุ่มเราคือ “บ้านอัจฉริยะ” จุดประสงค์ที่พวกเราทำโปรเจ็คชิ้นนี้ขึ้น ก็เพื่อให้ผู้อยู่อาศัยมีความสะดวกสบาย และอิสระมากขึ้น เพราะว่าในทุกวันนี้ ผู้สูงอายุ และผู้ที่นั่งรถเข็น พวกเขาเหล่านั้นไม่สามารถเคลื่อนไหวได้อย่างอิสระหากต้องอาศัยอยู่ในบ้านเพียงลำพัง ยกตัวอย่าง เช่น หากพวกเขาต้องการที่จะเปิด-ปิดไฟ หรือเครื่องปรับอากาศ ก็ไม่สามารถทำได้สะดวกเนื่องจากเขาต้องเคลื่อนที่ไปเปิดสวิตช์ หรือ ต้องเอื้อมมือเพื่อเปิดรีโมทแอร์ ซึ่งโดยทั่วไปแล้ว ไม่มีใครอยากรู้สึกว่าตัวเองต้องเป็นภาระต่อครอบครัว หรือต่อใครก็ตาม ดังนั้นพวกเราจึงอยากช่วยให้ผู้สูงอายุ หรือผู้พิการได้มีความสะดวกสบาย และอิสระในการอยู่อาศัยและการดำเนินชีวิตประจำวันของพวกเขา

กลุ่มโปรเจ็คของพวกเราได้เริ่มทำระบบบ้านอัจฉริยะขึ้น โดยมี 2 ระบบดังนี้ ระบบไฟภายในบ้าน และระบบเครื่องปรับอากาศ โปรเจ็คลักษณะแบบนี้สามารถพบได้ตามประเทศที่พัฒนาแล้ว อีกทั้งยังสามารถพบได้ในประเทศไทย ถึงแม้ประเทศไทยจะมีผลิตภัณฑ์ที่คล้ายๆกับโปรเจ็คของเรา แต่พวกเรานั้นมีฟังก์ชั่นในการทำงานที่พวกเขาไม่มี นั้นก็คือระบบการเรียนรู้จากพฤติกรรมมนุษย์ พวกเราคิดว่ามีโอกาสที่จะพัฒนาผลิตภัณฑ์ชิ้นนี้ขึ้นมาให้เป็นจริง

Acknowledgements

Our group would like to say thank you to our advisor and all committees which they give many information that needed to accomplish this project. We would like to say thank you our friends also for the ideas that they gave to us and new inspirational.

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Chapter 1
Introduction

1.1 Problem Statement and Approach

The number of aging people will almost quadruple to 395 million between now and 2050. Around 15 percent of the world's population, or estimated 1 billion people, live with disabilities. Many of them are living alone or living with their family. Our project want to help all of them to achieve more comfort and independence in daily life and in their house.

In this project we going to build devices that control two systems in the house. We are going to build lighting system and air-conditioning system. The lighting system will turn on and turn off the light when sensor detected/not detected any movement in a specific area. It can learn which time of the day to turn on the light by human behavior. Occupant can control the light to turn on/off through a web application. Occupant can control the air-conditioner simulator (see section 4.2 for more detail why we use air-conditioner simulator) to turn on/off through a web application, and it also turn off when not detected any movement for a period. Not only it can control through a web application, but it also can learning which time in the day to turn on like the lighting system. According to all system that I mentioned, these can solved problem for elderly or wheelchair people. Since they faced problem that they can't move independently in their house. Someone have to take care them all of the time. Therefore, it's good to have the devices that help these people to achieve more independence, comfort lives and can take care theirself. Naturally, people don't want anyone feel like it's their responsibility for taking care of them. So this is a good idea for people who lived alone or family that have to go to work and left elderly or disabled people in house alone.

Finally, state the category this project is commercial product and benefitting society. This will help elderly people and disabled people to achieve a better life.

1.2 Objectives

- To achieve more comfortable in daily life for elderly and disabled people by using lighting system, air-conditioning system and learning system.
- To achieve more independent in house elderly and disabled people by using lighting system, air-conditioning system and learning system.
- Using web application to control the whole system.
- Systems can learn when it should turn on by human behavior

1.3 Scope

Lighting System

- Turn on when detected any movement.
- System can learn when it should turn on the light by human behavior (count from human turn on light through web application).
- Turn on/off motion sensor of light to automatically mode or manually mode via web application.
- Turn on and turn off the light through web application.
- Turn off when not detected any movement.

Air-conditioning System

- Turn on/off the air-conditioner simulator via web application.
- Turn off when not detected any movement for a period.
- System can learn when it should turn on the air-conditioner simulator by human behavior (count from human turn on air-conditioner through web application).
- Turn on/off motion sensor of air-conditioner simulator to automatically mode or manually mode via web application.

Web Application

- Control lighting system to turn on/off the light
- Control motion sensor to automatically mode or manually mode via web application.
- Control air-conditioning system to turn on/off the air-conditioner.

1.4 Tasks and Schedule

Task	Description
1. Brainstorm	Gathering a list of idea to make a conclusion how to do the smart house system and equipment that will be used in this project.
2. Research	Research how to do the lighting system, temperature system, and surveillance camera system.
3. Implement Project (Lighting System)	
- Combine circuit board between H-Board and ThingsPort WiFi-S	Connect motion sensor and ThingsPort WiFi-S for lighting system to H-Board
- Programming	Implement microcontroller to control the light in house through web application and by using motion sensor
4. Implement Project (Air-conditioning System)	
- Combine circuit board between H-Board and ThingsPort WiFi-S	Connect motion sensor and ThingsPort WiFi-S for air-conditioning system to H-Board

- Programming	Implement microcontroller to control the air-conditioner in house through web application and by using motion sensor
5. Web Application	
- Programming	Implement microcontroller to create web application for sending command that user control through web application.
- Designing	Design interface for web application.
6.Implement Project (Learning System)	
- Programming	Implement learning system to automatically turn on electronic appliances and download code to microcontroller
7. Test and Feedback	Testing hardware and software to find out the bugs and get the feedback for improving our project.
8. Improve Project from Feedback	Improving our project to have better performance and more convenience from all feedback that we got.

Task	August				September				October				November				December			
1. Brainstorm																				
2. Research																				
3. Implement Project (Lighting System)																				
- Combine circuit board between H-Board and ThingsPort																				
- Programming																				
4. Implement Project (Air-conditioning System)																				
- Combine circuit board between H-Board and ThingsPort																				
- Programming																				

Task	January				February				March				April				May			
5. Implement Project (Web Application)																				
6.Implement Project (Learning System)																				
7. Test and Feedback																				
8.Improve Project from Feedback																				

Chapter 2
Background, Theory and Related Research

Many disabled and elderly people nowadays have faced movement problem such as leg disabled can't independently move to the light switch to turn on it or air-conditioner switch are beyond their reach. Our purpose is to achieve more comfort and independence for disabled and elderly people to do their daily life. Smart house project is improve their life quality. Not only they can turn on or off the light even they can't reach the light switch but also they can turn on or off the motion sensor mode for automatically turn on when sense any movement and off when not sense any movement, these can solve the problem of they can't reach the switch. Moreover, our project also have a learning system for them to automatically turn on from their behavior to turn on the electronic appliance. All of these features that I mentioned can control the light and air-conditioner from anywhere in house wifi range by smartphone or PC through web application.

2.1 Lighting System

Theoretical concepts

We are going to implement lighting system which it can learn when it should turn on the light by learning through human behavior, the light turn on or off by motion sensor and control through web application. For this project we are going to focus on bedroom due to any room in the house needs the different system such as bedroom and restroom. For bedroom, the light can be controlled by motion sensor when occupant usually want to go to toilet or got to do something in there in the night. Occupant can disable the system on the web application before they go to sleep (disable the motion sensor in bedroom, it will not detected when it sense any movement). To detection any movement in house we use passive infrared sensor (PIR). The PIR sensor allow you to sense movement, and always used to detect a human has moved in or out of the sensors range. They are inexpensive, low-power, small and easy to use. For these reason they are normally found in electronic appliances used in homes.

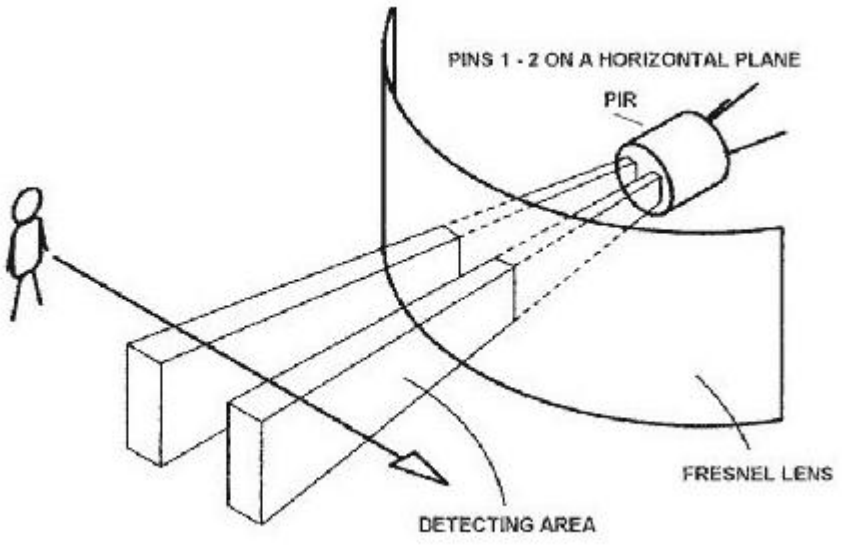

Figure 2.1 Passive infrared motion sensor vision sight

In figure 2.1, the motion sensor have two slots that can see out past some distance. When the sensor is idle, both slots detect the same amount of IR (Infrared), the ambient amount radiated from the room, 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 body leaves the sensing area, the reverse happens, whereby the sensor generates a negative differential change. Theses change pulses are what is detected.

2.2 Air-conditioning System

Theoretical concept

We are going to implement the air-conditioning system which it can learn when it should turn on by learning through human behavior, A/C simulator can turn on or off through web application and use motion sensor to counting time to turn it off when not sense any movement for a period. The sensor that we use to detect motion is the same as lighting system, so the theory of motion sensor is the same. For this project we are going to focus on the living room due to any room in the house needs the different system such as living room and bedroom.

2.3 Web Application

Theoretical concept

We are going to use HTTP protocol to send the data to web browser, and web browser will display on the screen. HTTP protocol is the one of protocol for communication that transfer the information through the internet. So, we use this protocol to send the web application data such as interface and control panel table. We design the interface simple as much as possible for elderly people because we need to make it clearly to use. We implement web structure by HTML, JavaScript (including AJAX). HTML is implemented for web structure such as Logo KMUTT, control panel table, our name project. JavaScript is implemented for updated status button on interface screen. Moreover, we use AJAX technique to creating fast and dynamic web pages. Since if you don't use AJAX, we must reload the entire page if the content had been changed. So, AJAX let us update specific part of a web page without reloading the entire page.

We are going to implement web application to communicate between hardware and software. Web application can control hardware to turn on/off the light, switch mode of motion sensor, turn on/off air-conditioner simulator. We used openPicus IDE to implement the web application since ThingsPort WiFi-S (microcontroller) is supported to openPicus IDE.

2.4 Software application and Hardware device

2.4.1 H-Board

H-Board is developed by Elec-Creations, it can control electronic devices through Wifi or Ethernet such as control light bulb in the house, turn on/off entry door in the house and etc. Furthermore, H-Board can be programmed for temperature, humidity, gas leak monitoring or environment monitoring in a specific area. It can be used with ThingsPort WiFi-S or ThingsPort Ethernet for controlling through PC or smartphone. H-Board have 5 outputs that can control five electronic devices at the same time, and it can be powered with 5-48VDC or 220VAC.

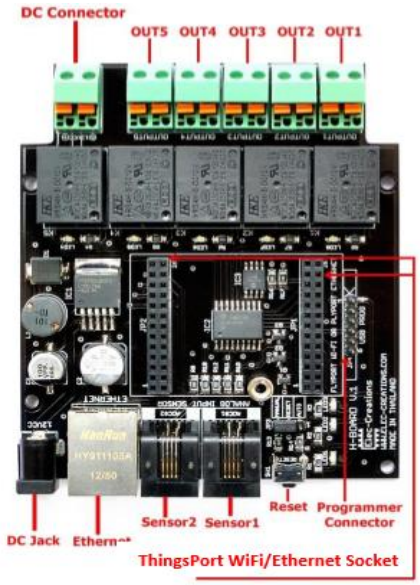

Figure 2.2 H-Board

We choose H-board because it's a completed design circuit board. H-board has port for shield that support to use with ThingsPort WiFi-S. It can also connected to the 220VAC for using in house.

2.4.2 ThingsPort WiFi-S

ThingsPort WiFi-S is a wireless device embedding a Microchip PIC24FJ microcontroller and a Wi-Fi transceiver developed by Elec-Creations. It has a 26 pins connector to communicate with external electronics, and it can be powered with 3.3 or 5V.

ThingsPort WiFi-S is a standalone system. It embeds the TCP/IP stack to control the WiFi-Ethernet and it can be programmed with user-written firmware to accomplish the actions as controlling relays, reading analog and digital IOs, communicating with SPI buses, UART, I2C, and so on. The Microchip PIC24FJ is a 16 bit microcontroller with 256 KB flash memory and 16 KB of RAM. To be used as a web server (with HTML pages and AJAX components). ThingsPort WiFi-S needs only a power supply and can also connect with remote TCP or UDP client/server and much more.

Specification

16 Bit Processor	PIC24FJ256, 256K Flash, 16K RAM, 16Mips@32Mhz
Transceiver	MRF24WG0MA/MB 802.11g Wi-Fi certified
Power Supply	5V or 3,3V, integrated LDO
Integrated RTC	32,768 Khz quartz onboard
Digital I/O	up to 18, remappable at Runtime
Analog In	up to 4, 10bits ADC, Vref=2,048V
Communication	up to 4 UARTs, SPI, I2C
Flash	SST25VF016B 16Mbit storage Flash memory
Connector	26 ways, 2 rows, standard 2.54mm male pin header
Dimensions	35 x 48 x 15 mm, 11 grams

Figure 2.3 ThingsPort WiFi-S

We choose ThingsPort WiFi-S because it is an embedded web server and it supported with our H-Board.

2.4.3 miniUSB Programmer

miniUSB programmer is used for program the ThingsPort WiFi-S, it can be used connecting to the standard USB port of PC. miniUSB programmer are seen as a serial port which is used to program the device and debug the firmware.

Specification

USB interface	miniUSB B-type (cable not provided)
Programing interface	6 ways pin header at 2.54mm (0.10”) pitch
Reset:	It can reset ThingsPort WiFi-S modules using a MOSFET onboard
Power Supply	Powered by USB port (5V)
Power output	5V
Dimensions	51 x 27 5 mm

Figure 2.4 miniUSB Programmer (also known as USB dongle)

2.4.4 Passive Infrared Motion Sensor

A passive infrared sensor (PIR sensor) is an electronic sensor that use for measures infrared light radiating from objects in its line of sight. It’s commonly used to detect whether a human has moved in or out of the sensor range. PIR sensor are inexpensive, easy to use and low-power consumption. For these reason they are commonly found in appliances and gadgets we used in house or businesses.

Figure 2.5 Passive infrared motion sensor

2.4.5 openPicus IDE

The openPicus IDE is a Windows application that allows user to program and manage all of the functionalities of the ThingsPort modules. It extends to the functions of integrating some powerful tool to ease the developing of an entire ThingsPort project. The openPicus is a free program, open-source and have a tool to develop web applications.

Figure 2.6 openPicus IDE

2.4.6 MPLAB C30 Compiler

MPLAB C30 is an ANSI x3.159-1989-compliant. It is optimizing C compiler for embedded control application. The compiler is Windows console application that provides a platform for developing C code.

2.4.7 Dreamweaver

Adobe Dreamweaver is a software program that have complete toolset for web designers, essentially a more fully featured web and programming editor. This program lets you create code and manage websites on any size screen. Dreamweaver supports multiple web and programming languages.

Figure 2.7 Dreamweaver CS6

2.5 Market Discussion

Our product is seems like an electric box controller via wifi or using Soft AP. There are not many product like us in Thailand, we only found one product that seems like to us that is ‘Click! Relay Pro’. Our product likes electric box controller that is can controller every electronic appliances. Since our product can change the output to connect with our product such as in our product have an example of control light bulb or air-conditioner, but generally our product can change the output to control, that’s mean our product can control entry door, microwave, garage door and etc. In generally smart house product in market is only do one thing such as Avi-on “GE Plug-In Smart Dimmer” product it can only adjust the lamp brightness and this product can’t use change the output that used with this product. Same like the other smart house brand, it design product for only do one purpose and can’t change their output. These is the reason why our product don’t have any competitor much. See reference section for more detail about smart product.

Figure 2.8 Our competitive product logo

Comparison Table

	Our product	Click! Relay Pro
Control through web application		
Control through mobile application		
Lower cost		
Simple for elderly and disabled people to use		
Motion sensor to turn on or off		
Learning when to turn on by human behavior		

Our product is cost 4500 baht per each (H-Board is 2900 baht, ThingsPort WiFi-S is 1200 baht, other devices 400 baht), but the competitor is cost 4000 and 6000 baht per each (it's up to your output specification). They interface design for elderly is simple to use like our product. They don't have motion sensor to turn on or turn off the electronic appliances. We have a learning system from user behavior and automatically turn on.

Chapter 3
Design and Methodology

3.1 Software requirements

Lighting System, Air-conditioning System and Web Application

- openPicus IDE on windows to write code for upload into microcontroller.
- Dreamweaver CS6 for windows to implement and design the web application

3.2 Feature list

3.2.1 Lighting System

- Turn on when detected any movement.
- System can learn when it should turn on the light by human behavior (count from human turn on light through web application).
- Turn on/off motion sensor of light to automatically mode or manually mode via web application.
- Turn on and turn off the light through web application
- Turn off when not detected any movement.

3.2.2 Air-conditioning System

- Turn on/off the air-conditioner simulator via web application
- Turn off when not detected any movement for a period.
- System can learn when it should turn on the air-conditioner simulator by human behavior(count from human turn on light through web application).
- Turn on/off motion sensor of air-conditioner simulator to automatically mode or manually mode via web application.

3.2.3 Web Application

- Control lighting system to turn on/off the light
- Control motion sensor to automatically mode or manually mode via web application.
- Control air-conditioning system to turn on/off the air-conditioner.

3.3 Schematics

3.3.1 Overall System

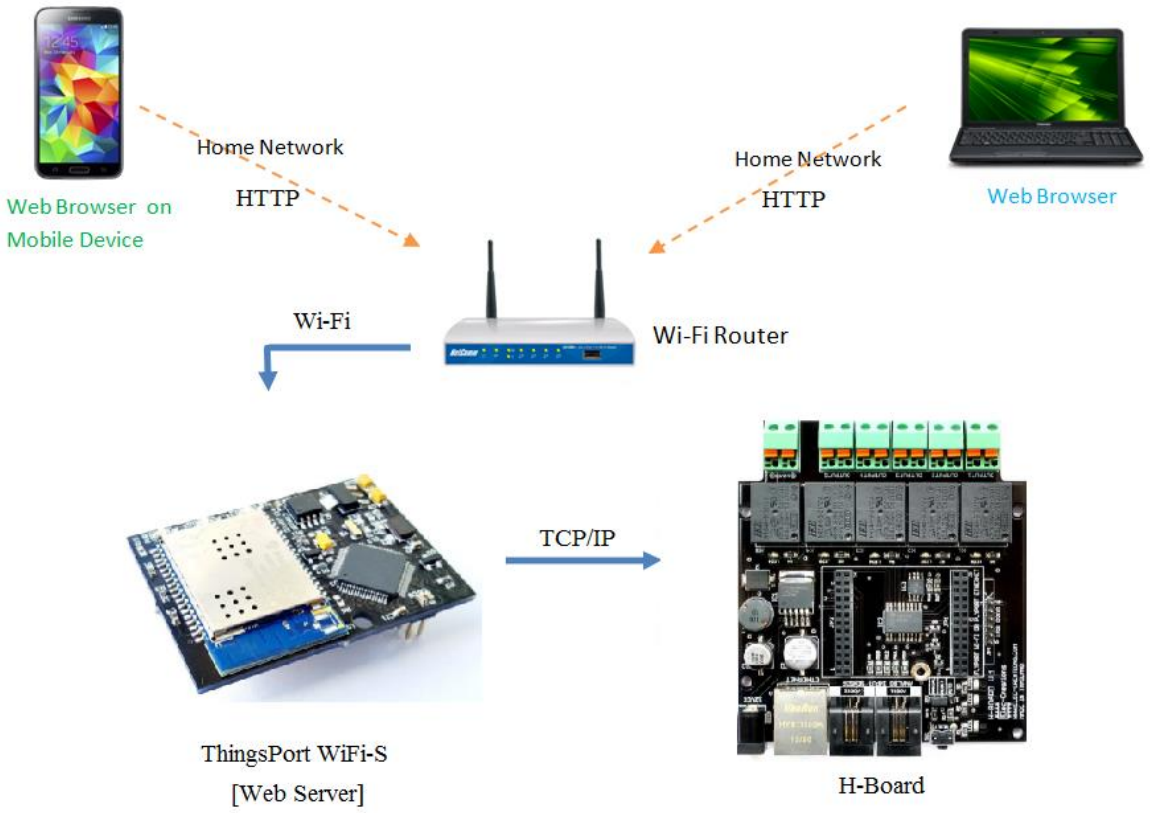

Figure 3.1 Overall system

We use H-Board as a power supply for ThingsPort WiFi-S. ThingsPort WiFi-S as a microcontroller. ThingsPort WiFi-S have embedded web server, therefore it uses to communicate with web application and hardwares via home network. Occupant must access the home network in order to enter control panel that is on the web application. Occupant can open the control panel through web browser via their mobile device, PC or laptop.

3.3.2 Overall Hardware Diagram

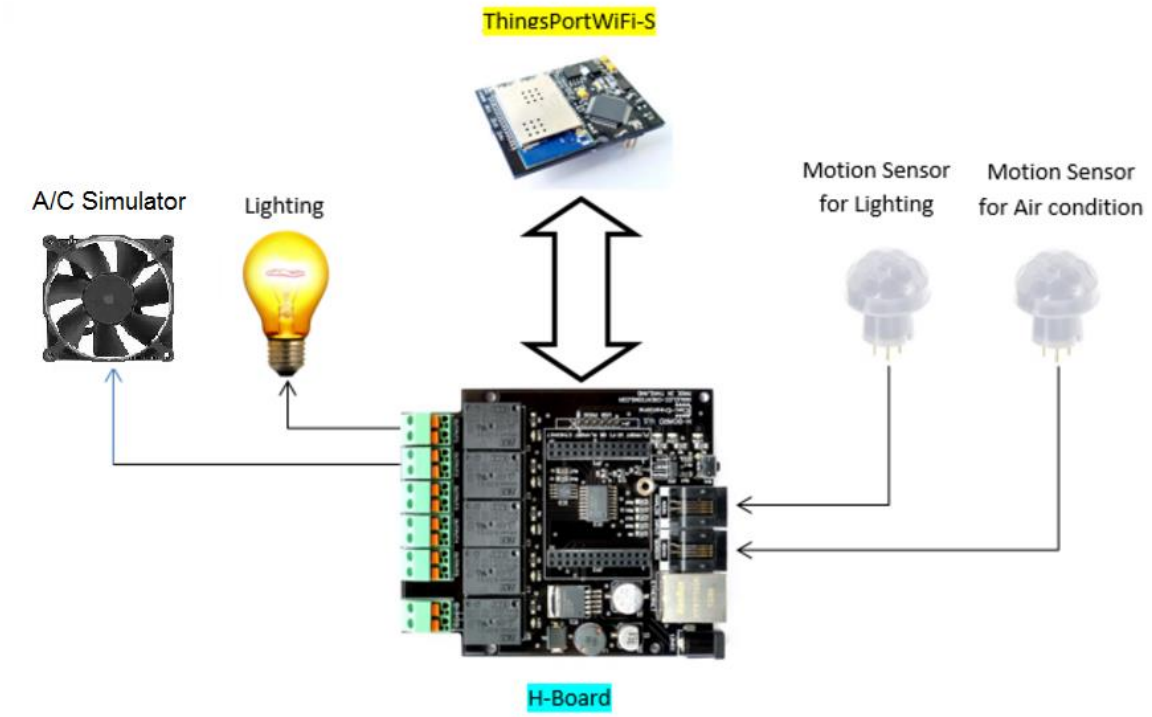

Figure 3.2 Overall hardware diagram

We connect two analog motion sensors to two analog sensor inputs. We connect light bulb and air-conditioner simulator at the output port. ThingsPort WiFi-S connected to ThingsPort WiFi sockets that is show in figure 3.2. H-Board is powered with 220V.

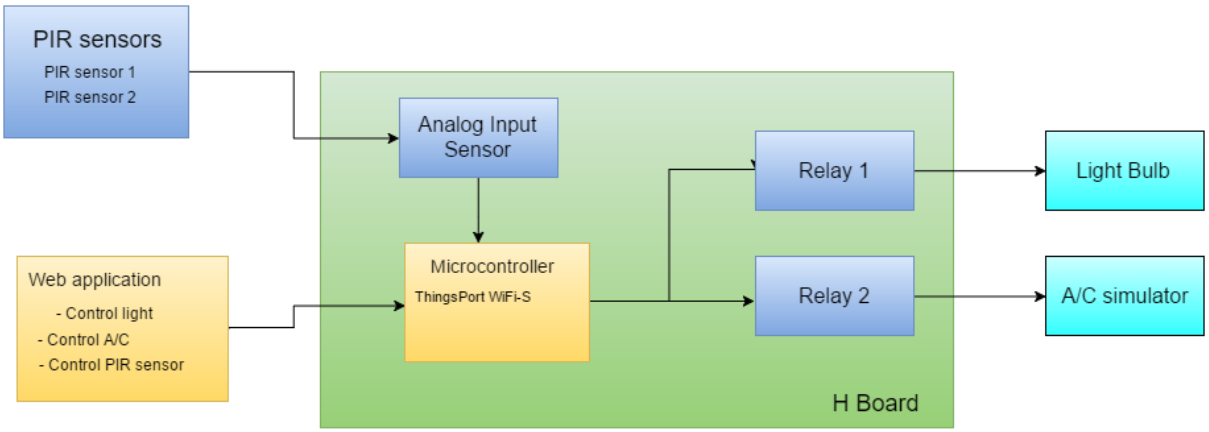

Figure 3.3 Overall Hardware Block Diagram

3.4 Lighting System

3.4.1 Protocol

- ThingsPort WiFi-S communicate to web application by TCP protocol.

3.4.2 Programming languages

Microcontroller

- C programming language

3.4.3 Hardware

- H-Board (See section 2.4.1 for more hardware detail)
- ThingsPort WiFi-S (See section 2.4.2 for more hardware detail)
- LED bulb
- PIR motion sensor (See section 2.4.4 for more hardware detail)

3.4.4 Software

– openPicus IDE on windows (See section 2.4.6 for more software detail)

3.4.5 Overall Flowchart for Lighting System

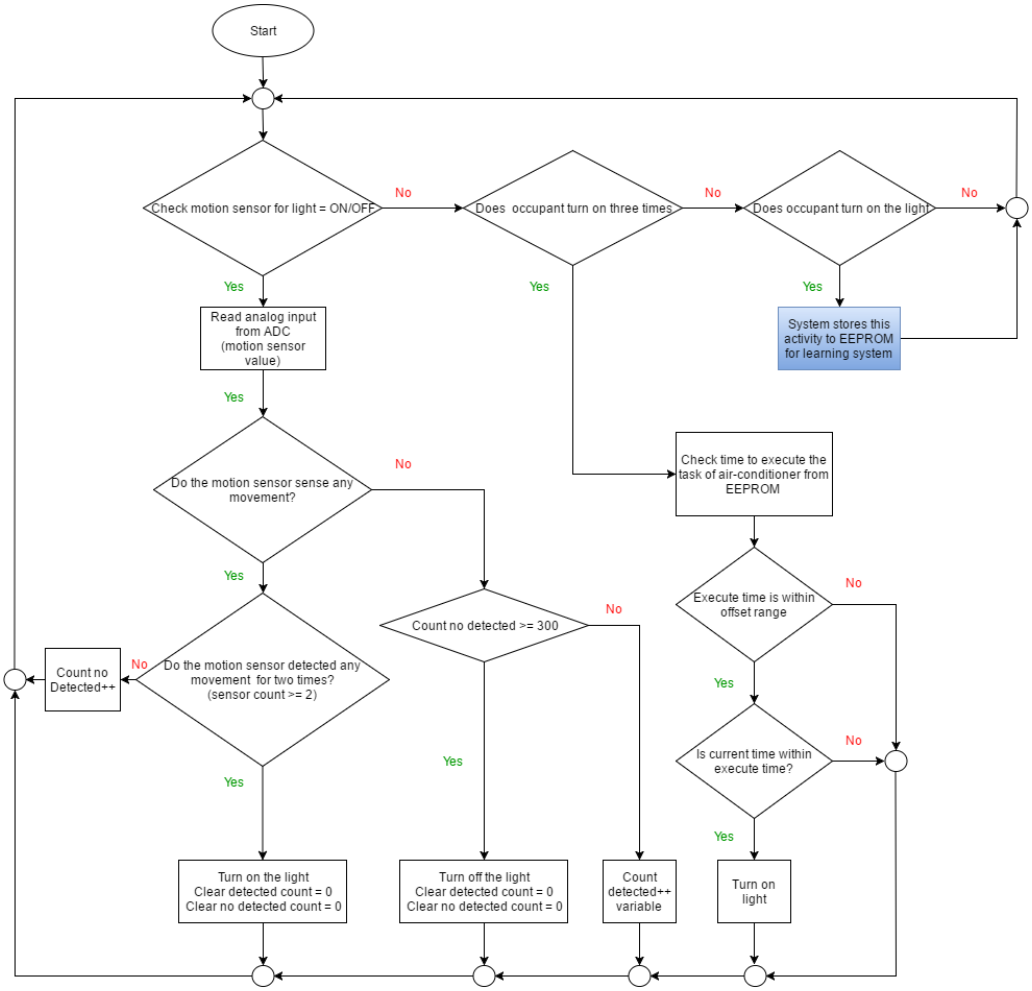

Figure 3.4 Flowchart Lighting System

The first feature for lighting system is to turn on the light when PIR sensor detected any movement and turn off when not detect for a period. Occupant can also turn on/off the light through the web application. The second feature is learning system, the learning system learns the human behavior through the human activity that is when occupant turn on the light at 18.00, and system will store this activity to the EEPROM. System will keep this activity until it happened three times, system will know when it should turn on the light.

3.4.6 Learning System for Lighting

Learning system is system that can learns when it should turn on the light by human behavior. Every time occupant turn on the light, these activities will be stored into EEPROM. The system will check activity in EEPROM, is that activity (turn on light) happened three times. If it reach three times, system will store the task that what it should do and when it should do the task. System always checks current time with turn on time. If current time within turn on time, it will turn on the light.

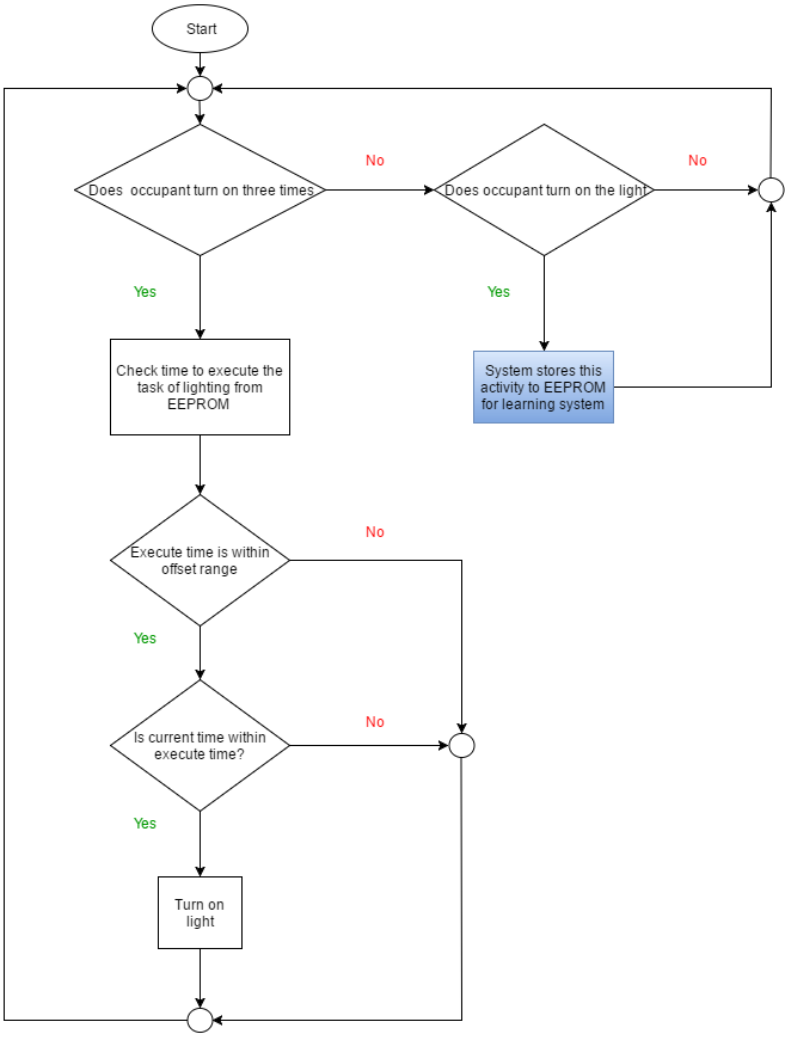

Figure 3.5 Lighting Learning System Flowchart

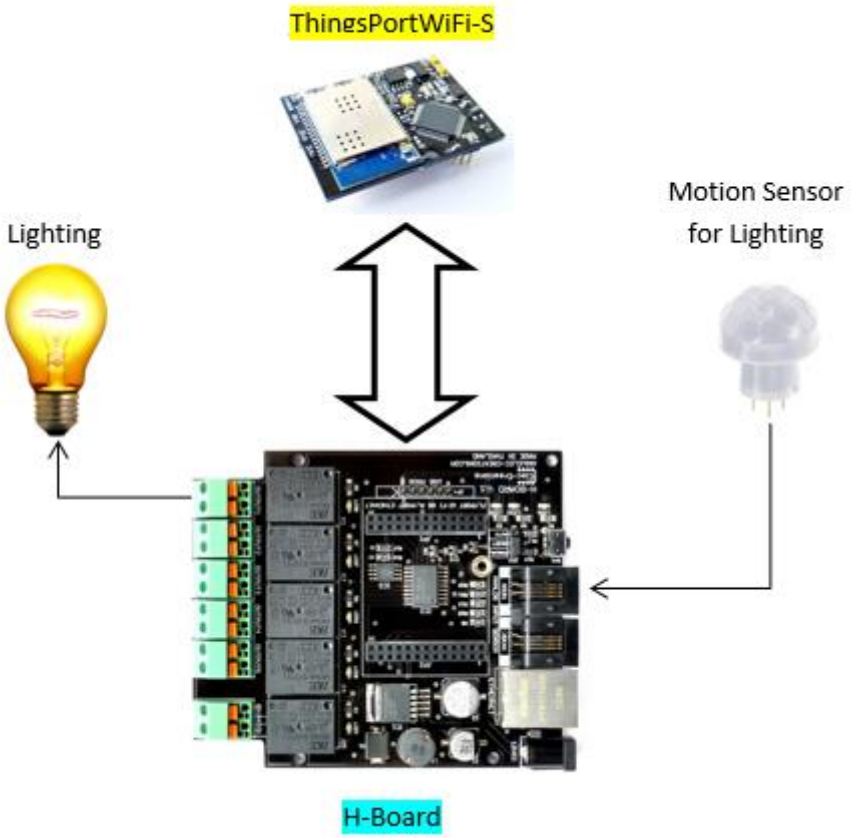

Figure 3.6 Hardware connection diagram (Lighting).

We use motion sensor to sense the motion whether it is detected or not detected. This sensor is connected to the analog input of the H-Board. The light bulb will turn on when detected any motion or when reach the time from learning system. It will turn off when not detected any motion.

ThingsPort WiFi-S have a function that can connect to the internet by using Simple network time protocol(SNTP) and get the current time from the internet, so the system will know the current time when ThingsPort WiFi-S connected to the internet.

3.5 Air-conditioning System

3.5.1 Protocol

- ThingsPort WiFi-S communicate to web application by TCP protocol

3.5.2 Programming languages

Microcontroller

- C programming language

3.5.3 Hardware

- H-Board (See section 2.4.1 for more hardware detail)
- ThingsPort WiFi-S (See section 2.4.2 for more hardware detail)
- PIR motion sensor (See section 2.4.4 for more hardware detail)
- Air-conditioner simulator (See section 4.2 for reason why we use air-conditioner simulator)

3.5.4 Software

– openPicus IDE on windows (See section 2.4.6 for more software detail)

3.5.5 Overall Flowchart for Air-conditioner

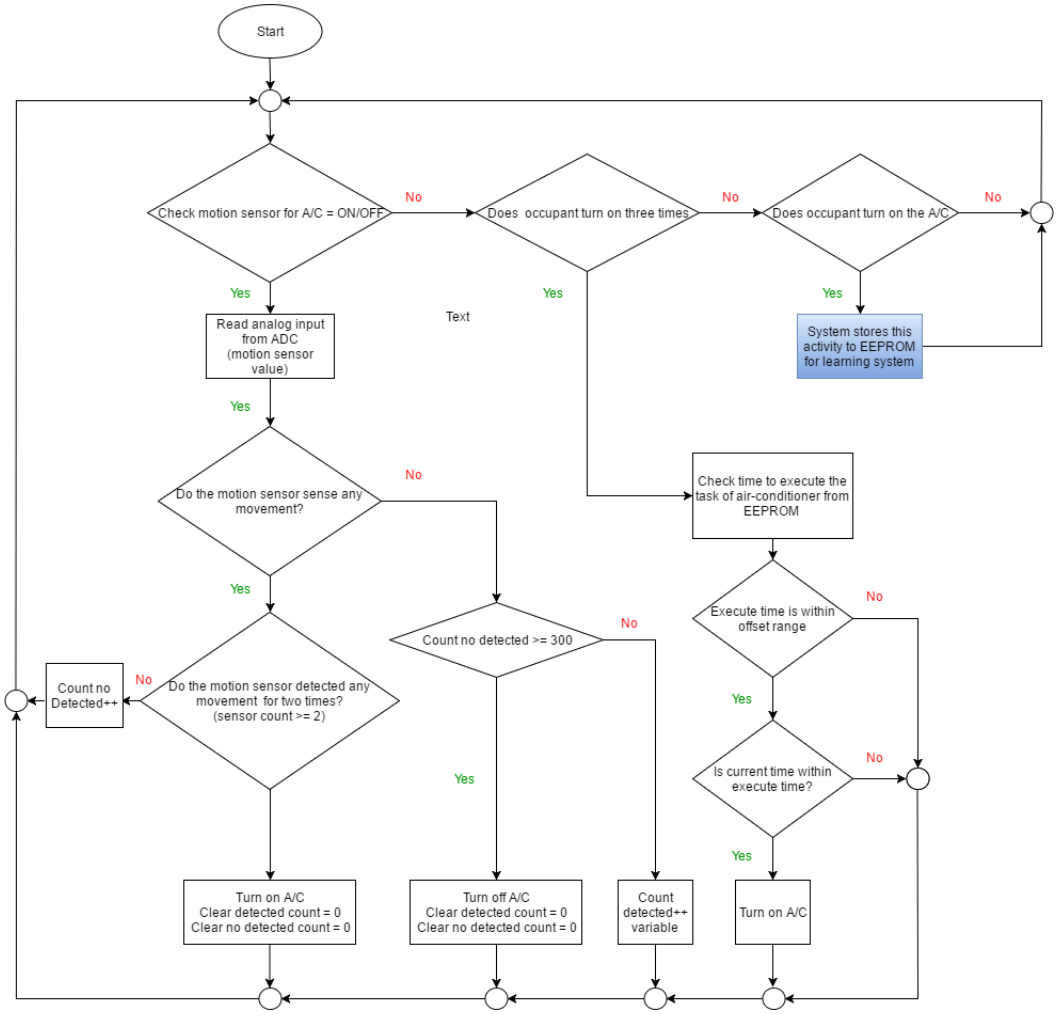

Figure 3.7 Overall flowchart for air-conditioner.

The first feature for air-conditioning system is to turn off the air-conditioner simulator when not detect for a period. User can also turn on/off the air-conditioner simulator through the web application. For the second feature is learning system, the learning system learns the human behavior through the human activity that is when occupant turn on the air-conditioner at 18.00, system will store this activity to the EEPROM. System will keep this activity until it happened three times, system will know when it should turn on the air-conditioner.

3.5.6 Learning System for Air-conditioner

Learning system is the system that can learns when it should turn on the air-conditioner by human behavior. Every time occupant turn on the air-conditioner, these activities will be stored into EEPROM. The system will check activity in EEPROM, is that activity (turn on air-conditioner) happened three times. If it happened three, system will store the task that what it should do and when it should do the task. System always checks current time with turn on time, if current time within turn on time, it will turn on the air-conditioner.

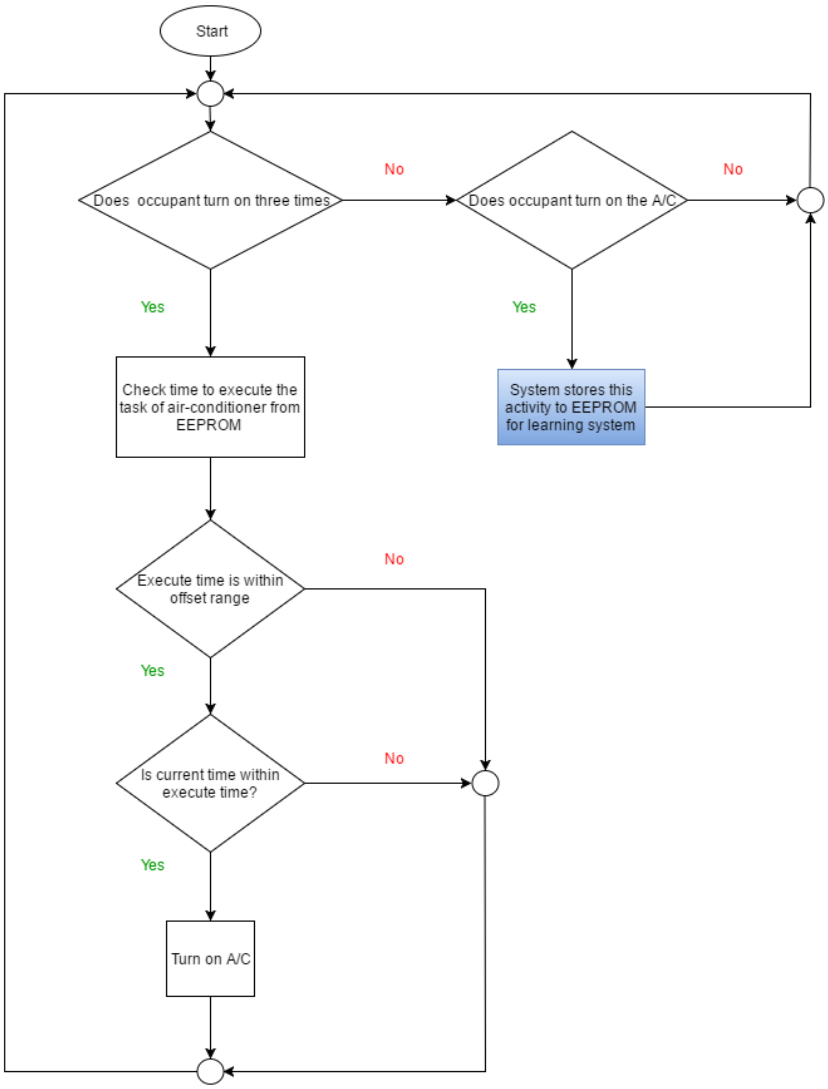

Figure 3.8 Air-conditioner Learning System Flowchart

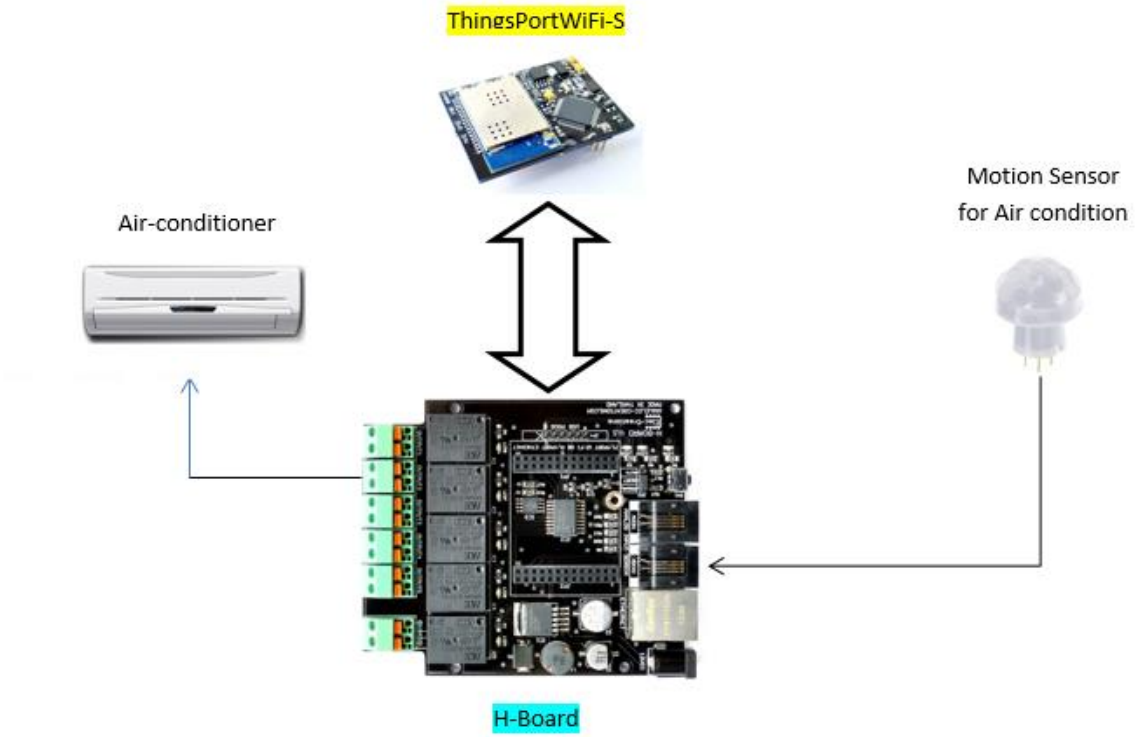

Figure 3.9 Hardware connection diagram (Air-conditioning)

We use motion sensor to sense the motion whether it is detected or not detected. This sensor is connected to the analog input of the H-Board. The air-conditioner will turn on when it reach time to turn on from learning system or user turn it on through the web application. ThingsPort WiFi-S will send the command to H-board to turn on the air-conditioner.

3.6 Web Application

3.6.1 Protocol

- ThingsPort WiFi-S communicate to web application by TCP protocol

3.6.2 Programming languages

- HTML and Javascript

3.6.3 Software

- openPicus IDE on windows (See section 2.4.6 for more software detail)
- Dreamweaver CS6 for windows (See section 2.4.7 for more software detail)

Use Case Diagram

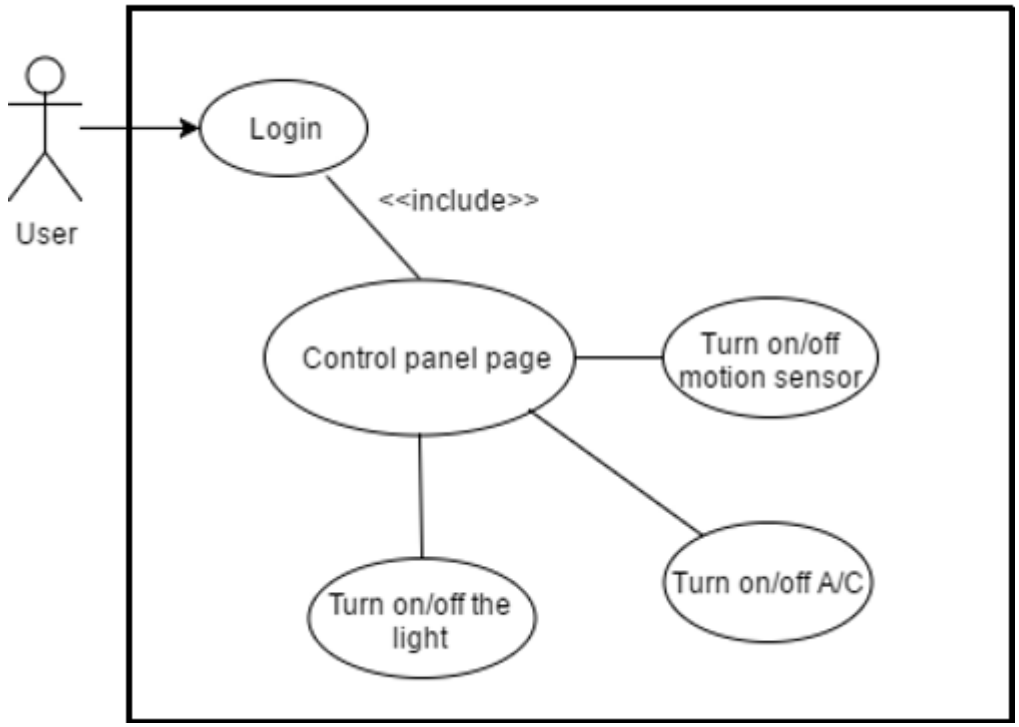

Figure 3.10 Use case diagram

This is a use case diagram that show how user interact with this web application, how technician set up the system, maintenance and service.

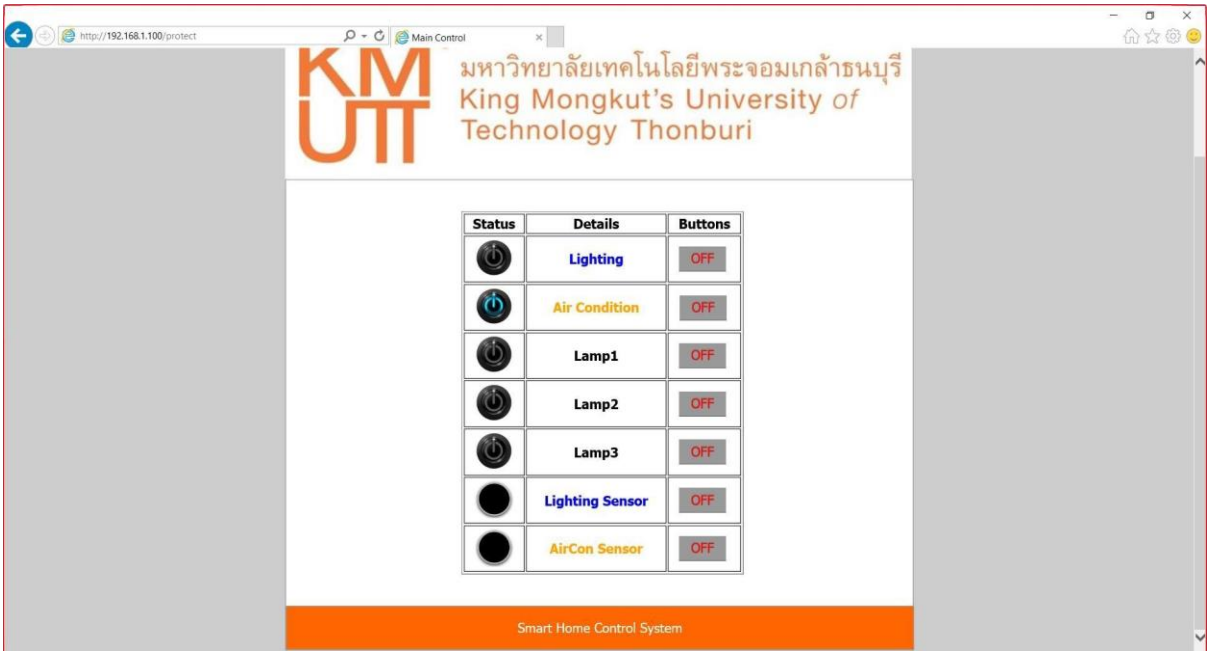

Figure 3.11 Web application interface design

Our web application has two main features

- Interface design

As the figure 3.12 is an interface design for our web application. We have three main parts in this interface design. First is KMUTT logo at page header, second is control panel and last one is page footer that show project group name.

- Control panel page

The table is divided into three parts.

1. Display a status of that output is running or not running.
2. Display the name of output.
3. The buttons to turn on/off the light or air-conditioner.

Chapter 4
Results and Discussion

The main purpose of this project is to help people who living alone or living with disabilities to achieve more independent and convenience in their house. Since our project has three main system, so we are going to explain these three system that what we have done or what problem we faced.

4.1 Lighting System

4.1.1 Features

Learning the human behavior

- System can learned the human behavior. It store activities from the occupant when they turn on the light from both of switch or through web application. If occupant turn on the light in living room at 8 P.M. every day, when this situation occurred four times. System will analyze data from the EEPROM, it will know that 8 P.M. the light must turn on in the living room.

Turn on and turn off through web application

- The light can turn on and turn off through web application. Occupant can control the light in wifi area range. For example, if you forget to turn off the light in the kitchen but you are not there, you can turn it off through web application.

Turn on and turn off using motion sensor

- The light can turn on when detected any movement for 3 – 4 seconds and turn off when not detected any movement for 3 - 5 minutes (time when turn off can be changed) for saving energy. Since you forgot something in the house and you want to grab and go outside, the light will not turn on for saving energy. When you are in the living room and you walk to the kitchen to grab some water and came back to living room, the light will not turn off instantly but have a delay to not turn off and turn on again.

4.1.2 Lighting system result

Figure 4.1 Turn on the light through web application (hardware)

Figure 4.2 Turn on the light through web application (interface)

Figure 4.3 Turn off the light through web application

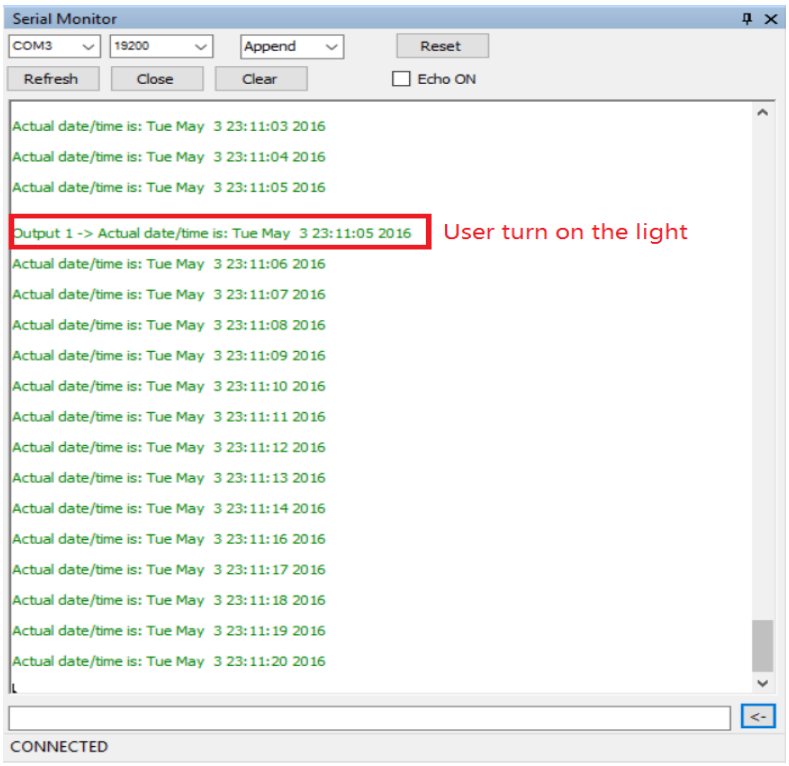

Figure 4.4 Store data when user turn on for learning system (serial monitor)

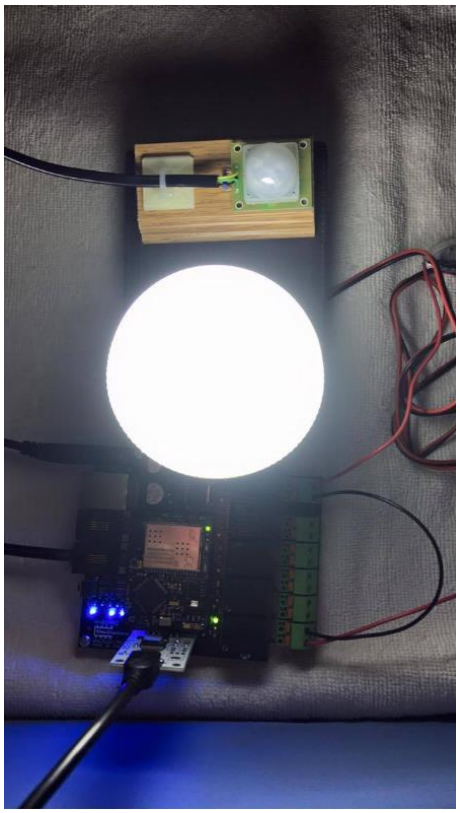

Figure 4.5 Turn on the light by learning system (hardware)

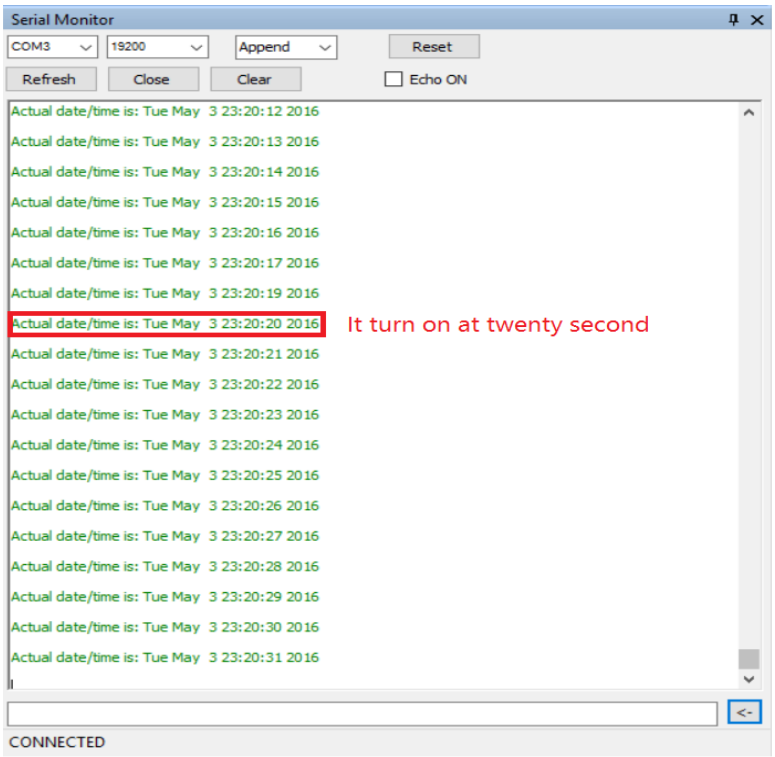

Figure 4.6 Turn on the light by learning system (serial monitor)

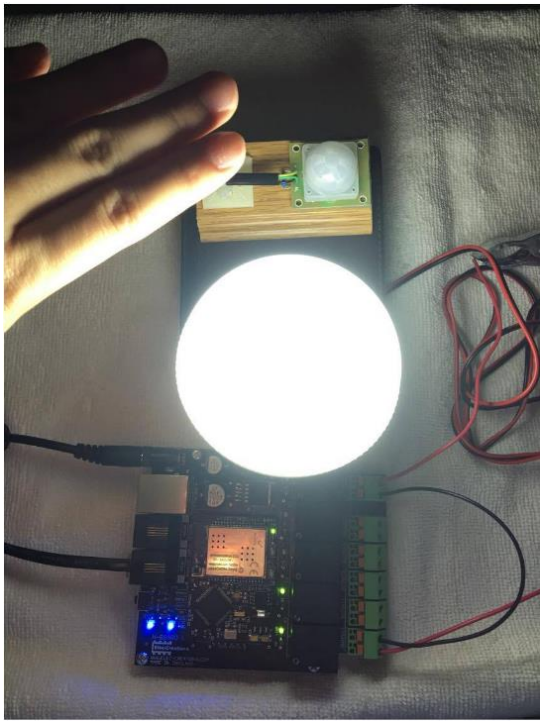

Figure 4.7 Turn on the light by motion sensor (hardware)

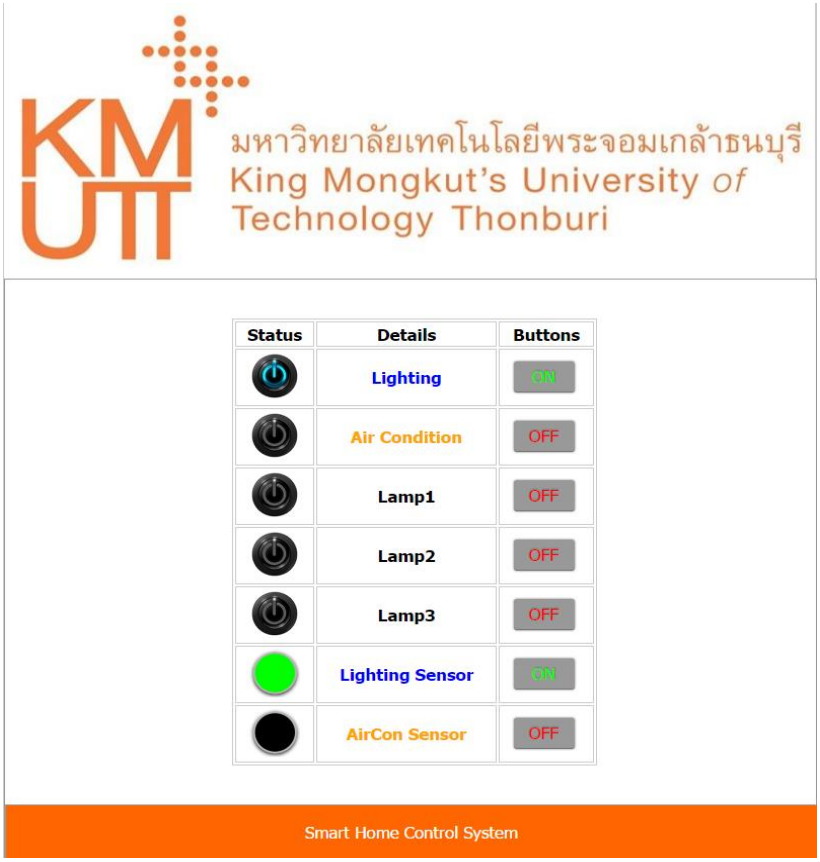

Figure 4.8 Turn on the light by motion sensor (interface)

4.2 Air-conditioning System

We still unable to control the air-conditioner by Infrared sensor (IR sensor), so we use computer fan as an air-conditioner simulator to test air-conditioning system, learning system and web application.

4.2.1 Features

Learning the human behavior

- This feature for air-conditioning system is the same as lighting system. The system store activities from the occupant when they turn on an air-conditioner from both remote or through web application. If occupant turn on the air-conditioner in a living room at 8 P.M. three times. The system will analyze data from EEPROM, system will know that you want to turn on it at 8 P.M, so the system will turn on the air-conditioner at 7.45 P.M to make the room cold enough before 8 P.M.

Turn on and turn off through web application

- A/C simulator can turn on and turn off through web application. Occupant can control A/C simulator in wifi area range. For example, if you forget to turn off A/C simulator in the kitchen but you are not there, you can turn it off through web application.

Turn on and turn off using motion sensor

- A/C simulator can turn on when detected any movement for 3 – 4 seconds and turn off when not detected any movement for 3 - 5 minutes (time when turn off can be changed) for saving energy. Since you forgot something in the house and you want to grab and go outside, A/C simulator will not turn on for saving energy.

4.2.2 Air-conditioning system result

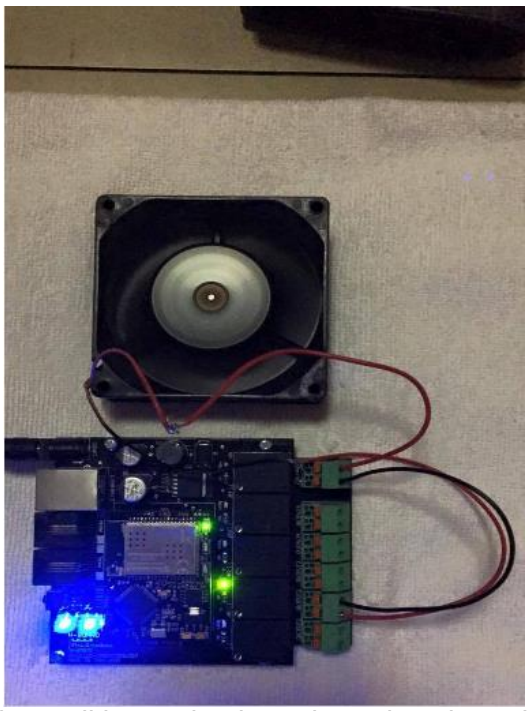

Figure 4.9 Turn on the air-conditioner simulator through web application (hardware)

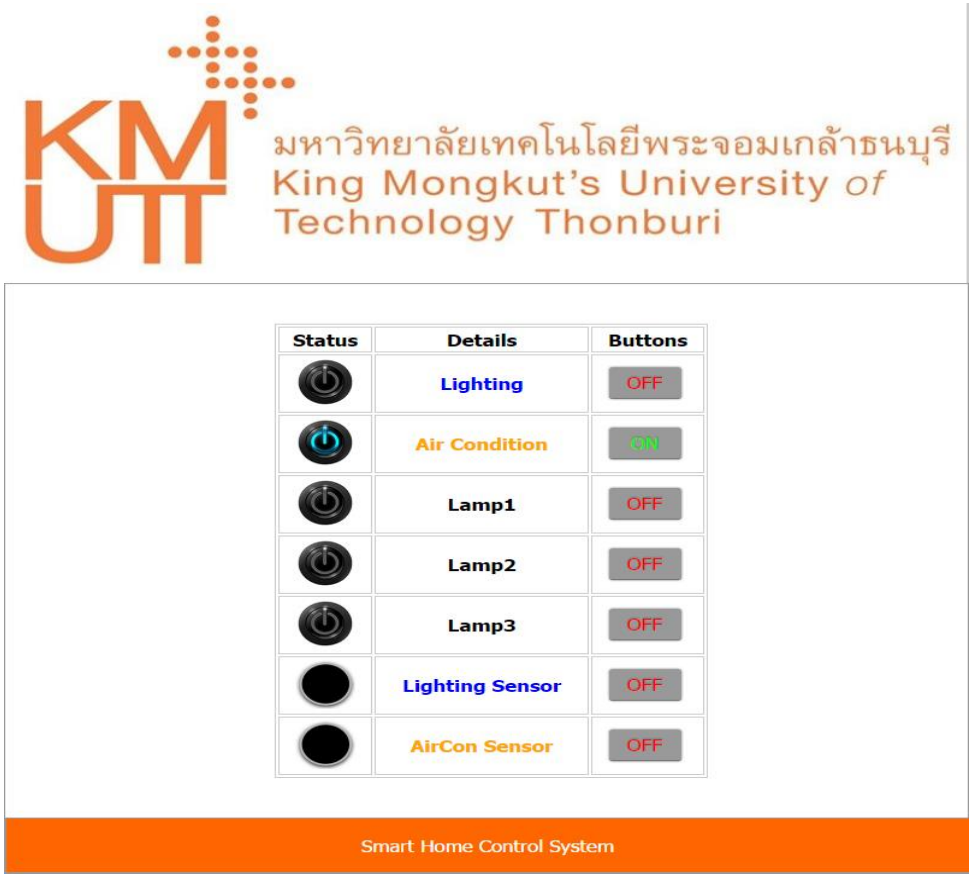

Figure 4.10 Turn on the air-conditioner simulator through web application (interface)

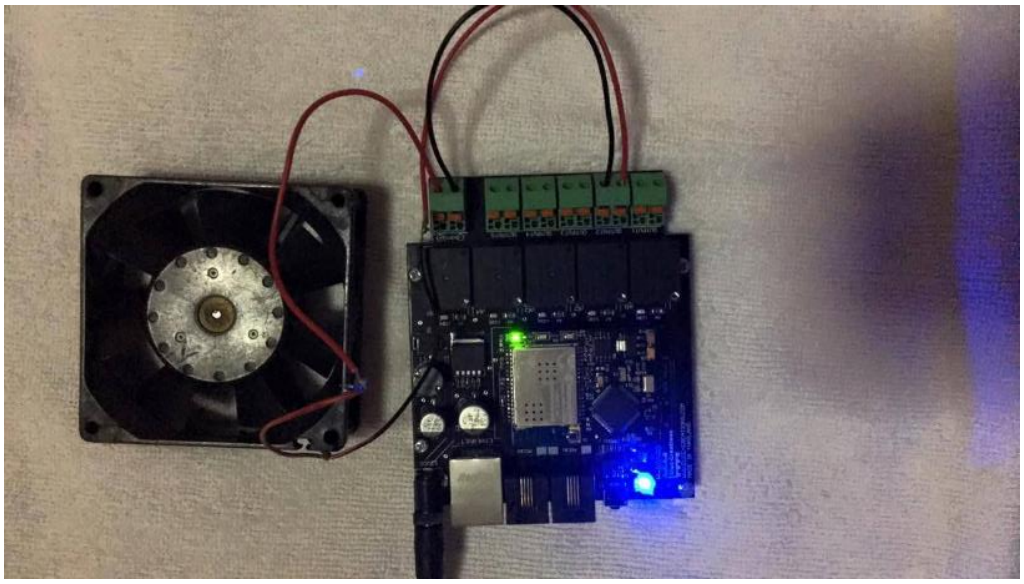

Figure 4.11 Turn off the air-conditioner simulator through web application

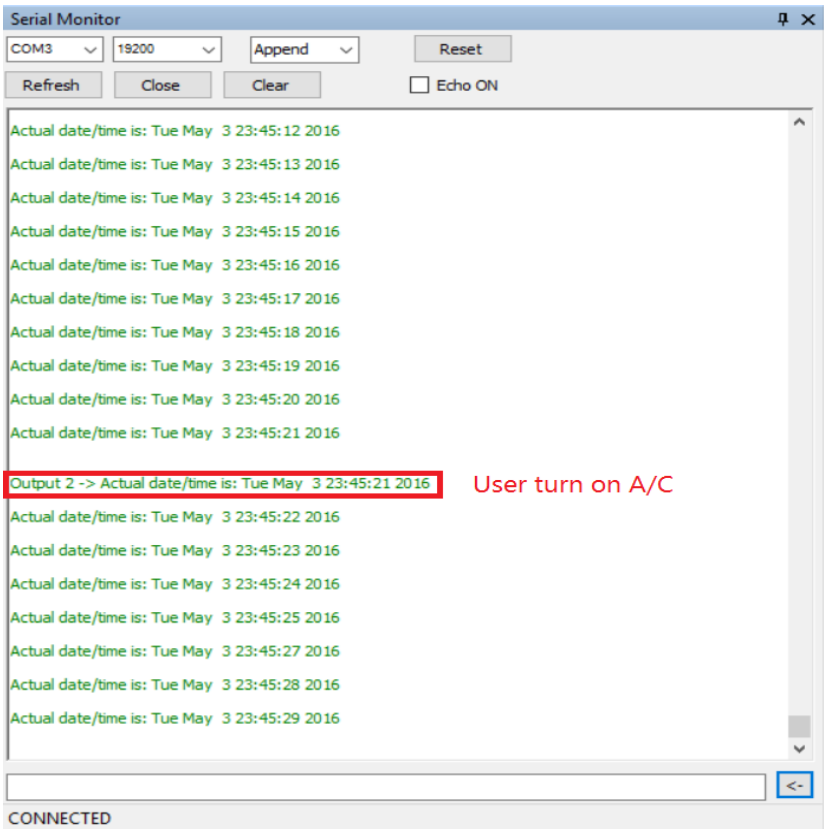

Figure 4.12 Store data when user turn on for learning system (serial monitor)

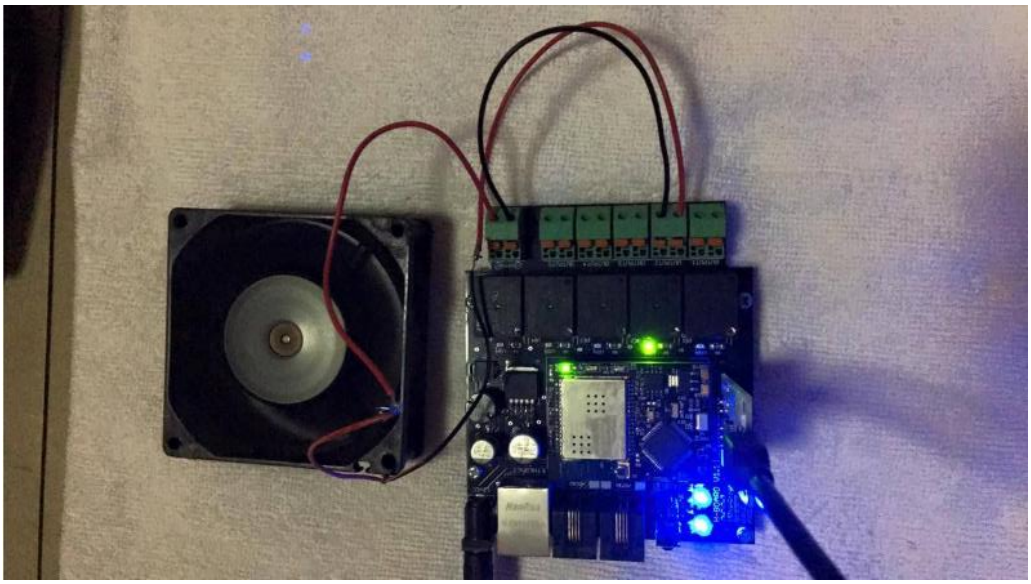

Figure 4.13 Turn on the air-conditioner simulator by learning system (hardware)

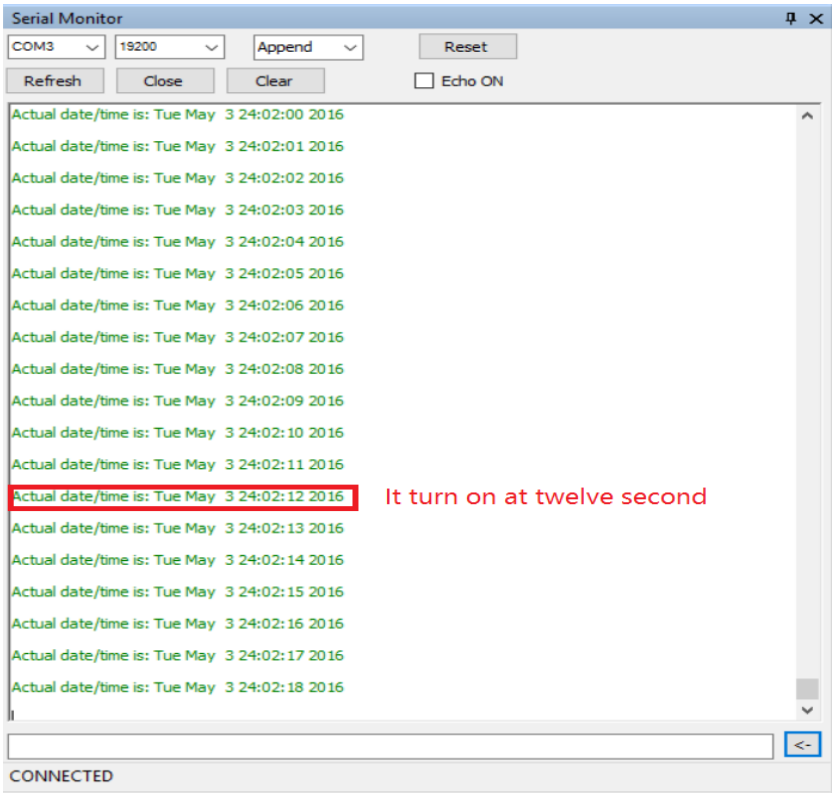

Figure 4.14 Turn on the air-conditioner simulator by learning system (serial monitor)

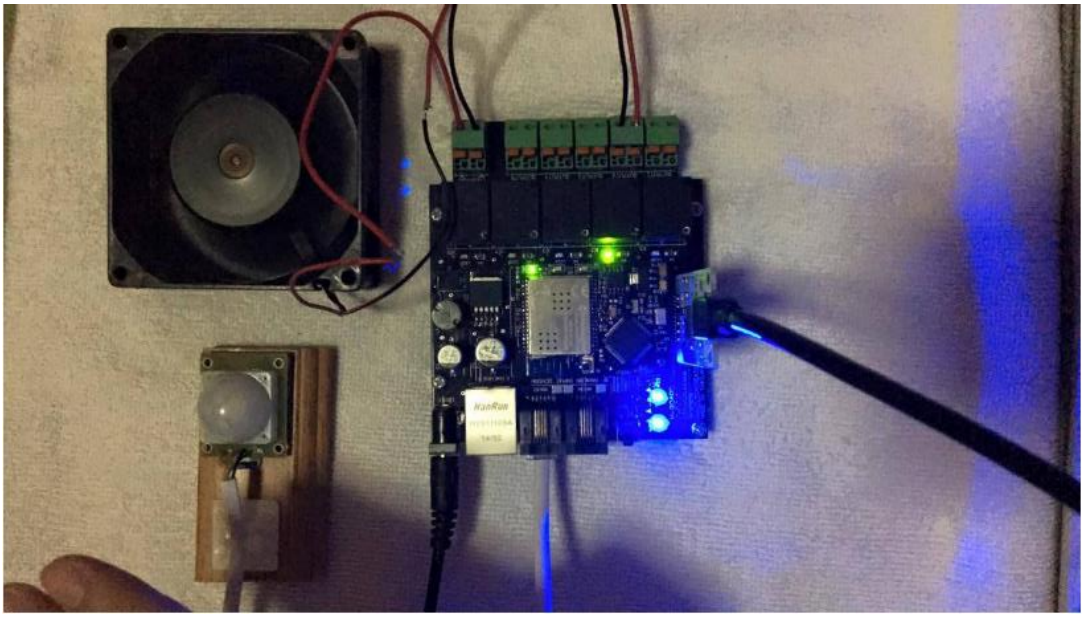

Figure 4.15 Turn on the air-conditioner simulator by motion sensor (hardware)

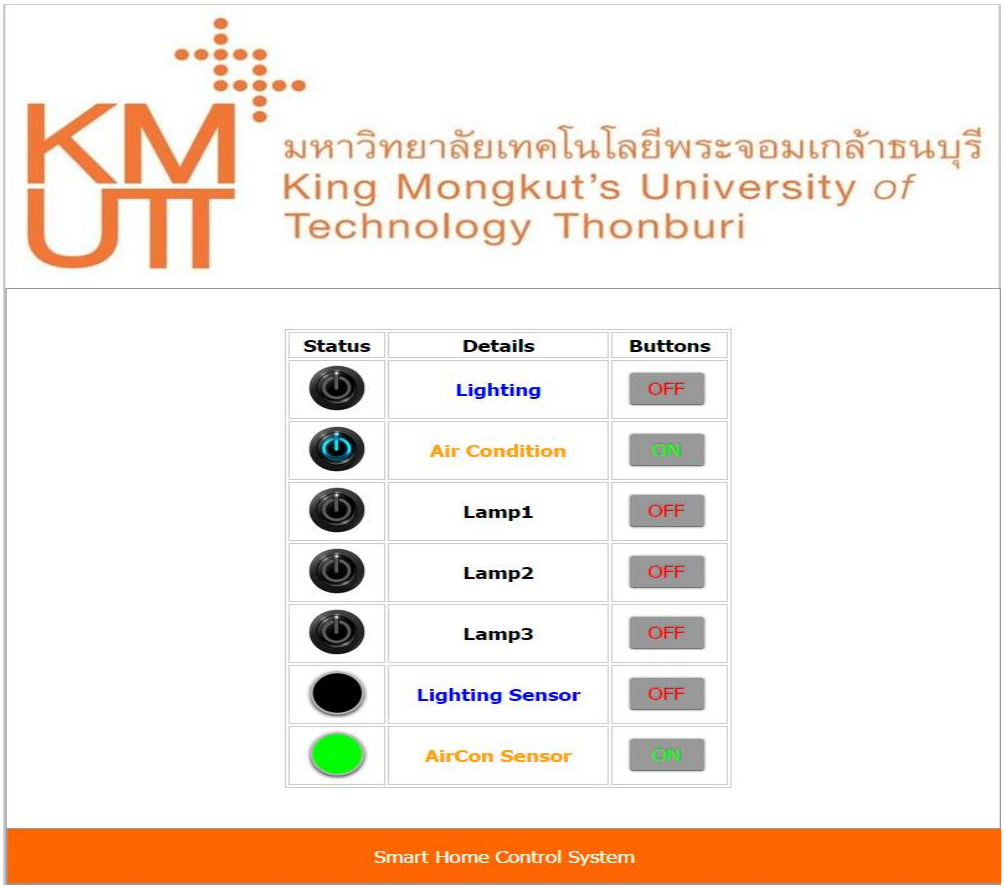

Figure 4.16 Turn on the air-conditioner simulator by motion sensor (interface)

4.3 Web Application

4.3.1 Features

Web application interface designs

- We have done interface design that looks like a simple website. Since we design these project for elderly people, naturally they are quite hard to understand how to use if the interface is designed complicate. It can control the light and the air-conditioner to turn on/off through microcontroller (ThingsPort WiFi-S).

Control the light bulb, air-conditioner simulator and motion sensor

- Web application control all of the systems for occupant convenience such as turn on/off the light and air-conditioner, it can also switching mode of motion sensor from automatically mode to manually mode. It also show device status, so occupants can check their device is turning on or turning off. For example, when you are at bedroom and going to sleep, you forgot to turn off the light or air-conditioner in the living room, you don't need to go to the living room and turn it off. You can stay in the bed and turn it off through the web application. Moreover, If you want to switching sensor mode due to when you are sleeping motion sensor still activated, it will detect your movement in the night. This will annoy when you want to go toilet for a few minute and the light will turn on, for this reason we provided this function for the occupant to change automatically sensor mode to manually sensor mode.

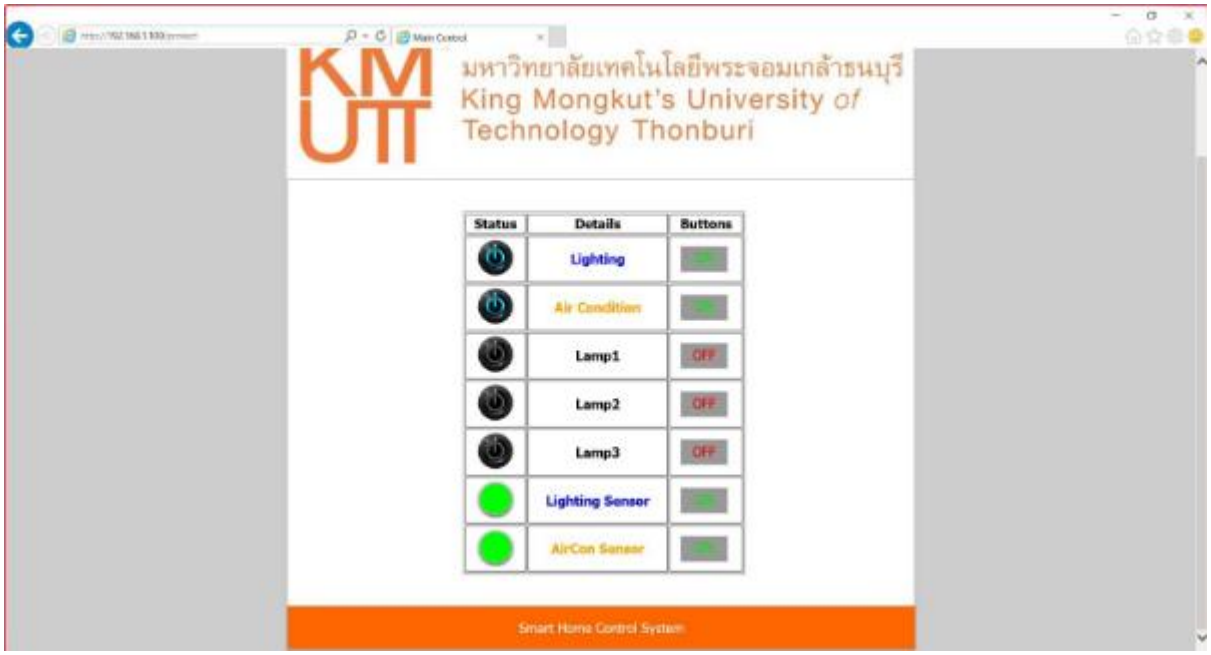

Figure 4.17 Display status of devices

4.4 Learning (Human behavior) System

4.4.1 Features

We designed this system to record time when occupant turn on the light through the web application. For instance, the occupant turn on light at 18.00, system will record hour, minute and second in the same range of time. This mean when the occupant turn on the light at 17.55, 17.59 and 18.00 respectively, all of these time will be count as the same range(system will count these three events as three times). If the record has over three times in the same range, system will set the time when light will automatically turn on.

```
#define EVENT_LIGHTING_BUFF_SIZE    6   // Max period time
#define EVENT_AIR_BUFF_SIZE         6

#define AI_LIGHTING_START_TIME  0       // Simulation time at secound
#define AI_LIGHTING_END_TIME    23      // Simulation time at secound
#define MAX_COUNT_LIGHTING      3
#define OFFSET_TIME_LIGHTING    2

#define AI_AIR_START_TIME   0       // Simulation time at secound
#define AI_AIR_END_TIME     23      // Simulation time at secound
#define MAX_COUNT_AIR       3
#define OFFSET_TIME_AIR     2
```

Figure 4.18 Initialize value for learning system

We assume that one second is equal to one hour(1 sec = 1 hour) since if we choose hour for testing our project, to get the result we must waiting for three hours for one testing(it have to waiting for a long time for one result). But if we choose second for testing our project, we will get the result in three minutes for one testing.

Furthermore, we separate the period of time to 6 ranges which is 0 to 23 seconds are substitute as 24 hours. We assume that the light turn on is “1” and not turn on is “x” by turning on the light each time must be through web application.

	0-3 sec	4-7 sec	8-11 sec	12-15 sec	16-19 sec	20-23 sec
Count 1	1	x	x	x	1	1
Count 2	x	x	x	x	1	x
Count 3	x	x	x	x	1	1
Total	1	0	0	0	3	2

From the table in first count, we assume that occupant turn on the light at 1, 18 and 21 second respectively. Second count is turn on the light at 19 second. Third count is turn on the light at 18 and 20 second. So, we have the three counts in twenty-four seconds. In 0-3 seconds we turned on the light one time, turned it on at 16-19 seconds three times and turned it on at 20-23 seconds two times. Therefore, system will set turning on time at 16-19 seconds since the occupant turned on the light three times before the other reaches.

Expected

The expected result from this project is to make disabilities people and aging people who living alone to achieve more independent and convenience in their house.

Chapter 5
Conclusion

5.1 Accomplished

For this project we have done so far is lighting system. Our lighting system can turn on and turn off. Furthermore, it also have learning system. It know what should to do by learning through human behavior. This make occupants more convenience and independent in their house, since this system is automatically turn on and occupants don't need to configuration. For temperature system, it also have learning system that is the same concept as lighting system. It's not finished yet and we have faced the problem with this system. However, we have been working on this system to find out the solution of this problem that we faced.

5.2 Accomplished in future

After we finish this project, we have planned to improve our device more features and modern design. This project considered as commercial product, therefore we have to design this product to a modern design and have all necessary features for user. Since when people make a decision to buy something, they look for functionality and design first. This project not only for commercial product but also benefiting society. When we add more necessary features, this product can help people to take care their own and more independent in their house.

5.3 Completion status table

Lighting System	**Status**
- Turn on when detected any movement.	Complete
- Learning from human behavior	Complete
- Turn on when reach the time from learning human behavior	Complete
- Control the light through web application	Complete
- Turn off when not detected any movement.	Complete
Air-conditioning System	**Status**
- Turn on the air-conditioner simulator	Complete
- Turn off the air-conditioner simulator	Complete
- Learning from human behavior	Complete
- Turn on when reach the time from learning human behavior	Complete
- Control the air-conditioner simulator through web application	Complete
Web Application	**Status**
- Interface Design	Complete
- Control panel Page	Complete

5.4 Discussion

5.4.1 Lighting System

We faced learning system problems that is how to make system remember human behavior. System could be remembered when occupant turn on the light such as at 6 P.M. Occupant will turn the light on in living room every day when they come back to their home, so how to system can remember. We use a simply logic by recording time when occupant turn on the light. After that we got the record time, system will recur the records. If there are recorded for three times in the same period of time, system will be remembered and it will automatically turn on when current time reach the system remembered time for doing task.

5.4.2 Air-conditioning System

We have faced the hardware problem that PIR sensor can't sense sleeping people. If there are occupants in the bed and stay still for a long time, PIR will not sense them and turn off the air-conditioner. There is a high technology PIR sensor that can sense whether sleeping people or not sleeping, but this device cost 10,000 - 15,000 baht per each. For the normal resident, it's not worth to use the technology like this, it should use for the highly security area.

We are still unable to control the air-conditioner by infrared sensor, so we use computer fan as an air-conditioner simulator to test our systems instead of air-conditioner.

5.4.3 Web Application

ThingsPort WiFi-S (Microcontroller) has a few memory to store, so there are limited of memory. For this reason, it force us to do interface design simple as it is. Even if we try to put one photo as a background, it still using 87% of total program memory. Since ThingsPort WiFi-S need to execute HTML and Javascript, all of these that I mentioned use a lot of memory to execute, so we can't put any decoration to our web application much.

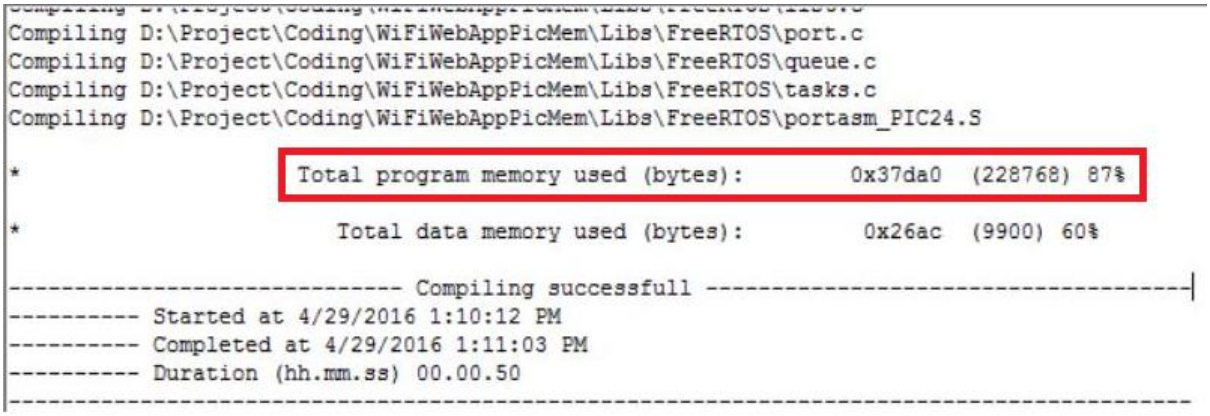

Figure 5.1 Memory usage

References

FLYPORT Wi-Fi 802.11G
http://space.openpicus.com/u/ftp/datasheet/datasheet_flyportpro_wifi.pdf

openPicus Programmer's Guide
https://elmicro.com/files/eikon/flyport_programmers_guide.pdf

Elec-Creations, รู้จักกับ Flyport
http://www.elec-creations.com/index.php?option=com_content&view=article&id=35:flyport-product&catid=25&Itemid=131

Elec-Creations, คู่มือการใช้งาน H-Board เบื้องต้น
http://www.elec-creations.com/images/file/H-Board_Manual_TH.pdf

Elec-Creations, คู่มือการใช้งานเบื้องต้น ThingsPort WiFi-S

Arduino Lesson 17: Using a PIR
http://learning.grobotronics.com/2014/09/arduino-lesson-17-using-pir/

Dreamweaver
http://www.computerhope.com/jargon/d/dreamweaver.htm

Avi-on Product
http://www.avi-on.com/

Belkin WeMo Light Switch
http://www.belkin.com/us/p/P-F7C030/

Philips 431643 Hue Personal Wireless Lighting, Starter Pack
http://www.philips.co.uk/c-p/8718291547778/hue-personal-wireless-lighting