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SUSTAINABLE HOME TEMPERATURE CONTROL SYSTEM (SHTC)

MOHD. HAFIZIE BIN SUDIN

A thesis submitted in fulfillment of the requirements for the award of the Bachelor of Engineering (Electrical-Control and Instrumentation)

Faculty of Electrical Engineering

Universiti Teknologi Malaysia

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Dedicated, in thankful appreciation for support, encouragement and understanding
to my beloved mother, father, brothers, and sisters.

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ABSTRACT

Temperature control is a process in which the temperature change is measured or otherwise detected and the temperature is adjusted to achieve a desired average temperature. In this project, LM35 temperature sensor is used for measuring surrounding temperature in degree celcius. The project is based on Malaysian weather with temperature range from 20˚C to 40˚C.The project is well compatible with the Equitorial Zone such as Malaysia that have uniformly high temperatures, high humidity, relatively light winds, and abundant rainfall throughout the year. Futhermore, at the hottest weather, the inside house temperature can be a little bit hotter than the outside temperature that is more than the outside temperature by at least 1 ˚C if the owner does not turn on any cooling system. This project's objective is to help people to control home temperature remotely even without being in the house. It is also for better comfortability inside the house as well as to minimize the use of electrical power for home cooling system such as fans or air conditioners. This project will be using a simple house model with two rooms, two sensors, and two fans that act as cooling agents. By using microcontroller attached with GSM module, the system will alert the user when the temperature inside house is hot that is more than 26 ˚C whether the owner is at home or not. 26 ˚C is choosen as the maximum average comfortable temperature where if the temperature is higher than that, the people at the house will not be comfortable. The owner can decide to turn on the cooling system by replying the sms that is send by the system or by turn it on manually.

ABSTRAK

Pengawalan suhu adalah proses dimana perubahan suhu diukur atau dikesan dan suhu diubah untuk mendapatkan suhu purata. Dalam projek ini, sensor haba LM35 digunakan untuk mengukur suhu persekitaran dalam degree Celcius. . Projek ini adalah berdasarkan cuaca di Malaysia yang mempunyai suhu dan kelembapan yang tinggi, angin yang perlahan, dan hujan sepanjang tahun. Tambahan lagi, pada cuaca yang sangat panas, suhu di dalam rumah akan menjadi lebih panas berbanding suhu di luar rumah sekurang kurangnya tinggi sebanyak 1˚C jika pengguna tidak menggunakan sebarang alat penyejukan. Projek ini membantu pengguna untuk mengawal suhu dengan senang walaupun pengguna tiada di rumah. Ia juga bertujuan untuk keselesaan di dalam rumah dan juga untuk mengurangkan penggunaan elektrik bagi sistem penyejukan seperti kipas dan penghawa dingin. Projek ini akan menggunakan model rumah yang ringkas yang mempunyai dua bilik, dua sensor, dan dua kipas sebagai agen penyejukan. Dengan menggunakan mikrokontroller yang digabungkan bersama modul GSM, sistem ini akan memberitahu pengguna apabila suhu di dalam rumah melebihi 26˚C sama ada pengguna berada di rumah ataupun tidak. Suhu 26˚C dipilih sebagai suhu maksima bagi purata suhu selesa. Pengguna hanya perlu menggunakan khidmat pesanan ringkas(sms) untuk mematikan kipas.

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LIST OF SYMBOLS

LM35	-	Temperature type, integrated centigrade temperature sensor
LCD	-	Liquid Crystal Display
SHTC	-	Sustainable Home Temperature Control System
˚C	-	Degree Celsius
m/s	-	Velocity
PC	-	Personal Computer
USB	-	Universal Serial Bus
Sms	-	Short Message Service
IC	-	Integrated circuit
CPU	-	Central Processing Unit
A	-	Ampere
Mm	-	millimeter
V	-	Volt
LED	-	Light Emitting Diode
GSM	-	Global System of Mobile communication

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.0 Background

Temperature control is a process where the temperature change is measured or detected and the temperature is adjusted to achieve a desired temperature. A home thermostat is an example of a closed control loop that constantly accesses the room temperature. In this project, LM35 temperature sensor is used for measure the surrounding temperature. LM35 are precision integrated-circuit temperature sensors that measure temperature in degree Celsius. There are many devices that can monitor temperature but not many that can control the temperature to a desired average temperature by using cooling system or heater. Temperature control system is popular nowadays especially in industrial environment where certain things need to have constant temperature. There are also many temperature sensors with for different range of temperature. Figure 1.0 shows the Liquid Crystal Display(LCD) used to display the temperature. Figure 1.1 shows the thermistor type temperature while figure 1.2 shows the temperature used in this project that is LM35 temperature sensor.

Figure 1.0: LCD display the temperature

Figure 1.1: Thermistor type temperature

Figure 1.2: LM35 Temperature sensor

1.1 Problem Statement

Malaysia weather is hot and humid almost all day. The temperature in Malaysia is stable because it is located within the Equatorial Zone with uniformly high temperatures, high humidity, relatively light winds, and abundant rainfall throughout the year[1]. From the encyclopedia of earth, the monthly average maximum temperature ranges from 32- 33° C year in Kuala Lumpur, 31- 33° C in Penang, 29- 33° C in Kuching, and 30- 32° C in Labuan[1]. This shows that the temperature in Malaysia is almost the same every day. What will happen to temperature inside our home when the temperature surrounding is hot? A reasonable thermal comfort temperature inside a house is between 25.5˚C and 28.5˚C[10]. Temperature inside house can increase up to 35˚C depending on outside temperature.

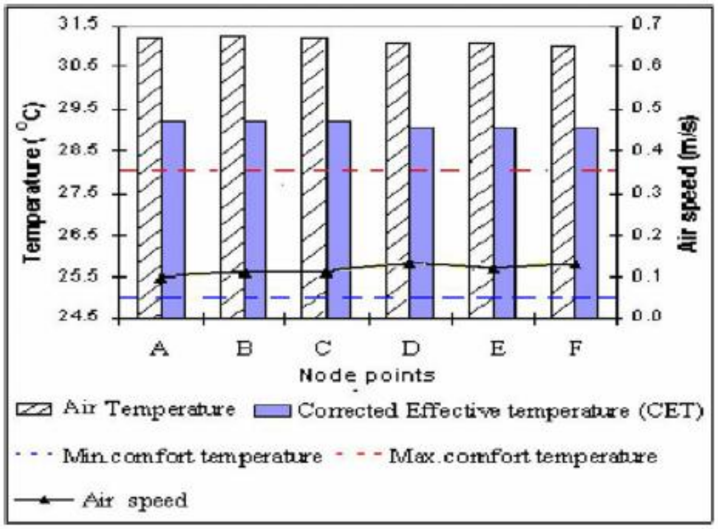


Figure 7 *Result of indoor environmental conditions in the modern low-income house (all doors and windows closed).*

By using air conditioners or fan, the temperature inside house can be decreases. However, using air conditioners will consume a lot of electricity especially when it is always turn on. Using fan continuously will also reduce the fan capabilities over time. The bigger problem is when the owner is not around but forgot to turn off the cooling systems. This will surely waste money on electrical bill because the cooling system such as air conditioners and fans is not turn off. Figure 7 shows the result of indoor environmental conditions in modern low-income house where it shows that the maximum comfort temperature inside house is around 28˚C.

1.2 Objective of Project

1. To design a user temperature control system that can be controlled remotely by sms

2. To develop a control scheme for sustainable home temperature control

3. To determine the performance over time and analysis of the home temperature for better comfort ability inside house

1.3 Scope of Project

This project will be using a house model with two rooms for two fans that functioning as cooling system for the house. Size of each rooms is about 25cm x 35cm. The temperature sensor in a ranged of from -55˚C to 150˚C from thermistor type temperature sensor and Integrated Centigrade Temperature Sensor LM35. This project is specifically for Malaysia weather with temperature in the range of 20˚C to 40˚C.

1.4 Outline of Thesis

This thesis consist of six chapters. The first chapter deal with the objective and scope of the project is discussed. Chapter 2 will review on the theory and literature reviews related to this project. It will discuss on the temperature monitoring system and the temperature control system.

Chapter 3 is about the methodology of the project regarding hardware and software implimentation. In Chapter 4, the result and discussion will be presented while Chapter 5 is conclusion and recommendation. The last chapter is Chapter 6 solely about the project management focusing on the project duration and cost.

1.5 Summary of Works

Figure 1.3 shows the overview of SHTC system where it begin with supplying DC voltage using 12V DC Power Supply to the microcontroller. Temperature sensor will read the surrounding temperature and display it on LCD. If the temperature is above 26˚C, the red Led will on and this will aslo activate the fan. Sms alert will be send to the user. If the user reply the sms sent by the system, the fan will off. If the temperature is below 26˚C, blue Led will light up. The fan is off and an alert sms will not be sent to the user.

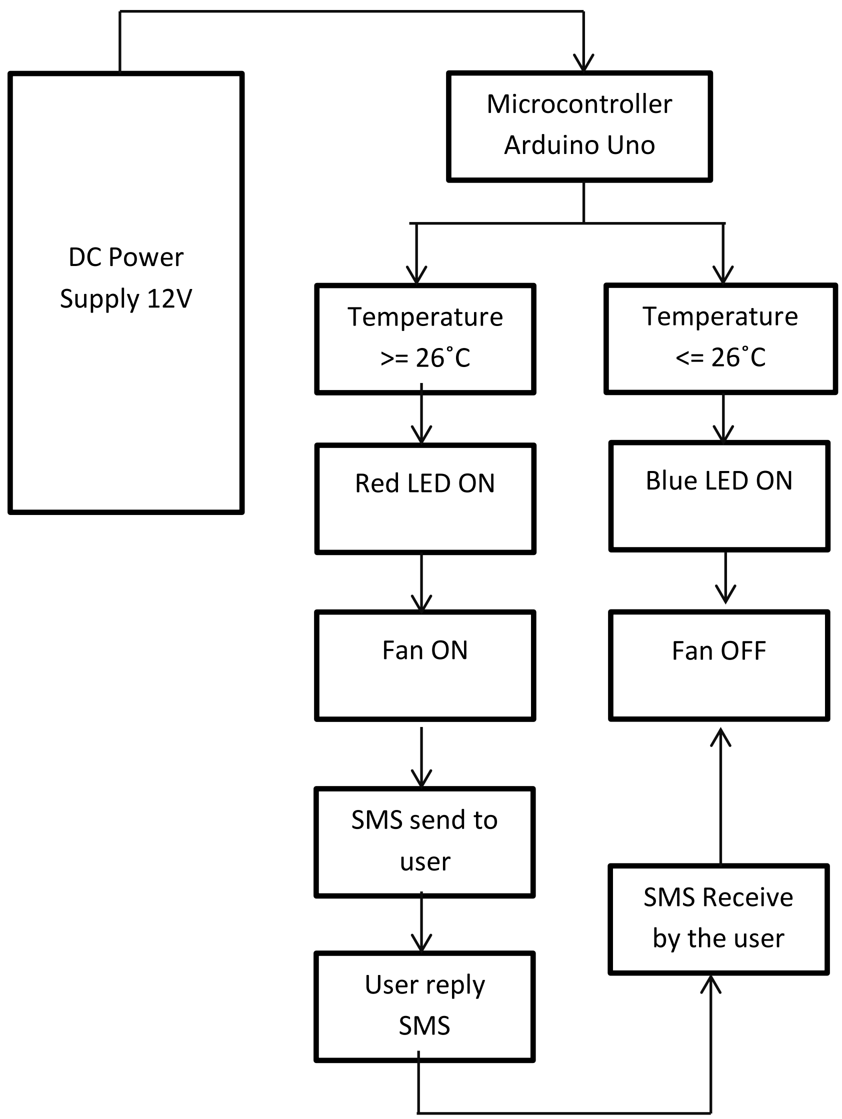


Figure 1.3: Overview of SHTC

CHAPTER 2

THEORY AND LITERATURE REVIEW

2.0 Introduction

This chapter will discuss about the theory behind Sustainable Home Temperature Control System and the literature review on this project. The literature review is on previous works that have been done commercially and academically. Works done are compared to the thesis scope of work to determine the improvements that has been made in the temperature monitoring system.

2.1 Temperature Monitoring System

Temperature monitoring is a process of reading temperature from time to time[12]. It is commonly used in many industrial processes and also used for home appliances. The main function of the temperature monitoring system is only to monitor temperature without doing anything to adjusting the temperature. It solely purposes is to show the temperature reading to users. Below are the example of temperature monitoring devices and its specifications.

2.1.1 Data Logger Aids Temperature Monitoring

Figure 2.0: Data Logger Aids Temperature Monitoring Device

Figure 2.0 shows the Data Logger Aids Temperature Monitoring Device designed by Lec Medical Company. It can be used for pharmacies, hospitals, laboratories and clinics. This device is capable of measuring and storing up to 16,378 temperature readings over a -35˚C to +80˚C range[2]. The data inside the device can be downloaded by plugging the data logger into a PC's USB port. In other words, this device is solely function to record temperature which can typically allow logging for up to one year and display the recorded temperature into PC. The device will only display the current temperature on its LCD display and store the previous reading.

2.1.2 Bluetooth Digital Thermometer for Android Devices

Figure 2.1: Bluetooth Digital Thermometer Watch

Figure 2.1 shows the Bluetooth Digital Thermometer Watch where it can monitor body temperature wirelessly on Android Phone or Tablet via Bluetooth. The upper and lower temperature can be set the alarms will be triggered to owner's phone when the temperature is out of range. The LCD display on the watch will display the current temperature value.

2.1.3 Thermofocus TH1500A3 Non-Contact Clinical Thermometer

Figure 2.2: Thermofocus TH1500A3 Non-Contact Clinical Thermometer

Figure 2.2 shows the Thermofocus Non-Contact Clinical Thermometer where it is the most modern, advance and safe device to measure body temperature. It is the first non-contact medical thermometer that enables the temperature of adults and children to be taken without touching the skin, simply by moving the thermometer close to the forehead at the distance indicated by the device. It uses infrared technology to instantly read the core body temperature at the forehead by taking the temperature at the temporal artery[3]. Thermofocus is non-invasive, totally hygienic, and non-irritating to babies and patients. The thermofocus can also measure the temperature at the navel or armpit, and can be set to Fahrenheit or Celsius.

2.2 Temperature Control System

Temperature control system is a process where the temperature is being controlled automatically or manually by the user[7]. Temperature controller is commonly used in industrial and air conditioning system. Its main function is to control the temperature by adjusting the heating or cooling element so that the temperature will drop or rise according to user's specification. Below are the example of temperature control system devices and its specifications.

2.2.1 Controller for Beer Fermentation and Kegerator

Figure 2.3: Temperature controller device for beer fermentation and kegerator

Figure 2.3 shows the temperature controller for beer fermentation and kegerator. This device has one output for cooling control and another for heating control. It can be used for beer fermentation or convert refrigerator to kegerator. By using both cooling and heating devices, the refrigerator can be controlled at specific temperature regardless in hot summer or cold winter.

This controller is a plug and play controller. Both the heating and cooling control modes are simple on/off control, similar to a mechanical thermostat but with much higher precision due to adjustable hysteresis band, precision sensor and digital read out. Anti-short function is provided for cooling to protect the compressor from being turned on with high pressure. The advantage is being much more reliable in moisture environment than thermistor sensor. It can be immersed over extended period of time. It also has a more uniform accuracy over an entire specified temperature range.

2.2.2 Intelligent Temperature Control Split Air Conditioners

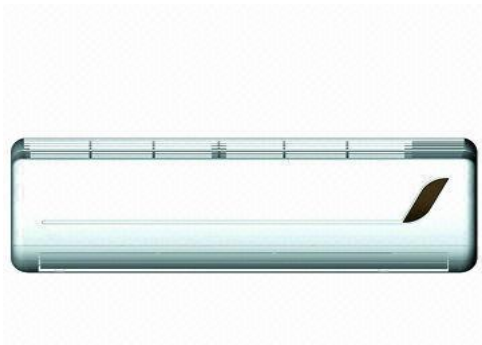


Figure 2.4: Intelligent Temperature Control Split Air Conditioner

Figure 2.4 shows the Intelligent Temperature Control Split Air Conditioner designed by Foshan Longrui Electrical Appliances Co. Ltd in China. It is the energy-saving type and super quite operating with relaxable style like cool breezy. It has wide temperature range from 16˚C to 30˚C. The room's temperature will be always fixed when used this air conditioners. It will maintain room temperature by adjusting the cooling or heating element.

2.3 Differences Between Current Devices and This Project

From the above example on temperature monitoring and temperature control system, we can conclude that the current device is already better but the differences are that the devices still using a lot of power consumption. The intelligent air conditioner above is a power saving air conditioner because it uses less power consumption than other air conditioners. The air conditioner is still continuously on unless it is turning off manually. Many devices also have the communication's specification that is calling or sms when the temperature is out of range. However, the function is only to alert user. User cannot do anything from far unless the user is near the device and turn it on or off. The communication is only for alerting user to let user know that the temperature is out of range. It is limited only in letting user know.

The SHTC will be design so that these flaws are overcome. SHTC will alert the user via smartphone's call or sms and the user can decide whether to reply the call or sms. Users can turn on/off the cooling system just by using smartphone even when the user is not at home.

2.4 Market Survey

There are many residential in Malaysia and its keep increasing every year. Table 2.1 below shows the number of property transaction in 2011-2012. From the transaction, we know that the residential is keep increasing every year at least by 300 residential.

Table 2.1: Number of property transaction by state 2011-2012

STATE	RESIDENTIAL		COMMERCIAL		INDUSTRIAL		AGRICULTURAL		DEVELOPMENT LAND	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
W.P. KL	24,314	24,010	6,478	5,934	353	294	-	-	519	528
W.P. Putrajaya	482	640	22	19	19	4	-	-	-	-
W.P. Labuan	313	363	27	36	26	25	43	33	207	204
Selangor	75,344	74,958	10,034	9,695	3,743	3,080	6,085	5,741	2,999	3,015
Johor	31,084	28,849	5,427	4,630	1,342	1,302	12,242	11,648	2,850	2,859
Penang	30,674	23,266	3,320	2,826	779	724	2,363	1,977	2,271	2,164
Perak	33,170	30,135	4,729	4,231	1,023	979	14,813	14,001	807	931
Negeri Sembilan	13,183	14,935	2,311	2,410	536	619	4,051	4,414	770	814
Malacca	7,221	9,267	2,011	1,998	466	613	2,720	2,863	1,476	1,165
Kedah	11,731	14,159	1,957	1,847	533	310	10,940	9,282	1,591	2,173
Pahang	8,774	12,329	1,496	1,382	340	404	6,519	5,488	628	738
Terengganu	10,385	12,489	660	572	68	60	3,871	3,861	3,438	3,693
Kelantan	3,731	7,223	510	859	36	505	3,610	3,753	1,507	1,738
Perlis	702	1,006	133	217	24	11	1,880	2,058	75	98

Source: Property Market Report 2012, National Property Information Centre (Napic).

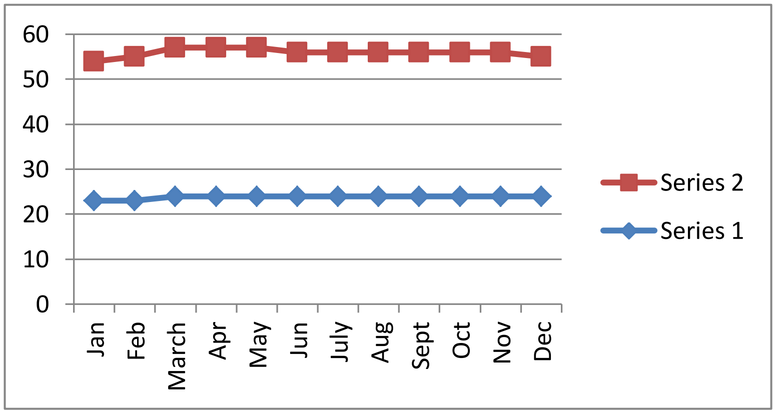
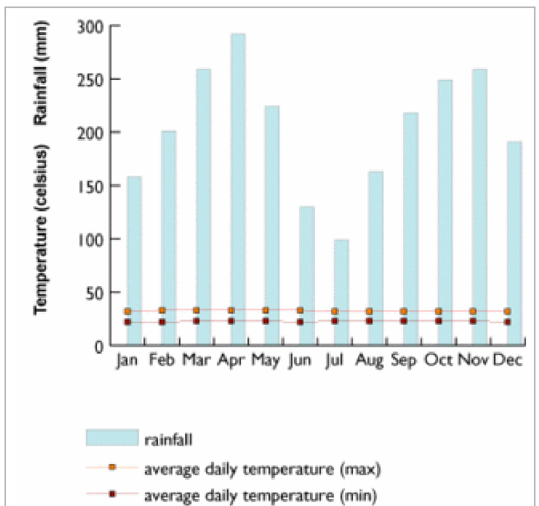


Figure 2.5: Average minimum and maximum temperature weather in Malaysia



Climate Graph for Kuala Lumpur. Source: BBC Weather

Figure 2.6: Average temperature and humidity for Kuala Lumpur

Figure 2.6 shows the average maximum temperature (red) and average minimum temperature (blue) in Malaysia. Figure 2.7 shows the climate for Kuala Lumpur. From both the figures, we can conclude that the temperature in Malaysia is quite hot and humid. This temperature will affect the in-house temperature and owner will need to use cooling system as the weather is hot. The cooling system such as air conditioners will use a lot of power, therefore the owner need to pay a large amount of money for the usage of air conditioners.

Therefore, the SHTC is design for home appliances for better comfort and to save electricity consumption. This devices function to turn on/off according to owner's need or instructions.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter will briefly explain about the flow of the project, the components used, and the expected outcome.

3.1 Hardware Implementation

3.1.1 DC Motor

The fan used is 12V, 0.3 A. The size of the fan is 8.5cm x 8.5cm. Since the fan uses 12V, 0.3A, an external power sources to the fan must be applied so that the fan can rotates faster.

The microcontroller used does not have enough power or volt to move the fan. Therefore for each fan, a 9V battery is used.

3.1.2 1602 HD44780 Character LCD Display Module

Liquid Crystal Display with blue backlight. The instruction of each pin is shown in table 3.1 below.

Table 3.1: LCD's pin instruction

No.	Symbol	Pin instruction	No.	Symbol	Pin instruction
1	VSS	GND	9	D2	Data
2	VDD	Positive	10	D3	Data
3	VL	LCD Bias voltage	11	D4	Data
4	RS	Data/Command choice	12	D5	Data
5	R/W	Read/Write choice	13	D6	Data
6	E	Enable signal	14	D7	Data
7	D0	Data	15	BLA	Back light anode
8	D1	Data	16	BLK	Back light cathode

The first pin: VSS means GND

The second pin: VDD connect +5v

The third pin: VL is the terminal of LCD for adjusting the contrast. Connecting anode, the contrast is weak; connecting GND, contrast is high. Contrast is too high which will result in 'ghost'.10k potentiometer can be used to adjust the contrast in operation'.

The fourth pin: It is register choice. High level, choose data register, Low level, choose instruction register.

The fifth pin: R/W is signal wire of 'read' and 'write'. High level, execute 'read', Low level, execute 'write'. When RS and R/W are at low level simultaneously, you can write command or show address. When RS&R/W are at high level simultaneously, you can read the busy signal; When RS is at high level and R/W is at low level, you can write data.

The sixth pin; E terminal is enable terminal. When E terminal becomes from high level to low level, LCD module executes command.

The seventh pin: D0 to D7 is 8 pin bi-directional data cable

The fifteenth pin: Black light anode

The sixteenth pin: Black light cathode

3.1.3 Temperature Sensor

There are two temperature sensors used in this project that is SN-TEMP-MOD shown in Figur 3.1 and LM35 shown in figure 3.2. SN-TEMP-MOD comes with two outputs, analog and digital. This temperature module uses NTC Thermistor to detect temperature changes with onboard components providing power of 3.3V to 5V DC. Negative Temperature Coefficient (NTC) thermistor will change the effective resistance over temperature, utilizing this behavior. Room/environment temperature may be detected by measuring the voltage from a resistor network, like a voltage divider. However, this module is not suitable to measure absolute temperature and is suitable for relative temperature measurement. Below is the front view of SN-TEMP-MOD temperature sensor.

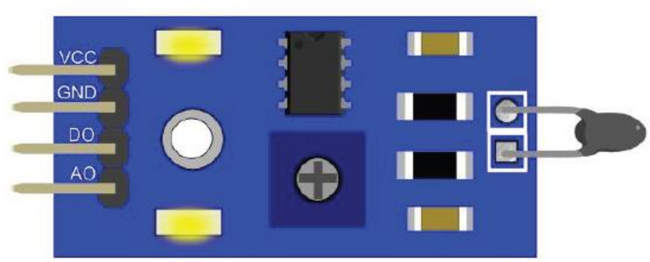


Figure 3.1: Temperature sensor module board layout

This temperature sensor is sensitive to environment temperature and the sensitivity can be adjusted for digital output with on board potentiometer, clockwise will set the threshold at low, and counter clockwise will set the threshold at temperature high for trigger. When the actual temperature is higher than threshold, D0 will be LOW and wise versa. A0 is around 1.45V at 27˚C and the higher the temperature, the lower the voltage at A0.

LM35 are precision centigrade temperature sensor whose output is linearly proportional to the Celsius (Centigrade) temperature. It does not require any external calibration or trimming like SN-TEMP-MOD to provide typical accuracies of ±1/4˚C at room temperature over a full -55˚C to 150˚C temperature range. Figure 3.3 shows the upper view of LM35 where it has three pins which is Vs pin for voltage to the LM35, Vout for voltage to the microcontroller, and GND for ground.

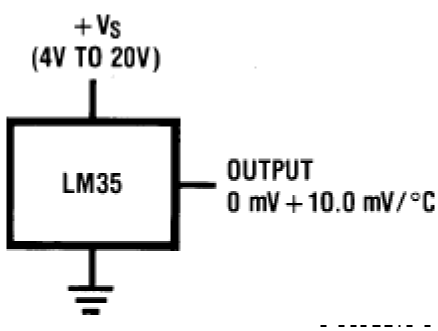


Figure 3.2: LM35 Schematic diagram

Figure 3.3: LM35 Upper view

3.1.4 SIM900 GSM Shield

GSM is known as Global System of Mobile Communication. It is being used as standard for nowadays in our cell phone. Over 200 countries and 2 billion people are using it as a phone today. GSM would work any place as long as the signal/network is available. SIM900 can be used in a wide range of application. For this project, SIM900 is used for sending and receive SMS only. Table 3.2 below shows the features of SIM900.

Table 3.2: SIM900 GSM Shield Features

Feature	Explaination
Power Supply	3.2V ~ 4.8V
Power Saving	Typical power consumption in sleep mode is 1.0mA
Frequency Bands	SIM900 Quad-band: can search the 4 frequency bands automatically Compliant to GSM Phase 2/2+
Temperature Range	Normal operation: -30˚C ~ +80˚C Restricted operation: -40˚C ~ -30˚C and +80˚C ~ +85˚C Storage temperature: -45˚C ~ +90˚C
Data GPRS	GPRS data downlink transfer max 85.6kbps GPRS data uplink transfer max 42.8 kbps
SMS	MT, MO, CB, Text and PDU mode SMS Storage: Sim Card
Real Time Clock	Support RTC

The following figure shows a functional diagram of SIM900 and overview of SIM900 GSM/GPRS Shield.

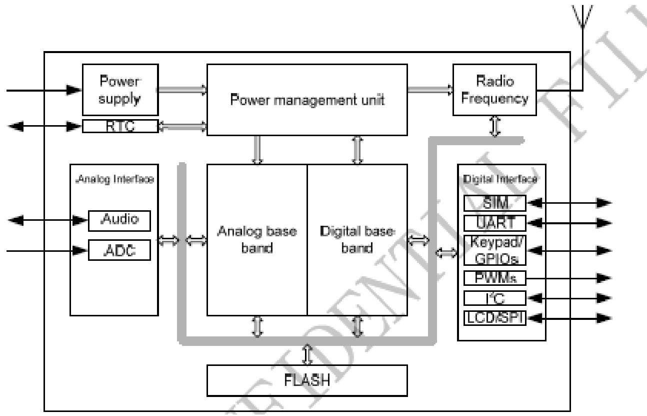


Figure 3.4: Functional block diagram of Sim900 GSM Shield

Figure 3.5: Sim900 GSM Shield

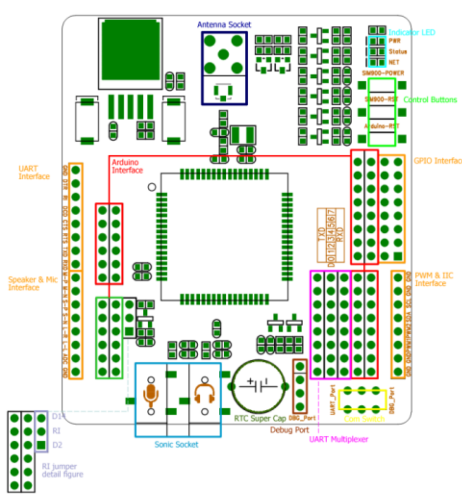


Figure 3.6: Sim900 GSM Shield Schematic

Figure 3.6 shows the schematic of Sim900 GSM Shield where it already has its own microcontroller pins to be attached to Arduino Uno.

3.1.5 Light Emitting Diodes (LEDs)

Two blue leds and red leds will be used. The leds used is 5mm led. The blue LEDs will indicate that the temperature is below 26˚C while the red LEDs will indicate that the temperature is above 26˚C.

3.1.6 Microcontroller Arduino Uno

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language(based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software running on a computer.

3.2 Software Implementation

In this project, one main software is used that is Arduino IDE for programming the microcontroller. Arduino IDE using Atmega328 programming such as assembly and high level language. The Arduino programming language is an implementation of Wiring, a similar computing platform, which is based on the processing multimedia programming environment. The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based.

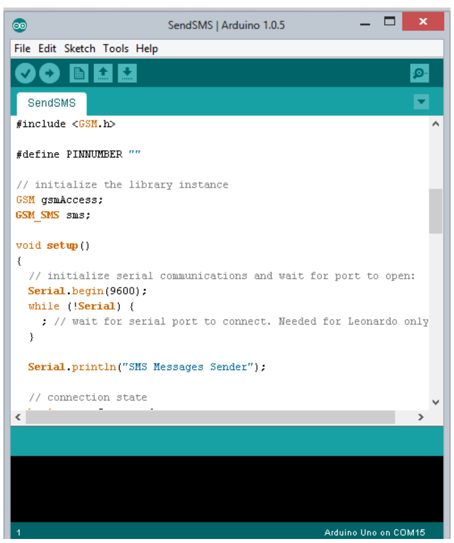


Figure 3.7: Arduino IDE open-source software overview

Figure 3.7 shows the overview of Arduino IDE open-source software used to programm the Arduino Uno. Assembly language and high level language can be used for coding or programming.

CHAPTER 4

RESULT AND DISCUSSION

4.0 Introduction

This chapter will show the result of project research and discuss several experiments or testing that has been made for better understanding of the project research.

4.1 Flowchart

From the flowchart as shown in figure 4.1, the process begins with reading value from temperature sensors and displays the reading on Liquid Crystal Display (LCD) 16x02cm. The decision will be taken when the temperature is out of range. The range for in-house starting hot temperature is 26˚C. When the temperature is below 26˚C, the blue Led will turn on while the cooling system will not turn on but when the temperature is above 26˚C, the red Led will turn on and the cooling system will also turn on. When the temperature goes above 26˚C, the GSM will send SMS. Its is up to the user whether tp reply it or not. When the user reply the SMS or sending the SMS to the system, the fan will automatically of regardless of the temperature value. The process in the flowchart is a basic idea for automatic temperature control.

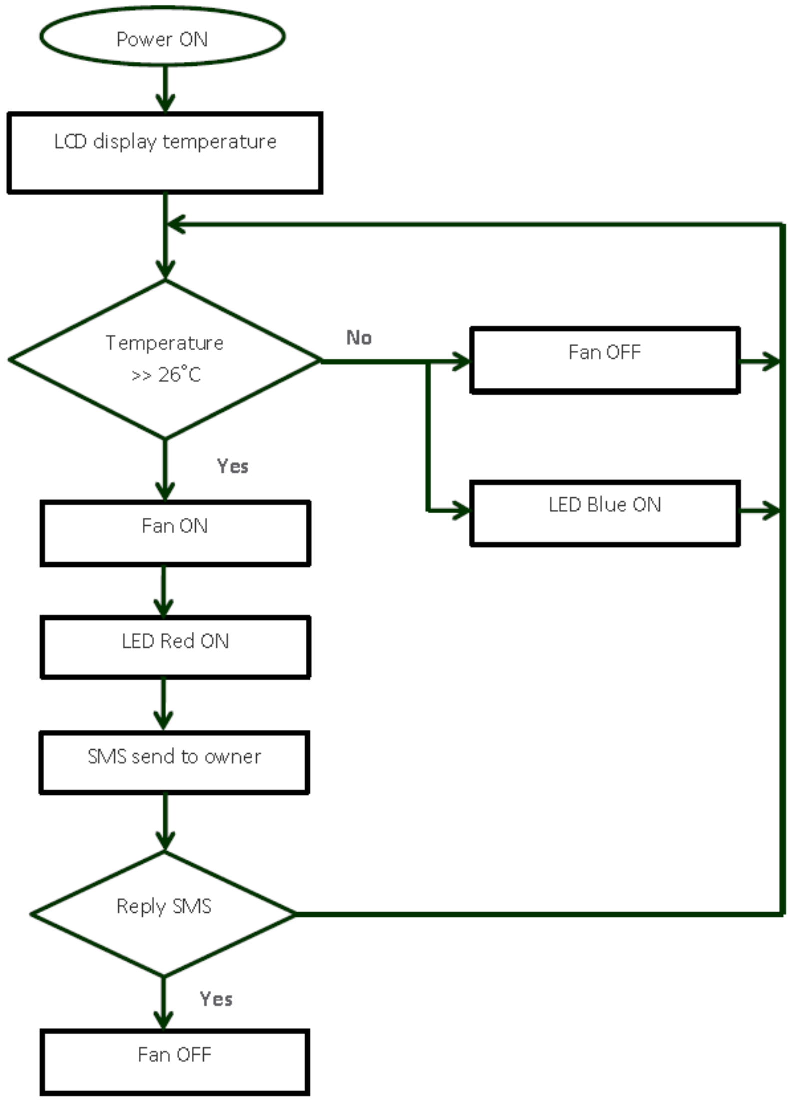


Figure 4.1: Flowchart diagram of the whole process of SHTC

4.2 Main Component With GSM Module

Figure 4.2 below shows the main components that are already available and attached to one another. Two fans and two temperature sensors is attached to the main body. The GSM Shield is attached to the Arduino Uno. LEDs, LCD, Temperature sensors, and fans are connected to the GSM Shield using Arduino Uno pins. Figure 4.3 shows the connection of LCD,Leds, DC Motor, and temperature sensors to Arduino Uno.

Figure 4.2: SHTC Devices

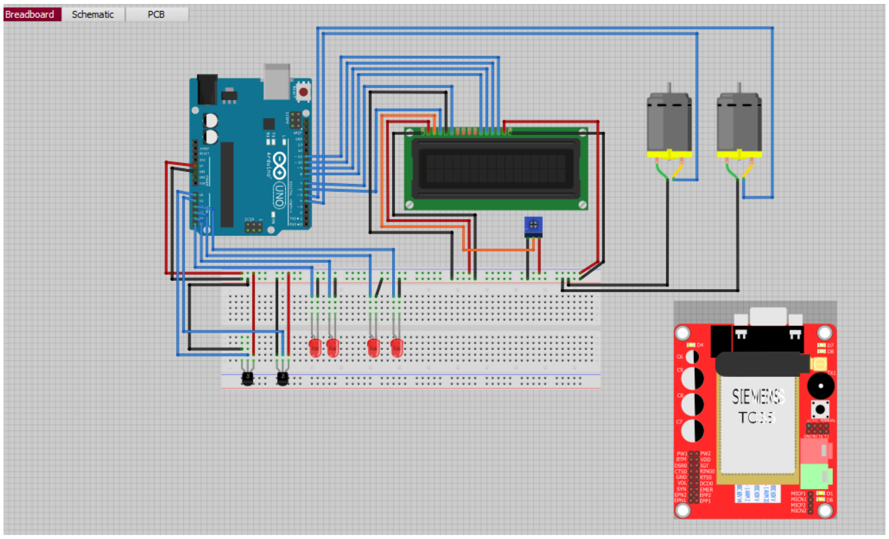


Figure 4.3: shows the connection of Arduino Uno, LCD, LEDs, DC Motors, and temperature sensors.

4.3 Block Diagram

Figure 4.4 below shows the block diagram of Sustainable Home Temperature Control Device where it begins with the temperature sensors that will send feedback to the microcontroller Arduino Uno. The Leds and fans will activated based on the temperature value whether it is hot or cold. LCD will display the temperature value and an alarm will triggered if the temperature is above 26˚C. This will cause the system to alert the user by sending sms and the user can choose whether to deeactivate the fans or not by replying sms if the user want to deactivate it.

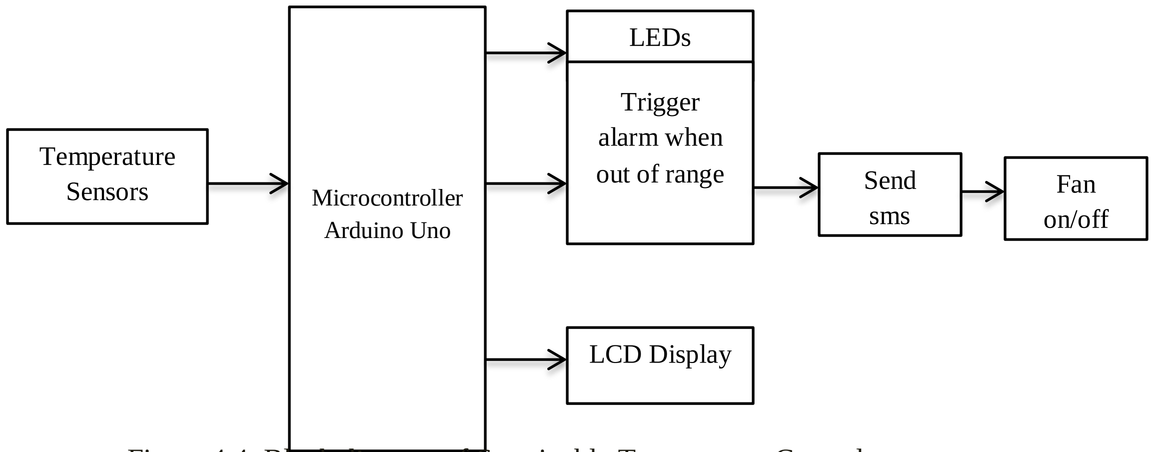


Figure 4.4: Block diagram of Sustainable Temperature Control System

4.4 Result

4.4.1 Preliminary Result

The preliminary result is result obtain from the first semester of Final Year Project. During the first semester, the result is more on the learning on how to program and assemble the component used.In appendix A1 show the coding for the LM35 temperature sensor and display it on the LCD and computer monitor.

In Appendix A2 shows the coding for the Red and Blue Led to light up. Blue Led is light up first, then the red Led will light up. After one second, the blue and the red Led will light up then both will turn off.

In the first semester, the fans and the GSM SIM900 is still not bought because of money problem. Therefore the LCD, and the Leds is test out first. However, a fan from the laptop cooling pad is used first to test out the LM35 sensor. Below is the overview of the first prototype without the GSM module.

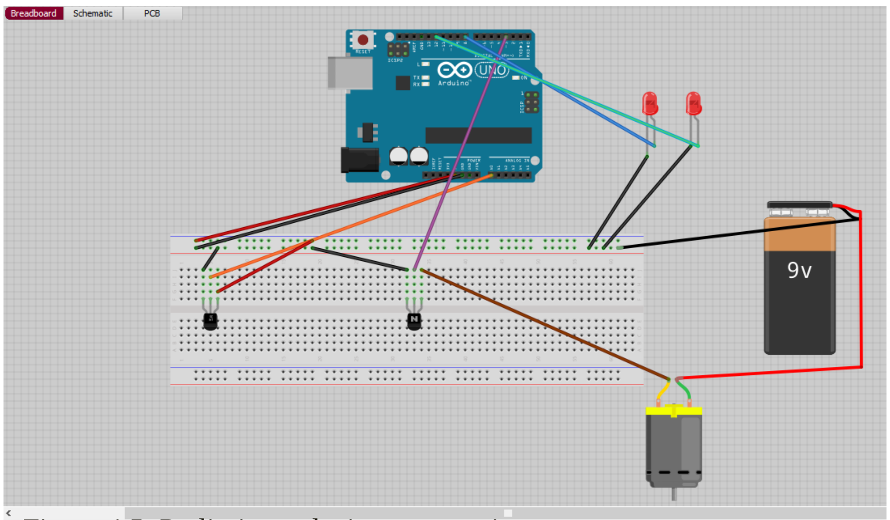


Figure 4.5: Preliminary devices connection

From the figure 4.5, The LM35 is connected to anaog pin(A0) of arduino, the blue Led to digital pin 8 of arduino, red Led to digital pin 12, and the fan is connected to digital pin 3 of arduino. The fan using the power from the battery so that the fan can rotates faster. Transistor NPN is used to supply the power from 9V battery to the fan. The coding for the fisrt protoype without the GSM module is appendix A3.

4.4.2 Final Result

The final result will include two LM35 temperature sensor, two fans(DC Motor), LCD display, two red Leds, two blue Leds, and SIM900 GSM Shield. The LM35 temperature sensor will measure the temperature inside two mini rooms. The temperature will be display on the LCD. If the temperature goes beyond 26˚C, the red Led will light on and the SMS from the system will be sent to the user. The user will receive the alert SMS indicating that whether mini room 1 or mini room 2 is hot. User can choose whether to reply the SMS or not. If the SMS is replied, the cooling system will be turn off. If the SMS is not replied, the cooling system will be turn On. User will receive SMS from the system in another six hours after the system receive a replied SMS from the user if the temperature is still beyond 26˚C in those six hour.

Figure4.6 shows and overview and the schematic of the main system without GSM connection.

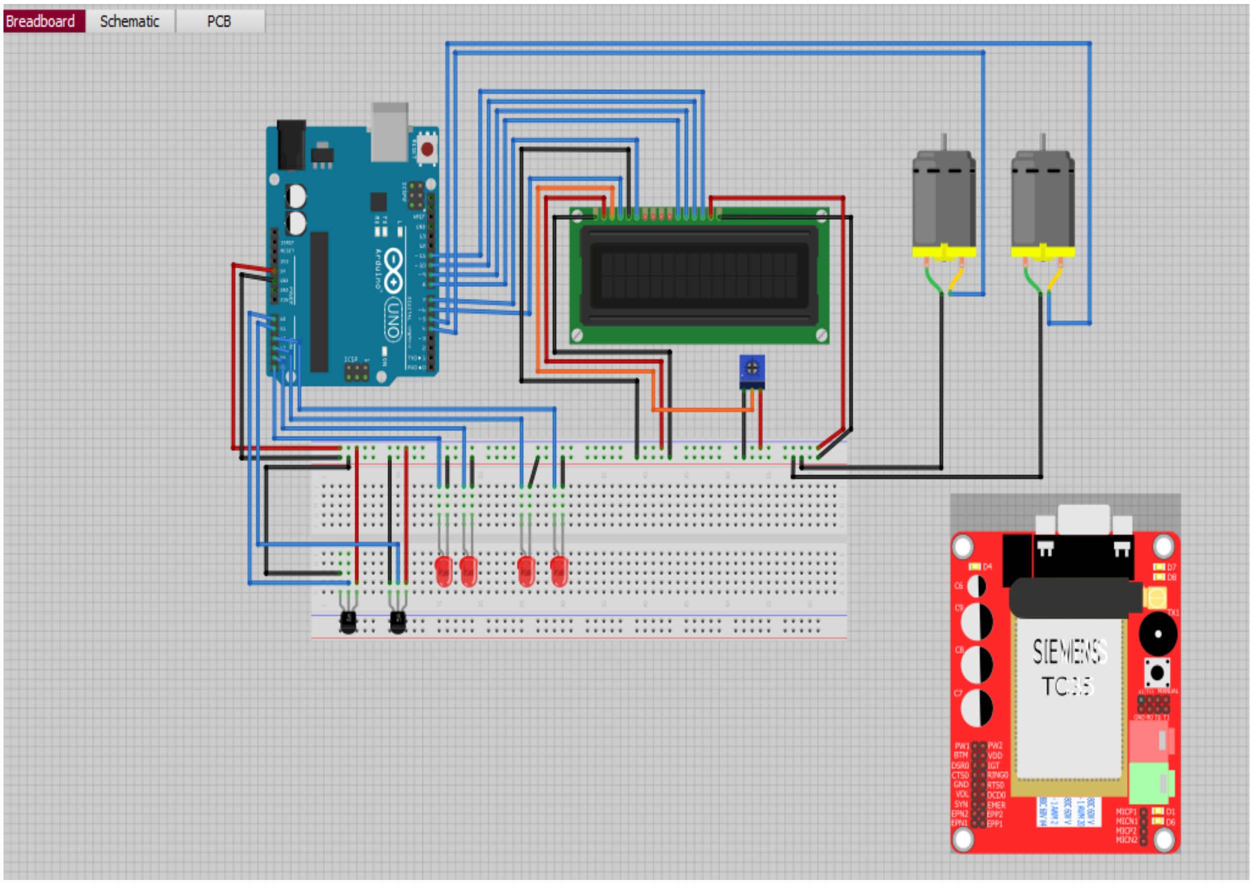


Figure 4.6: overview of SHTC's connection

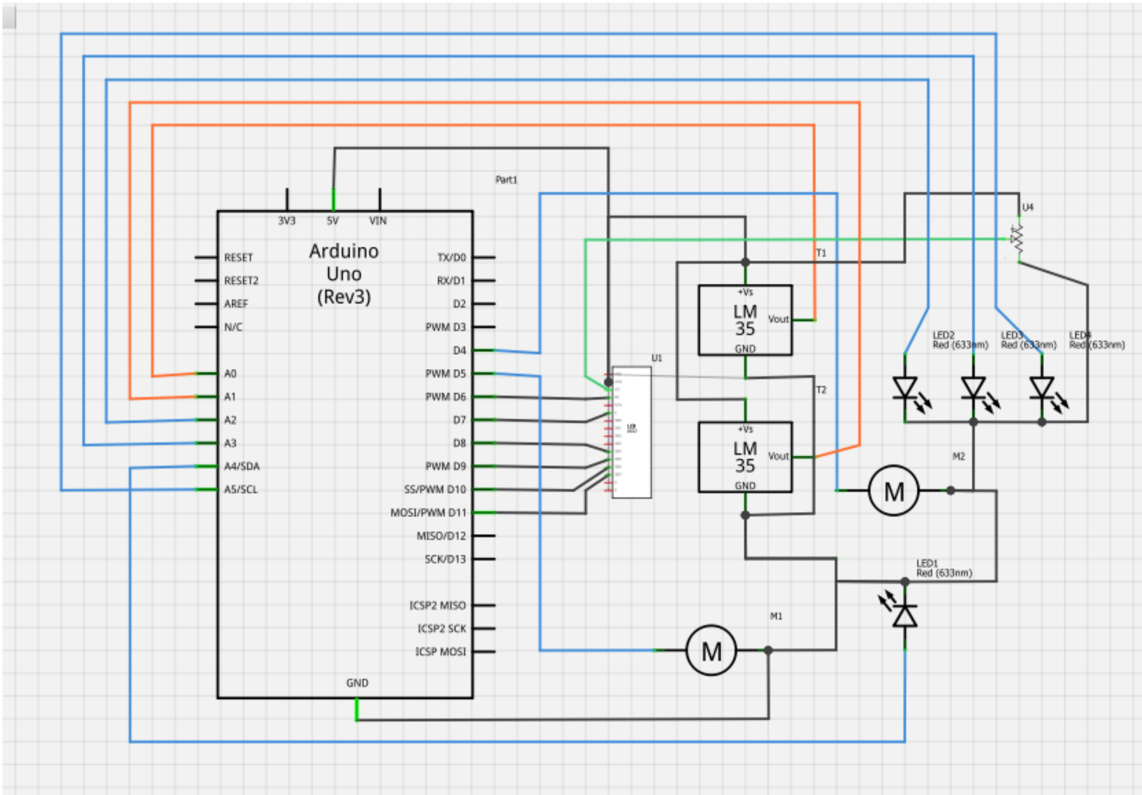


Figure 4.7: overview of SHTC's schematic diagram.

The schematic in figure 4.7 shows the connection of the system without the GSM SIM900 since the SIM900 does not have fritzing file. The GSM Shield SIM900 will be using the TX and RX pin of arduino that is digital pin 0 and digital pin 1. TX pin is for transmit signal from the GSM Shield and the RX pin is for receive signal to the GSM Shield. GSM Shield SIM900 pin's for arduino is pin 2 of TX and pin 3 of RX. Figure 4.8 below shows the pin of GSM Shield to be used for arduino uno.

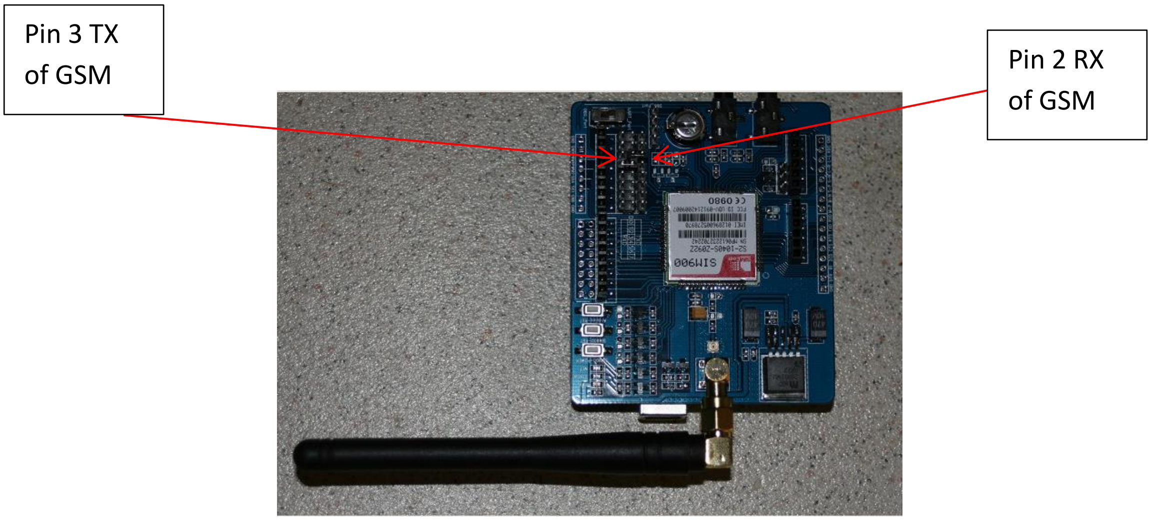


Figure 4.8: TX and RX pin of Sim900 GSM Shield

Figure 4.9 show the final product of the project where it consist of 4 port, two port for temperature sensors and two port for fans.

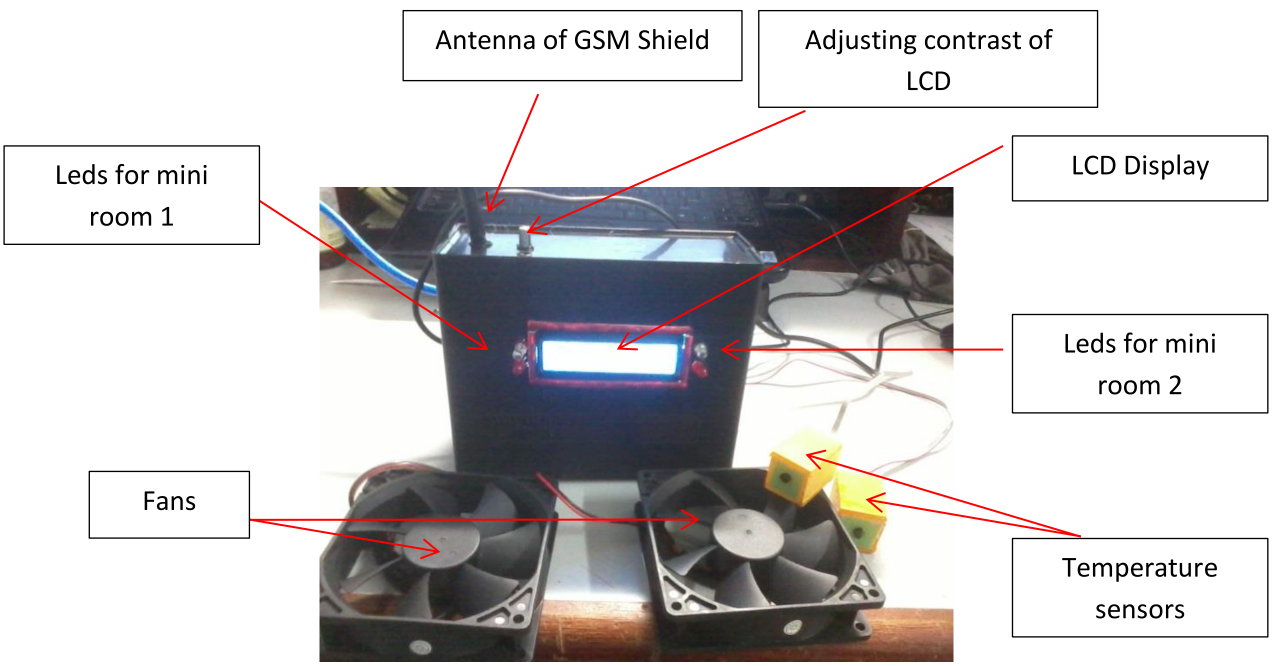


Figure 4.9: SHTC main components

The temperature sensor is tested by taking the temperature readings from mini room 1 and mini room 2. Table 4.2 below show the reading taken before the fans is attached.

Table 4.2: Mini room's normal temperature reading

Time (s)	Temp1(˚C)	Temp 2 (˚C)
0	0	0
10	29.1	29.1
20	29.1	29.1
30	29.6	29.1
40	29.6	29.6
50	30	29.6
60	30	29.6
70	30	30
80	29.7	30
90	29.7	29.7
100	30.1	30.1
110	30.1	30.1
120	30.1	30.1
130	30.5	31.1

From the table above, the average mini room temperature before the fans is on is about 29.8˚C for both mini rooms. Table 4.3 and Figure 410 below shows the value of the temperature readings when the fans is apllied to the mini rooms.

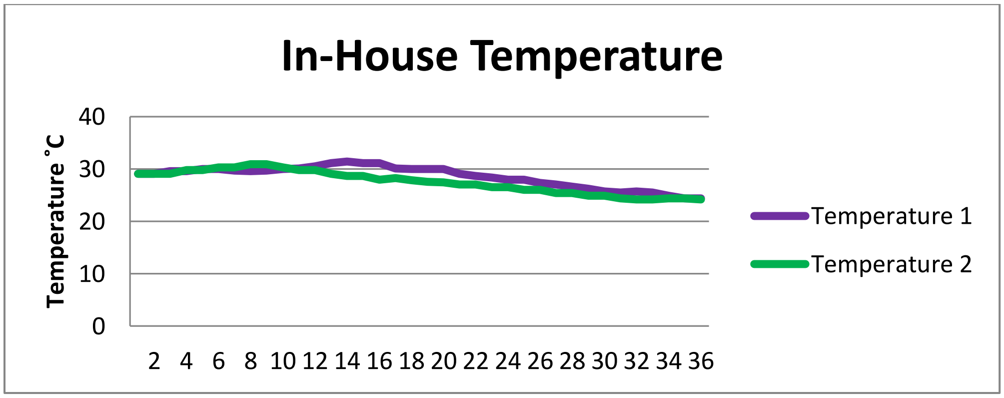


Figure 4.10: Graph of temperature reading before and after the fans is on for both mini rooms

Table 4.3: Temperature reading before and after the fans is on for both mini rooms

Time(Minutes)	Temperature 1	Temperature 2
	29.1	29.1
2	29.1	29.1
	29.6	29.1
4	29.6	29.8
	30	29.8
6	30	30.3
	29.7	30.3
8	29.6	30.9
	29.7	30.9
10	30	30.3
	30.1	29.8
12	30.5	29.8
	31.1	29.1
14	31.4	28.7
	31.1	28.7
16	31.1	28
	30.1	28.3
18	30	27.9
	30	27.6
20	30	27.5
	29.1	27.1
22	28.7	27.1
	28.4	26.5
24	28	26.5
	28	26
26	27.4	26
	27	25.4
28	26.6	25.4
	26.2	24.9
30	25.7	24.9
	25.5	24.4
32	25.7	24.2
	25.5	24.2
34	24.9	24.4
	24.4	24.4
36	24.4	24.2

From the graph shown above, the time taken for the mini room to cool down below 26˚C when the fans is on is around 20 minutes for room size 25cm x 35cm. However, this is only true for the normal average room temperature around 29.8˚C. The graph show the decreasing temperature after both of the fans is on aroun minutes 15.

When the temperature is above 26˚C, the red Led will turn on and the sms will be sent to the user. User can reply the sms to turn off the fans. Figures below shows the process of the system.

Figure 4.11: Mini room model consist of two rooms

The house model for the system consist of one fan and one temperature sensor for each room as shown in Figure 4.11. There is two rooms in this house model. The main body is attached outside the house model while the sensors and the fans is inside the mini rooms. A glass wall is used as the front wall and the roof so that the fans can be observe clearly whether it is on or not.

Figure 4.12: The red Led for both mini rooms is light up

Temperature exceed 26˚C will light up the red leds. From the figure 4.12, both the leds is on because both of mini room's temperature is above 26˚C. Both of the fans will automatically on when the temeprature exceed 26˚C.

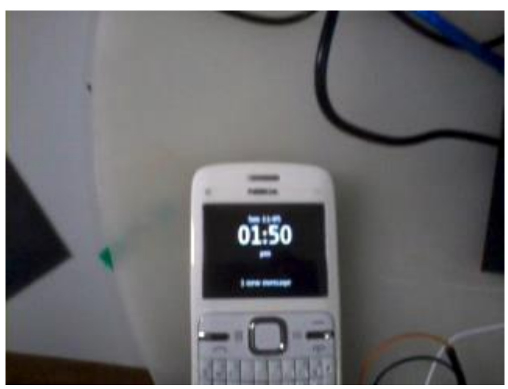


Figure 4.13: SMS received by the user sent from the system

The high temperature will result in the system sending sms to the user to alert the user about the rising temperature value whether in mini room 1 or mini room 2 as shown in Figure 4.13. The sms will state whether mini room 1 or mini room 2 or both rooms is hot.

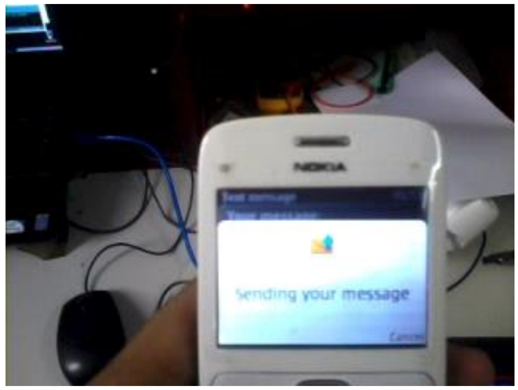
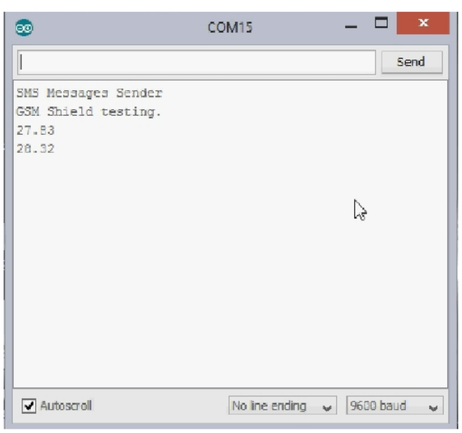


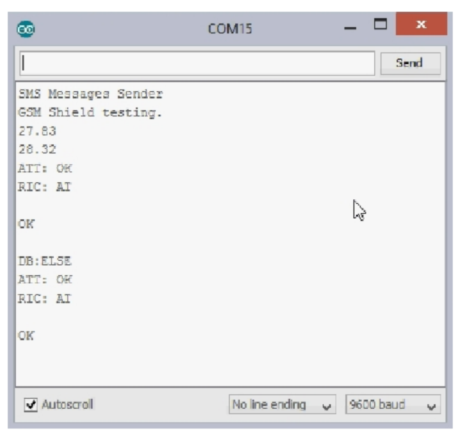
Figure 4.14: User reply the received SMS.

User can decide whether to reply sms or not. By replying the sms as shown in Figure 4.14, user can turn off the fans even if the room is hot. Even without notification about the exceeding temperature, user can still send sms to the system to turn off the fans. Any text or words can be used to send to the system. The system will send sms again after six hour after receiving the sms from the user if the temperature maintain above 26˚C during those six hour.

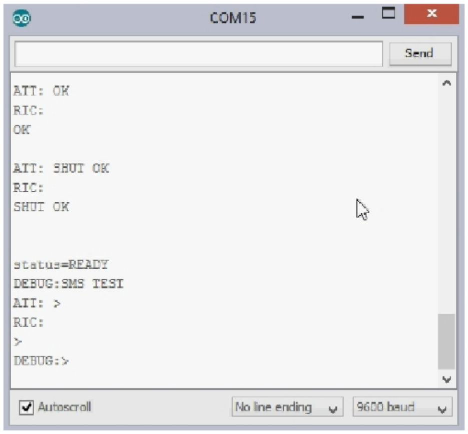
Below shows the details about how the sms is send and receive by the user.



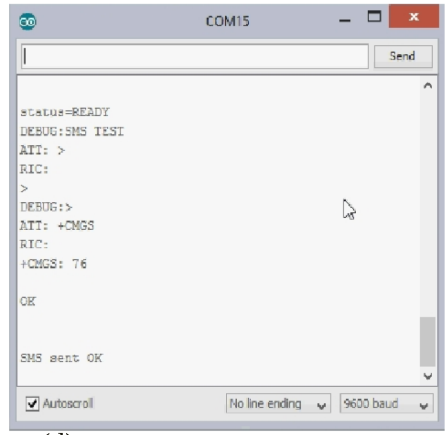
(a) **Read Temperature Sensor**



(b)**GSM testing**

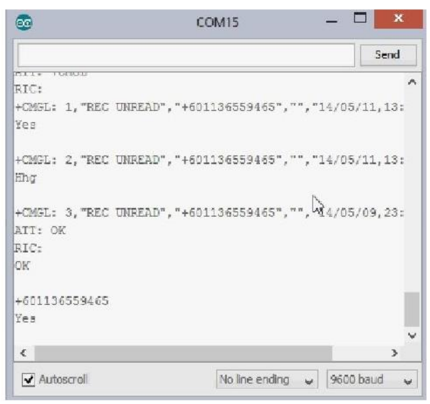


(c) **GSM is Ready**



(d) **SMS is Sent**

Figure 4.15: Serial print from the computer shows the GSM process (a) for the temperature reading, (b) GSM Testing, (c) Indicate that GSM is Ready, (d) SMS is sent



SMS Reply

Figure 4.15e: Serial print from the computer shows the GSM process for the SMS Reply

Figure 4.15a show the temperature reading from the surrounding. When the temperature exceed 26˚C, the GSM Shield SIM900 will be tested first as shown in figure 4.15b. Figure 4.15c show the GSM is ready whether to send or receive sms while Figure 4.15d show the sms is sent by the Sim900 GSM Module. Figure 4.14e show sms is replied by the user. The coding for overall process is shown in appendix A4..

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The SHTC will be a better solution to users who have problems especially when forgotting to turn off the cooling system. The user can turn off the cooling system without having to go back to their home. However, since the device only uses a mere 12V DC power supply and operates at 5V power, it is not suitable to be used using a real fan especially an air conditioner. This project shows how the user can automatically control the cooling system by an automated sytem and simply using sms.

5.2 Recommendation

The SHTC will be using a prepaid sim card. Therefore it will cost more in term of communication cost. Each sms is charge one cent depending on the prepaid sim card type. There are a lot of prepaid plan so that user can choose which plan to use for the system to minimize the sms cost. This problem cannot be solved by removing the sim card. However, the sms cost can be minimise using a chaper plan for prepaid sim card. User need to cleverly choose which prepaid plan is the cheapest and the top up renew is longest.

This device can only hold up to two sensors and two fans only. It can be modified to hold three temperature sensors and three fans at maximum only. This problem can be solved by modification. The system need to be modified by using a larger Integrated Circuit(IC) or larger microcontroller so that it can hold many sensors, leds, and fans at the same time.

The device can not be applied to real fan especially air conditioner since real fan need a power source directly from the electrical plug. The fan in this device is supplied by 9V battery. The device can be used for real fan if the part where the power source activated the fan is modified a bit. It can be modified so that the power source to activated the fans is supplied by the home electricity and not by the battery. The modification for this part is not hard but it will increase the usage of electricity as compare to the current SHTC device.

CHAPTER 6

PROJECT MANAGEMENT

6.0 Introduction

This chapter will explain details about the project schedule and the cost of the project. Gantt chart is used to shows the shcedule based on each stage of study. There will be two gantt chart for two semester during this one year project.

The cost estimation will shows the overall cost for this project.

6.1 Project Schedule

Table below shows the gantt chart. Since the final year project consist of two part or two semester, the gantt chart also divided into semester. Table 6.1 show the gantt chart for semester one while table 6.2 show the gantt chart of semester two, the continuation of semester one’s gantt chart.

Table 6.1: Gantt chart for semester one

No	Date / Stages of Study	SEMESTER 1														
		September	October					November				December				
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15
1	Project Briefing	■														
2	Literature Review		■	■	■	■	■	■	■	■	■	■	■	■		
3	Flowchart and Gantt Chart				■	■	■									
4	Preparing Components and Design						■	■	■	■	■	■	■			
5	Coding and Debug							■	■	■	■	■	■	■	■	■
6	Testing Main Board								■	■	■	■	■	■	■	■
7	Testing Temperature Sensor									■	■	■	■	■	■	■
8	Report											■	■	■	■	■

Table 6.2 : Gantt chart for semester two(continuation of semester one)

No	Date / Stages of Study	SEMESTER 2														
		February			March				April					May		
		Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15
1	Literature Review	■	■	■	■	■	■	■	■	■	■	■	■	■		
2	Preparing Components and Design	■	■	■	■	■	■	■	■	■	■	■	■			
3	Coding and Debug	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
4	Testing Main Board	■	■	■	■	■	■	■								
5	Testing Temperature Sensor	■	■	■	■	■	■	■	■							
6	Testing cooling fan	■	■	■	■	■	■	■	■							
7	GSM/Wifi Module	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
8	2D and 3D Simulation		■	■	■	■	■	■	■	■	■	■	■	■	■	
9	Data Analysis	■	■	■	■	■	■	■	■	■	■	■				
10	Data Verification	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
11	Report				■	■	■	■	■	■	■	■	■	■	■	■

For the first semester, the final year project begins with project briefing and literature review. We need to find our own title and suggest it to project supervisor that has been assigned to each student. The literature review will be continuously search for better understanding on the project. After the project has been chosen and verified by supervisor, a Gantt chart is prepared so that it will keep the project in motion. The components are prepared. For the first semester, only the main component is prepared because of lack of budget.

6.2 Cost Estimation

Table 6.3: Cost for main components

Component Name	**Cost**		**For 1 module**	**Subtotal(For 1 Unit)**
	Unit Range	**Price**		
Arduino Uno R3	1	RM 58.00	1	RM 58.00
iComsat GSM/GPRS Shield Module	1	RM 240.00	1	RM 240.00
1602 HD44780 Character LCD Display Module	1	RM 12.00	1	RM 12.00
Male to male breadborad wire jumper	10 - 20	RM 1.10	10	RM 11.00
Mini jumper	10 - 20	RM 0.20	5	RM 1.00
Female to female jumper	1	RM 4.50	1	RM 4.50
DC 12V 0.3A Cooling fan	1 - 4	RM 6.00	2	RM 12.00
Project Board	1	RM 17.00	1	RM 17.00
Solder Lead	1	RM 32.00	1	RM 32.00
Temperature Sensor LM35	1 - 5	RM 8.00	2	RM 16.00
Transistor NPN 2N3904	1 – 5	RM 0.20	2	RM 0.40
Hot glue	1 – 2	RM 1.90	1	RM 1.90
			Subtotal	RM 405.80

All other small electronics component is provided by FKE Store.

Table 6.4: Components obtain from FKE Store

Component Name	**Cost**		**For 1 module**
	Unit Range	**Price**	
Straight Pin Header(Male)	1 - 20	-	10
Straight Pin Header(Femlae)	1 - 20	-	20
Donat/Matric board	1 – 3	-	1
PCB Connector 2 ways	1 – 10	-	4
PCB Connector 4 wyas	1 – 10	-	4
PCB Stand	1 – 12	-	4
Potentiometer 50kΩ	1 – 2	-	1
Battery9V	1 – 6	-	2
Battery holder	1 – 6	-	2
Leds	1 – 15	-	4
Crown Pin	10 – 30	-	12
Resistor 330Ω	1 – 10	-	4

Therefore, the overall cost of SHTC device exclude the components obtain from FKE Store is RM 405.80. The components that are bought is as in table 6.3.

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APPENDICES

A1. Programming code to display temperature value to LCD

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(6,7,8,9,10,11);
float temp1;
int temp1Pin = 0;
void setup()
{
Serial.begin(9600);
Lcd.begin(16,2);
Serial println("Temperature Sensor Value");
}
void loop()
{
temp1 = analogRead(temp1Pin);
temp1 = temp1 * 0.48828125;
delay(1000);
temp1 = temp1 * 0.48828125;
delay(1000);

Serial.println(temp1);
lcd.clear();
lcd.setCursor(1,0);
lcd.print("temp1 = ");
lcd.print(temp1);
delay(100);
}
```

A2. Programming code for Leds

```
int BlueLed = A5;
int RedLed = A4;

void setup()
{
pinMode (BlueLed, OUTPUT);
pinMode (RedLed, OUTPUT);
}
void loop()
{
analogWrite (BlueLed, HIGH);
analogWrite (RedLed,LOW);
delay(1000);
analogWrite (BlueLed,LOW);
analogWrite (RedLed,HIGH);
delay(1000);
analogWrite (BlueLed,HIGH);
analogWrite (RedLed,HIGH);
delay(1000);
analogWrite (BlueLed,LOW);
analogWrite (RedLed,LOW);
delay(1000);
}
```

A3. Programming code for device without GSM

```
#include<Servo.h>

Servo servol;
float temp;
int tempPin = 0;
int fan1 = 2;
int led1 = 12; int led2 = 8;
int pos = 0;

void setup()
{  Serial.begin(9600);
  pinMode (fan1,OUTPUT);
  pinMode (led1,OUTPUT);
  pinMode (led2,OUTPUT);
  servol.attach(9); }

void loop()
{
  temp = analogRead(tempPin);
  temp = temp * 0.48828125;
  delay(1000);
Serial.println(temp);

  if (temp > 33)
  {          pos = 180;
             digitalWrite (fan1,HIGH);
             digitalWrite (led1,HIGH);
             digitalWrite (led2,LOW);
             servol.write(pos);
  }
  else
  {          pos = 90;
             digitalWrite (fan1, LOW);
             digitalWrite (led1, LOW);
             digitalWrite (led2,HIGH);
             servol.write(pos);
  }
  delay(3000);
}
```

A4: SHTC's programming

```
/*
Temperature Control System using 2 temperature sensors,
2 fans, lcd, and 4 leds.

led1 to pin A5
led2 to pin A4
led3 to pin A3
led4 to pin A2
temp1 to pin A1
temp2 to pin A2
fan1 to pin 4
fan2 to pin 5
LCD(vss,vdd,v0,rs,rw,e,d0,d1,d2,d3,d4,d5,d6,d7,a,k)
LCD(GND,+5v,middle pin of contrast,pin 5,GND, pin 6,_,_,_,pin 8,pin9, pin 10, pin 11,
+5v,GND)
Contrast(1st pin GND, middle pin to LCD, 3rd pin to +5v)

When temperature >=26 degree C
-fan ON
-SMS from GSM
When temperature <=26 degree C
-fan OFF

if the user reply SMS, the fan will OFF

Created 10 May 2014
by Azeo Hafizie / UTM FYP
azeohafizie@yahoo.com

*/

#include<LiquidCrystal.h>
```

```
#include "SIM900.h"
#include <SoftwareSerial.h>
#include "sms.h"
SMSGSM sms;

LiquidCrystal lcd(6,7,8,9,10,11);
float temp1;
float temp2;
int temp1Pin = 0;
int temp2Pin = 1;
int fan1 = 4;
int fan2 = 5;
int pos = 0;
int led1 = A5;
int led2 = A4;
int led3 = A3;
int led4 = A2;
int numdata;
boolean started=false;
char smsbuffer[160];
char n[20];


void setup()
{

  Serial.begin(9600);
  lcd.begin(16,2);

  pinMode (fan1,OUTPUT);
  pinMode (fan2,OUTPUT);
  pinMode (led1, OUTPUT);
  pinMode (led2, OUTPUT);
  pinMode (led3, OUTPUT);
  pinMode (led4, OUTPUT);

 Serial.println("SMS Messages Sender");
  boolean notConnected = true;
 Serial.println("GSM Shield testing.");
```

```
//if (gsm.begin(2400))
  //{
  //  Serial.println("\nstatus=READY");
  //  started=true;
//  }
 // else Serial.println("\nstatus=IDLE");

}

void loop()
{
  temp1 = analogRead(temp1Pin);
  temp2 = analogRead(temp2Pin);
  temp1 = temp1 * 0.48828125;
  temp2 = temp2 * 0.48828125;

  delay(1000);

  Serial.println(temp1);
  Serial.println(temp2);
  delay(100);
  lcd.clear();
  lcd.setCursor(1,0);
  lcd.print("temp1 = ");
  lcd.print(temp1);
  delay(100);
  lcd.setCursor(0,7);
  lcd.print("temp2 = ");
  lcd.print(temp2);
  delay(1000);

  if (temp1 && temp2 > 26)
  {
    pos = 180;
    digitalWrite (fan1,HIGH);
    digitalWrite (fan2,HIGH);
    digitalWrite (led1, LOW);
```

```
  digitalWrite (led2, HIGH);
  digitalWrite (led3, LOW);
  digitalWrite (led4, HIGH);

  if (gsm.begin(2400))
{
  Serial.println("\nstatus=READY");
  started=true;
}
else Serial.println("\nstatus=IDLE");

 if(started)
  {
   if (sms.SendSMS("+601136559465", "Both Temp Exceed 26"))
   Serial.println("\nSMS sent OK");
   delay(30000);
  }
  if(started)
  {

   if(gsm.readSMS(smsbuffer, 160, n, 20))
     {Serial.println(n);
     Serial.println(smsbuffer);
      digitalWrite (fan1,LOW);
      digitalWrite (fan2,LOW);
      delay(10000);
     }
    }
   delay(60000);

}
else if (temp1 && temp2 < 26)
{
  pos = 90;
  digitalWrite (fan1, LOW);
  digitalWrite (fan2, LOW);
  digitalWrite (led1, HIGH);
  digitalWrite (led2, LOW);
```

```
  digitalWrite (led3, HIGH);
  digitalWrite (led4, LOW);

}
else if (temp1 > 26 && temp2 < 26)
{
  pos = 180;
  digitalWrite (fan1,HIGH);
  digitalWrite (fan2,LOW);
  digitalWrite (led1, LOW);
  digitalWrite (led2, HIGH);
  digitalWrite (led3, HIGH);
  digitalWrite (led4, LOW);

  if (gsm.begin(2400))
{
  Serial.println("\nstatus=READY");
  started=true;
}
else Serial.println("\nstatus=IDLE");

 if(started)
  {
   if (sms.SendSMS("+601136559465", "Temp1 Exceed 26"))
   Serial.println("\nSMS sent OK");
   delay(60000);
  }
   if(started)
  {

   if(gsm.readSMS(smsbuffer, 160, n, 20))
     {
       Serial.println(n);
     Serial.println(smsbuffer);
      digitalWrite (fan1,LOW);
      digitalWrite (fan2,LOW);
      delay(10000);
    }
```

```
  }
  }
  else if (temp1 < 26 && temp2 > 26)
  {
    pos = 180;
    digitalWrite (fan1,LOW);
    digitalWrite (fan2,HIGH);
    digitalWrite (led1, HIGH);
    digitalWrite (led2, LOW);
    digitalWrite (led3, LOW);
    digitalWrite (led4, HIGH);

     if (gsm.begin(2400))
  {
    Serial.println("\nstatus=READY");
    started=true;
  }
  else Serial.println("\nstatus=IDLE");

   if(started)
    {
     if (sms.SendSMS("+601136559465", "Temp2 Exceed 26"))
     Serial.println("\nSMS sent OK");
     delay(60000);
    }
     if(started)
    {

     if(gsm.readSMS(smsbuffer, 160, n, 20))
       {
         Serial.println(n);
       Serial.println(smsbuffer);
        digitalWrite (fan1,LOW);
        digitalWrite (fan2,LOW);
        delay(10000);
      }

  }
  delay(3000);
}}
```