“Designing of an office appliance system using temperature sensor & micro controller for efficient use of electricity”

A Thesis submitted to the
Dept. of Electrical & Electronic Engineering, BRAC University in partial fulfillment of the requirements for the Bachelor of Science degree in Electrical & Electronic Engineering

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Declaration

We do hereby declare that the thesis titled “Designing of an office appliance system using temperature sensor & micro controller for efficient use of electricity” is submitted to the Department of Electrical and Electronics Engineering of BRAC University in partial fulfillment of the Bachelor of Science in Electrical and Electronics Engineering. This is our original work and was not submitted elsewhere for the award of any other degree or any other publication.

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And Special thanks to MR. Annajiat Alim Rasel sir for his great support to complete our thesis project.

Abstract

This project will present the design, construction, development, control and evaluation of an automatic electric office appliance such as Light, Heater, Fan, Air-conditioner and Fire alarm. The microcontroller base Electronic appliance system presented in this project is required to fulfill the requirement of technologies. The Technology which will help out to reduce the waste of electricity. The electric appliance automatically switches on according to the environment temperature change. This electric appliance system contains combination of sensor, controller, LDR and LCD with integration of embedded controlled programming. This project also presents the expected performance of the electric appliance system, construction of hardware and software development to gather the performance data. Finally, this system performance will be evaluated by comparing performance data to the theoretical.

TABLE & FIGURE LIST

Chapter 1

Introduction

1.1 Motivation

Electricity is a major problem in a third world country like ours. According to The Report of PDB in 2011 out of our total electricity 14% is lost due to lack of our awareness. No matter how much responsible a human being is, they are bound to make some mistakes. For this reason Human needs the help of Technology. By using Technology we can reduce the wastes of electricity. So we tried to solve the problem with technology. Sometimes electric Fan, Light, Air-condition and Fire alarm usage is wasting power because of human attitude. Human also mostly demands something that easily to be used without wasting Energy. To minimize or reduce the power usage, this project developed an automatic Light, Heater, Fan, Air-condition and Fire alarm system which will be control by the room temperature.

1.2 Project Review

In our project we have developed a micro-electronic device which sense the temperature through a temperature sensor and also constructed a LDR circuit using NMOS, both gives input to a microcontroller based controller. In the controller we embedded programming command with the help of Proteus and MikroC PRO software to control total device system. As the embedded programming command putted in the controller, then the controller will control output appliances such as Light, Heater, Fan, Air-conditioner and Fire alarm according to the room temperature. An integrated Liquid crystal display (LCD) is also used for real time display of Temperature acquired from various sensors.

The Total project is a combination of Hardware and software Implementation. The below Fig 1.1 shows the work flow of our Project which involves system development from hardware and software to the integration of both elements. Then, the system is being tested to produce a certain results that will be analyzed to produce the results that compatible with the system.

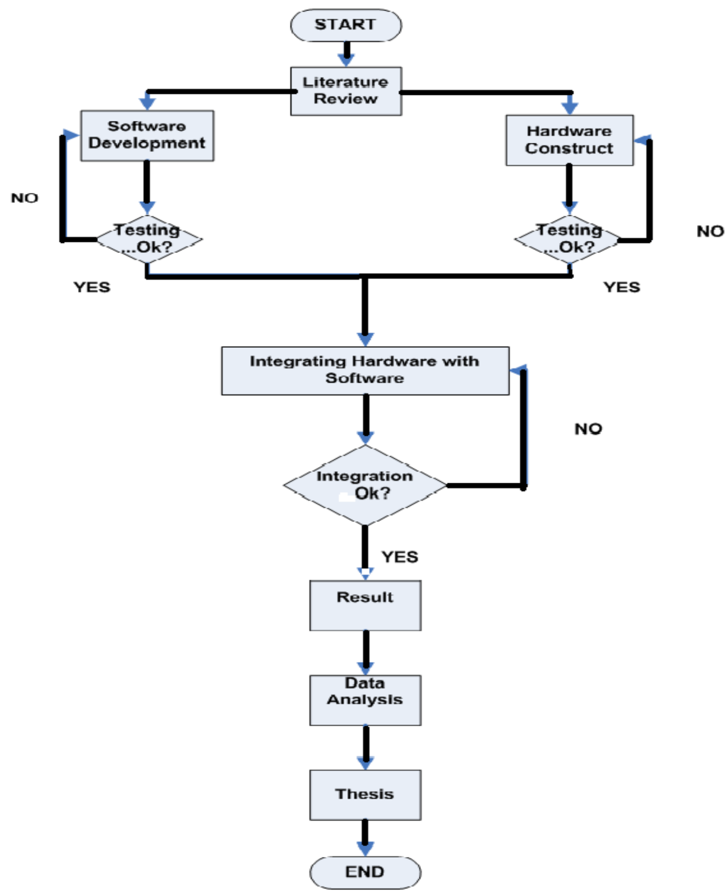


Fig 1.1: The Work Flow of the Project

The project has three basics as:

i) PIC61F887 as the main controller.

ii) Temperature sensor DS18B20 and LDR as the input for the microcontroller.

iii) The LCD and appliance such as Light, Heater, Fan and Air-Conditioner are the output for this system.

Summary of the Chapters

In the upcoming Chapters we are going to discuss about our project that how we construct and develop it? At *Chapter 2* we will talk about the theoretical background of our project, in theoretical Background we have discussed about the Input Semiconductor temperature sensors and why we choose it? Also along with regarding the types of Temperature sensors. In a further topic we discuss about the LDR circuit construction. In the end of the *chapter 2* where we introduce our Microcontroller and its operation and as well about our Output appliance.

Chapter 3 discussed on the topic of the way we develop and design and also about the architect of our system. And *Chapter 4* shows the efficient result of our project. In last *chapter 5* we show the Conclusion and the future scope our project.

Chapter 2

Theoretical Background

2.1 Digital input Temperature Sensors

This system is controlling Device such a Hitter, fan and an Air-conditioner while monitoring remote temperature is the chief function of the IC. Users of this part can choose between two different modes of the device control. In the PWM mode, the microcontroller controls the device vocation as a function of the measured temperature by changing the duty cycle of the signal sent to the device.

This permits the power consumption to be far less than that of the linear mode of control that this part also provides. Because some Devices emit an audible sound at the frequency of the PWM signal controlling it, the linear mode can be advantageous, but at the price of higher power consumption and additional circuitry. The added power consumption is a small fraction of the power consumed by the entire system, though.

‘’This IC provides the alert signal that interrupts the microcontroller when the temperature violates specified limits. A safety feature in the form of the signal called "overt" (an abbreviated version of "over temperature") is also provided. Overt could be used to shut down the system power supplies directly, without the microcontroller, and prevent a potentially catastrophic failure’’ [Maxim, 2001].

2.1.1 Types of Temperature sensors

Except for IC sensors, all temperature sensors have nonlinear transfer functions. In the past, complex analog conditioning circuits were designed to correct for the sensor nonlinearity. These circuits often required manual calibration and precision resistors to achieve the desired accuracy. Today, however, sensor outputs may be digitized directly by high resolution ADCs. Linearization and calibration is then performed digitally, thereby reducing cost and complexity [Kester & else, 1999].

2.1.1.1 Resistance Temperature Devices (RTDs)

“Resistance Temperature Devices (RTDs) are accurate, but require excitation current and are generally used in bridge circuits. Unlike a thermocouple, however, an RTD is a passive sensor and requires current excitation to produce an output voltage. The RTD's low temperature coefficient of 0.385%/°C requires similar high-performance signal conditioning circuitry to that used by a thermocouple; however, the voltage drop across an RTD is much larger than a thermocouple output voltage” [Kester & else, 1999].

2.1.1.2 Thermistor

Thermistors have the most sensitivity but are the most non-linear. However, they are popular in portable applications such as measurement of battery temperature and other critical temperatures in a system. “Similar in function to the RTD, thermistors are low-cost temperature sensitive resistors and are constructed of solid semiconductor materials

Which exhibit a positive or negative temperature coefficient. Although positive temperature coefficient devices are available, the most commonly used thermistors are those with a negative temperature coefficient" [Kester & else, 1999].

2.1.1.3 Thermocouples

"Thermocouples are small, rugged, relatively inexpensive, and operate over the widest range of all temperature sensors. They are especially useful for making measurements at extremely high temperatures (up to +2300°C) in hostile environments. They produce only millivolts of output, however, and require precision amplification for further processing" [Kester & else, 1999].

2.1.1.4 Semiconductor

"Modern semiconductor temperature sensors offer high accuracy and high linearity over an operating range of about –55°C to +150°C. Internal amplifiers can scale the output to convenient values, such as 10mV/°C. They are also useful in cold junction- compensation circuits for wide temperature range thermocouples" [Kester & else, 1999].

There are certain features that should be considered when choosing the temperature sensor for any use. The features are showed in Figure 2.1

TYPES OF TEMPERATURE SENSORS

THERMOCOUPLE	RTD	THERMISTOR	SEMICONDUCTOR
Widest Range: –184°C to +2300°C	Range: –200°C to +850°C	Range: 0°C to +100°C	Range: –55°C to +150°C
High Accuracy and Repeatability	Fair Linearity	Poor Linearity	Linearity: 1°C Accuracy: 1°C
Needs Cold Junction Compensation	Requires Excitation	Requires Excitation	Requires Excitation
Low-Voltage Output	Low Cost	High Sensitivity	10mV/K, 20mV/K, or 1µA/K Typical Output

Fig 2.1: Types of temperature sensors

We Have used a Semiconductor based Temperature sensor which is suitable for this project. So here we used Sensor DS18B20.

2.1.1.4.1 Sensor DS18B20

Our Sensor DS18B20 is a 3-Pin To-92 models. This digital thermometer provides 9-bit to 12-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trigger points.

2.2 Photo-resistor or LDR Circuit

A Light dependent resistor (LDR) is resistor whose resistance decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. We are using LDR as an another input to the controller.

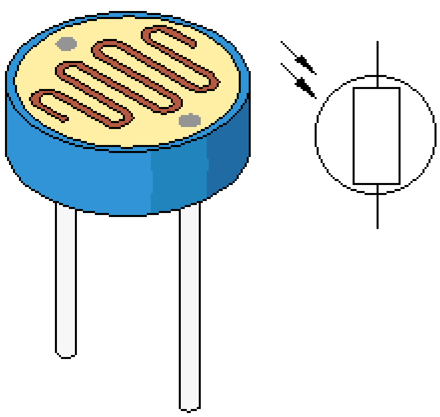


Fig 2.2: Light dependent Resistor

A photo-resistor is made of a high resistance semiconductor. If light falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.

2.2.1 Types of LDR or Photo-resistor

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire bandgap. Extrinsic devices have impurities, also called dopants, added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor.

2.2.2 LDR Circuit Components

In the Project the LDR circuit is constructed with a 470k resistor, 10k resistor, MOSFET (NMOS) and LDR.

2.2.2.1 N-MOSFET

In this project we have used an N-Chanel enhancement mode standard level field-effect power transistor in a plastic envelope using **trench**' technology. As this device features very low on-state resistance and has integral zener diodes giving

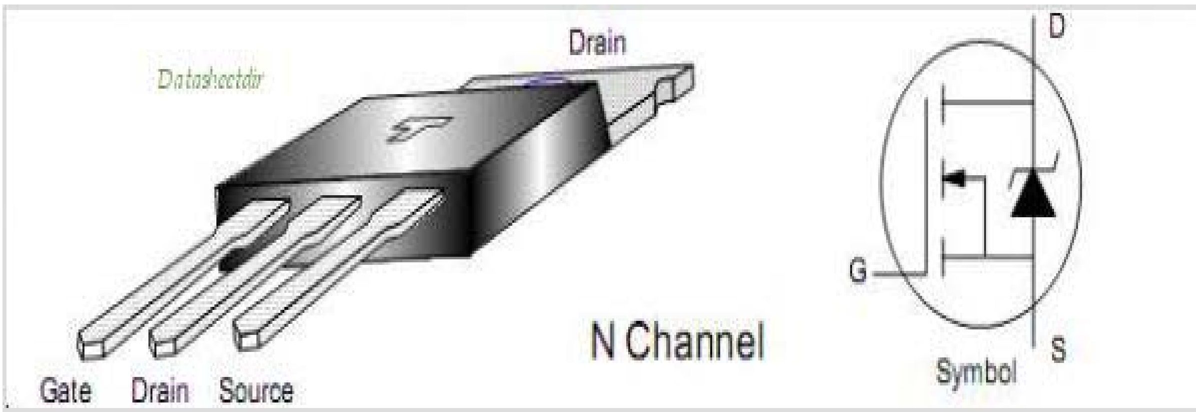


Fig 2.3: N-Chanel MOSFET

ESD protection up to 2kV. It is intended to use for switched mode power supplies and general purpose switching applications. The Figure 2.3 shows NMOSFET.

2.3 Controller

Controller is the main part of the system where all the process flow will be controlled by this hardware accordingly to the embedded programming in it. Microcontroller is chosen for the system as the controller. In other word it is the heart of this device system. The functions of the microcontroller are limited by manufacturers or the types of certain model.

2.3.1 Microcontroller PIC16F887

The PIC16F887 is one of the latest products from *Microchip*. It features all the components which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc.

2.3.1.1 Features of PIC16F887

The Figure showed the Pin assessment of Pic16F887 and the features are

- ❖ *RISC architecture*
    - o Only 35 instructions to learn
    - o All single-cycle instructions except branches
- ❖ *Operating frequency 0-20 MHz*
- ❖ *Precision internal oscillator*
    - o Factory calibrated
    - o Software selectable frequency range of 8MHz to 31KHz
- ❖ *Power supply voltage 2.0-5.5V*

    - Consumption: 220uA (2.0V, 4MHz), 11uA (2.0 V, 32 KHz) 50nA (stand-by mode)
- *Power-Saving Sleep Mode*
- *Brown-out Reset (BOR) with software control option*
- *35 input/output pins*
    - High current source/sink for direct LED drive
    - software and individually programmable *pull-up* resistor
    - Interrupt-on-Change pin
- *8K ROM memory in FLASH technology*
    - Chip can be reprogrammed up to 100.000 times
- *In-Circuit Serial Programming Option*
    - Chip can be programmed even embedded in the target device
- *256 bytes EEPROM memory*
    - Data can be written more than 1.000.000 times
- *368 bytes RAM memory*
- *A/D converter:*
    - 14-channels
    - 10-bit resolution
- *3 independent timers/counters*
- *Watch-dog timer*
- *Analogue comparator module with*
    - Two analogue comparators
    - Fixed voltage reference (0.6V)
    - Programmable on-chip voltage reference
- *PWM output steering control*
- *Enhanced USART module*
    - Supports RS-485, RS-232 and LIN2.0
    - Auto-Baud Detect

❖ *Master Synchronous Serial Port (MSSP)*
  - Supports SPI and I2C mode

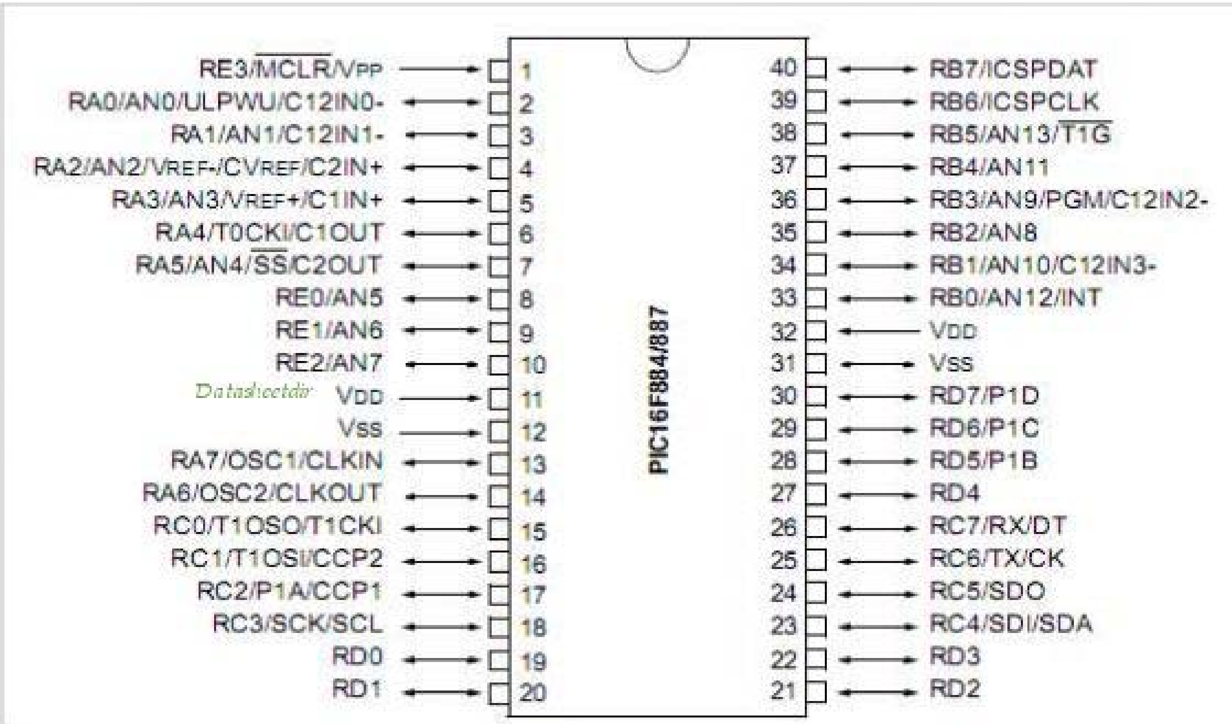


Fig 2.4: 40 Pin PIC16F887 pin Assessment

2.4 Output Appliance

As Output Appliance we will use Light, Heater, Fan, Air-conditioner and Fire alarm. The entire output appliance will work according to the command embedded in the controller.

2.4.1 Liquid Crystal Display

LCD is as well another output appliance here. It is used to display character in the ASCII code form which is mean the data for character that been sent by the controller to the LCD should be in 8-bit ASCII representation. The characters that will be displayed on the LCD panel should be characters that available in the LCD datasheet characters table. Most of the LCDs are using the Hitachi driver. The system is using the LCD to preview the current temperature value and motor speed level. In the project we have used A LCD Display (16x2) and the model Number is MIS-00010.

Chapter 3

System Design and Development

3.1. System Implementation

In this Chapter we are going to Explain about the system Design construction through Hardware and development of software. In addition, the chapter elaborates the hardware and the software stage by stage. All the operations of hardware and software are also included in this chapter. The system design of the total project is shown in below Figure3.1 with simple block diagram.

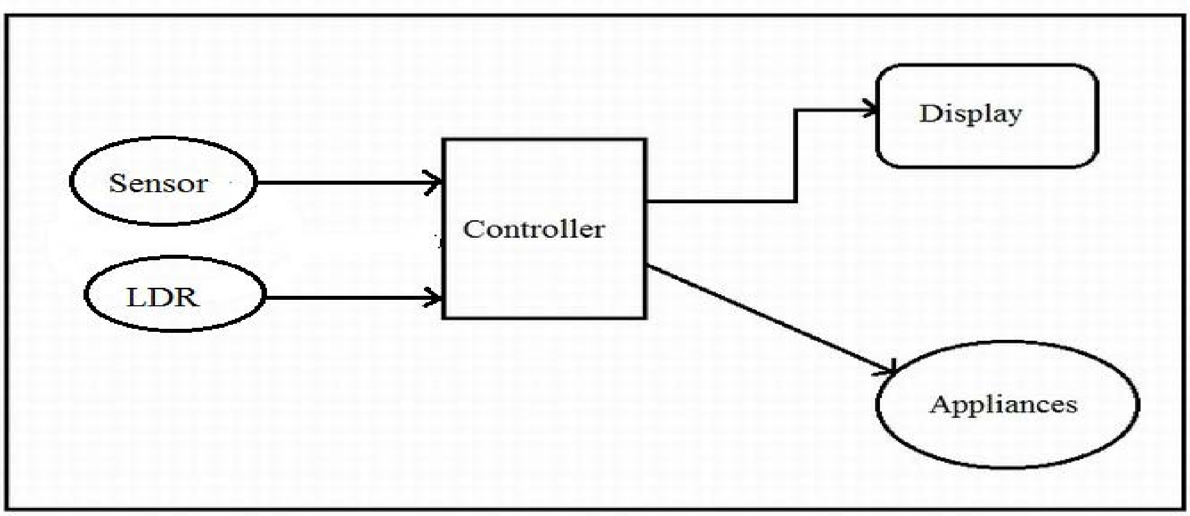


Fig 3.1: Block Diagram of Simple System Design

The sensor basically will be the input that will be triggered the controller to control the motor by certain condition or programming. The controller is set to decide how the output will be produced from the motor and will be displayed at the display part.

As the system requires the use of microcontroller, the design consists of two parts, hardware and software. Hardware is constructed and integrated module by module, hardware to software for easy troubleshooting and testing.

3.2 System Architecture

The system architecture of the automatic output appliance can be divided into 4 main Modules. They are:

- **i.** Microcontroller Module
- **ii.** Sensory and LDR Module
- **iii.** Liquid Crystal Display (LCD) Module
- **iv.** Appliance Module

The integration of the modules are producing the system which is more or less can be divided into two phase where the first phase is the output smart Appliance system and the second phase is the monitoring system. Figure 3.2 is shows the separated phase through the boxes. The microcontroller, sensory and Appliance modules are in the first phase of the system and LCD Module is in the second phase monitoring system.

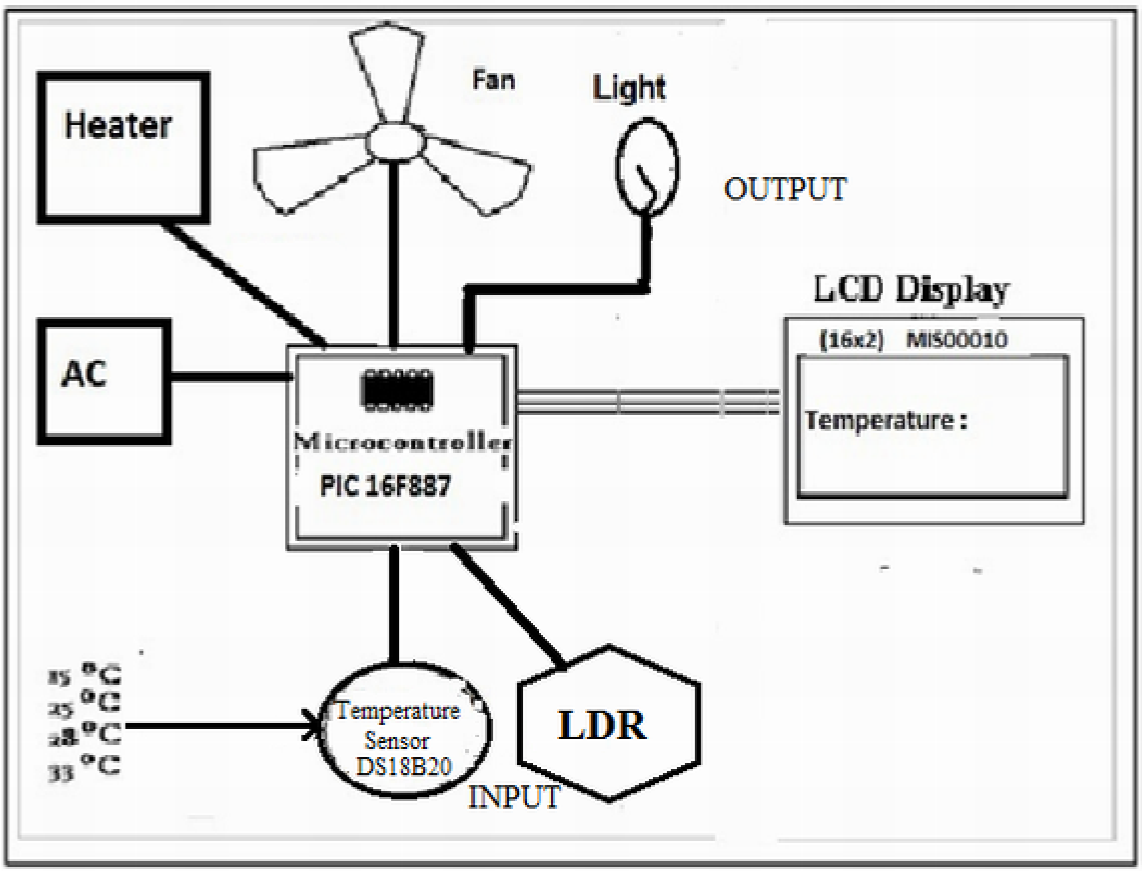


Fig 3.2: Block Diagram of Smart Appliance system

The Smart Appliance systems will produce the output in four different levels that are the same level with input is senses. Each level is senses by the input which will trigger the same level of output and the status of the output and temperature view on the LCD panel. The Figure 3.3 shows the total Architect of the project in a complete Flowchart.

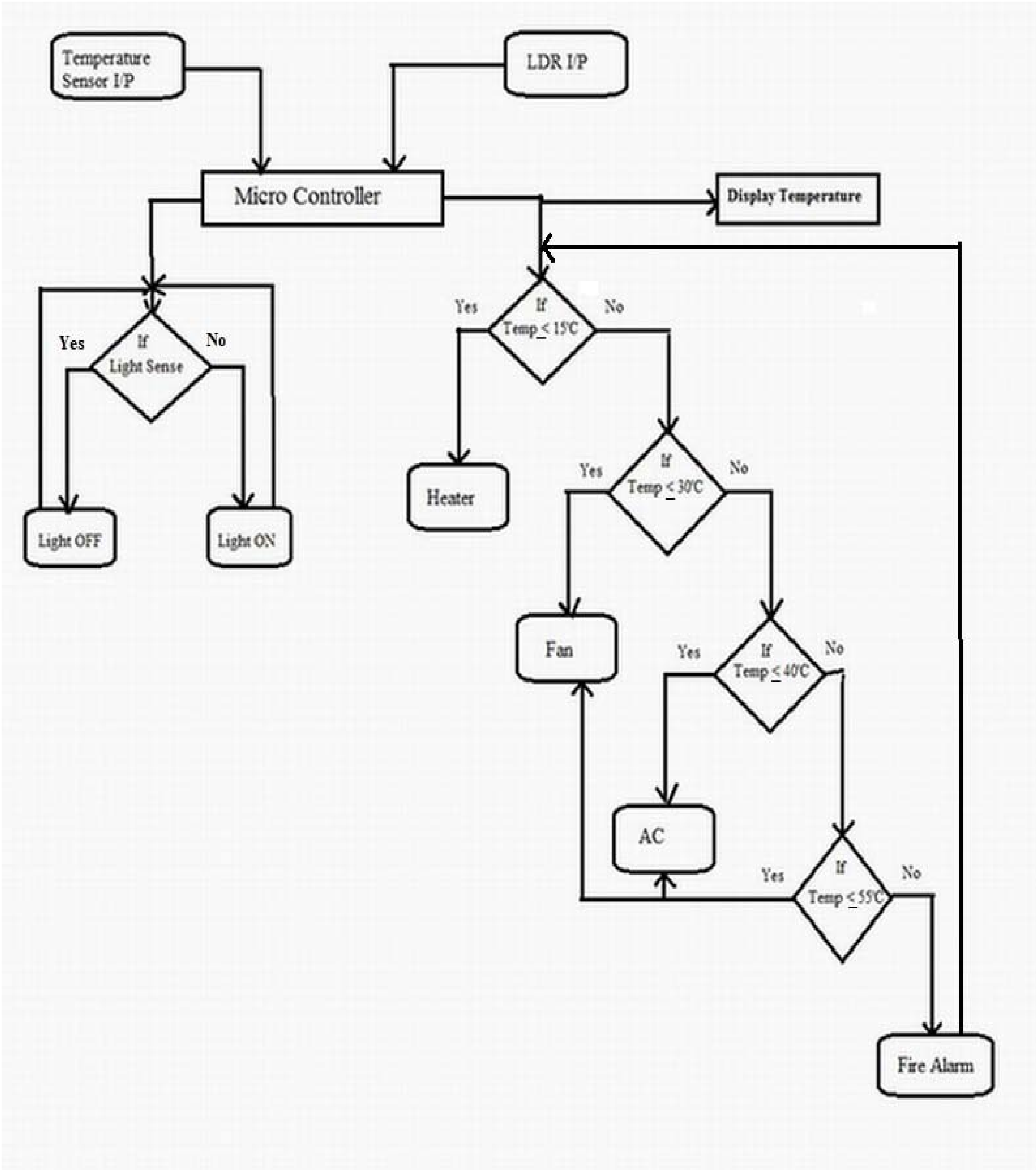


Fig 3.3: Complete flowchart of the Project

3.2.1 Microcontroller Module

The PIC16F887 is chosen as the controller for the project since it offers various functions and applicable for the system also it is mostly available in the market. It's a 40 pin IC.

3.2.2 Sensory and LDR Module

Both Modules are working here in this Project as Input modules.

3.2.2.1 Sensory Module

Here DS18B20 is used as a Temperature Sensor Device. Its Temperature operating range is -55°C to +125°C. It converts Temperature in to 12-bit Digital word in 750ms (Max). The core functionality of the DS18B20 is its direct-to-digital temperature sensor. In Figure 3.4 shows the Pin out of DS18B20.

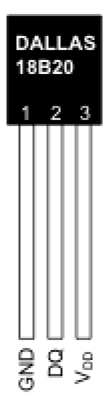


Fig 3.4: A 3-pin To-90 Model DS18B20

3.2.2.2 LDR Module

With a LDR and an NMOS, we have constructed a LDR circuit. That gives input to Microcontroller. The Figure 3.5 shows the LDR Circuit construction.

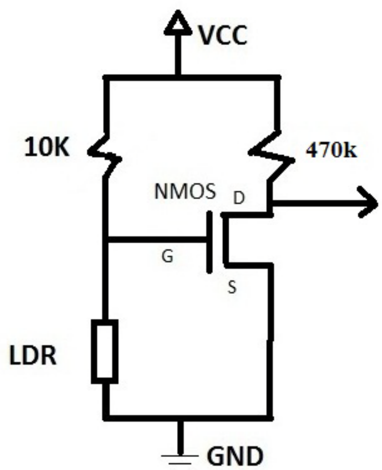


Fig 3.5: The Diagram shows LDR Construction for this Project

3.2.3 LCD Modules

LCD is used to Display Temperature output. The temperature sensor Device senses the temperature and gives the output as a display in the LCD.

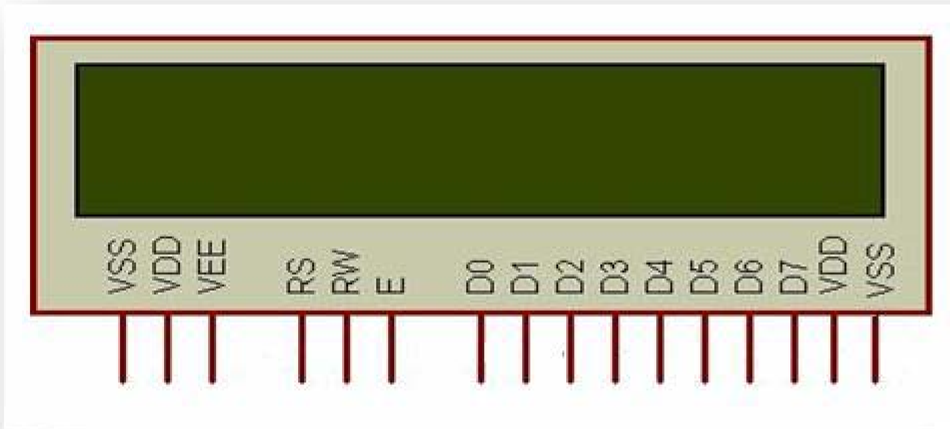


Fig 3.6: LCD Model MIS00010

3.2.4 Appliance Module

In the Appliance Module we have Five types of output such as Light, Heater, Fan and Ac. In a room after the day light comes in, the light will automatically switch off and if the day light is no more than the light will switch on automatically.

In case of heater if the temperature is below 15˚C then the Heater will start heatin g and if the temperature is upper than 15˚C but below 30˚C then the Fan switch is opened. In another case if temperature level exceeds 30˚C then the switch of AC will start ON and AC will start to cool. If the temperature exceeds 40˚C then both Fan and AC will start and if Temperature exceeds 55˚C then the Fire alarm will rang. This process will continue until the sensor device is stopped.

Chapter 4

Results & Calculation

4.1 Calculation

For our Project, we have calculated the power consumption of 12^{th} floor,

Working Hour = (8 a.m. to 5 p.m.) = 9 hours.

Attached Fan= 28 X 35W = 980 W = 0.98 KW

Stand Fan = 25 X 55 W = 1375 W = 1.3 KW

1 ton AC = 9 X 1550 W = 13950 W = 13.95 KW

4 ton AC = 2 X 6200 W = 12400 W = 12.4 KW

Tube Lights = 168*4 W = 6720 W = 6.72 KW

Total Power required per hour = 35.35 KW

We assumed 60% of the available appliances remain on every hour.

So total power consumption stands = 35.35 X 60%

= 21.21 KW

For a whole day Total power Consumption = 21.21 X 9 hours = 190.89 KWH

4.2 Results

After our Calculation we find out that we can save electricity up to several hours. So our saving results shows,

Here we assumed that,

- Attached fans will be ON if Temperature > 15 and Temperature <20

- Stand fans will be ON if Temperature > 21 and Temperature <25

- Air-Conditioner will be ON if Temperature > 25 and Temperature <30

- Stand fan and Air-conditioner will be ON if

  Temperature > 30 and Temperature <35

- The light will be ON if the light is insufficient for reading

For 168 Tube Lights = 6.72 KW X 60% = 4.03 KW

For 9 hours → 4.03 X 9 = 36.28 KWH

If for 3 hours → 4.03 x 3 = 12.09 KWH

For Attached 28 fans = 0.98 KW X 60% = 0.58 KW

For 9 hours → 0.58 X 9 = 5.292 KWH

If for 7 hours → 0.58 x 7 = 4.06 KWH

For Stand 25 fans = 1.3 KW X 60% = 0.78 KW

For 9 hours → 0.78 KW X 9 = 7.02 KWH

If for 5 hours → 0.78 KW X 5 = 3.9 KWH

For 1 ton AC = 13.95 KW X 60% = 8.37KW

For 9 hours → 8.37 KW X 9 = 75.33 KWH

If for 3.5 hours → 8.37 KW X 3.5 = 29.29 KWH

For 4 ton AC = 12.4 KW X 60% = 7.44 KW

For 9 hours → 7.44 KW X 9 = 66.96 KWH

If for 7 hours → 7.44 KW X 4 = 29.76 KWH

So the total power require for a whole working day hours = 79.19 KWH

So the Total power Save = (190.89 – 79.19) KWH

= 111.70 KWH

So far only for one floor waste of electricity was 111.70 KWH!!!

Total Efficiency of the project = (111.7/190.89) x 100% = 58.52%

Chapter 5

Conclusion & Future Scope

5.1 Conclusion

In this work, an attempt has been done to design of an Office appliance system using Temperature sensor and Micro controller for efficient use of electricity. It will help to reduce the wastage of electricity. The program we embedded in the micro controller works according to our wish.

A step-by-step approach in designing a Microcontroller based system for temperature measurement has been followed. According to the study and analysis of various parts of the system, a design has been carried out. The results obtained from the measurement have shown that the system perform well under all the conditions.

5.2 Future Scope

The Performance of microcontroller and Temperature sensor based efficient use of electricity in Office appliance system has been found on expected lines. However, there exists a scope for further improvement in its speed, number of channels, power consumption, and PC interface software for post data analysis. Because there is say that ***"Tomorrow is more advanced than Today".***

1) The system can be modified with the use of graphical LCD panel so that the analysis is done by the system itself. The number of analog channels can be increased to monitor more sensor outputs.

2) The output Appliance's can be made more smart by changing the program such as inside certain temperature not only the Heater, fan or Ac will start on, so as there level of their speed will also change with adjust of the Temperature

3) We can even also combine the motion sensing part to sense the presence of human being with this project to make this project more efficient.

Appendix 01

Total Code in MikroC Pro

```
/*Header**********************************************************/

// LCD module connections
sbit LCD_RS at RB4_bit;
sbit LCD_EN at RB5_bit;
sbit LCD_D4 at RB0_bit;
sbit LCD_D5 at RB1_bit;
sbit LCD_D6 at RB2_bit;
sbit LCD_D7 at RB3_bit;
sbit LCD_RS_Direction at TRISB4_bit;
sbit LCD_EN_Direction at TRISB5_bit;
sbit LCD_D4_Direction at TRISB0_bit;
sbit LCD_D5_Direction at TRISB1_bit;
sbit LCD_D6_Direction at TRISB2_bit;
sbit LCD_D7_Direction at TRISB3_bit;
// End LCD module connections

// define Switch pins for input
#define SW1 RA0_bit
#define SW2 RA1_bit
```

```
// define Switch pin Direction
#define SW1_TRIS  TRISA0_bit
#define SW2_TRIS  TRISA1_bit

// define LED pins for output
#define LED1 RD1_bit
#define LED2 RD2_bit
// define LED pin Direction
#define LED1_TRIS  TRISD1_bit
#define LED2_TRIS  TRISD2_bit



const unsigned short TEMP_RESOLUTION = 12;
char *text = "000.0000";
unsigned temp;
unsigned char ch;                    //
unsigned int adc_rd;                 // Declare variables
char *LDR;                           //
long tlong;                          //



void Display_Temperature(unsigned int temp2write) {
```

```
const unsigned short RES_SHIFT = TEMP_RESOLUTION - 8;
char temp_whole;
unsigned int temp_fraction;



// check if temperature is negative
if (temp2write & 0x8000) {
   text[0] = '-';
   temp2write = ~temp2write + 1;
}
// extract temp_whole
temp_whole = temp2write >> RES_SHIFT ;

// convert temp_whole to characters
if (temp_whole/100)
   text[0] = temp_whole/100 + 48;
else
   text[0] = '0';

text[1] = (temp_whole/10)%10 + 48; // Extract tens digit
text[2] = temp_whole%10 + 48;      // Extract ones digit

// extract temp_fraction and convert it to unsigned int
temp_fraction = temp2write << (4-RES_SHIFT);
temp_fraction &= 0x000F;
temp_fraction *= 625;
```

```
    // convert temp_fraction to characters
    text[4] = temp_fraction/1000 + 48;     // Extract thousands digit
    text[5] = (temp_fraction/100)%10 + 48; // Extract hundreds digit
    text[6] = (temp_fraction/10)%10 + 48;  // Extract tens digit
    text[7] = temp_fraction%10 + 48;       // Extract ones digit

    // Display temperature on LCD
    Lcd_Out(1, 8, text);
    Lcd_Out(1, 1, "Temp:");
}


void main() {
    C1ON_bit = 0; // Disable comparators
    C2ON_bit = 0;
    TRISC = 0;
    TRISD = 0;
    TRISA = 0xFF;
    INTCON = 0;                   // All interrupts disabled
    ANSEL = 0;
    ANSELH = 0;


    Delay_ms(2000);
```

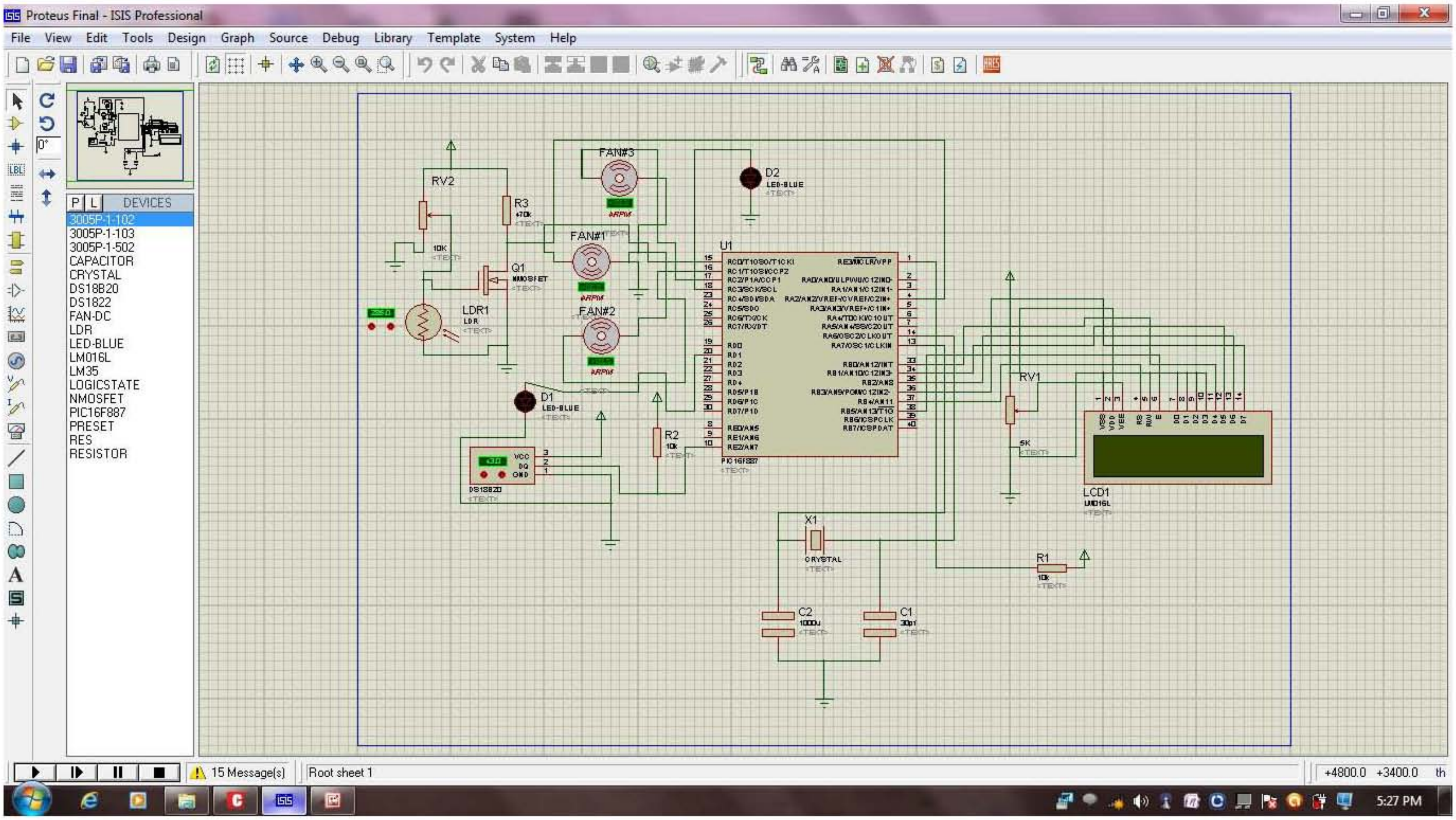
```
 // make SW1 and SW2 pin as input
    SW1_TRIS = 1;
    SW2_TRIS = 1;

    // make LED1, LED2 and LED3 pin as output
    LED1_TRIS = 0;
    LED2_TRIS = 0;
    // turn off LED
      LED1 = 0;
      LED2 = 0;
      PORTD = 0b00000000;

 Lcd_Init();   // Initialize LCD
 Lcd_Cmd(_LCD_CLEAR);      // Clear LCD
 Lcd_Cmd(_LCD_CURSOR_OFF); // Turn the cursor off



 // Print degree character, 'C' for Centigrades
 Lcd_Chr(1,13,223);        // different LCD displays have different char code for degree
 // if you see greek alpha letter try typing 178 instead of 223

 Lcd_Chr(1,16,'C');

 //--- main loop
do{
    //--- perform temperature reading
```

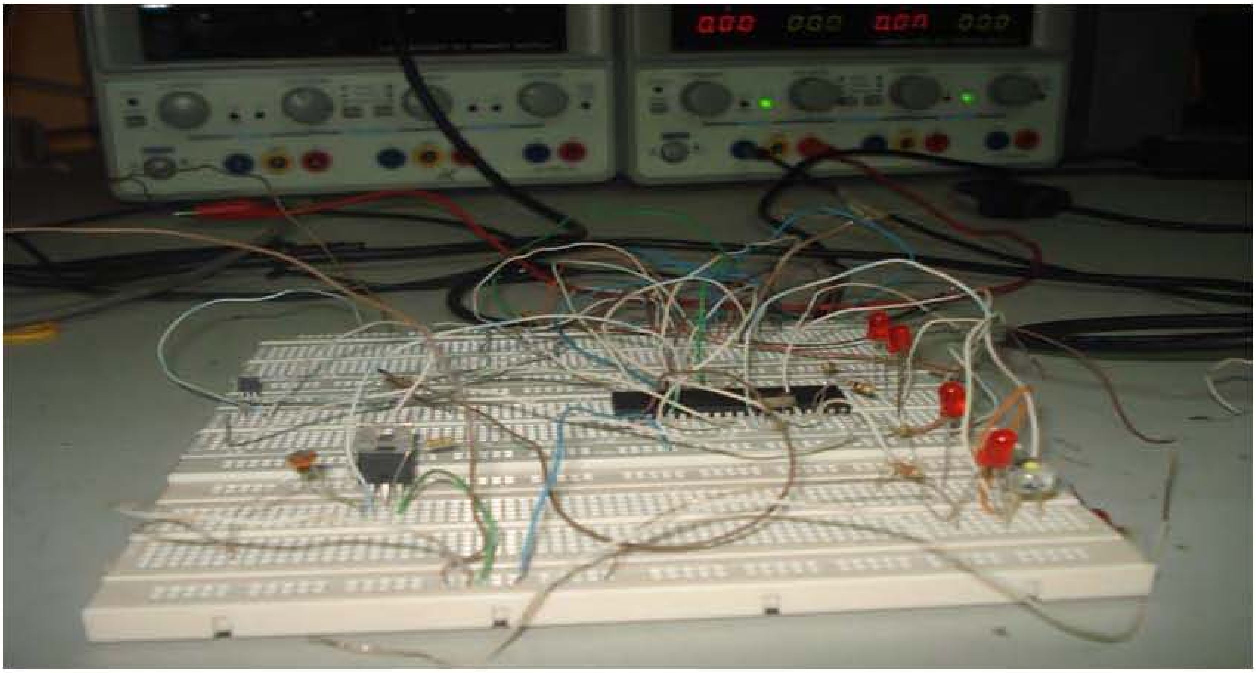
```
  Ow_Reset(&PORTE, 2);        // Onewire reset signal
  Ow_Write(&PORTE, 2, 0xCC); // Issue command SKIP_ROM
  Ow_Write(&PORTE, 2, 0x44); // Issue command CONVERT_T
  Delay_us(120);
  Ow_Reset(&PORTE, 2);
  Ow_Write(&PORTE, 2, 0xCC); // Issue command SKIP_ROM
  Ow_Write(&PORTE, 2, 0xBE); // Issue command READ_SCRATCHPAD
  temp = Ow_Read(&PORTE, 2);
  temp = (Ow_Read(&PORTE, 2) << 8) + temp;



  //--- Format and display result on Lcd
  Display_Temperature(temp);
  Delay_ms(100);



if ((temp/16)<= 27){
  PORTC = 0b00000001;}
else if ((temp/16)>=28 && (temp/16)<=32){
  PORTC = 0b00000010;}
else if ((temp/16)>=33 && (temp/16)<=35){
  PORTC = 0b00000100;}
else if ((temp/16)>=36 && (temp/16)<=40){
PORTC = 0b00000110;}
else if ((temp/16)>= 42){
```

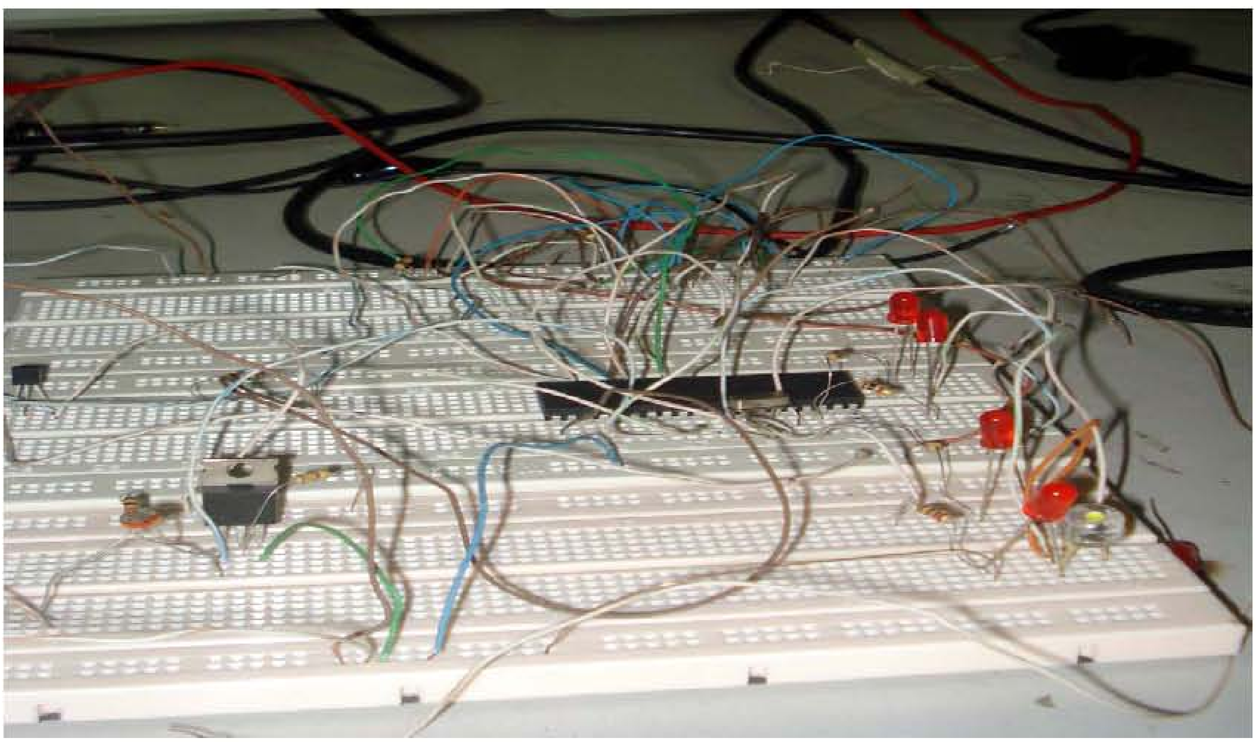
```
      PORTC = 0b00001000;}
     else PORTC = 0b00000000;




  if(PORTA.B2)        //input in PORTA button 2 (RA2)


  { LED1 = 0;                  LCD_Out (2,1,"Light  OFF");
  }
  else
  {  PORTD = 0b00000010;       LCD_Out (2,1,"Light   ON");
  }



      }while(1);
}
```

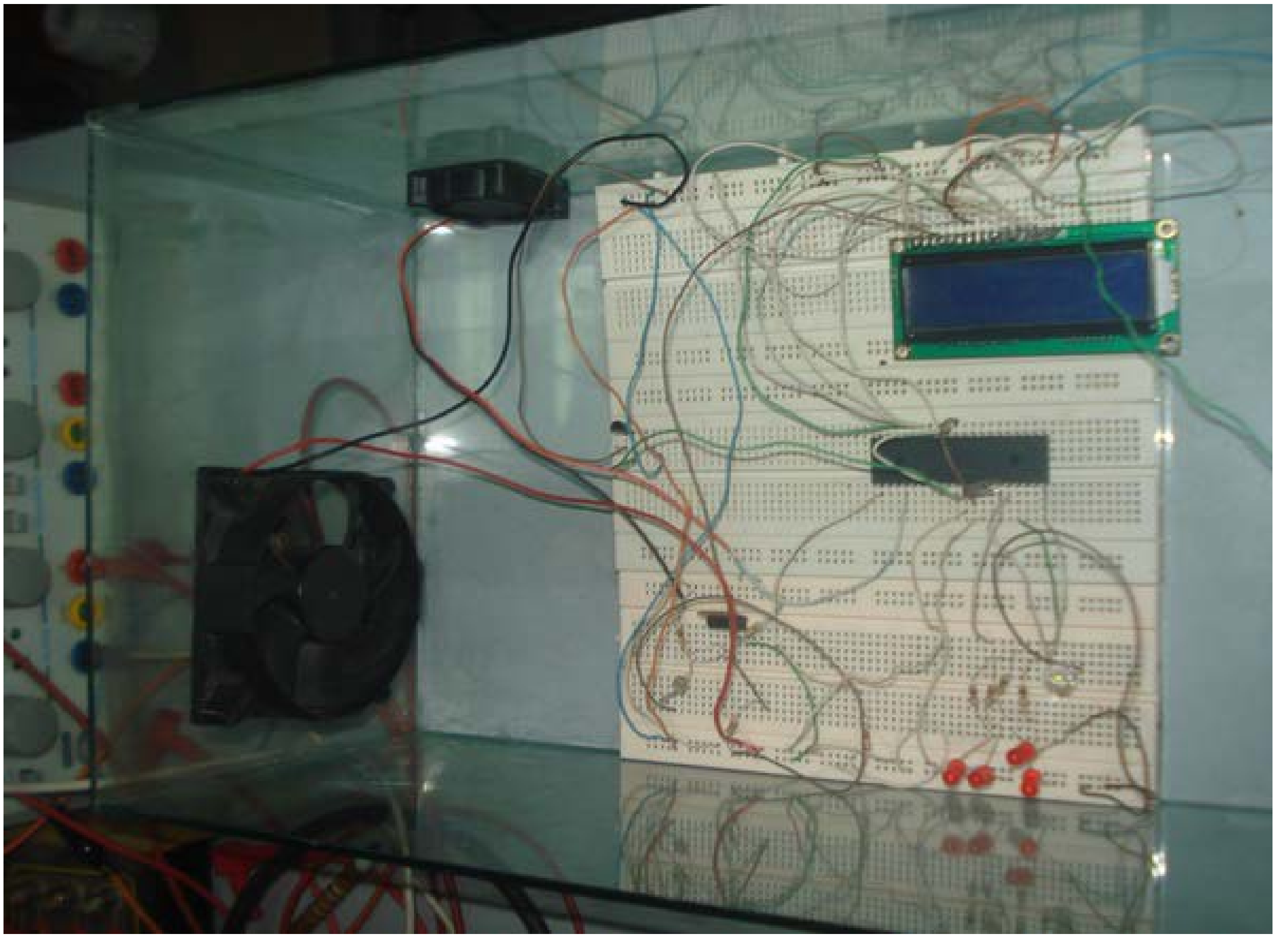
Appendix 02

Simulation File









Thank You