



**AN AUTOMATED ROOM TEMPERATURE CONTROLLER**

**BY**

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**APRIL 2019**

**DECLARATION**

I hereby declare that this research project is my original work and has never been presented to any other university, college or learning institution for academic credit or any other purpose, to the best of my knowledge. Where other people’s work has been used, due acknowledgement has been made.

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**DEDICATION**

With thanksgiving I dedicate this work to my parents Mr. & Mrs. Mwangi for the love, upbringing and sacrifices they have made to educate me. To all my siblings thank you for your support during my entire academic journey.

## **ACKNOWLEDGEMENT**

My sincere gratitude to the almighty for the gift of life and good health. It is with outmost joy I want to thank my lecturers and mostly my supervisor Dr. Motochi for his guidance, sincere corrections and moral support during the preparation and presentation of the project.

I would like to thank Madam Tabitha for the support accorded during that crucial moment. To all my course mates may the lord continue guiding us and bless you all in your career journey. Thank you for the team work we have shown to each other.

## **ABSTRACT**

This project work presents the design of an automated room temperature controller system. This system allows the user to set a desired temperature which is then compared to the room temperature measured by DHT11 temperature sensor. With the help of Atmega 328 based on Arduino microcontroller, the system responds by turning ON and OFF the two (2) loads (fan or a heater) automatically depending on the temperature difference in the room. The fan is triggered ON when the room temperature is higher than the set temperature and the heater is triggered ON when the room temperature is lower than the set temperature. The system was designed and simulated using Proteus 8, circuit building software used for building electronics system. Proteus software was used to design and simulate the main circuit; Arduino IDE was used to write a program on how the system will operate which was then loaded to the microprocessor. An LCD was used to display temperature readings obtained by the DHT11 temperature sensor and the condition of the heater and the fan whether ON or OFF. A digital multimeter was then used to take the voltage readings across the heater and the fan. When the system was simulated the heater and the fan were turned on automatically depending on the room temperature. The heater turned on when the temperature was below 27 degree Celsius while the fan turned on when temperature fell below the threshold. In both cases, either of them was on at a specified time but not both. When the heater was on the fan was off and vice versa.

**KEYWORDS:** Arduino, Automation, threshold value, temperature

## **DEFINITION OF TERMS**

### **Arduino**

Arduino is an open-source electronics platform based on easy to use hardware and software that allows programming and prototyping.

### **Automation**

The act of implementing the control of equipment with advanced technology involving electronic hardware.

### **Threshold value**

This is the reference value or minimum value above or below which the control unit is supposed to switch the fan or heater ON or OFF.

### **Temperature**

This is the hotness or coldness of a body that can be detected by a temperature sensor or a temperature measuring device.

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## **CHAPTER 1**

### **2.0 BACKGROUND OF STUDY**

The idea of an automated room temperature controller system goes back to the eighteenth century. The idea was first secured in Norman School, Oklahoma by an educator named Warren S. Johnson. It was called Automatic temperature adjusting system for air conditioner room.(Johnson et al., 2006).

Earlier Janitors were compelled to move in every classroom to check the temperature of the classes, and after that, control the dampers in the S-basement in like manner. Johnson introduced an approach that would end, or possibly limit the classroom intrusions of the janitors. ( Johnson et al., 2006). The Automatic Temperature Control System was to meet this very need which prompted Warren S. Johnson stop teaching and began his electric administration organization that specialized in programmed control systems. Warren S. Johnson initially built temperature control framework which was used in temperature control in a room by room in structures and homes.

By the mid twentieth century the Automatic Temperature Control System was noticeable in enterprises and homes. A great number of automatic room heater systems are now accessible in the market and this includes devices such as AIRCONS ( Johnson et al., 2006). Weather changes at short intervals, and as a result, the external conditions always have an influence on the indoor conditions.

The temperature control systems that are currently in use have limitations. One of these limitations is that the user has to manually adjust the system every time the external conditions change. This is cumbersome and not to be an effective way of controlling the temperature of a room. Also, physically challenged people face a lot of difficulties when operating temperature control system in their houses because these systems require them to use physical contact or some hand remote devices to operate them.

To reduce the need for human intervention, a system that works automatically is handy. This research project presents an automated room temperature controller system. This is an air conditioning system which monitors the room temperature and controls the circulation of fresh air in the room without human intervention. This design uses a microcontroller and a DHT11 temperature sensor to monitor and control the temperature of a room. The user sets the system temperature to a reference value (threshold value) that he or she wants to maintain in that room.

The temperature sensor detects the temperature and communicates with the microcontroller. The microcontroller reads the temperature and compares it with the set value. If the measured value is less than the set value, the heater is automatically turned ON to warm up the temperature of the room until it returns back to the set value and turns OFF. If the measured value is greater than the set value, the fan is automatically turned ON to cool up the temperature of the room until it returns back to the desired value and turns OFF. This work saw the design of a simple, efficient

and cost-effective temperature control system. The system considered the 10 principles of sustainable and cost effective design( S. Ludwig and J. Pritchard,2010).

## **2.1 PROBLEM STATEMENT**

All living organisms want comfort and do away with all aspects that try to bring discomfort to them. One of the common causes of discomfort is temperature fluctuations. Human beings are the most peculiar species known for its problem-solving skills and they have not been left behind in trying to solve these temperature fluctuations. Most of the systems present however are manual hence tedious to turn on and off. These expensive systems are also disadvantageous to the physically challenged people who find it difficult to access switching mechanisms. This makes it necessary to have an automated room temperature controller system within the home that can be operated by both able-bodied and physically challenged. The air conditioner minimizes discomforts due to varying weather conditions. This system is efficient, cheaper, easier to use and cost effective.

## **2.2 OBJECTIVES**

### **2.2.1 MAIN OBJECTIVE**

To design a room temperature controller system.

### **2.2.2 SPECIFIC OBJECTIVE**

1. To record voltage outputs across the DHT 11 sensor, fan and heater when they are in operation.
2. To test its applicability in different temperature ranges as measured by the DHT11 temperature sensor.

## **2.3 JUSTIFICATION AND SIGNIFICANCE**

Advancement of technology has made automation become part of our lives. A home is usually the most occupied place. Areas in the home that are usually occupied by people, such as the living room and bedrooms need to be maintained within an acceptable temperature ranges. The problem becomes more acute in areas of the home that are occupied by infants. Adults could possibly find their way around thermal discomforts, but infants may not. Other rooms in home that are used as storage for perishable food items also need to be thermally regulated in order to prevent accelerated decay of such items. Hence this project is a need of the hour.

## CHAPTER 2

### 2.0 LITERATURE REVIEW

#### 2.1 Related work

In the past few years, the need for automation has increased and has been widely applied to cooling and heating systems. There are plenty of commercial temperature control systems which can be bought from manufacturers or inventors, and also, quite a lot of work has been published in this area.

In a related invention (Hedges,1947),R.E. Hedges invented an automatic temperature control systems intended at automatically controlling the temperature of an object or a region so as to continuously maintain the said temperature at a constant value. In his design, the temperature control system can only control a single heat source. It is difficult therefore to attain temperature control of systems emitting simultaneously and in combination of the desirable features of large capacity, high response, and accuracy.

In 1992 (Ian,1992) , Ian Bell invented a self-programmable heating and cooling system, which is based on temperature control system. This system is not easy to operate and can only be operated by experts as it has to be interfaced with a computer anytime the re-programming is needed.

M. R. Levine (Levine, 2013) invented an automatic temperature adjusting system for an air conditioner room. The automatic temperature adjusting system for the air conditioner room was made simple in operation and was capable of monitoring the temperature of the human body at any time in the air conditioned room and transmits the corresponding signals to the air conditioner in time. The air conditioner conducts adjustment, so that the health of people is guaranteed. However, this is also a one-time programming and it is needed to be interfaced with the computer anytime reprogramming is needed, hence, the operation of the system becomes complex.

Other automated temperature controller systems that have been designed and published include;

- Automatic temperature control for transport airplanes(Hedges, 1947).
- Wireless thermostat and room environment control system.( Tate and Ries,1990)
- Automatic temperature control system.(Minoru, 1996) ,
- Automatic heater controller.( Poll,2006) .
- Design of automatic temperature control system on laser diode of erbium-doped fiber source, in: Proceedings of (Chengxiang, Zhenhua, Xu and Feng,, 2011).
- Design of automatic temperature-control circuit module in tunnel microwave heating system.( Fu, Wang and Yang, 2011).

These designs are not easy to use in terms of programming and temperature adjustment. The systems work on the benefits of using temperature adjustable and fan temperature control

systems. These systems are either one time programmable or need analog adjustment which is not accurate and more difficult to use.

More recent, real time based temperature control using Arduino was published (Amoo *et al*, 2014). The system uses Arduino based on ATMEGA 89C51, which is just one of the applications of Arduino. The system is not simple in terms of operation as it is tedious to change the reference temperature. The system is similar to the ones presented by the authors in the following systems;

- A precision temperature controller using embedded system. ( Pimpalgaonkar *et al*, 2011).
- Design and experiment about temperature control system of sealing machine based on Fuzzy PID. (Cao *et al*, 2011).

Other works based on temperature control do exist in different areas and different applications. Such work such as electric cable interference temperature monitoring in power transmissions ( Li *et al*, 2011), server room temperature measurement using Bluetooth embedded system (Loup *et al*, 2011), control system for communication room using wireless temperature monitoring system (Bing and Wenyao, 2011) and temperature sensor and Zigbee based temperature measurement (Pengfei *et al*, 2011) do exist. These systems have the same problem of cost as well as the need for experts in re-programming.

This leaves a gap for the design of a system that is not only simple, cost effective, efficient, easy to program and one that minimizes components so as to reduce the size of the design. The automated room temperature controller system thus comes in handy to provide solutions to the gaps that can be noted in the previous systems. It is simple, cost effective and can be used to provide real-time air conditioning for both home and commercial institutions.

## **2.2 Sensors**

A sensor can be defined as a device that measures a physical quantity such as temperature, light, motion or any other physical phenomenon and converts it into an electrical signal (Mengistie, 2018). Examples of sensors include temperature sensors, humidity sensors, motion detection sensors, oxygen sensors and infrared sensors. The output of sensors is usually current, charge and voltage. Temperature sensors are devices that are temperature sensitive, and respond to changes in temperature.

There are 2 kinds of temperature sensors:

- 1) Contact sensors
- 2) Non-Contact sensors.

However, the 3 main types are thermometers, resistance temperature detectors, and thermocouples. All three of these sensors measure a physical property (i.e. volume of a liquid, current through a wire), which changes as a function of temperature. In addition to the 3 main types of temperature sensors, there are numerous other temperature sensors available for use.

### 2.2.1 Contact Sensors

Contact temperature sensors measure the temperature of the object to which the sensor is in contact by assuming or knowing that the two (sensor and the object) are in thermal equilibrium, in other words, there is no heat flow between them (Augustin & Fröhlich, 2019).

Examples include;

- Thermocouples
- Resistance Temperature Detectors (RTDs)
- Full System Thermometers
- Bimetallic Thermometers

### 2.2.2 Non-contact sensors

These temperature sensors measure the thermal radiant power of the Infrared or Optical radiation received from a known or calculated area on its surface or volume within it.

An example is the pyrometer

### 2.3 DHT11 Temperature and Humidity sensor.

DHT11 Temperature & Humidity Sensor features a temperature & humidity sensor with a calibrated digital signal output. It uses exclusive digital-signal-acquisition technique and temperature & humidity sensing technology; it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component, and connects to a high performance 8-bit microcontroller, offering excellent quality, fast response, anti-interference ability and cost-effectiveness.

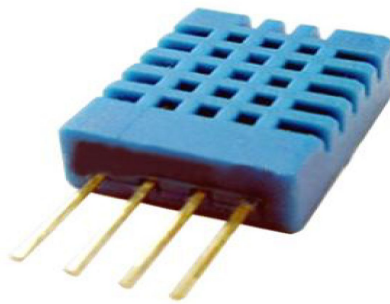


Figure 2.1 DHT11 Temperature and Humidity sensor

Table 2.1. Electrical characteristics of DHT 11 sensor

Electrical characteristics	
Maximum power supply	5V DC
Minimum power supply	3VDC
Minimum current supply	0.5mA
Maximum current supply	2.5mA

The DHT11 has 4 pins as shown below;

Pin 1: VCC 3-5.5V DC

Pin 2: DATA PIN

Pin 3: NOT CONNECTED

Pin 4: GROUND

## 2.4 LCD (Liquid Crystal Display)

The most basic and commonly used LCDs are the 16×2 because they are cheap, easy to program and can display wide range of characters. This is a 16-pin device which displays 16 × 2 characters. In this project the 16×2 LCD is used to display the state of heater or fan and the DHT11 readings.

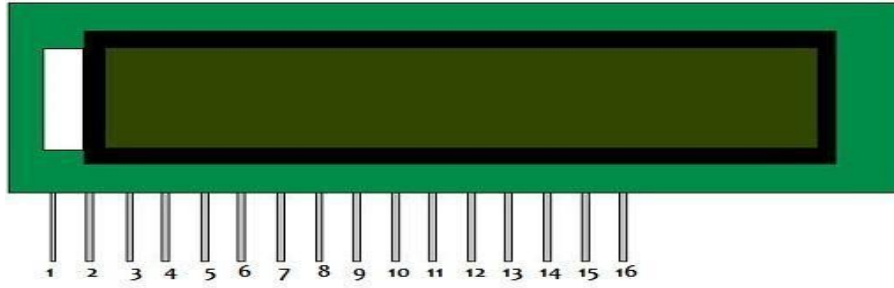


Figure 2.2. 16 ×2 Liquid Crystal Display.

When using 8-bit configuration all 8 data pins (DB0-DB7) are used while only 4 data pins (DB4-DB7) are used in a 4-bit configuration.

Table 2.2. LCD pins and their connections

Pin number	Function	symbol
1	Ground (0V)	VSS
2	Supply voltage (5V)	VDD
3	Contrast adjustment; through a variable resistor(potentiometer)	V0
4	Selects command register when low; and data register when high	RS
5	Low to write to the register; High to read from the register	RW
6	Sends data to data pins when a high to low pulse is given	E
7	8-bit data pins	D0
8	8-bit data pins	D1
9	8-bit data pins	D2
10	8-bit data pins	D3
11	8-bit data pins	D4



12	8-bit data pins	D5
13	8-bit data pins	D6
14	8-bit data pins	D7
15	Backlight V <sub>CC</sub> (5V)	A
16	Backlight Ground (0V)	K

## 2.5 Microcontroller

It can be defined as a self-contained system that incorporates a microprocessor for sensing input from the real world and controlling devices based on the input. They consist of a processor, memory and some peripherals. Microcontrollers are used in digital applications for automation and as control units. They work according to a program that is written in their processors. These programs are often written using assembly languages but also high level languages such as C, C++, PASCAL and Java (Mengistie, 2018).

Categories of microcontrollers

### 2.5.1 Alf and Vegard's RISC Processor (AVR)

A Reduced Instruction Set Computer (RISC) is one whose Instruction Set Architecture (ISA) allows it to have fewer cycles per instruction was developed in 1996 by Atmel corporation. They are loaded with an Integrated Development Environment (IDE) and a C compiler. They contain output and input parts, timers, interrupts, USART, I2C interface channels and on chip analog comparators. They are fabricated with Modified Harvard Architecture which allows what is contained in the instruction memory to be accessed as if it were data. However, they are difficult for beginners to work with (Barrett and Pack, 2006).

### 2.5.2 8051 Microcontroller

It was developed by Intel Corporation in 1980. It processes 8-bit data at a time and their name results from the fact that they can all be programmed using 8051 assembly language (Mazidi, n.d.). Their main drawback is their language of programming. The assembly language used is complex and difficult to use.

### 2.5.3 Programmable Interface Controller (PIC)

It was originally developed by General Instruments Microelectronics Division. They are affordable and perform better than 8051 microcontrollers. They are better off than 8051 microcontrollers because they have small low pin count devices, however like 8051 microcontrollers they are difficult and cumbersome to program hence cannot be recommended for a beginner.

## 2.5.1 Arduino

Arduino is a company in Italy that sells Printed Circuit Boards (PCBs) called Arduino boards. Arduino is an open source electronics design platform which is designed for prototyping and programming with Atmel microcontrollers(Arduino, 2018). They interact with physical environment through sensors. They can be made to respond to physical phenomenon and hence are widely used for automation purposes. Some of Arduino older boards include;

- Duemilanove
- Duemila
- NG Rev C
- Arduino NG 240
- Arduino V2
- Arduino Extreme
- Arduino USB V2

### 2.5.1.1 Arduino UNO Rev 3

The word UNO means one in Italian and was chosen to mark the release of Arduino software Integrated Development Environment(IDE)(Evans, 2011).This is one type of Arduino boards that is widely used due to the following feature

- They have 8-bit bidirectional input/output pins with internal pull up resistors
- 1 KB Electronic Erasable Programmable ROM
- 32 KB flash memory
- 2 KB of RAM

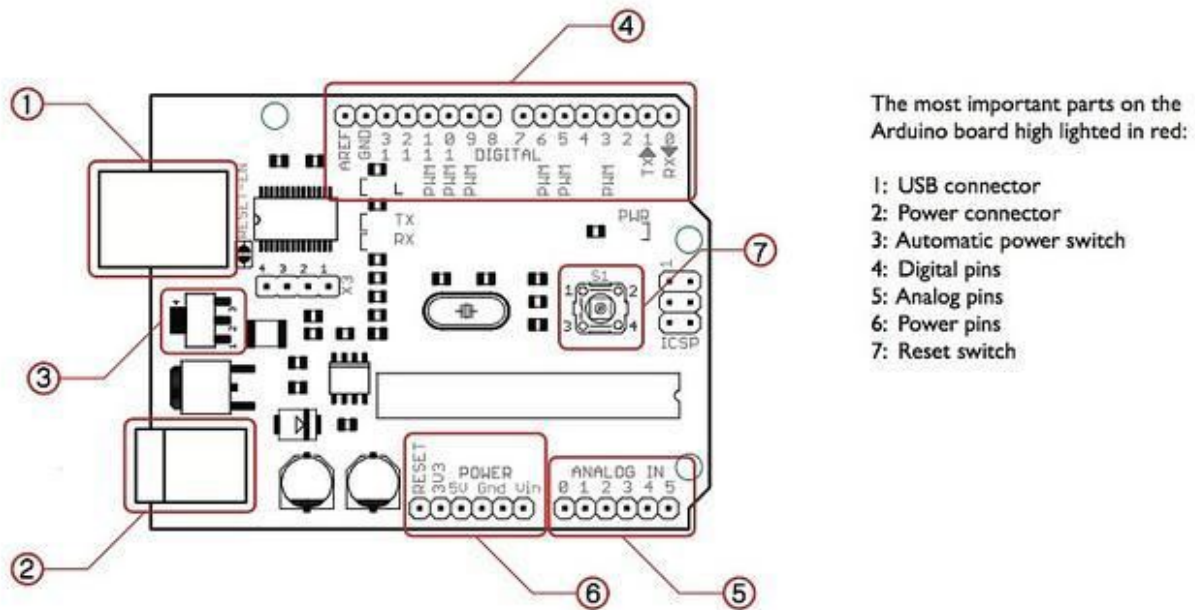


Figure 2.3.Arduino uno rev 3 pins

Arduino UNO is a microcontroller board based on the ATmega328 datasheet. It has 14 digital input/output pins (6 can be used as PWM outputs), 6 analog inputs, a 16MHz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button.

Examples of inputs: -temp sensor, motion sensor, distance sensor, switch etc.

Examples of outputs: -light, screen, motor etc.

### Technical specifications

- Microcontroller- ATmega328
- Operating Voltage- 5V
- Supply Voltage (recommended)- 7-12V
- Maximum supply voltage (not recommended)- 20V
- Digital I/O Pins 14- (of which 6 provide PWM output)
- Analog Input Pins- 6
- DC Current per I/O Pin- 40 mA
- DC Current for 3.3V Pin- 50 mA
- Flash Memory- 32 KB (ATmega328) of which 0.5 KB used by bootloader
- SRAM 2 KB- (ATmega328)
- EEPROM- 1 KB (ATmega328)
- Clock Speed- 16 MHz
- LED\_builtin- 13
- Length-68.6mm
- Width-53.4mm
- Weight-25g

### Arduino pin functions

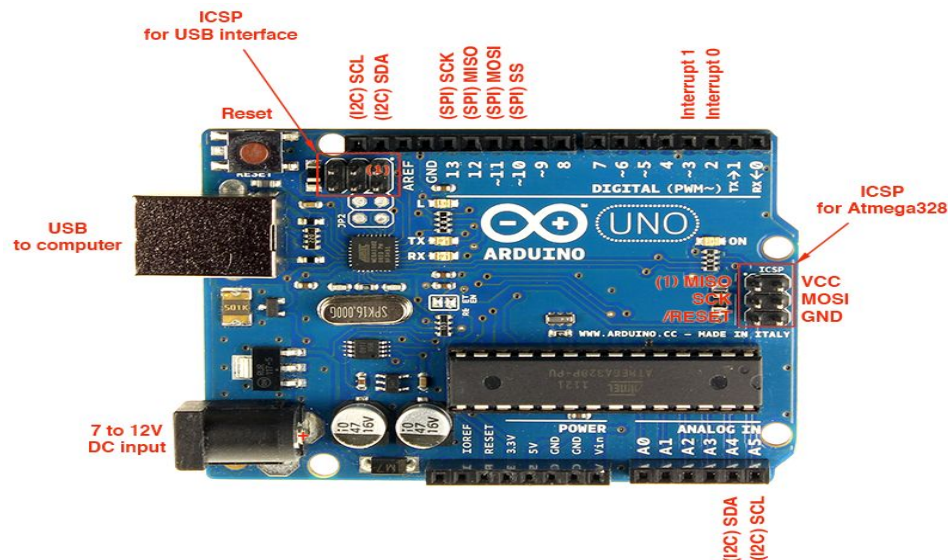


Figure 2.4. Diagrammatic view of Arduino Uno rev 3 and pins description

- **USB TO PC:** It is used to communicate Arduino via Universal Serial Bus to PC for programming/sending data to Arduino serially.

- **7V to 12V DC input:** - For external supply voltage. The recommended voltage range is 7-12V. A 9V battery can also be used to power the Arduino UNO.
- **Reset Button:** - It resets the Arduino board if pressed.
- **ICSP:** -An abbreviation for In Circuit Serial Programming which consists of MOSI, MISO, SCK, RESET, VCC and GND. It is either used to Programme USB or Microcontroller. It allows the user to Programme the microcontroller when it is in circuits i.e. it allows to Programme ATmega328p-pu directly with AVR instructions without using Arduino IDE.
- **SDA:** - SERIAL Data; it is the bidirectional data line that is used by I2C.
- **SCL:** - Serial Clock; it is used to indicate that data is ready on bidirectional data line that is used by I2C.
- **AREF:** - Analog Read Reference; it is mainly used for analog reference () function calls, as default it is not required but to use it you have to add some voltage source between 0V to 5V in AREF pin which will be considered as accurate reference voltage.
- **GND:** - Ground
- **SCK:** - Serial Clock, which is used by SPI (Serial Peripheral Interface). It is clock generated by a master which is used to clock the data to the slave.
- **MOSI:** - Master out Slave In; the data transmitted from master to slave
- **MISO:** - Master in Slave Out; the data transmitted to master from slave
- **SS:** -Slave Select; it is used to select the 'slave'. Make high to SS pin to deactivate and make low to activate it.
- **INT1&INT0:** - These are hardware interrupts. It calls the ISR (Interrupt Service Routine) when the pin change occurs
- **TX:** - Transmit; it is used to transmit TTL serial data. Also referred to as 'outwards' since it transfers data from Arduino to the connected peripheral.
- **RX:** -Receive; it is used to receive TTL serial data. It is also referred to as inwards since it receives data from external hardware to Arduino.
- **Vin:** - Voltage In; if Arduino board is powered from USB then nothing is obtained from the Vin pin. But if the board is powered directly with an external supply, then that supply is obtained directly from Vin pin. However, the supply voltage obtained at the Vin pin is usually lesser by 1V than the voltage supplied due to reverse polarity protection diode.
- **5V Pin:** - it is used to power external components connected to Arduino which needs 5V.
- **3.3V Pin:** - it is used to power external components connected to Arduino that need 3.3V.
- **IOLref:** - Input Output Voltage Reference; it allows shields connected to Arduino board to check whether the board is running at 3.3V or 5V

### **Programming of arduino uno.**

- Arduino UNO is programmed in C/C++ language. The first step to programming Arduino is to download the Arduino software package (desktop version) from the Arduino download page. Once downloaded and installed, when one launches, it gives the page below:

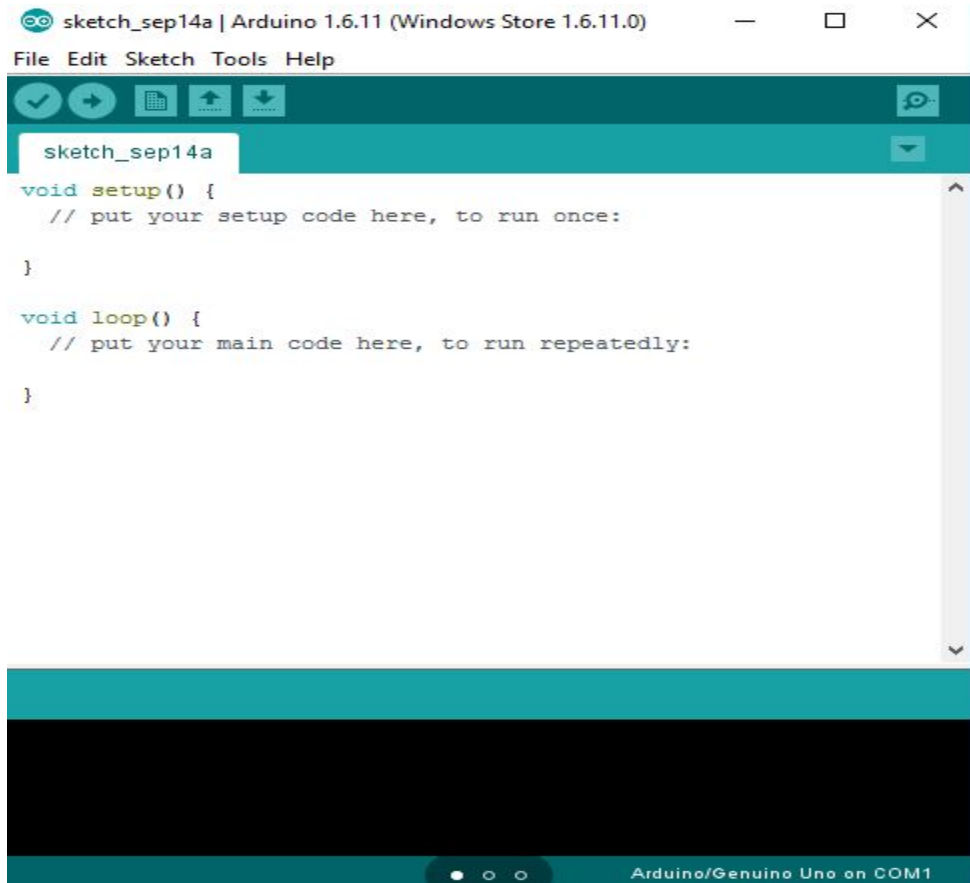


Figure 2.5.A sketch of Arduino IDE window

Every sketch needs two void types. The syntax of the Arduino IDE includes the `setup ()` and `loop ()`. Void is essentially a type of function that doesn't return any value. `Setup ()` is where you want to do any initialization steps while `loop ()` is when you want to run the code over and over again.

In Arduino there are two types of special functions. These are `pinMode` and `digitalWrite`. `pinMode` takes two variables; the pin number and whether it's an input or output pin. `digitalWrite` also takes two values; the pin number and the level whether high or low. High also means on-state and low means off-state. An example of a Programme for Arduino is as shown below:

It is based on Atmega 328 AVR microcontroller and has 14 digital input/output pins and 6 analog inputs (Arduino, 2018).

### 2.5.1.2 Arduino Mega 2560

This is an advancement of Arduino UNO and has a total of 54 input pins of which 16 are analog inputs. This PCB is relatively larger than that of Arduino UNO Rev 3.



## CHAPTER 3

### 3.0 Design and implementation

The system has three major parts; temperature sensing part, control section and the output section. The room temperature was measured using DHT11 temperature sensor. The control unit was achieved using ATmega328 microcontroller based on Arduino platform. The output was then displayed on the LCD which was the state of the Fan, Heater and the temperature value as read by the DHT11. Two stages of design were undertaken; hardware and software.

### 3.1 Hardware Design

#### 3.1.1 Control unit

This was achieved using Atmega 328 based or Arduino Uno platform. The Arduino Uno was selected because it's cheaper. It has 20 pins in total. 14 of the 20 pins are digital whereas 6 of them are analog. In the design of the automated temperature controller system, the analog pins were used as inputs whereas the digital pins were used as the outputs.

The selected pins were as shown below;

Table 3.1.A table showing all components connections to the control unit

Pin	Connections
Digital pin 2	LCD D7 pin
Digital pin 3	LCD D6 pin
Digital pin 4	LCD D5 pin
Digital pin 5	LCD D4 pin
Digital pin 11	LCD Enable
Digital pin 12	LCD RS pin
Digital pin 1	Fan
Digital pin 6	Heater
Analog Pin A0	Connection to Temperature Sensor
VCC	5VDC
GND	Ground

### 3.1.2 Sensing unit

This was achieved by DHT 11 which was mounted on the board. The pins of the DHT11 were connected as follows.

Table 3.2.A table showing pins of the DHT 11 sensor and their connection

PIN	CONNECTION
VCC	5V
DATA PIN	A0
GROUND	GROUND

The figure below shows the schematic diagram of DHT11 sensor connection to control unit.

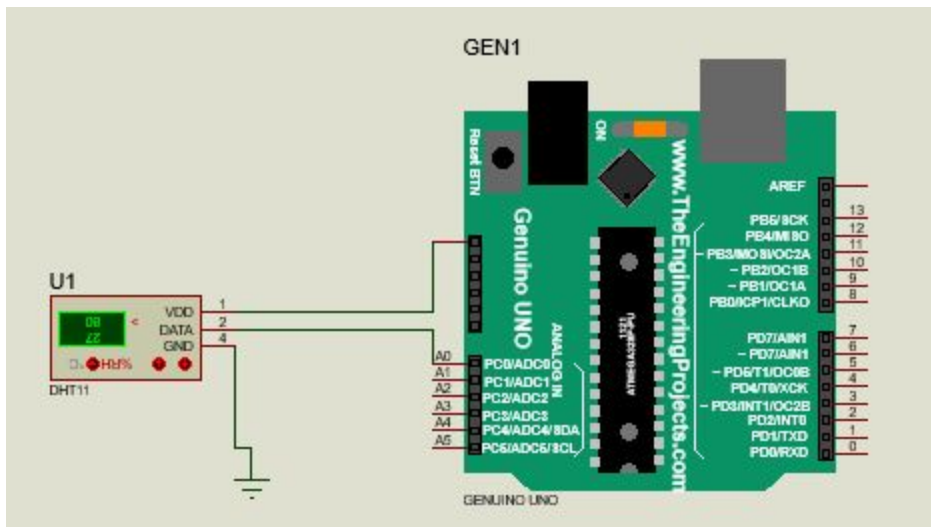


Figure 3.1.A figure showing DHT11 sensor connection to Arduino



### 3.1.3 Display unit

This was implemented using a 16\*2 Liquid Crystal display. The LCD was used to display the value of temperature as read by the DHT11 and the state of the Fan and Heater. The connections of the LCD to the control unit were done as shown in the schematic diagram below.

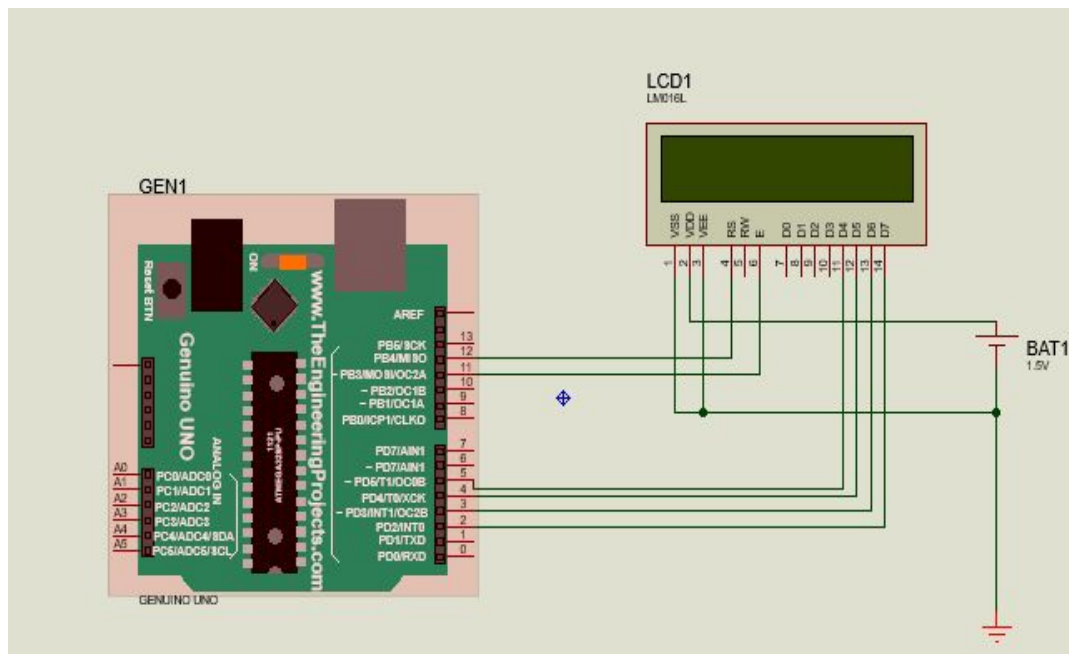


Figure 3.2. A figure showing LCD connection to the control unit

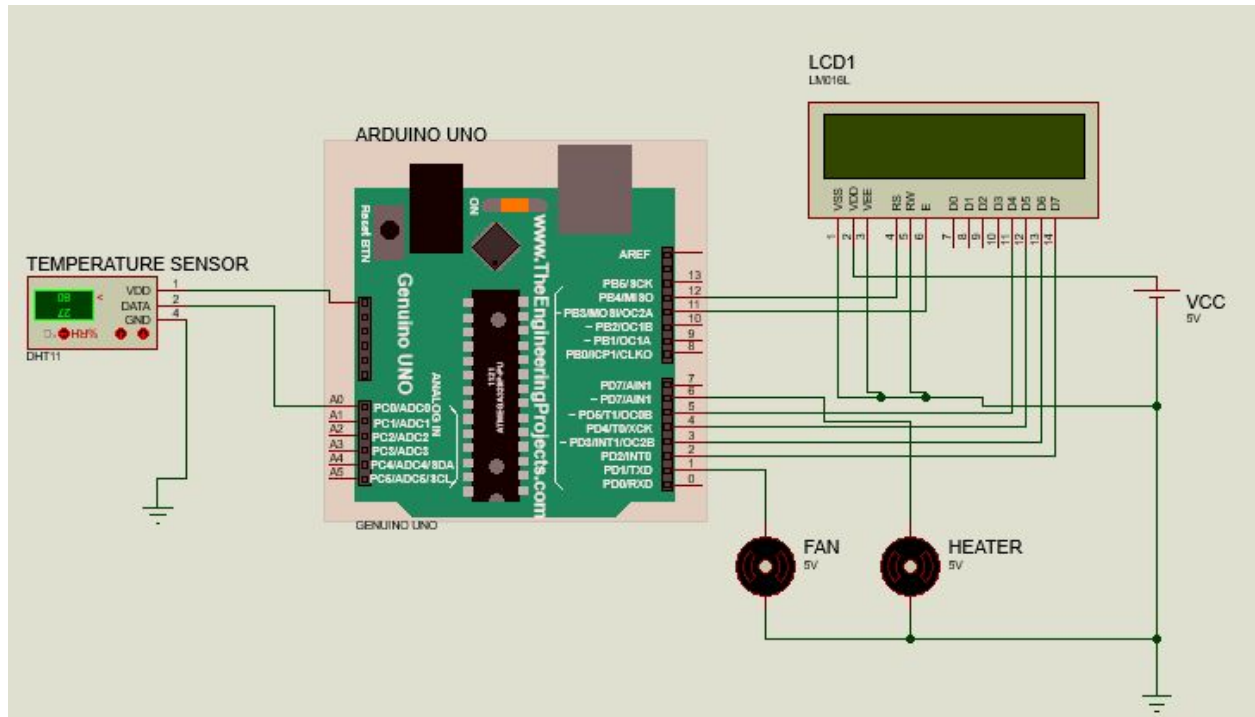


Figure 3.3. Circuit diagram of the automated room temperature controller system.

## CHAPTER 4

### 4.0 Results and discussions

#### 4.1 Results

The results were obtained by connecting the digital multimeter across the following equipment.

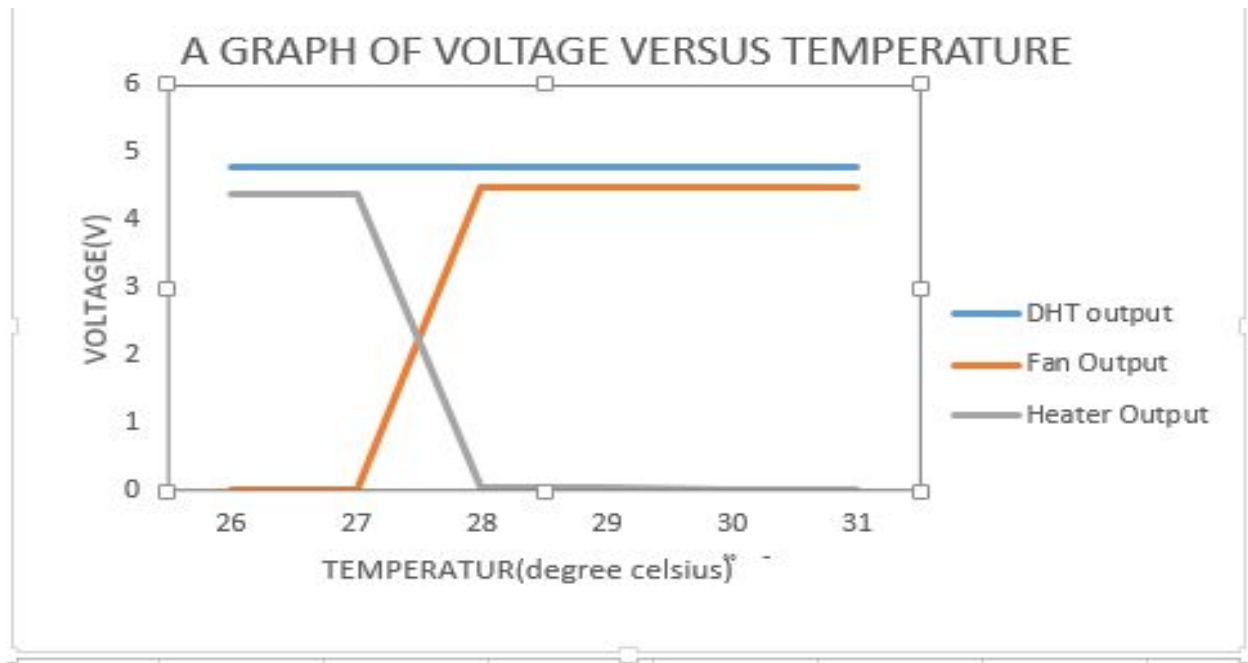
- DHT 11
- Fan
- Heater

The output value was in Volts (V)

TEMPERATURE	DHT 11 OUTPUT VOLTAGE(V)	FAN OUTPUT VOLTAGE(V)	HEATER OUTPUT VOLTAGE(V)
26	4.78	0.01	4.39
27	4.79	0.02	4.39
28	4.79	4.49	0.03
29	4.79	4.49	0.03
30	4.79	4.49	0.02
31	4.79	4.49	0.02

Table 4.1A table showing output voltages

## Graph



Graph 4.1. A graph of voltage (V) against Temperature (degrees Celsius)

### 4.2 Discussion

As shown from the graph 4.1. The DHT11 voltage is not affected by the temperature. The output for the fan and the heater varies with temperature then suddenly becomes constant. This makes the DHT 11 sensor most applicable in this research project.

For temperature measuring this sensor uses a thermistor. A thermistor is a variable resistor that changes its resistance with change of the temperature. It is hence a contact temperature sensor. Thermistors use a semiconductor sensor that provides a power function relationship between temperature and resistance. Their operation is based upon an exponential relationship between electrical resistance and temperature

## **CHAPTER 5**

### **5.0 Conclusion**

An automated room temperature controller system was designed successfully. The system used Atmega 328 on Arduino microcontroller for the control unit and DHT11 as the temperature sensor. The Fan was turned ON and heater turned OFF when the room temperature was higher than the reference temperature and the heater was turned ON and Fan turned OFF when the DHT11 reading was below the threshold or reference value. The system is helpful for people who are disabled and can be used in the industry or any environment whose temperature is supposed to be maintained.

### **5.1 Recommendations**

For future improvement the following recommendations are made;

- A GSM module can be integrated with the system so that one can be able to operate their temperature control system using a digital signal such as an SMS.
- A dial pad can also be integrated and used to key in the reference temperature for easy changes in the threshold value without necessarily interfacing with a computer.
- A relay circuit can be incorporated for switching purposes when an external power supply needs to be used.

## APPENDICES

### CODE

/\*

#####

SCHOOL OF SCIENCE AND INFORMATION SCIENCES

DEPARTMENT OF MATHEMATICS AND PHYSICAL SCIENCES

BSC PHYSICS

NAME : MARTHA WANJIKU MWANGI

REG.NO:BS01/109/2015

PROJECT TITTLE: AUTOMATED ROOM TEMPERATURE CONTROLLER

OPERATION: WHEN TEMPERATURE IS LESS THAN THRESHOLD HEATER IS  
TURNED ON

OTHERWISE FAN IS TURNED ON.

#####

\*/

```
#include <LiquidCrystal.h>
```

```
int DHT11=A0;
```

```
int Heater=6;
```

```
int Fan=1;
```

```
int Threshold=27;
```

```
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
```

```
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
```

```
void setup() {
```

```

pinMode(Heater,OUTPUT);
pinMode(DHT11,INPUT);
pinMode(Fan,OUTPUT);
lcd.begin(16, 2);
Serial.begin(9600);
}

void loop() {
  sensorReading=analogRead(DHT11);
  if (sensorReading<Threshold){
    pinMode(Heater,HIGH);
    pinMode(Fan,LOW);
    Serial.println("COLD");
    Serial.println(analogRead(A0));
    lcd.clear();
    lcd.setCursor(0,0);
    lcd.print(sensorReading);
    lcd.setCursor(5,0);
    lcd.print("HEATER ON");
    lcd.setCursor(0,2);
    lcd.print("FAN OFF");
  }
  else
  {
    pinMode(Heater,LOW);
    pinMode(Fan,HIGH);
    Serial.println("HOT");
  }
}

```

```
Serial.println(analogRead(A0));  
lcd.clear();  
lcd.setCursor(0,0);  
lcd.print(sensorReading);  
lcd.setCursor(0,1);  
lcd.print("HEATER OFF");  
lcd.setCursor(0,2);  
lcd.print("FAN ON");  
  delay(A0);  
}  
}
```





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