HOME AUTOMATION SYSTEM

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***Abstract*: Home automation system is becoming popular all-over the world. Starting from simple home to huge industrial setup everywhere Home Automation is used in a huge number. With the advancement of technologies home automation system are gradually advancing more and more, making the life of every individual smoother and easier with minimizing the work pressure. Home automation refers to the automatic control of household appliances, features and activities which is initially developed with the aim to provide supporting system for the elderly and disabled, especially those who live alone but now a days it also fulfil the requirement of a large number of population seeking luxury and sophisticated home automation platform. The main objective of the paper is to provide the necessary freedom of controlling devices in home like tube light, electrical bulbs, electrical fan, AC etc. automatically using different sensors like PIR, DHT 11, wit the Arduino platform by sensing the presence of individual. The device is made smart enough to detect human presence using PIR sensor and measuring different other parameters like daylight, temperature etc to control Electrical bulbs and the speed of fan. The proposed prototype also come with a LCD display to make the user to see the different values of measured parameters like temperature etc. The device also enables the user to manually control different activities like ON/OFF lights and speed of fan. The device is also a cost effective model to make itpossible to implement by everyone according to thererequirements.**

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I. INTRODUCTION

A home automation system focuses on automation of controlling home electronic devices whether user is inside or outside of the home. Home automation gives an individual the ability to automatically control things around the home. A home appliance is a device or instrument designed to perform a specific function, especially an electrical device, such as a refrigerator, for household use.[1]. Home automation includes mainly centralized control of lighting, temperature, appliances, and other systems, to provide improved comfort, convenience,efficiency and security. For disabled and elderly person, home automation can be the substitute of institutional care. With the energy saving concept, home automation or building automation makes life very simple nowadays. It involves automatic controlling of all electrical or electronicdevices in homes or even remotely control through wireless communication. Centralized control of lighting equipment, air conditioning and heating, audio/video systems, security systems, kitchen appliances and all other equipment usedin home systems are possible with this system[2][3][4][5].

II. MOTIVATION

India is currently undergoing a massive digital transformation on across a multitude of fields. This digital revolution has sparked a new sector that is currently the talk of the town in India and that is – Smart Homes, the sector which is expected to grow beyond 14 billion dollar by 2026 [6][7][8]. If we observe the current consumer

behavior, people are increasingly buying products that convert or upgrade their homes into smart homes. The adoption rate of smart home products in India is testimony to the fact that it's just a matter of time before every urban homeowner would proudly claim that they are living in a smart home. People want to lead more convenient, energy saving and stress-free lives, and who wouldn't love to have someone helping them to control their homes more efficiently? There are many advantage of using a Home Automation System. It saves time and lets people focus on their other activities and have fun. It helps in conserving energy with thermostat-enabled devices and also save some bucks for you. The installation process is easy and the devices are affordable enough to purchase. We can control (turn on/off) all our devices automatically or manually. It automatically set the fan speed or AC temperature in our home and switch it ON once we reached home. It is capable of controlling almost all the devices used in home.

III. PROBLEM STATEMENT

Home automation has been a feature of science fiction for many years, and began to be put into practice in the early 20th century [9][10]**.** With the advancement of technology, one can think about designing a smart home automation system for his or her home but there are still some factors like a high cost , availability of proper infrastructure and adding to that also the complexity of installing it and configuring it are the major factors. Though home automation can exhibit a wide range of function and seem to be a part of a rich home yet installing a home automation system in every home can control the unnecessary waste of resources like electricity and ensure proper use of electricity. With this thought in mind a smart but low cost, complex but easy to use centralised home automation system can be designed. The proposed system will enable the user to concentrate on his or her day to day work without involving in managing work like switching On or Off lights, fan AC etc or controlling speed or temperature of AC etc as all this can be controlled by the smart system. It will monitor different parameters like temperature, humidity etc and control different devices automatically when required. It also monitor the presence of members of the home and switch On or Off different devices. If no one is present in home it only monitor but will not ON a light or fan though it is dark or very high temperature. The cost of the proposed design will be very low so that a average family of India can afford it.

IV. OBJECTIVES

This paper focuses on the design of a home automation system and implement a costeffective yet an efficient platform for all end users.

V. SIGNIFICANCE

This work is undertaken to create a home automation system at low cost and easy to create, this will benefit both the manufacturer and the client. It will help the manufacturer by making it easy and cheaper to apply it, and it will also benefit the clients by making it cost effective and the most important advantage is that it will make the house a much more convenient place for the clients especially for the elders and the handicapped [6]. Besides these the system will reduce the electricity consumption of every home (where it is installed) by switching Off the appliances automatically when not required.

VI. METHODOLOGY

The system is designed in such a way that it can be kept at a safe place inside the house. All programming and components installation are doneand tested inside the laboratory and in home. There are a lot of components and wires that we have used for the system. This is done in the easiest and lowest way possible. However, the system is flexible and can be customized by the user.

As seen in the Fig.1, all steps are important to properly develop the Home Automation System.

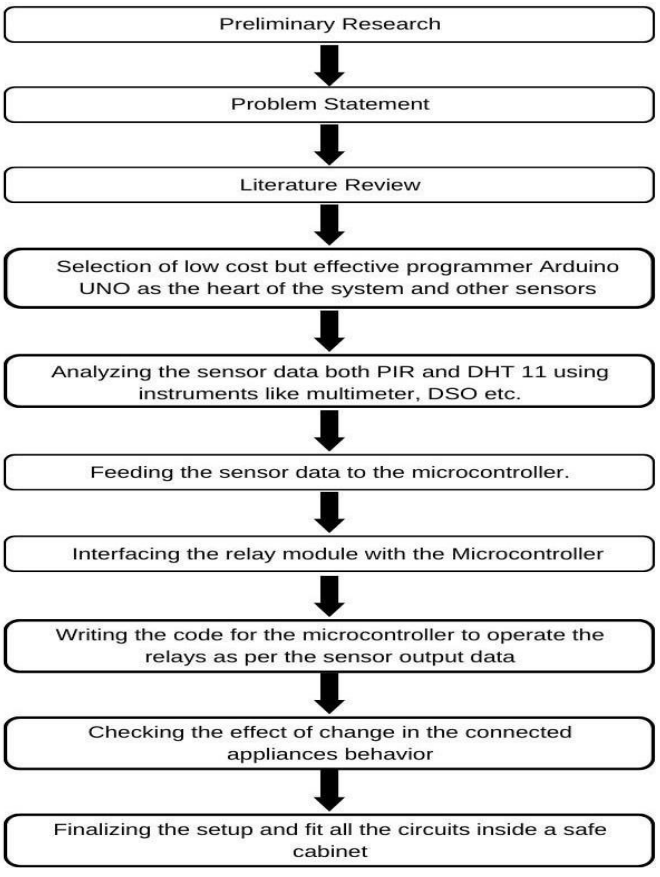

Fig 1: Methodology

The block diagram of the Home Automation System isshown in Fig 2. As seen in the block diagram, the whole content of the system can be categories into two sections, Input section and output section. The input section includethe sensors like DHT 11 (temperature sensor) and PIR sensor, Manual mode selection switch and the knob for manual speed control. As seen in the block diagram the DHT 11, knob for manual speed control and Manual mode selection switch are connected to the different input pin of Arduino UNO microcontroller. The data from all this are directly feed to the microcontroller and analysed. Though the PIR is also a input sensor yet it is not directly connected to the input section of the arduino microcontroller. The PIR sensor will control the relays connected to the fan as well as to the bulb. The relays are also controlled by the other input section devices. In the output section LCD module, Relay 3, Servo motor, Fan regulator and bulbs are present. Generally for this system output section means different appliances that will be controlled by the system. The servo in this case is not a appliances here but it controls the speed of the fan by controlling the rotation of the Fan speed regulator. The LCD is provided to let the user knowabout the current temperature status along with the different mode selected. The Relay 3 and Relay 2 works together to control the fan operation.

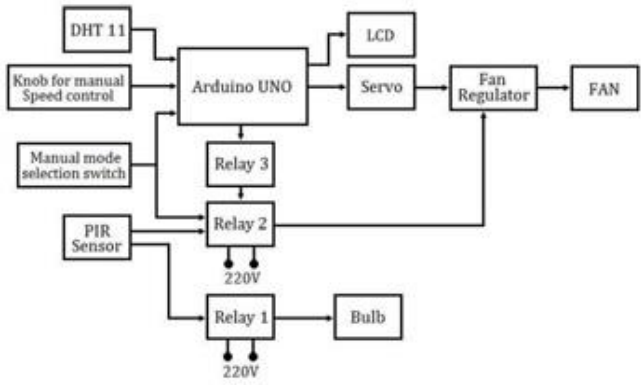

Fig 2: Block Diagram

VII. WORKING DETAILS

The PIR (passive infrared sensor)is an electronic sensor that measures infrared light radiating from objects in its field of view. PIR can detect animal/human movement within a certain range, it works as an eye for the Home Automation System. The PIR sensor has three terminals for connections as Vcc, GND and output. The Vcc pin of the PIR is connected with the 5V supply of the system. As seen in Fig 3 the 5V is supplied from the Arduino UNO itself. The GND of the PIR sensor is connected with the common ground of the circuit. The output of the PIR sensor remain low when there is no movement of human body and become high when detect human movement. The output of the PIR is connected with the base of a NPN transistor (2N2222) through a current limiting resistor of 220 ohm.The collector of the transistor is connected with the one terminalof a 5V relay (Relay 1) of the 4 channel Relay module. The emitter of the transistor is connected to the GND. The other terminal of the relay (Relay 1) is connected to the 5V supply.

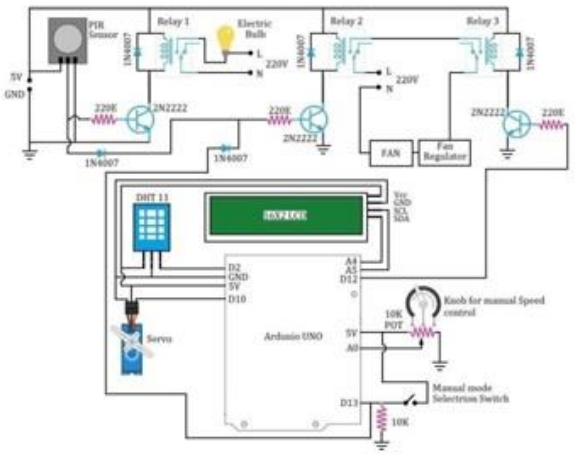

Fig 3: Complete circuit diagram

In normal condition the output of the PIR sensor is low which in turn makes the base of the transistor low and turning the transistor to cut off. In this condition no current flows from its emitter to the collector thus turningthe relay (Relay 1) Off. When there is no human movement, the PIR sensor output become high, turning the base of the transistor high. In this condition the transistor goes to saturation and maximum current will now flow from the emitter to collector, making the relay (Relay 1) circuit complete and turning the relay (Relay 1) On. In the common (C) terminal the relay (Relay 1) Neutral (N) of the AC 220V is connected and the Normally Open (N/O) pin of the relay (Relay 1) is connected to the bulb and the Line (L) of the AC 220V is directly connected to the bulb. So when the relay (Relay 1) gets On, the C and N/O pin of the relay (Relay 1) get connected thus turning the bulb On. In simple word it can be said that when the PIR sensor detects the human movements the bulb gets On.The PIR sensor output will remain high till there is movement within the range of the PIR sensor field of view. Once the movement stops, the PIR sensor wait till is delay time is over and after that its output gets low, turning the bulb Off.The output of the PIR sensor is also connected to the Relay 2 through another current limiting resistor and a transistor turning the Relay 2 On and Off similar to Relay. Relay 2 is again connected to another relay, Relay 3, which is controlled by the Arduino UNO too. Both the relays, Relay 2 and Relay 3 commonly determine the On and Off state of the Fan connected. Now Relay 3 will gets On when there is temperature more than 26°C inside the home.

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The truth table of relays to operate the fan can be explained as below

TABLE1: TRUTH TABLE OFRELAYS STATE AND FAN STATE

Relay2	Relay3	Fan
ON	OFF	OFF
ON	ON	ON
OFF	ON	OFF

The status of the fan according to the human movement and temperature can be explained as below The above function explained are happen when the system is working at its default automatic mode. There is another mode as Manual mode.

TABLE 2: TRUTH TABLE OF HUMAN MOVEMENT AND TEMPERATUREWITH FAN STATE

Human movement	Temperature	Fan
NO	Less than 23^0C	OFF
YES	Less than 23^0C	OFF
YES	More than 23^0C	ON
NO	More than 23^0C	OFF

As seen in the circuit diagram , fig 3, the Arduino UNO board is connected with a LCD, a DHT 11 sensor and with a Servo. A potentiometer, a manual mode selection switch and Relay 2 are also connected with the Arduino UNO.The LCD is connected with a I2C module and then to the Arduino UNO. In I2C mode the data pin for the LCD is reduced to 2 from 4 and also eliminate the brightness controlling circuit as it is in built in the I2C module. As shown in the fig 4 the LCD now has only 4 pins to be wired with the arduino , Vcc, GND, SDA and SCL.

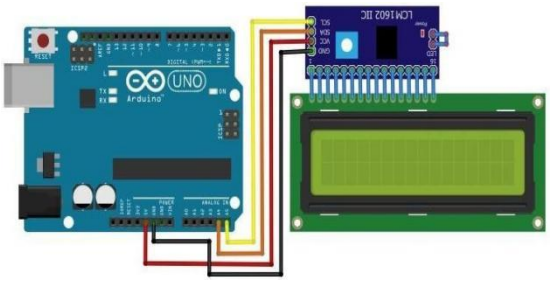

Fig 4: I2C module and LCDconnection

The Vcc is now connected to the 5V supply of the system, GND to the GND , SCL and SDA pins are connected to the A5 and A4 pin of the Arduino UNO. The wire diagram is shown in the fig 5.

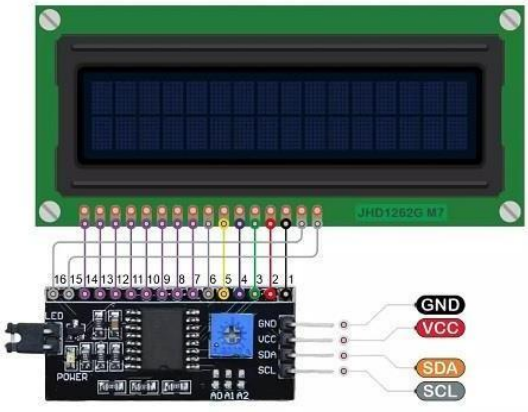

Fig 5: I2C module, LCD and Arduino connection

The LCD will show the real time temperature of the home as well as the mode on which the system is running. The temperature and humidity sensor (DHT 11) have 3 pins to connect with the Arduino UNO. They are Vcc, GND and output. The Vcc and GND of the DHT 11 sensor are connected to the 5V and GND of the system. The output pin of the DHT 11 sensor is connected to the D2 (digital pin 2) of the Arduino UNO. The DHT 11 sensor comes with a dedicated NTC to measure temperature and a 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor can measure temperature from 0°C to 50vC and humidity from 20% to 90 % with an accuracy or +-1°C and +- 1%. The serial data from the DHT 11 sensor is execute by the Arduino UNO and the actual value of the temperature is feed to the LCD to display.

The Relay 2 is connected with the Arduino UNO at pin D12 and controlled by the Arduino UNO depending on the temperature reading from the DHT 11 sensor. When the temperature is less than 26°C measured by the DHT 11 sensor, the digital pin 12 of the Arduino is in low state. If the temperature reading from the DHT 11 sensor is more than 26°C, the Arduino code make the D12 pin turn to high state. The D12 pin of the Arduino is connected to the base of the transistor associated to Relay 3. If D12 is high, the transistor goes to saturation mode making the Relay 3 ON and vice-versa. Though the DHT 11 sensor measures the humidity value of the room, the system will not monitor it in the present configuration. So DHT 11 sensor is used to measure the temperature only. The threshold value of temperature is set to be 26^0 C for now, it can be changed as per requirement.

If the circuit, given in fig 3, is observed properly, it can be seen that the Arduino UNO not only control Relay 3, it also controls Relay 2, D10 pin is connected to the base of the transistor associated with the Relay 2 as similar as the output of the PIR is connected. In normal automatic mode the D10 pin is low. So in this condition the Relay 2 is controlled by the PIR only. D10 of Arduino will become high when the mode selection button is pressed. The circuit connection with DHT11 to LCD and Mode selection switch is shown in the fig 6 below.

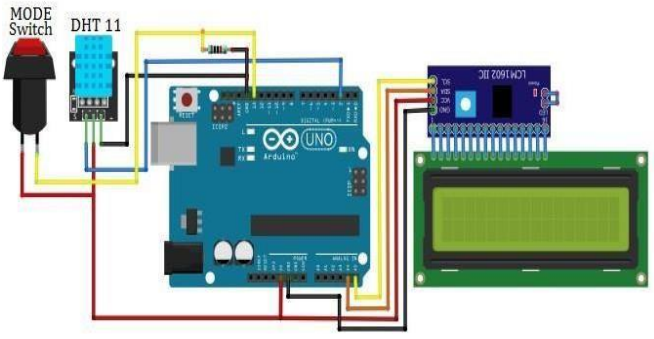

Fig 6: I2C module, LCD, DHT 11 and Arduinoconnection

The mode selection switch is connected in such a way that when it is not pressed, its output is low but when pressed it become high. As seen in the circuit (figure 6) the mode selection switch is connected to the digital pin D13 of the Arduino. D13 is also connected to ground with a resistor of 10K ohm. So when the mode selection switch is not pressed, the D13 pin of the Arduino remain low by the 10K ohm resistor. But when the mode selection switch is pressed, D13 pin become high as it is connected to the 5V supply through the mode selection switch. In the arduino code, the status of the D12 pin iscontrolled by the status of the D13 pin. When

D13 is low, D12 will remain low but when D13 is high, it turns the D10 and D12 is high. D12 is controlled by the value of the temperature from the DHT 11 sensor. When the temperature is less than 26^0 C, D12 remain low and when the temperature raises more than 26^0 C, D12 become high. But when the manual mode selection switch is pressed, D12 is forced to remain high irrespective of the value of the temperature from the DHT 11 as well as the Relay 3 is force to switch On. The complete wiring diagram is shown in the fig 7 below.

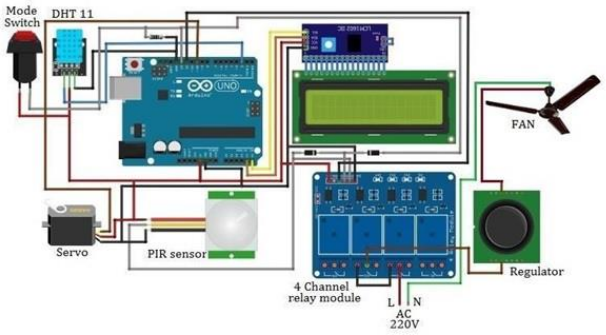

Fig 7: Complete wire diagram of the HomeAutomation System

D10 of the Arduino is connected to a servo motor. The Vcc and GND terminal of the servo is connected to the 5V and GND of the system. The arduino code is generating a PWM signal which is send to the servo through the D10 pin of the Arduino. The PWM signal controls the rotation of the servo.

In automatic mode (when mode selection switch is not pressed) the D10 pin generates PWM according to the temperature value send by the DHT 11 sensor to the Arduino. The shaft of the servo is mechanically fitted with the the shaft of a linear fan regulator. So when there is low temperature (less than 26°C), the servo receive PWM signal and rotate in such a way that the linear fan regulator shaft hold its initial position. The servo rotation function is defined for 26°C to 35°C, for the time being, which means that at 29.9°C, the servo makes the linear fan regulator shaft to be at initial position and at 35°C, the servo makes the shaft of the linear fan regulator to be at its maximum position.

Therefore, in automatic mode, if the temperature isless than 23 ^{0}C and no movement of human being detected, the fan will remain Off. Now if human movement detected, the Relay 2 will get On and the Arduino will check the temperature status, if the temperature is less than 26°C, the Relay 3 will remain Off, making the fan to be remained in Off condition. If there is movement and the temperature is more than 26°C, the Relay 2 and Relay 3 will get On, making the Fan On as discussed earlier. The Arduino continuously analyze the temperature from the DHT 11 sensor and set the servo motor shaft to be at a particular position which in turn regulate the regulator of the Fan and thus the speed of the Fan get controlled. With the raise and fall of temperature the speed of the fan thus controlled.

Now when movement is detected by the PIR sensor Relay 2 will be On but if the temperature is less than 26 ^{0}C the Relay 3 will be in Off state which in turn switched Offthe fan. In this case if the mode selection switch is press, the Arduino will understand that the fan need to be switched On as required by the user so the Arduino overwrite the process and make the Fan ON by making D12 high. In the same time ”Overwrite Mode” will be displayed in the LCD along with the current temperature reading in the LCD. Again if movement is detected by the PIR sensor and the temperature is more than 26°C, the Fan will get switched ON and set the speed accordingly. If Manual mode is selected in this condition, the Arduino receives values from the potentiometer associated with pin A0. Higher the rotational position of the potentiometer maximum position of linear fan regulator knob acquired. Thus the user is now enabled to control the Fan speed manually. Finally, in the auto mode, when the user left the home, the system will detect no movement and so it will wait until the PIR delay time is over and then turn Off all the relays which in turn switch Off all the light as well as the Fan.

VIII. EXPERIMENTAL RESULTS AND DISCUSSION

After connecting all the components and programming the Arduino the initial experiments were done. The components were connected on a bread board to make it easier to customise the circuit. The PIR sensor is mounted on a PCB holder and the power to the circuit is given. In the fig 8 below the construction of Home automation system with all the components connected is shown.

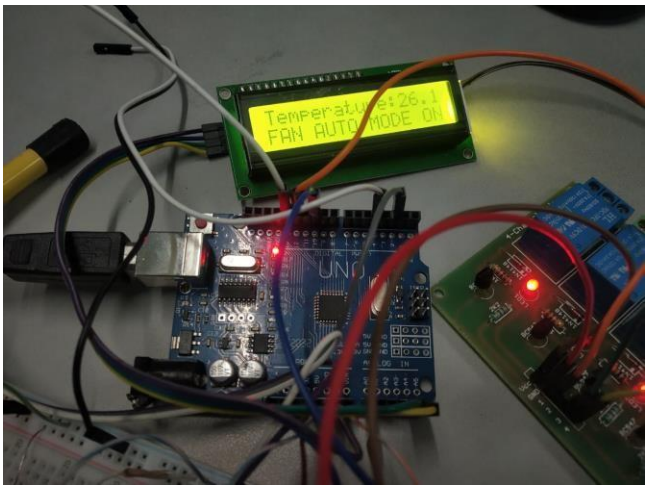

Fig8: Home automation system with all the components connected

Here is another image (fig 9) showing the top view of the complete Home Automatio System showing differen sensors and modules

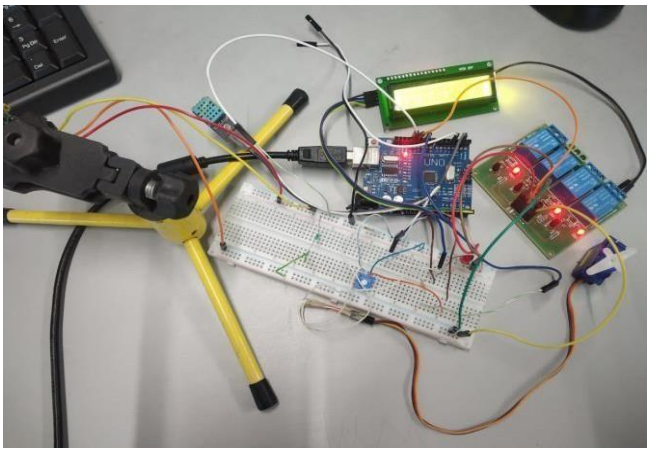

Fig 9: Top view of the home automation system showing differen sensors and modules

As seen in the images above (fig 8 and fig 9), it can be seen that the system is working normally. The DHT 11 sensor measures the temperature to be 26.1°C. The mode, as seen in the LCD display in the image of figure 9 is Auto mode. As described earlier, in this mode the system switch ON the Relay 3 and as there are movement so the output of the PIR is high and thus Relay 1 and Relay 2 are also ON. The status of the three relays are seen in fig 9. So the system now switching On the bulb as well as the Fan and the peed of the fan is also controlled by the system depending on the temperature reading from the DHT 11 sensor.

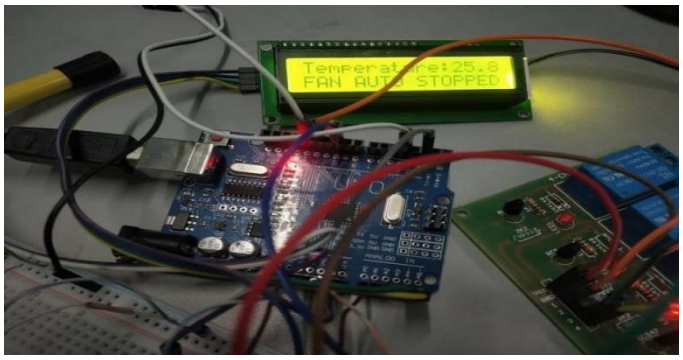

Fig 10: Temperature is less than the threshold and thesystem switching Off the fan

As seen in the images above (fig10), it can be seen that the DHT 11 sensor measures the temperature to be 25.8°C. As the system is running in auto mode so the the system will switch Off the Relay 3 and as there are movement so the output of the PIR is high and thus Relay 1 and Relay 2 are also On. In this condition the bulb will glow but the Fan will be auto Off. In the LCD also the status can be seen as ”Fan Auto Stopped”.

In the image shown in fig 11, it can be seen that the DHT 11 sensor measures the temperature to be 27.3°C and the mode here is selected to be Manual Mode. In this condition as the temperature is more than the threshold and movement are there so the system will turn the bulb and fan both On. But the speed of the Fan is controlled bythe potentiometer manually.

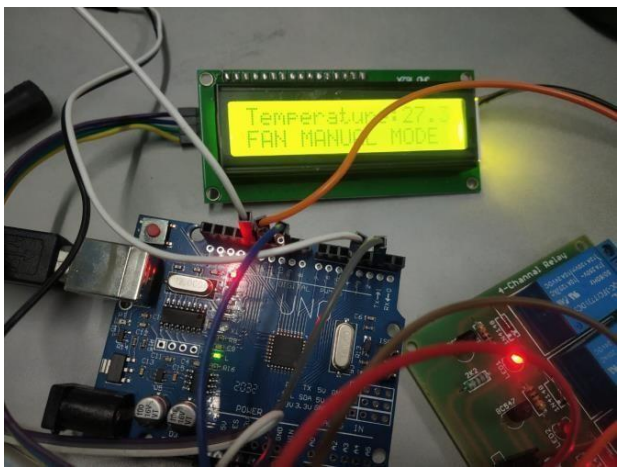

Fig 11: Manual mode of the Home AutomationSystem

In the image shown in fig 12, it can be seen that the DHT 11 sensor measures the temperature to be 25.7°C and the mode here is selected to be Manual Mode. As the temperature is less than the threshold temperature so the system goes to Overwrite mode instead of manual mode. Details explanation about the overwrite mode is given earlier. In this mode the system forcefully On the Fanand the speed of the Fan can be controlled using the potentiometer knob.

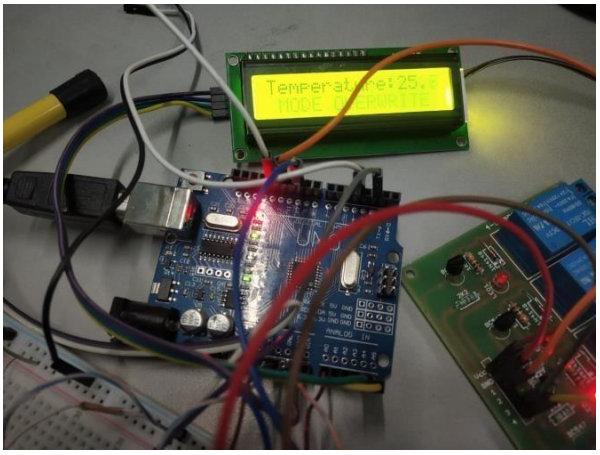

Fig 12: Overwrite mode of the Home Automation System.

Once all the mode and conditions are tested successfully for the Home Automation System, the whole setup is now assembled inside a plastic cabinet. The assembled system is shown in fig 13. The sensors like DHT 11 and PIR are mounted on the outside of the assembly to make it easier to monitor the movement and temperature respectively.

Fig 13: Final assembled Home AutomationSystem

Testing are done for Auto mode and manual mode of the Home Automation System after assembling it inside the cabinet. In the following fig 14 and fig 15 the working modes can be seen.

Fig 14: Final assembled Home Automation System (Automode)

Fig 15: Final assembled Home Automation System(Manual Mode)

IX. CONCLUSION

The Home Automation system designed here is centrally controlled by Arduino UNO and effectively monitors parameters. It is a cost effective home automation system yet an efficient one. It provide real time temperature monitoring and displaying at the same time. It can sense the human presence inside the home and operate the appliances accordingly. It can reduces the unnecessary use of electricity by switching Off appliances connected to it when not required and thus it saves electricity bills.

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