International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 12 | Dec 2020 www.irjet.net p-ISSN: 2395-0072

Smart Circuit Board for Classroom and Workplace Automation

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Abstract - *In the present world the technology is improving at a tremendous pace, there are electric cars, Smart TVs and many more advancements that can be added to the list. However, the place where we study and work hasn't seen much of an improvement since ages. We are still stuck with physical switches to turn the appliances ON or OFF, and have basic rudimentary regulators to vary the speed of fans. This poses a variety of drawbacks and obviously isn't in trend. We need to be physically present near the switch board to operate the appliances. In addition, if there is a faultiness in the switches you may get electrocuted. This will be an even bigger problem for elderly and disabled people as it is not easy for them to move. Therefore, we have presented this paper as a simple but effective solution which will enhance the current electric system.*

Key Words: ***smart, classroom, circuit-board, automation, workplace.***

1. INTRODUCTION

Now, workplace automation is anything that enables you to use your workplace's lighting, heating (thermostats) and projection devices more conveniently and efficiently. It can be as simple as a remote or automatic control of a few lights or it can be a complete system that controls all major parts of the workplace. We are able to custom-suit to our own personal preference. The main objective of this project is to develop an automation system that is easy to be used and avoids manual labor, this is especially useful for elderly and disabled people. This project focuses on wireless automation technologies – which in turn are easy to retrofit into existing workplaces (no need for new wiring and no ripping apart the circuitry or drilling holes into walls). Workplaces can be interfaced with various sensors like temperature sensors, lux sensors, ultrasound modules and Arduino which is used toggle devices based on conditions, combined with ESP8266 board being remotely controlled by Smartphone using inbuilt assistant and web applications, all connected through IOT to fit the workplace/classroom settings at a markedly low budget.

2. LITERATURE SURVEY

Over the years there has been many advancements in automation pertaining to buildings from its infrastructure to the technology used, we had gone through some of these improvements to come up with an efficient project.

In IoT based Classroom Automation System [2] they proposed an automated class room which is updated with the security system. They used the internet of things to control the lights, air conditioner, luminous, cooking rice etc, using the smartphone. But this is not completely automated and would still require some manual input.

An IoT-Based Home Automation System Using Wi-Fi Wireless Sensor Networks [3], introduces a sophisticated chatbot based automation, which uses http servers for a variety of automation but that requires a specific user and a lot of custom coding which will not be efficient and might be difficult for many users to implement it on their own.

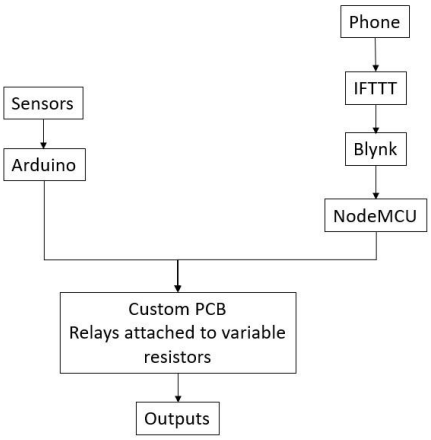
From Micro-controller based Remote Monitoring using Mobile through Spoken Commands, researchgate [4], it is evident that SMS automations is an alternative approach instead of Wi-Fi, they have used a mobile phone to send voice calls as command and automate appliances, but this won't suit for applications based on a single building, and it cannot link many devices and can face other issues like sporadic network and so on.

Later many automation ideas were put forth but the major advancement came after Smart Automated Home Application using IoT with Blynk App [8], via the introduction of Blynk, they used this application to create virtual keys in our phone to operate the appliances. This is quite efficient way but it would be better if there are some voice automations and sensor automations added.

The above idea was developed and improved in Google Assistant Controlled Home Automation [5], it gives an idea of how use assistants in the phone to use the Blynk application. We integrated this design in our project at a later stage, to give an optional manual voice control if required.

3. METHODOLOGY

Flowchart:



Above diagram is the flow chart of the proposed model, the flow of the project is as follows:

1. Sensors - Various sensors like LUX meter, temperature sensor and ultrasonic sensors are attached at various parts of the building where ever necessary, these sensors collect the data and send the information to the Arduino.

2. Arduino – It is used to retrieve the data from the sensors and perform various computations based on our needs, for example retrieve the light intensity of the room and vary the resistance of a potentiometer. The Arduino is then connected to the Custom PCB.

3. Phone – The main used of the phone is to send voice commands to operate the appliances, we can use the inbuilt assistants like Google assistant, Alexa and Siri for this purpose.

4. IFTTT – This is a web application with various uses, we will be using it to receive particular voice commands from the phone via an assistant say Google assistant, to trigger a link. In our case we will be using it to trigger a URL, which is connected to the Blynk server.

5. Blynk – This is a phone application which is used to control a microcontroller in our case the NodeMCU using virtual keys via Wi-Fi, it also provides an auth-token which enables us to control the microcontroller over the net using a URL. Once this URL is triggered that particular pin on the NodeMCU is triggered.

6. NodeMCU – This is a microcontroller board with a Wi-Fi module ESP8266, it has a variety of uses especially in Wireless IOT, we will be using it to control a relay system over the Wi-Fi, which in turn controls all the appliances in a room.

7. Custom PCB – We will be designing a PCB which consists of various relay systems attached to various variables resistors like a digital potentiometer, based on our needs. The basic relay system turns the appliances ON or OFF, based on the voice commands received from NodeMCU and the variation of resistance is done based the inputs received from the Arduino to vary speed of fan, intensity of light, etc.

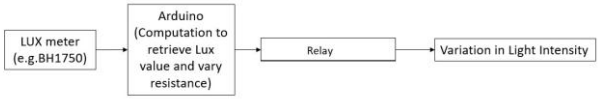
8. Outputs – These are the various appliances that are connected to the Custom PCB, which will be automated.

4. IMPLEMENTATION

Implementation of various sensors for automation

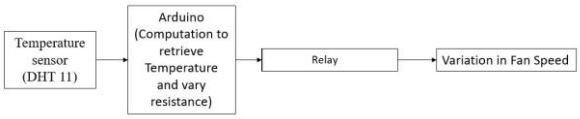
1. LUX meter (BH1750): Reading documents and looking at projections are a major aspect of a classroom or workplace, therefore the intensity of light should always be apt for these conditions, so our eyes are safe. Depending upon the luminous and sunlight, the intensity of light will be varied. The current luminous will be measured using BH1750 and the light's intensity will automatically be varied using a digital potentiometer (MCP4131).

Block Diagram:



2. Temperature sensor (DHT 11): Used to automatically control the fan based on temperature. Detects the temperature in the room and varies the fan speed by varying the value of digital potentiometer using Arduino. The ground and Vcc of the sensor are connected to the Arduino. And the center pin which gives the reading is connected to an analog 2 pin in Arduino.

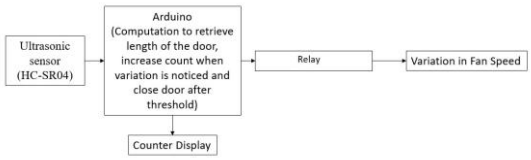
Block Diagram:



3. Ultrasonic sensor (HC-SR04): Helps to keep count of people in a building and allow limited number of people where required especially in hospitals and offices, due to covid-19. Detects the number of people entering the room because of distortion detected in the sensor which is attached to a counter and connected to an Arduino. If the count crosses the threshold number, it closes the door and gives a message to wait. Connect the Vcc and ground to the Arduino. Connect the trigger pin and echo pin to digital pins in Arduino. A program is used to calculate the length of the door, so when a person crosses the door the distance is varied and a counter

increases its count. Once it reaches a threshold value the relay is triggered and the door is closed.

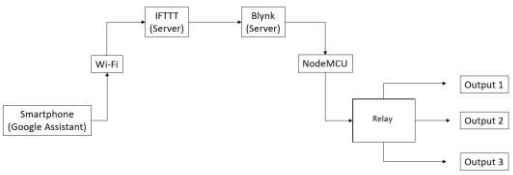
Block Diagram:



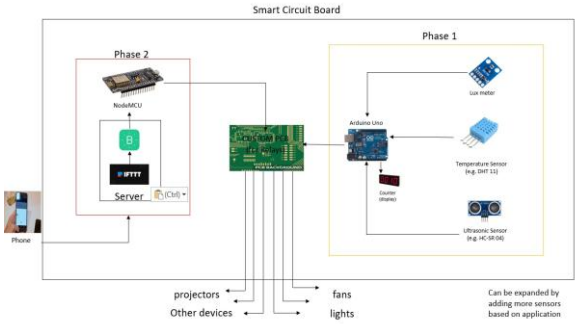
4. Implementation of Voice Automation using Google Assistant

The Voice Automation System is operating on NodeMCU ESP8266 controller and the command is given by the Google Assistant in a mobile phone using the Wi-Fi network. The NodeMCU ESP8266 has an inbuilt Wi-Fi module. It is an open-source platform for developing Wi-Fi based embedded systems. We have to create a Blynk project to create virtual switches to activate certain NodeMCU pins which in turn trigger the relay. As we create virtual pins, we will receive an auth-token which will be necessary to control the NodeMCU over the Wi-Fi, which will be triggered in the form of a URL. Next, we should create an IFTTT account to take specific commands from google assistant and to trigger certain URLs when the command is received. The flow of the project goes like this, at 1st the commands are received through Google Assistant from our phone, these commands are transferred to the IFTTT server via Wi-Fi. The IFTTT server receives these commands and triggers a link, which in turn transfers the commands to the Blynk server (We will customize the commands and triggers in the IFTTT webpage based on our needs). This commands from Blynk server are transferred to the NodeMCU via Wi-Fi (We will make a custom preset of virtual keys on the Blynk application so a particular command triggers a particular relay). Finally, the NodeMCU toggles the necessary relays ON or OFF based on the command received.

Block diagram:



Final Block diagram:



5.RESULT

The project was implemented on a bread bord and later implemented in a room by retrofitting it to an existing electric board.

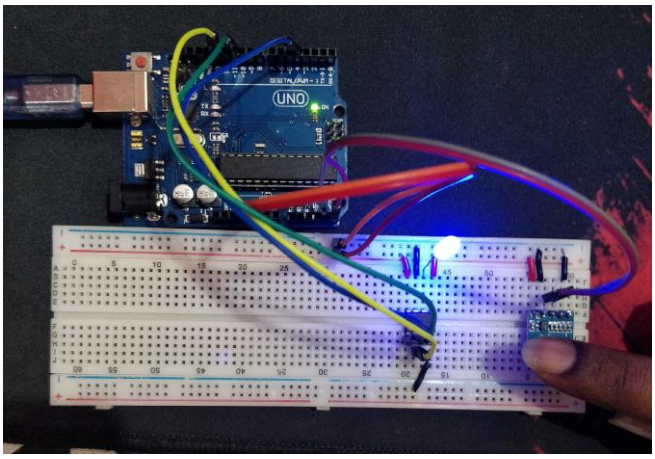


Fig.1(a)

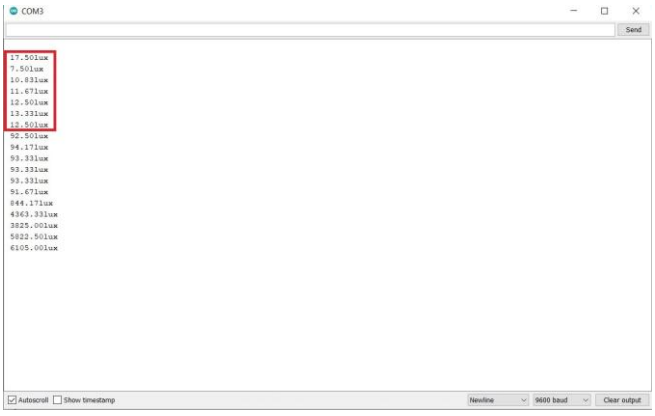


Fig.1(b)

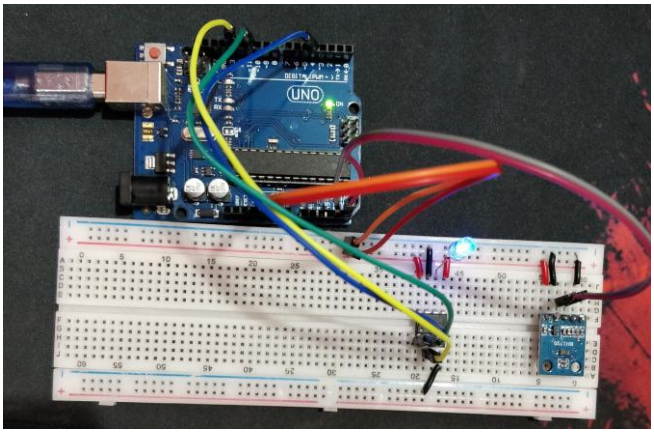


Fig.2(a)

Fig.2(b)

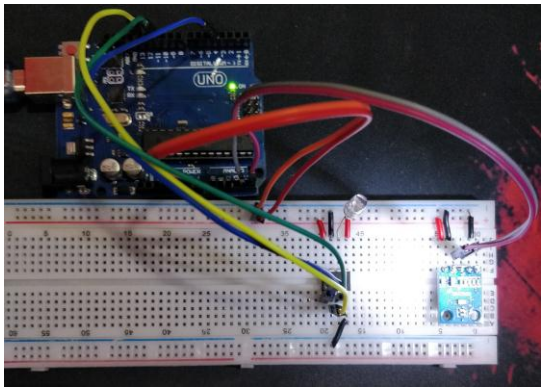


Fig.3(a)

Fig.3(b)

First, we implemented the variation of light intensity of a LED based on the value of lux present in the room. In fig1. (a) it can be seen that the lux sensor is covered using my finger hence the lux value is very less around 10 lux, which in turn reduces the resistance value in the digital pot, thereby increasing the light intensity. The value of lux can be seen in fig1. (b). Similarly, as seen in fig 2. (a) and (b) when the lux sensor is not covered, it senses a value of around 90 lux, thereby increasing the resistance a little which reduces the light intensity accordingly. Finally, in fig 3(a) and (b) it can be seen when we flash a torch on the lux sensor the value of lux increases significantly, thereby increasing the resistance to its max, and completely offing the LED.

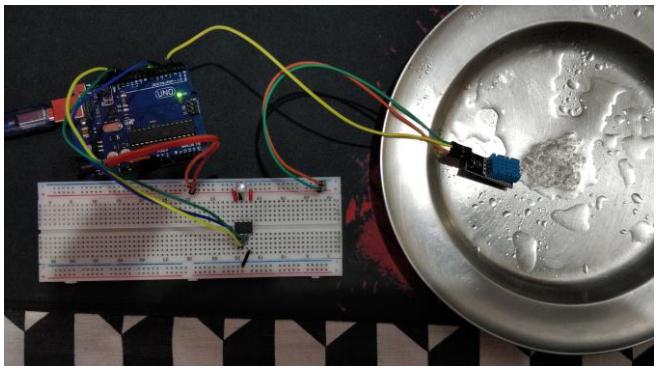


Fig.4(a)

Fig.4(b)

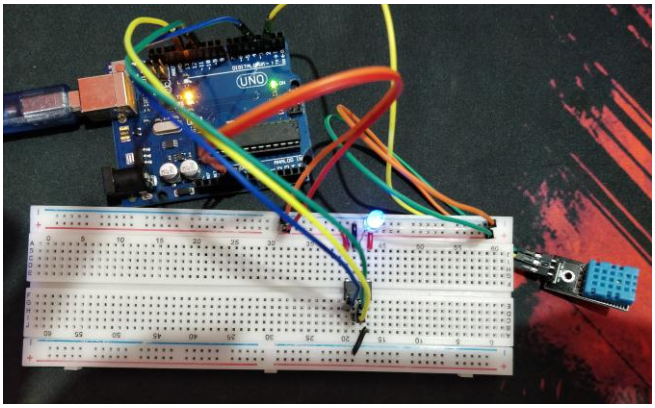


Fig.5(a)

Fig.5(b)

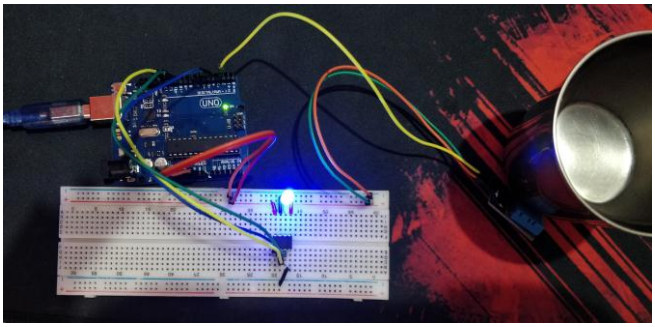


Fig.6(a)

Fig.6(b)

Secondly, we implemented a way to vary the fan speed (in the prototype the light intensity) based on the temperature. In fig 4 (a) it can be seen that the temperature sensor is placed in a plate filled with ice to represent cold climate, as the temperature is low the resistance increases thereby reducing the light intensity (fan speed). The temperature values can be seen in fig 4 (b). Similarly, in fig 5 (a) and (b) it can be seen that at room temperature the resistance has reduced a little and the light is glowing moderately. Finally, in fig 6 (a) and (b) it is seen, that when the sensor is placed next to a glass of hot water to represent hot climate, the resistance in completely reduced and the light glows brightly.

Fig.7(a)

Fig.7(b)

Next, we implemented a count system using ultrasonic sensor as seen in fig 7 (a), the distance between the two planks was approximately 20cm as seen in fig 7 (b). As I passed my hand between the plank the length detected reduced, this indicates that a person has passed through the door. We counted the number of times the length dropped and activated a buzzer after a certain threshold.

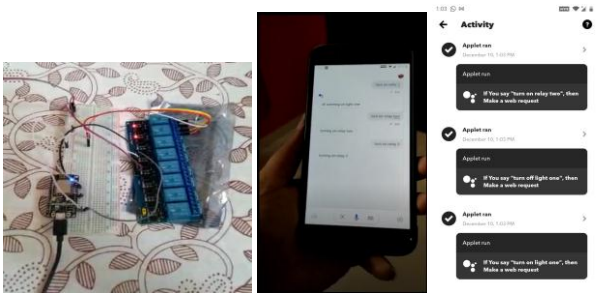


Fig.8(a) Fig.8(b) Fig.8(c)

Finally, we implemented the voice automation using google assistant using NodeMCU as seen in fig.8 (a). We were able to control all the LEDs using our custom voice commands that we set in IFTTT as seen in fig 8 (b) and (c).

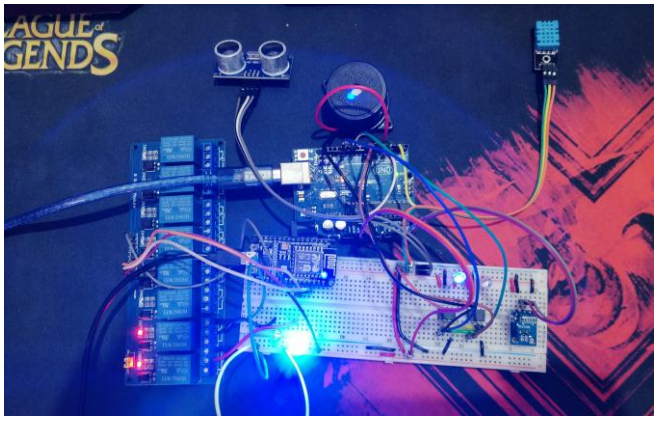


Fig.9(a)

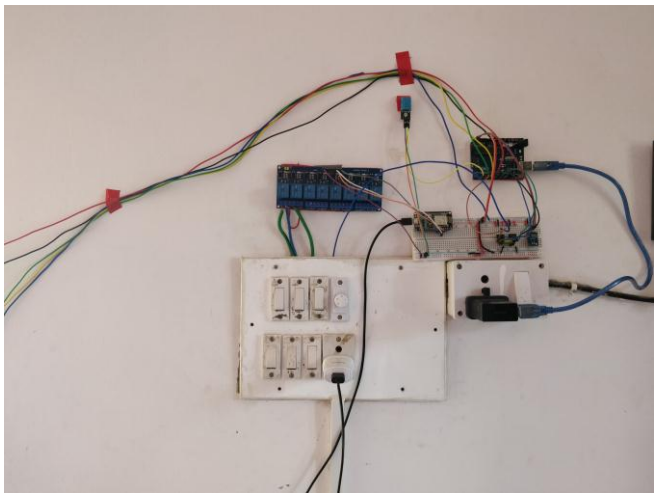


Fig.9(b)

Fig.9(c)

At the end, we integrated all the modules and made the final circuit board as seen in fig 9 (a). This was then attached to the existing circuit board as seen in fig 9 (b) and (c). We were able to control the appliances using google assistance. In addition, we can also turn on and off appliances from a different floor or room as long as you stay connected to the same network. The variation of light intensity and fan speed were observed though these variations very little less as compared to the LEDs. This can easily be overcome by using a larger digital potentiometer with higher range and capacity. The buzzer started to buzz after the set threshold (we set it to 10) was crossed. Following figures show the outputs.

Fig.10(a) Fig.10(b) Fig.10(c) Fig.10(d)

Fig.10(e) Fig.10(f)

6. CONCLUSION

A simple Classroom/Workplace automation system using Internet-of-Things has been designed by connecting simple appliances to it and the appliances can be controlled remotely through the internet. Our project has been designed considering the student, employees, differently abled and old people in our minds. This project is a huge step in making their lives easier. Different work scenarios will have different lighting. Manual need for changing fan speed is omitted. The number of people entering a room is calculated and confined. The designed system not only monitors the sensor data like temperature, light, motion sensor but also actuates a process according to the requirement. It can operate remotely from anywhere around the building. This experiment will be expanded with the addition of various other sensor for a variety of applications. Furthermore, this project can be advanced by making an entire building smart and creating a master room to have everything in control.

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