Intensity Control of Home Appliances Using MQTT Protocol

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***Abstract*—Control the intensity of bulb and fan at different levels by making use of IoT devices through various input methods such as voice using google assistant, slide bar using ubidots and based on our gesture with the help of an accelerometer which in turn helps avoid unnecessary wastage of power. The motivation of our system is to take care of several home appliances that may normally be hard for those who are visually/physically handicapped and old aged people to become self-regulating. It helps the user to control the electronic devices using his/her smartphone for voice and slide bar technique. This project also includes a smart watch which helps in controlling the intensities of devices taking hand gestures as input. This system is designed to be low cost and allowing a variety of specially challenged people, such as a dumb person can make use of slide bar/gesture technique, visually/physically handicapped can make use of voice technique to control devices right from there place.**

Keywords—home automation, IoT, gesture, voice controlled, slide bar, MQTT protocol

I. INTRODUCTION

We live in an exciting time where everyday things are becoming smart. With advancement of automation technology, life is getting easier and simpler in all aspects. Internet of Things gives the accesses to control some parameters of devices at home remotely through the Internet. Hence IoT can be defined as a network of embedded objects that helps connect and exchange data with other devices via internet.

Day by day the number of internet users are rapidly increasing over the past decade has made it a part of life. The Internet of Things (IOT) refers to network of physical objects that are embedded with sensors, software and other technologies for purpose of connecting and exchanging data with other devices and systems over the internet. This project aims to developing a system which can control the intensity of light and speed of the fan by various input methods that is relatively affordable, simple to implement, or configure and users friendly. We aim to create a wrist band for specially challenged people which can help them control light/fan at various levels.

This IoT project focuses on controlling the intensity of bulb and fan at different levels by making use of IoT devices through various input methods such as voice using google assistant, slide bar using ubidots server and based on our gesture with the help of an accelerometer which in turn helps avoid unnecessary wastage of power.

We have made use of MQTT protocol for transferring data from user to devices via Wi-Fi. Message Queuing Telemetry Transport is abbreviated as MQTT which is simple, light weight messaging protocol. The specifications of MQTT such as MQTT being built on top of TCP and lets TCP do a lot of hard work and no payload definitions was specified has made us take up this protocol to solve the problem stated. It provides many advantages such as efficient distribution of information, increased scalability, maximizes available bandwidth, reduces update rate to seconds.

II. LITERATURE SURVEY

In [1] they have used innovative way of controlling a light bulb based on CoAP as an application of smart clothing. It gives users a new experience which traditional lighting control cannot make. But this system experiences delays in processing of gestures. Our solution will make the interaction between the user and lights more natural.

In [2] they have used advanced technique of monitoring a light bulb built on CoAP as a use of smart clothing. Gives consumers a fresh knowledge which outdated lighting control cannot mark. They have a lesser reaction time. Our result will make the communication between the human and lights more normal.

In [3] they have used OpenCV for correct gesture recognition. The automation module in which IR, flame and DHT 11 sensors are interfaced, is able to successfully manipulate the state of the sensors. The ‘text to speech’ module converts the input test provided into the form of speech which further provides a user-friendly format of displaying the output. OpenCV used is not as robust as other

method as sufficient lighting is needed. This method is depended on background and objects.

In [4] they have used NFC wearable wristband helps people to control the automation system by operating it from a distance. This system uses NFC technology in wearable wristband through which we can operate home appliance with in the radius of 10m.

In [5] they have used Uses CoAP protocol and different sensors. Temperature sensor connected to esp32 acts as a client and different led's in a home is connected to esp8266. Different sensors like soil moisture and ultrasonic are connected for knowing health status of a plant in home and water level status in overhead tank respectively. CoAP uses UDP which is not reliable, therefore we have used MQTT which uses TCP.

In [6] the innovations enable the innovational activities work more efficiently by reducing the energy consumption. If the data transmission delay is reduced, the better and more efficient the processes in the smart houses will be done. But in this technique, they did not account about the security aspect of the innovation.

III. METHODOLOGY

The proposed system is to allow a user with any android enabled device and smart watch to run downloadable software on any mobile device such as a smart phones or mobiles. This home automation system will allow the user to control or operate a device such as light and fan that is connected at various intensities with the help of Wi-Fi.

We have come up with a wrist band which can take inputs such as hand gesture movements with help of an accelerometer. With the help of google assistant we take our voice as input and a slide movement of a sliding bar in ubidots server. System recognizes these inputs and data is published with the help of Node MCU via MQTT Broker which is then subscribed with the help of another Node MCU at electric devices.

We use a Wi-Fi Module ESP8266 is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your Wi-Fi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Which then reaches the dedicated device and helps user control the speed of fan and intensity of light at various levels.

We have made use of MQTT protocol for its following advantages –

1) Distribute information more efficiently.
2) Reduce update rates to seconds.
3) Very well-suited for remote sensing and control.
4) Maximize available bandwidth.
5) Extremely lightweight overhead
6) Increase scalability.
7) The real advantage of MQTT over HTTP occurs when we reuse the single connection for sending multiple messages in which the average response per message converges to around 40 ms and the data amount per message converges to around 400 bytes.

✓ Setup of MQTT broker using Ubidots

Ubidots is an Internet of Things (IoT) platform that allows innovators and businesses to prototype and expand IoT applications to production. From any Internet-enabled device, use the Ubidots platform to transfer data to the cloud. After that, you can set up actions and alerts based on your real-time data and use visual tools to uncover the value of your data. Data sources, variables, values, events, and insights are all accessible using Ubidots' REST API. An API Key is required for the API, which supports both HTTP and HTTPS.

The following steps are to setup MQTT broker on the Ubidots cloud:

1) Create an account on the Ubidots website.
2) From the Dashboard, select Devices to display a drop-down menu of options.
3) Click on devices again.
4) Hover your mouse over the '+' icon on the right side of the screen, then click the smaller '+' icon.
5) Select the "blank device" block. Fill in the device name and label fields. You have successfully created the device.
6) Select the newly created device from the devices list.
7) Select the 'Add Variable' block, then the 'Raw' option. Assign a name to this variable. A notification should appear that says "Variable Successfully Created."
8) Return to the dashboard. To select a widget, click the '+' icon and select the widget you want. I chose the slider option to give the appliance a slider control.
9) After you've chosen the widget, go to '+ add variable' and choose the newly formed device. Then select the variable you just made.
10) To build a widget, fill in the widget's fields and then click the green tick in the bottom right.
11) You've set up your MQTT broker. The appliance's parameters can be controlled and monitored.

✓ The Subscriber Circuit

The Subscriber circuit is the main circuit that is responsible for controlling AC voltage. This circuit is a microcontroller-based circuit, where the microcontroller used is NodeMCUThe NodeMCU (Node Micro Controller Unit) is an open-source hardware & software programming platform based on the ESP8266, a low-cost System-on-a-Chip (SOC).The NodeMCU has inbuilt WI-FI support with TCP/IP protocol.

With the aid of NodeMCU, this circuit is connected to the internet through WI-FI. It receives data from the MQTT server or the cloud. Upon receiving these data, the circuit controls the various appliances connected to it. The method used for controlling the AC voltage is the Leading-Edge Phase dimming method.

The circuit is split into two sections:
1) Circuit with a Zero Cross Detector
2) Triac-based phase/angle control

✓ Zero Cross Detector circuit

To regulate the AC voltage, the first thing we need to do is identify the AC signal's zero crossings. The AC signal frequency in India is 50 HZ, and it is alternating in nature. As a result, whenever the signal approaches zero, we must use the Zero-Crossing Identification Technique to identify that position. The dimmer is synchronised using zero-crossing.

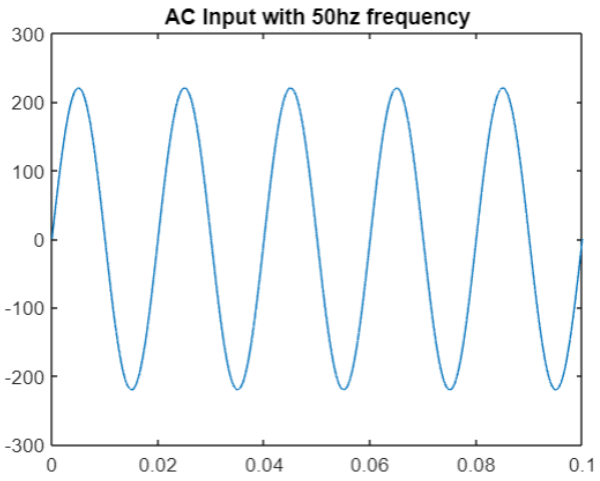

Fig 3.1 AC Input with 50Hz frequency

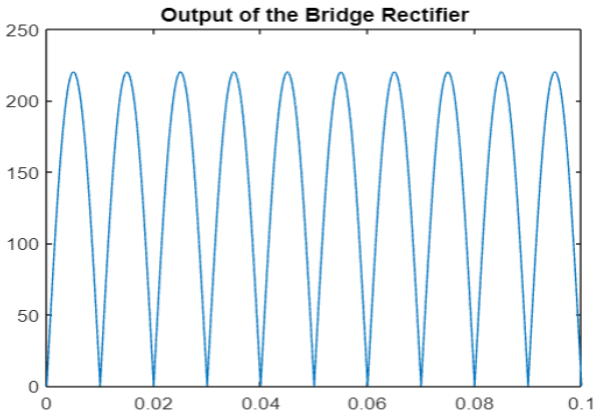

Fig 3.2 Output of the bridge rectifier

When the transistor conducts the current, the output at pin 5 is pulled down to 0. The input at the D6 pin of the NodeMCU receives a digital LOW. When the output of the Bridge Rectifier passes through the zero points. The IR led of the MCT2E is off. This results in an open circuit of the transistor. The output of pin 5 is pulled up to 5v. The input at the D6 pin of the NodeMCU receives a digital HIGH.

The above operation results in the generation of pulses every time the AC signal crosses the zero value. For an AC signal having 50Hz as its frequency, one cycle has a duration of 20ms. The signal crosses the zero value at the half cycle which is 10ms. So this generates pulses every 10ms.

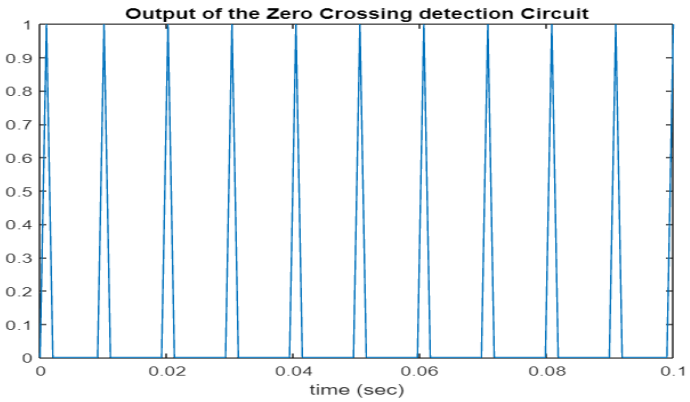

Fig 3.3 Output of Zero Crossing detection Circuit

✓ Phase/Angle control using Triac

The phase/ angle control using Triac is the second part of the subscriber circuit. This circuit mainly includes a Triac BT 136 and an optocoupler MOC3021. Triac is a semiconductor device that is abbreviated to Triode AC switch. It is 3 terminal electronic device that is bidirectional that can conduct current in both directions depending on the gate signal being positive or negative. Triac is a part of thyristor devicesIn AC control applications, triacs are employed. They can convert high voltages and currents, as well as the positive and negative cycles of an AC waveform, over both sections. Triac circuits are therefore well fitted for a variety of power switching applications. This Triac needs a driving IC

The approach is known as leading-edge phase dimming because it uses a current that is shut off as the AC waveform begins, immediately after it passes zero.

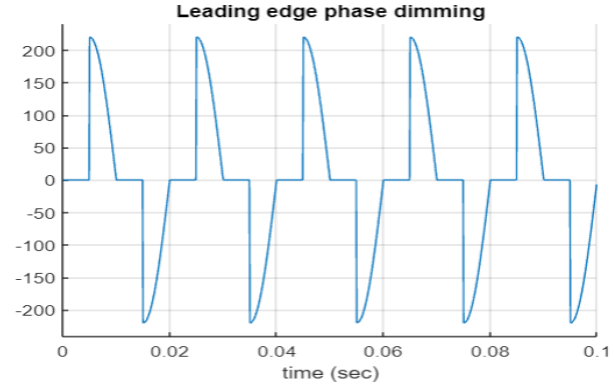

Fig 3.4 Output of the AC wave with Triac control

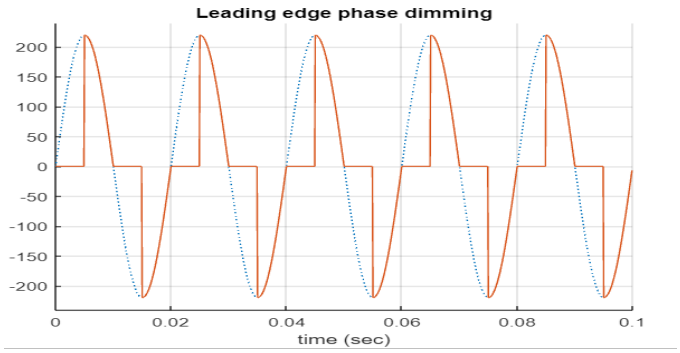

Fig 3.5 Comparison of AC wave with the output of leading phase edge dimming

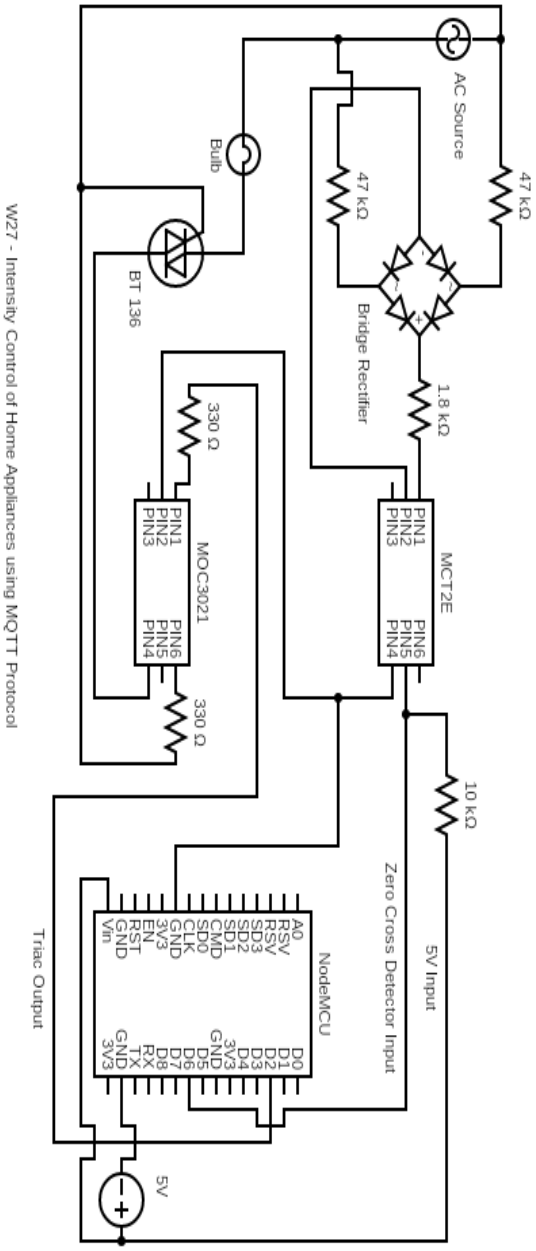

Fig 3.6 Schematic of the Subscriber Circuit

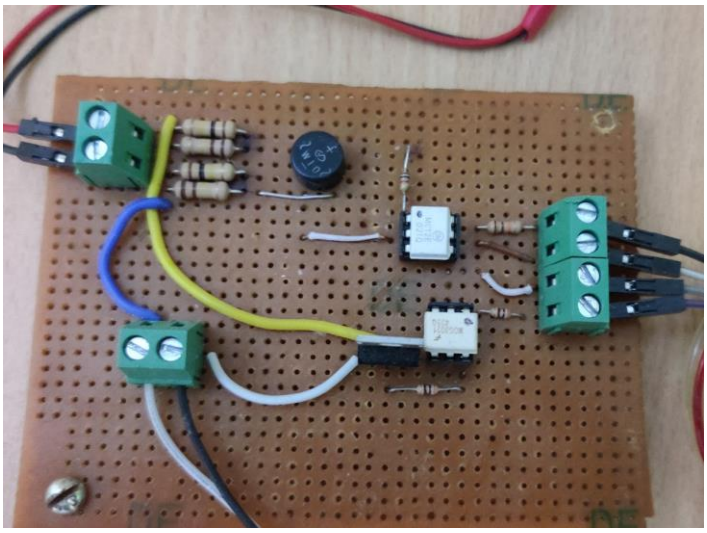

Fig 3.7 The Subscriber Circuit

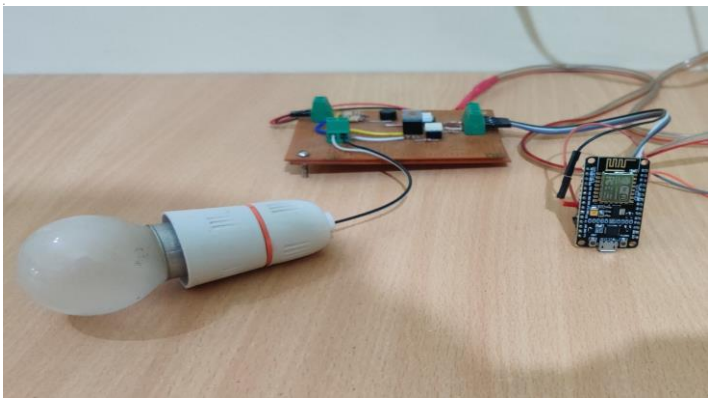

Fig 3.8 The side view of the Subscriber Circuit

➢ GESTURE-BASED WRIST BAND

The gesture-based wristband mainly consists of NodeMCU and a sensor moduleMPU-6050. To power the wristband, we have used a 18650 lithium-ion battery which has a capacity of 1200 Mah with a voltage rating of 3.7V.

Data is sent between devices using only two wires in I2C:

SDA (Serial Data) - This is the data transmission channel between the master and slave

Serial Clock Line (SCL) — This is the line that carries the clock

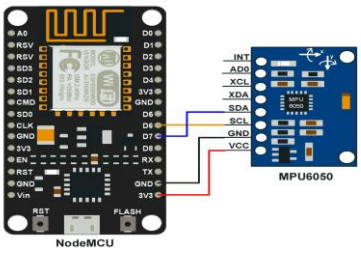

Fig 3.7 Connections between NodeMCU and MPU6050

We have used the accelerometer of the MPU6050 to control the intensity of the home appliances. We have used the Y-axis of the accelerometer function to adjust the intensity of the appliances. We have set a limit to the x-axis, to prevent unwanted registers due to random movement of the wrist. The MPU6050 sends the values continuously to the NodeMCU. The Values change based on the tilt angle of the wrist. When you tilt your wrist towards the left, the value decreases resulting in decreasing the brightness. When you tilt your wrist towards the right, the value increases resulting in increasing the brightness of the bulb.

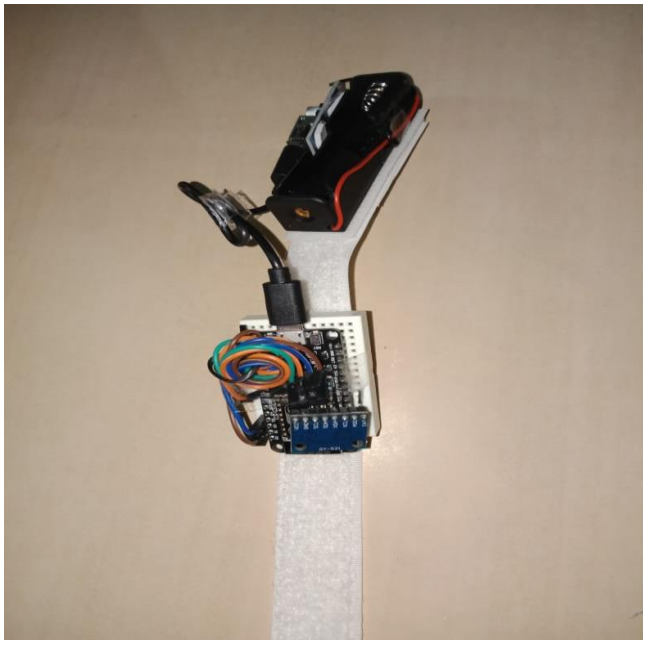

Fig 3.8 The design of the wristband (1)

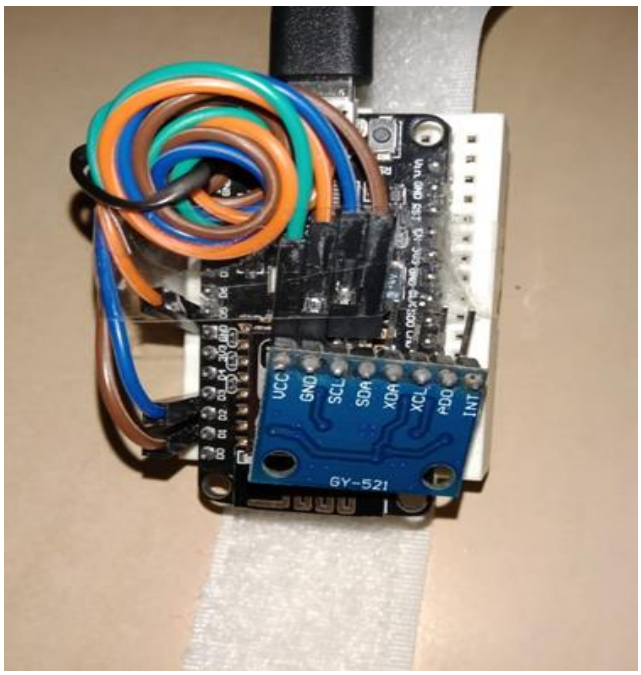

Fig 3.9 The design of the wristband (2)

VOICE CONTROL THROUGH GOOGLE ASSISTANT

Google Assistant

Google Assistant is a voice-activated assistant created by Google. Almost all Android devices have Google Assistant built in. The phrase "Hey Google"/"Ok Google" is used to communicate with the Google Assistant

IFTTT

“If This Then That (IFTTT) is a software solution that links various developers' apps, technologies, and services in order to activate one or more automated systems using those apps, equipment, and services”. “Applets, or basic conditional statements, are created using IFTTT”.

Webhooks

In web development, a webhook is a technique of using custom callbacks to enhance or change the behavior of a web page or web service. A webhook delivers data in real time to other apps, so you can see it straight away.

Creating applets using IFTT

1) Once you have downloaded the app, create an account by logging into your Gmail account.
2) Click on create to make a new applet.
3) Click on add in the If this block.
4) Choose the google assistant services from the list.
5) In the next option, click on say a phrase with number option.
6) Create simple commands like “Turn on the Bulb for # percent”
7) Once the If this block is created, click on then that block.
8) Choose webhooks from the list of services.
9) In the URL block, paste the Ubidots webhook link with the Device name that you have configured in the Ubidots dashboard and the Ubidots account token number.
10) Choose the GET option for the method option.
11) Choose application/JSON option for the content-type option.
12) In the Body block, type the variable name and the data type that you have configured in the Ubidots dashboard.
13) The applet has been created.

Hey Google/ Ok Google is the hot keyword used to engage with the google assistant. The voice command is received by Google Assistant, which then converts it to data. Interpreted data is analyzed and checked whether the command is for IFTTT or some other application. If the data is intended for IFTTT, the data is analyzed and sent to IFTTT.. For example, If I say the phrase “turn on the bulb for 30%”.

Google Assistant interprets the phrase as BULB =30% and the interpreted data is sent to the IFTTT. The IFTTT interprets this BULB= 30% as the trigger and the action field is activated to send the number field 30 to Ubidots MQTT server. The number received by then is displayed on the dashboard. The Subscriber circuit NodeMCU receives this value and the subscriber circuit operation is executed to adjust the intensity of the appliance as per the value received from the MQTT server.

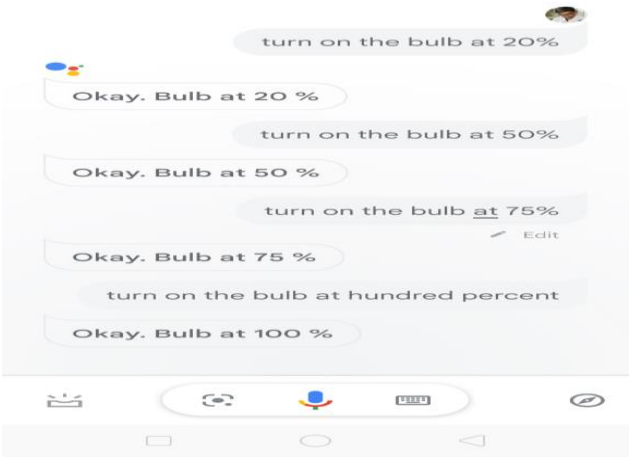

Fig 3.10 Voice Commands in Google Assistant

IV. RESULT

Intensity of bulb and fan gets varied with different inputs like gesture, voice, slide bar and integrated all three methods.

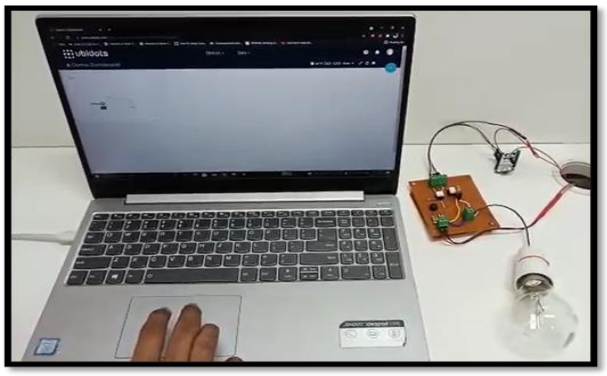

Fig 3.11 Slide Bar

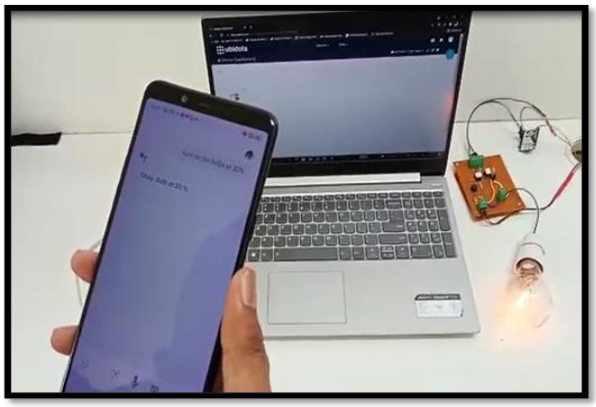

Fig 3.12 Voice Commands

Fig 3.13 Gesture Based

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