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Iot Controlled Home Automation Using Arduino

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ABSTRACT: The Internet of Things (IOT) is the network of, devices, vehicles and other objects which are embedded and equipped with electronics, software, sensors, and network connectivity, enabling these objects to collect and exchange data. The system proposed is a home automation system which enables us to control any appliance through our smart phones, tablets or PCs. The system is implemented using a cloud based system which is programmed to give a certain output when triggered by corresponding input values. The system also uses a Web-Based Service, IFTTT (If-This-Then-That) which connects the Web Server to the different virtual assistant platform like Google Assistant, Alexa, Siri, etc. The hardware components required are Arduino Micro-controller and a Wi-Fi Module (namely ESP8266). Software assistance of Arduino IDE and Processing Development Environment (PDE) are required for control.There is also a provision for connecting and controlling multiple devices through this system.

KEYWORDS: Internet of Things (IoT), Arduino, Home-Automation, Web servers.

I. INTRODUCTION

Internet has made lots of advancements in the recent years and this has a huge impact on the lives of people, connecting people in every part of the world. Similar advancements have been made in the fields of processors, micro-controllers, sensors, actuators, transmitters and receivers. This has led to a rapid development in communication not only within software devices but also between software and hardware devices as well. This has led to the development of the concept of Internet of Things (IOT) which describes the network of physical objects, "things", embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

The Internet of Things is the logical next step in the evolution of the Internet and is a continuation of M2M (machine-to-machine) networks and technologies, building upon and extending technologies in M2M, mobile technologies, RFID and more.

Though it is relatively a new concept in the field of technology, it has got much popularity and now has a huge industrial as well as domestic demand. With more than 7 billion connected IOT devices, experts are expecting this number to grow to 10 billion by 2020 and 22 billion by 2025.

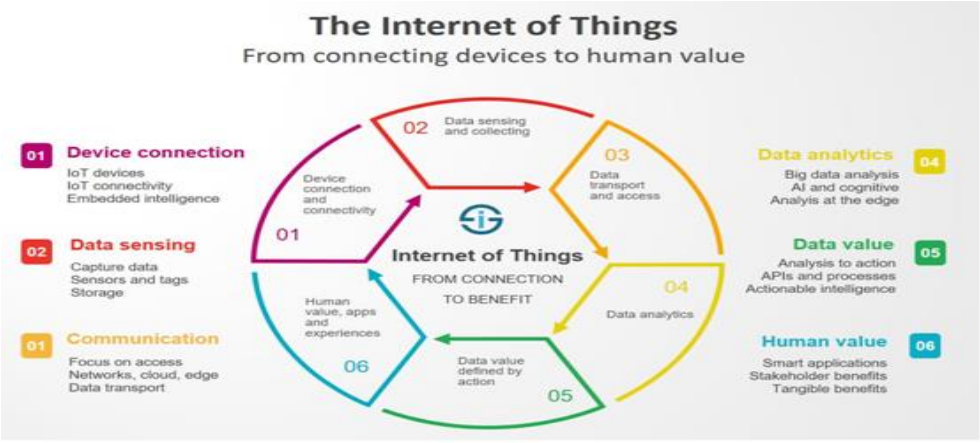

Figure 1: Role of Internet of Things (IOT) in data-cycle

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- IOT is also an umbrella term for a broad range of underlying technologies and services, which depend on the use cases and in turn are part of a broader technology ecosystem which includes related technologies such as artificial intelligence**,** cloud computing, next-gen cybersecurity, advanced analytics, big data**,** various connectivity/communication technologies**,** digital twin simulation**,** augmented and virtual reality, block-chain and more.
- Internet of Things is a reality and it helps devices to configure devices to configure themselves without the intervention of human-beings.

This paper propose, a unique and cheap method for automating any home appliance through the use of an Arduino Uno Micro-controller, a Wi-Fi module and a Relay. The Web Service and Server used in the method are free of cost which makes it a very efficient and doable methods. Nowadays, the IOT controlled devices available are quite costly, but through this proposed system, the same efficiency can be obtained in a much simpler and cost-efficient way. In the paper, the system has be proposed for automating a single device but by using multiple relays we can automate a number of device by using a single Arduino.

II. COMPONENT DESCRIPTION

1. Arduino Uno Micro-controller: Arduino UNO is a microcontroller board which is based on the ATMEGA 328P [5]. It has 14 digital Input /Output pins, 6 Analog Input/ Output pins, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It also includes: Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader, SRAM 2 KB (ATmega328) EEPROM 1 KB (ATmega328).

2. Wi-Fi Module (ESP8266): The ESP8266 Wi-Fi Module 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. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to the Arduino device. It uses the L106 32-bit RISC microprocessor core based on the Tensilica Xtensa Diamond Standard 106Micro running at 80 MHz. It has 32KiB instruction RAM, 32 KiB instruction cache RAM, 80 KiB user-data RAM and 16 KiB ETS system-data RAM. It also includes External QSPI flash (up to 16MiB is supported), IEEE 802.11 b/g/n Wi-Fi and 16 GPIO pins.

3. 2-Channel 5V Relay: 2-Channel 5V Relay Module is a relay interface board, it can be controlled directly by a wide range of microcontrollers such as Arduino, AVR, PIC, ARM and so on. It uses a low level triggered control signal (3.3-5VDC) to control the relay. Triggering the relay operates the normally open or normally closed contacts. It is frequently used in an automatic control circuit. It is an automatic switch to control a high-current circuit with a low-current signal.5V relay signal input voltage range, 0-5V. VCC power to the system. JD-VCC relay in the power supply. JD-VCC and VCC can be a shorted.
4. An Electrical Appliance: Any electrical device which is to be automated by the system has to be connected between the relay and a power supply.
5. A Virtual Assistant: Any Virtual Assistant like Google Assistant, Cortana, Siri or Alexa is required through which the user can give the instruction to the Web Service.

III. CONNECTING THE WI-FI MODULE (ESP8266-01) TO THE ARDUINO

- Connect VCC with 3.3V of Arduino (do not connect it with 5V as that can damage the module.)
- Connect GND with any GND of Arduino
- Connect Rx pin with Tx of Arduino
- Connect Tx pin with Rx of Arduino
- Connect the CH_EN (Chip-Enable) pin to 5V or 3.3V. When connected to high, it is used to enable the operation.
- When the Reset pin is connected to high voltage, it is used to reset the Wi-Fi Module.
- The GPIO pins are used for boot operations

(Here **Tx** refers to the **Transmitter Pin** and **Rx** refers to the **Receiver Pin**)

Note: When uploading the program, one must disconnect the Rx and Tx pins of the Wi-Fi Module with the Arduino.

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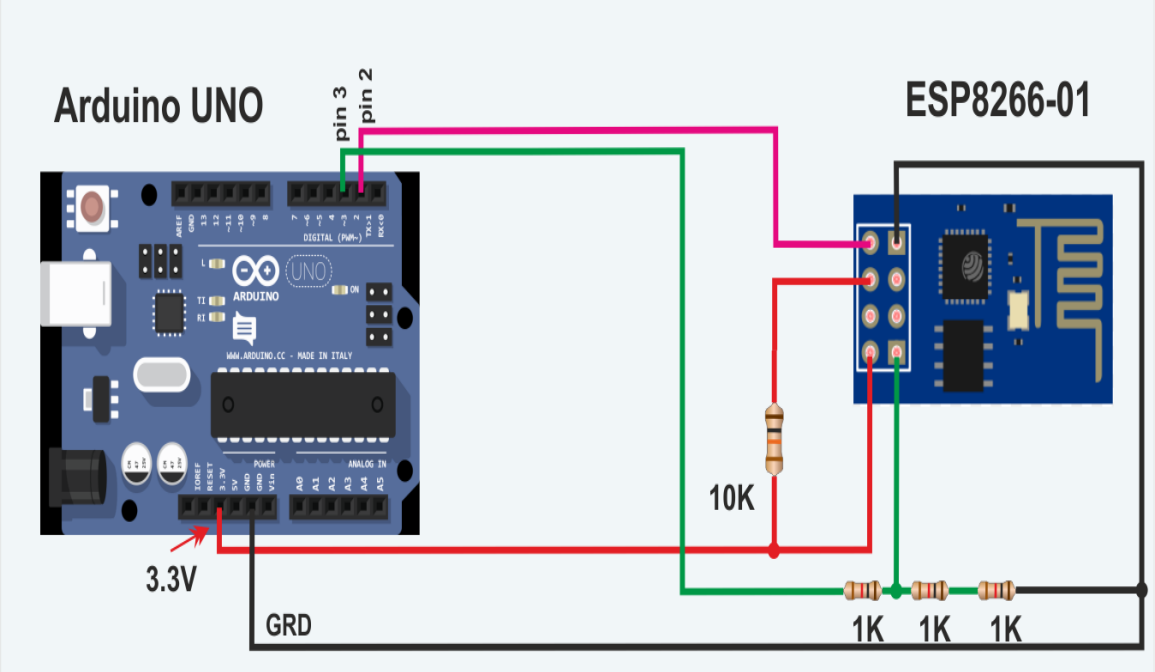

Figure 2: Connecting the Arduino Uno to the Wi-Fi Module (ESP8266)

IV. REASEARCH ELABORATION

4.1. BASIC WORKING OF THE SYSTEM

- First, the user has to create two IFTTT applets which will be triggered when the user ask Google Assistant (or any other virtual assistant) to either turn ON or OFF the light. The instruction required for the Google Assistant can be configured during the creation of the applet.
- The applet is then connected to the Web Server, and programmed to give an output of value 1 when the user instruct Google Assistant to Switch ON the device and 0 for Switching OFF the device. Here, a preferable option for the Web Server is the Thingspeak Web Server.
- Accordingly, a value will be sent to the Web Server, every time the user gives any instruction to the Google Assistant. (1 to Switch ON and 0 to Switch OFF).
- Then the user have to set up our Wi-Fi Module (ESP8266) which will be provided with the API key of our Thingspeak Channel, Channel ID and others required parameters which will enable it to connect the Wi-Fi Module to the ThingSpeak Web server..
- When the Wi-Fi Module sends the URL of the Thingspeak Channel, it get connected to it, and receives the String given by the Thinkspeak Cloud as an output. This string contains the value of the field value, that is, the value of the variable which determines the state of the device.
- From the String, the user have to extract the field value. In this case the field value will be the state of the device to be operated by the user (1 for ON and 0 for OFF positions).
- Now, the Arduino gets this field value and triggers the relay module according to the value of the field variable.
- If the value is 1, then the relay is triggered to connect the device to the voltage supply and as a result the device (or appliance) turns ON. If the value is 0, the relay is triggered to break the connection of the device from the voltage supply and hence the device is turned OFF.

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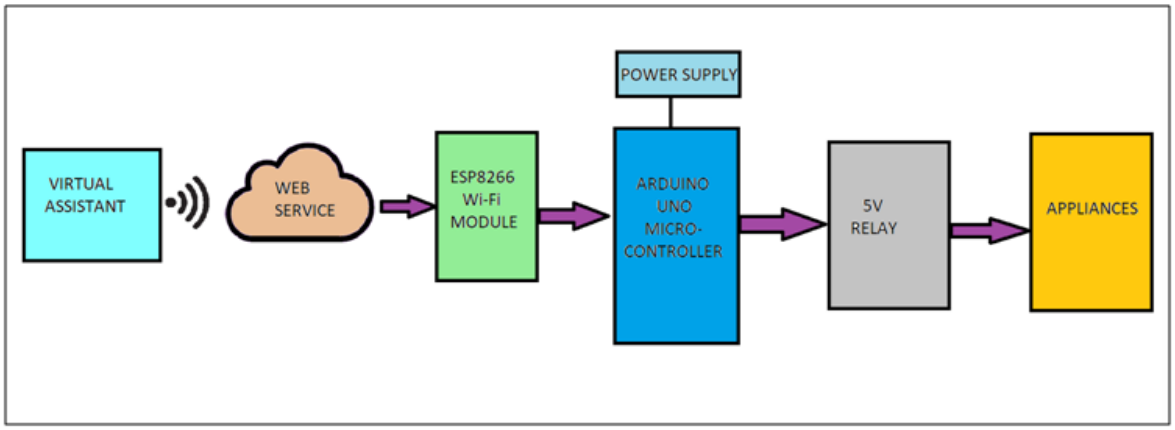
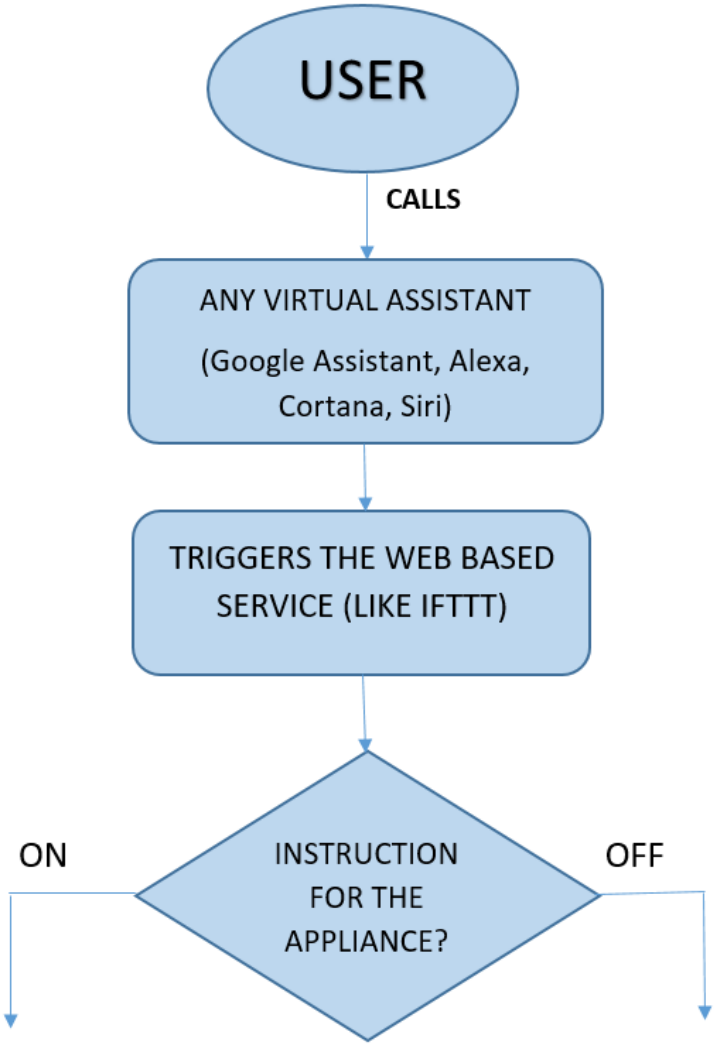


Figure 3: Overview of the working Mechanism of the Proposed System

4.2. PROCESS FLOWCHART OF THE PROPOSED SYSTEM



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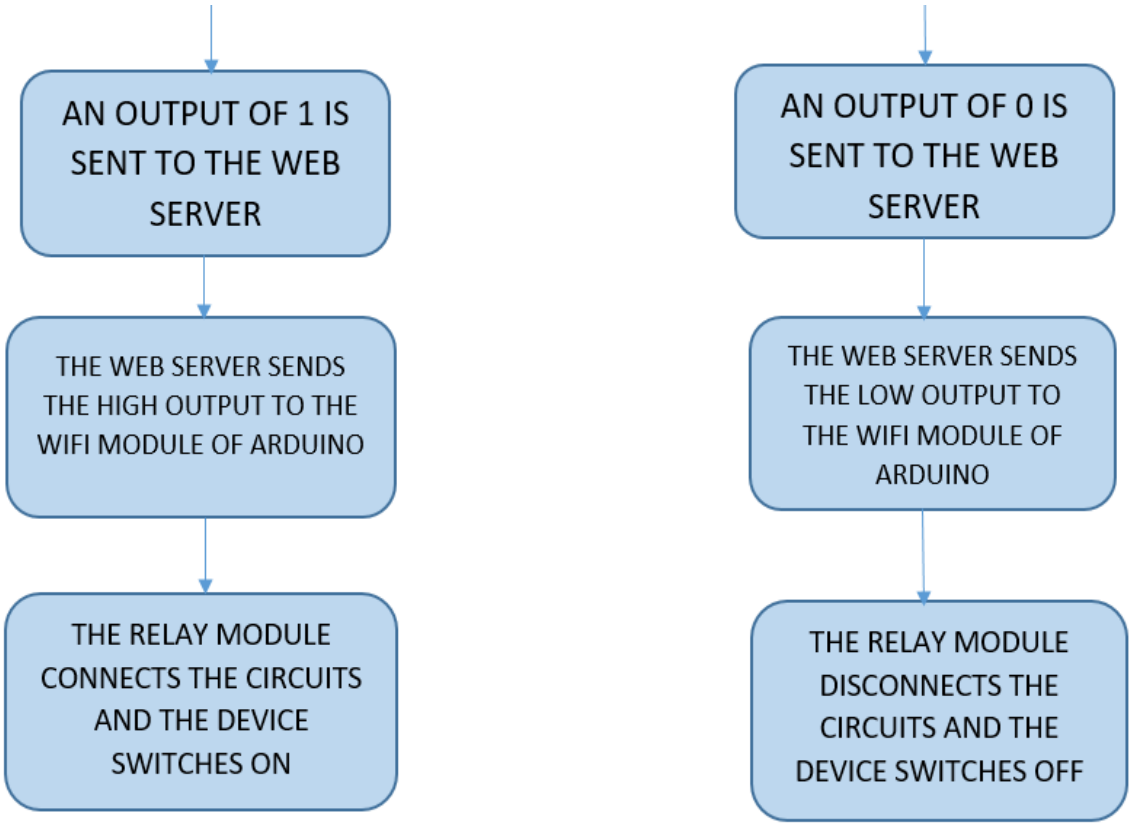

4.3. ALGORITHM

1. START
2. User gives the instruction to the Virtual Assistant.
3. The exiting Web Applet get triggered and receives the instruction as an input.
4. The input is then evaluated.
5. If input== Switch On,
6. Send an output of 1 to the Web server.
7. The web server connects to the Wi-Fi module, and sends a high output.
8. The Arduino Uno pin connected to the Relay, send a HIGH output.
9. The circuit connected to the NO (Normally Open) pin of the relay gets connected.
10. The circuit gets connected and the device switches ON.
11. Else if input== Switch OFF,
12. Send an output of 0 to the Web server
13. The web server connects to the Wi-Fi module, and sends a low output.
14. The Arduino Uno pin connected to the Relay, send a LOW output.
15. The circuit connected to the NO (Normally Open) pin of the relay gets disconnected.
16. The circuit gets disconnected and the device switches OFF.
17. Else,
18. Invalid Output
19. STOP

4.4. Advantage of using the proposed System

- It will provide wide range and more efficiency.
- One can control the appliance from anywhere, only requirement being the device must be connected to internet.
- This is a much cheaper method as compared to in-built IOT devices
- Anything and everything can be controlled through one device and separate applications is not required.
- Equipment can be placed almost anywhere
- No need for additional Ethernet output.
- By adding sensing devices, we can cause the devices to communicate with one another, thus increasing the automation level.

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Figure 4: Role of IOT in Home Automation

V. DISCUSSIONS AND PROCEDURE

SHOWN BELOW IS A SAMPLE PROGRAM FOR THE PROPOSED SYSTEM

```
#include<SoftwareSerial.h>     //Including the software serial library
SoftwareSerial espSerial(2,3);      //the connections to the ESP8266 WiFi Module(2 as Rx & 3 as Tx)
int Relay= 6;                       //connection of the relay with Arduino Uno

String output="";
String wifiname="Autohome";       //WiFi Name
String pass="wert234";            //WiFi Password
String sendData="GET/channels/1078485/fields/1.json?api_key=YAQ3JJABHSOM8VTC&results=1";  //Stores the API key to receive data from Thingspeak Cloud
void setup() {
  Serial.begin(9600);          //Starting the serial Monitor
  espSerial.begin(9600);       //Starting the WiFi Module
  pinMode(Relay,OUTPUT);                                          //The relay pin is to be used as output
  espCommand("AT+RST",1000);                                    //Reset the WiFi Module
  espCommand("AT+CWMODE = 1",1000);                     //Configuring it to be a client
  espCommand("AT+CWJAP=\""+wifiname+"\",\""+pass+"\"",1000);    //Setting up the WiFi name and password
  while(!espSerial.find("OK"))
    {
      //Here it is waiting for proper connection
    }
  Serial.println("Wifi Connected");     //Once the WiFi is connected, an appropriate message is shown
  delay(1000);
  espCommand("AT+CIPMUX =0",1000);        //The module will only be connected to 1 device
  espCommand("AT+CIPSTART=\"TCP\",\"api.thingspeak.com\",80",1000);          //Connecting to the Thingspeak Cloud
  espCommand("AT+CIPSEND="+String(sendData.length()+4),1000);    //Length of the URL

  delay(100);
  output="";
  espCommand(sendData,1000);                                          //sending the URL
  delay(100);

  int l=output.length();                                      //stores the length of the incoming String
  char c=output.charAt(l-5);             //The field value is always present at the (l-5)th index position
  Serial.print("The Response is: ");
  Serial.println(c);                                                  //prints the field value
  if(c=='0')
```

Done compiling.

```
  if(c=='0')
  {
    digitalWrite(Relay,LOW);    //when the field value is zero, the relay is not triggered
  }
  else if(c=='1')
  {
    digitalWrite(Relay,HIGH);   //when the field value is 1, the relay is triggered to switch on the light
  }
}

void loop() {
                //the loop is kept empty. This is because, we don't want to continuously read the data
}
void espCommand(String command,const int timeout) //this function sends all the ESP commands to the Modules
{
  Serial.print("AT Command ==>");
  Serial.print(command);
  Serial.println(" ");
  espSerial.println(command);
  //The next set of program is only used for the last command so as to read the data from the thingspeak cloud
  long int time = millis();

  output=""; //clear the string

  while ( (time + timeout) > millis()) //Calculates the small timeout after each command
  {
    while (espSerial.available())
    {
      char i = espSerial.read(); // read one char at a time
      output += i; //Combine char to string
    }
  }
  Serial.println("Received  ");
  Serial.print(output);       //prints the input received from the Thingspeak cloud in the serial monitor
}
```

Done compiling.

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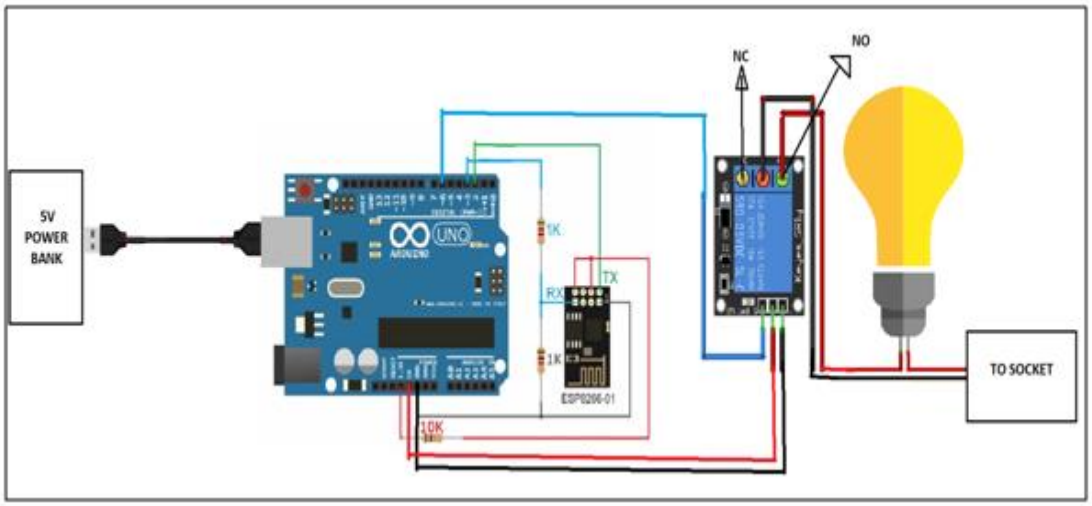

Figure 5: Circuit Diagram of the proposed system

(NOTE: HERE THE LIGHT BULB SIGNIFIES ANY DEVICE WITH HAS TO BE AUTOMATED THROUGH THIS SYSTEM)

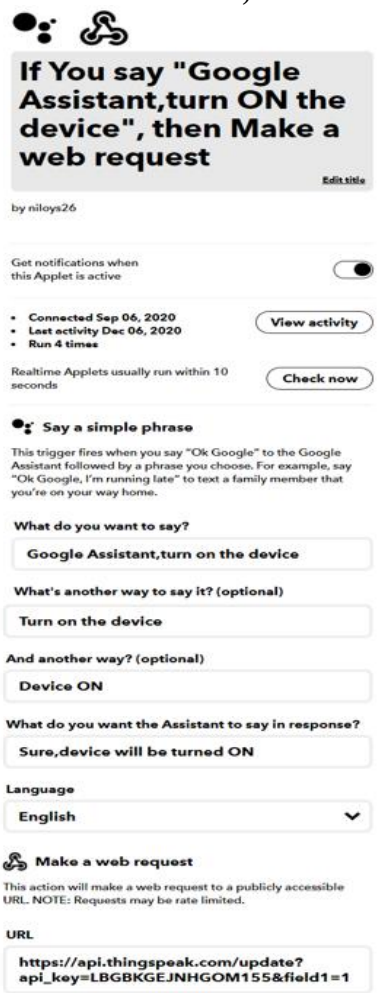

Fig 6: The IFTTT Applet to Turn ON the device

Fig 7: The IFTTT Applet to Turn OFF the device

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VI. CONCLUSION:

There is huge potential of smart homes market in the World due to changes in the socio-economic factors. Both traditional energy companies and smart technology developers are competing in this market. This article is about wireless home automation using mobile helps one to implement such a fantastic system in our home at a very reasonable price using cost-effective devices. Thus, it overcomes many problems like costs, inflexibility, etc. No additional applications are required to control each appliance as is the case of the IOT devices available in the market. The only requirement is a mobile phone and this system is capable enough to automate the entire home. The future of smart homes is very bright and there is a huge potential in this field which is yet to be tapped.

In the post- COVID situation when the world is under a state of financial crisis, such cost-effective methods can prove to be quite helpful. IOT being such a diverse field may open up quite a number of new career option for the people. Thus, it has the potential to make the lives of people easier and faster, along with providing people with new jobs. Worldwide spending on the Internet of Things (IOT) is forecast to pass the $1.0 trillion mark in 2022, reaching $1.1 trillion in 2023.

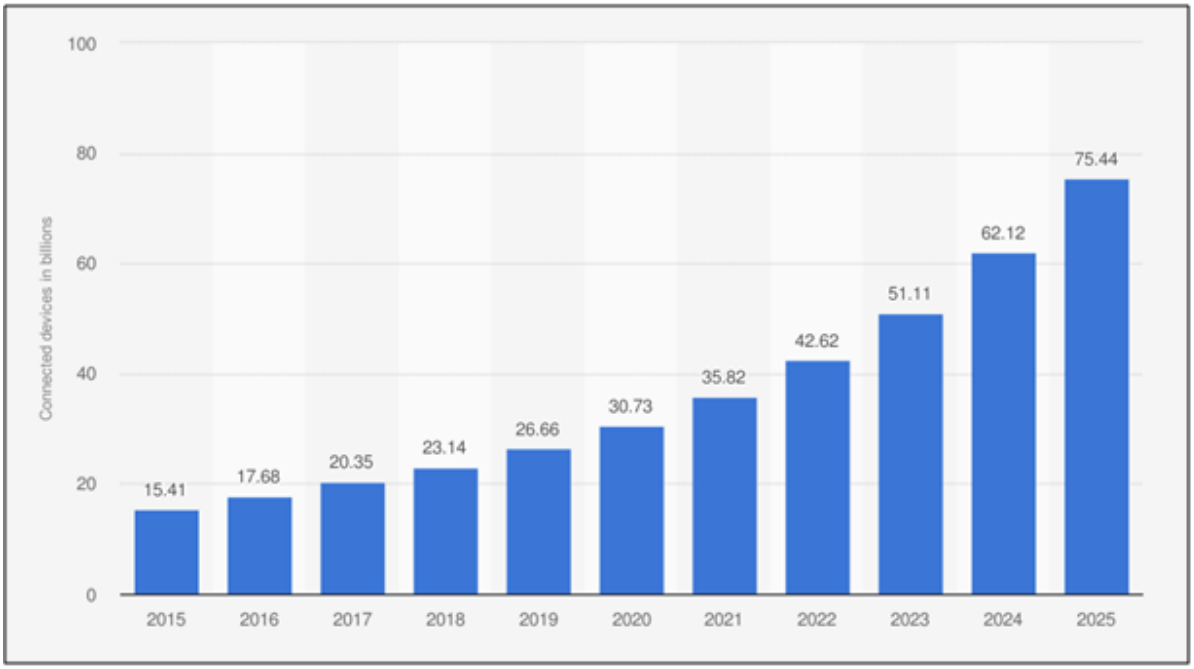

Figure 8: Estimated Number of connected devices in the near future (Source: Statista)

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