Controlling an humanoid robot using IOT

U Padmesh\(^1\) and A Kumaraswamy\(^2\)
\(^1\) ME Student, Department of Mechanical Engineering, Sri Venkateswara college of Engineering, Pennalur, Sriperumbudur, Tamilnadu, pincode -602117, India.
\(^2\) Assistant Professor, Department of Mechanical Engineering, Sri Venkateswara college of Engineering, Pennalur, Sriperumbudur, Tamilnadu, pincode -602117, India.

E-mail: upadhmesh@gmail.com

Abstract. The internet of things make peoples life easier, smarter and allow them to control over their surroundings. The project describe the design and understanding of the mobile application for the Android based system which is focused on manual control of humanoid robot using wireless technology. NodeMcu - ESP8266 is a Wi-Fi enabled chip, which is used for controlling the robot. Programming is done based on the requirement and uploaded to the Node Mcu by using Arduino IDE. Google Firebase is used as a cloud provides that helps information to be synchronized between users and to store that information on to the cloud. MIT APP INVENTOR is used to develop an application for Android phones. Robot can be now controlled from any device which has this application specifically developed for this robot and the major advantage is we control this robot from any location through internet.

1. Introduction

Internet of Things (IoT) lays a base for users to make their devices, smart and facilitate to connect them to the Internet allowing the devices to exchange data between one another. IoT build itself from machine to machine (M2M) communication, machine communicates to one another through a network without human being intervention. machine to machine communication means the product is connected to the cloud and the data's collected and managed. Internet of connect human being, system and many other application to share and collect information. An Internet of Things system will have internet-allowed appliance that use microprocessor, different sensor based on the requirement and other equipments to send, store and process the information they got from their situation. IoT device send and receive sensors information by linking to an Internet of Things entryway where information is moreover send to the internet storage to be revise. occasionally, these IoT equipment communicate with one another associated device and take action based on the data from the other device. The device do job mostly with no person intervention.

1.1. Node MCU

NodeMcu-esp8266 is an micro controller that aids you to make IoT project. The board runs at 3.3v, and all pins can have a max load of 12mA and a 3.3v logic. This board does not have the LED connected to pin/gpio13, instead it has it connected on pin/gpio. The labels on the NodeMCU don’t correspond to the digital pins.
1.2. Arduino IDE
The arduino IDE (Integrated Development Environment) is a software which is developed for Windows, macOS and other OS for programming. Programs can be written and uploaded to Arduino compatible boards. To change the code into a text of hexadecimal encoding the arduino IDE uses the avrdude.

1.3. MIT App Inventor
MIT App Inventor can be accessed through web portal, which was offered by Google and now be maintained by MIT. It allows beginner to create application for two systems they are for Android and iOS. MIT App Inventor lets us pick and place visual objects, give them functions and by which we can easily creating an app.

1.4. Network
Network is a collection of things that are interlinked to share Infomation. A network generally comprises of two things: A server and a client. There are certain terms that we need to know when we talk about a network.

1.4.1. Server
Server is the device or the system that has all the resources and information. Its also called as a service provider, In our case NodeMCU and the google Fire base db are the server. It has all the resources like webpage.

1.4.2. Client
Client is the device that requests the server for resources. In our case Laptop and the Nodemcu the client, Its also called as the service requester.

1.5. Google Fire Base
The Firebase is a Real-time cloud-hosted Database. This database helps you store and synchronized between your clients in realtime. Using one API, the Firebase database gives your application with both, it updates the data and the current value of data. The Realtime Database software development kit uses local cache on the equipment to serve and save variations. The local data is synchronized automatically, when the device comes online. The Realtime Database can mix with Firebase verification to provide a simple and spontaneous authentication method. Firebase Cloud Messaging (FCM) gives a dependable and battery-efficient link between server and client that permits you to carry and obtain messages and notifications on iOS, Android, and the web.

1.6. Humanoid robot
This humanoid robot has various capabilities such as walking, neck rotating and audio facility. The major components of humanoid robot are motor, gearbox, link joints, outer casing, speaker, circuit board. The dimension of robot are as follows length - 210mm, breath - 100mm, width - 75mm.

2. Methodology
The work was conducted on a robot using NodeMcu - ESP8266, which is a Wi-Fi enabled chip. Programming is done based on the requirement and uploaded to the Node Mcu by using Arduino IDE. Google Firebase is used as a cloud, So that the data which send to Mcu which in turn control the robot. mobile application is developed using MIT App Inventor, all the network accessible components are connected to Google firebase.
2.1. Hosting Google Firebase

The first is to setup the Firebase database.

- Visit Google firebase and login to an Google account.
- A new welcome screen will appear with two keys as shown below:

![Create New Project](image1.png)

**Figure 1.** Creating New Project.

- Click on Create New Project button as shown in ‘figure 1’.
- This will bring up the Create a project screen, where you have to name the project and the name must be unique. In our case "IoT ROBOT". choose a Country/region, where India is choosen so that database will to be hosted in India. Select Create Project.
- Click on the Database, a link will appear which is shown in ‘figure 2’.

![Database URL](image2.png)

**Figure 2.** Database URL.

- Database URL as highlighted in the screen above. This is an unique database URL that is accessible to the clients for integration for this project. The mobile app will be created by connecting the input keys to this URL.

2.2. Creating Application

- Open MIT App Inventor in browser.
- Click on Projects → Start New Project.
- Name it as IoT_ROBOT.
• In the layout drop box choose vertical arrangement as shown in ‘figure 3’.

![Figure 3. Setup vertical arrangement.](image1)

• Go to experimental, drag 'firebaseDB' after vertical arrangement 1 as shown in ‘figure 4’.

![Figure 4. Attaching Firebase DB.](image2)
• In the Firebase db1 property drop box, the URL to pasted here, So that now Firebase will be linked with Application as shown in ‘figure 5’.

![Figure 5. Connecting to Firebase DB.](image)

• Inserting two buttons and name them as shown in ‘figure 6’.

![Figure 6. Creating buttons.](image)
Inserting 3 images as shown in 'figure 7'.

Figure 7. Inserting images.

Moving to the blocks side, For creating functions for both the buttons as shown in ‘figure 8’.

For the first button "walk", Robot must walk. For that firebase need to get the information. So drag and drop Firebase Function box, in the Tag - "Robot" and in the Value to store "1".

The Inserted image should be appear and disappear based on the condition. for walk option, Walking Image should appear.

Figure 8. Creating function for walk button.
This could be done by making the walking Image to True and other images false. For the Second button "confused", Robot gets confused. For that firebase need to get the information. So drag and drop Firebase Function box, in the Tag - "Robot" and in the Value to store "0".

The Inserted image should be appear and disappear based on the condition. for confused option, confused Image should appear. This could be done by making the confused Image to True and other images false as shown in ‘figure 9’.

Figure 9. Creating function for confused button.

2.3. Arduino IDE

- Arduino IDE is a official software which is used for coding micro-controller. The process of coding has become simple so that even a newbie can do the coding using basics, help option and with the example sketches.
- This software is available for MAC, Windows and other operating systems. Arduino comes with function and command that helps in editing, debugging and uploading the code. A variety of Arduino modules which including Arduino Mega, Arduino Micro, Arduino Uno, and several more.
- The program for Micro-controller is shown in appendix.

2.4. Uploading to Node Mcu esp8266

- Connect the Node Mcu esp8266 to the laptop using usb cable.
- Open arduino IDE.
- Code a applicable program.
- Verify the program, by selecting as shown in ‘figure 10’.

Figure 10. Verifying the program.
After completion of verification, upload the program to the node Mcu by selecting upload symbol as shown in ‘figure 11’ after connecting a usb cable as shown in ‘figure 12’.

2.5. Humanoid robot
The Humanoid robot can perform two major operation. First operation is walking and second operation is acting like its confused. The various components humanoid robot as shown in ‘figure13’ and ‘figure14’ are 1-Leds, 2-motor, 3-gearbox, 4-link joints across the whole body, 5-speaker, 6-wheels for the foot.
2.5.1. **First operation**

The first operation is to make humanoid robot to walk. So, two things need to control: they are leg and hand movement. For those movements, torque from the motor is transmitted to the gear box and its output are connected to link joints. These joints are connected to the whole body. When the motor gets power, power transmission takes place and it starts walking as shown in ‘figure 15’.

![Figure 15. First operation.](image15.jpg)

2.5.2. **Second operation**

The second operation is to make the robot confused. So, two things need to control: they are led and neck movement. For those operations, rotary power from the motor is transmitted to the gear box and its output is connected to link joints which in turn connects to the neck joint and for this operation power goes to led. As a result when second operation is initiated the robot’s neck starts rotating and led starts glowing as shown in ‘figure 16’.

![Figure 16. Second operation.](image16.jpg)
2.6. Connecting Node Mcu to robot

- The robot has two input, each input has its own purpose.
- In the micro-controller, two outputs are assigned through program.
- These outputs are connected to the robots input as shown in ‘figure 17’.

![Figure 17. Connecting Mcu with the robot.](image)

Figure 17. Connecting Mcu with the robot.

![Figure 18. Pin 4 and 5 is used for connection.](image)

Figure 18. Pin 4 and 5 is used for connection.

- Pin number 4,5 are used as outputs from the node Mcu as shown in ‘figure 18’.
Using jumper cables, the input and output are connected.

3. Appendices

3.1. Appendix

```c
#define FIREBASE_HOST "iot-robot-13be6.firebaseapp.com"
#define FIREBASE_AUTH "GOVxl4a2yAslne3lbsEsNWgL9WlRZLtBjuy0QBR4a"
#define WIFI_SSID "POCO PHONE"
#define WIFI_PASSWORD "padhu123"
const int walk = 5;
const int confused = 4;
void setup()
{
    Serial.begin(9600);
}```
pinMode(walk, OUTPUT);
digitalWrite(walk, LOW);

pinMode(confused, OUTPUT);
digitalWrite(confused, LOW);

WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
Serial.print("connecting");
while (WiFi.status() != WL_CONNECTED)
{
    Serial.print(".");
    delay(500);
}
Serial.println();
Serial.print("connected: ");
Serial.println(WiFi.localIP());
Firebase.begin(FIREBASE_HOST, FIREBASE_AUTH);

void loop()
{
    int value = Firebase.getString("robot").toInt();
    Serial.println(value);
    if (value == 1)
    {
        digitalWrite(walk, HIGH);
        digitalWrite(confused, LOW);
    }
    else if (value == 0)
    {
        digitalWrite(walk, LOW);
        digitalWrite(confused, HIGH);
    }
else
{
    digitalWrite(walk, LOW);
    digitalWrite(confused, LOW);
}

4. Result and conclusion
The study was performed, the connection was established between server and client through mobile application. When an Input is provoked, the information goes to the server (Google Firebase db) and from there information goes to Node Mcu esp8266 which acts as client. Then Node Mcu gives the signal accordingly, So that the robot is controlled as shown in ‘figure 19’.

![Figure 19. Working procedure.](image)

When walk button is selected as shown in ‘figure 20’, The data from the mobile application goes to the Google Firebase db and the data is fed to Node Mcu esp8266. Then Node Mcu gives +5 volt to pin number 5 which was declared in the program and 0 volt to pin number 4. As a result of this action, The robot starts walking as shown in ‘figure 21’.
When confused button is selected as shown in ‘figure 22’, The data from the mobile application goes to the Google Firebase db and the data is fed to Node Mcu esp8266. Then Node Mcu gives +5 volt to pin number 4 which was declared in the program and 0 volt to pin number 5. As a result of this action, The robot starts acting like its confused as shown in ‘figure 23’.

5. References

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