

# *The FPGA implementation of Practical Access Control for Integrating Wireless Sensor Networks into IoT- Programming & Algorithm*

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## ***Introduction***

Using web administrations is the most remarkable and resonating method for giving remote administration access by making the applications which can speak with one another. The Internet of Things (IoT) can be portrayed as interfacing regular articles like cell phones, sensors and actuators are brilliantly connected together to empower new types of correspondence where individuals and gadgets can exist together through the web. A new dimension to the world of information and communication technologies has been created by the significant developments and innovations over the last couple of years. This headway is prompting whenever, anybody, anyplace availability for things with the desire being to expand and make an altogether propelled dynamic system of IoTs. This new innovation can be utilized for making present day ideas and expansive advancement space for keen homes so as to give knowledge, comfort and enhanced nature of way of life.

The smart home is anything but another term in the field of science anyway it is still undeniably progressively far from individuals' vision. As we see electronic advances are joining, the field of home mechanization is consistently growing. A Wi-Fi-based home computerization framework utilizes a NODE-MCU and portable application that deals with the associated home gadgets. Different savvy frameworks are available where by means of Bluetooth, web, short message benefit (SMS) based, and so forth client can control and deal with the framework desiredly

through versatile application remotely. Also, the wide range possibilities of home automation devices like power management components and security components cannot be denied. The online home automation and monitoring system designed and implemented here uses ARDUINO-UNO, NODE-MCU, IR PAIR, LCD SCREEN, LED, DC MOTOR and PIEZO BUZZER as the alarm device; all controlled by mobile app connected with NODE-MCU.

# ***System Design***

## **I- Central Unit**

### **1-Arduino-UNO**

The Arduino UNO is an open-source microcontroller board based on the microchip Atmega328P microcontroller and developed by arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable.

Each of the 14 digital pins and 6 Analog pins on the Uno can be used as an input or output, using functions like pinMode(), digitalWrite(), and digitalRead(). They operate at 5volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labelled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024

different values).

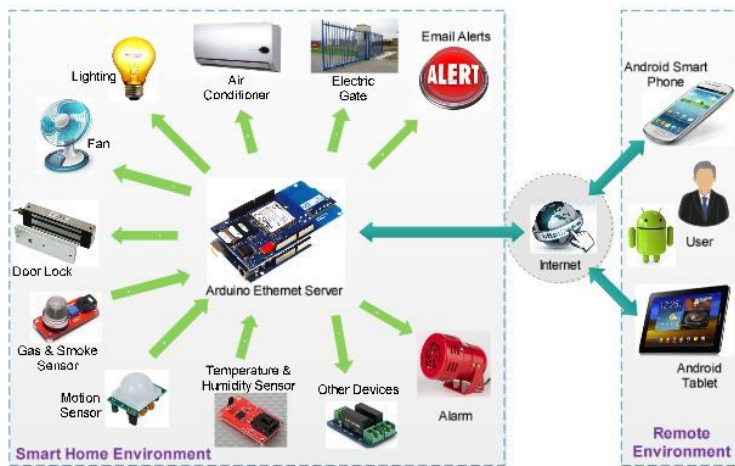


Figure 1. System Architecture of the proposed Ubiquitous Smart Home

## II-Bridge of the System

### 1- Node-MCU(ESP8266)

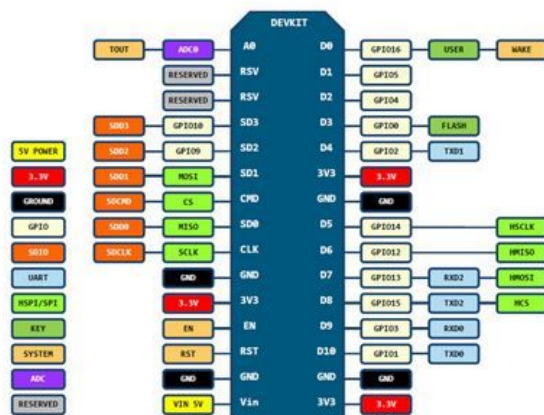
Node-MCU is an open source IOT platform. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. Some creative ESP8266 enthusiasts have developed an Arduino core for the ESP8266 Wi-Fi SoC that is available at the GitHub ESP8266 Core webpage. This is what is popularly called the "ESP8266 Core for the Arduino IDE" and it has become one of the leading software development platforms for the various ESP8266 based modules and development boards, including Node-MCU. It is a bridge of the whole system through which we

are connecting the mobile app and the hardware part. There is Wi-Fi pin which is recognized by mobile app and mobile app connects with it.



NODEMCU(ESP8266)

#### PIN DEFINITION



### **III-Web/app used to execute the system**

#### **1- Mobile App**

A mobile app or mobile application is a computer program or software application designed to run on a mobile device such as a phone/tablet or watch. Apps were originally intended for productivity assistance such as Email, calendar, and contact databases, but the public demand for apps caused rapid expansion into other areas such as mobile games, factory automation, GPS and location based services, order-tracking, and ticket purchases, so that there are now millions of apps available.

In this project we are using android app where we are executing the whole system with the help of mobile app. It is connected through Wi-Fi connection with Node-MCU and through this Wi-Fi module it is running each and every part whether it is checking the members in the house or doing lights on or off or any function which system is hoping can be done through app.

#### **IV- MOTION DETECTION UNIT**

##### **1- IR Sensor Pair**

IR sensors allow you to sense motion, almost always used to detect whenever a human has moved in or out of the home. They are small, inexpensive, low-power, easy to use and don't wear out. It does this sensing by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion.

These sensors are at the entry and exit of the smart-home so that whenever a person enters or exit it is noted by sensors and total number of members are displayed on the LCD screen.



IR LED Pair



## 2- DC Motor

The DC motor is a machine that transforms electric energy into mechanical energy in form of rotation. Its movement is produced by the physical behaviour of electromagnetism. DC motors have inductors inside, which produce the magnetic field used to generate movement.

A motor is an electrical machine which converts electrical energy into mechanical energy.

The principle of working of a DC motor is that "whenever a current carrying conductor is placed in a magnetic field, it experiences a mechanical force". The direction of this force is given by Fleming's left-hand rule and its magnitude is given by  $F = BIL$ . Where,  $B$  = magnetic flux density,  $I$  = current and  $L$  = length of the conductor within the magnetic field.

In this project we are using it to perform any task e.g.: filling the water in the tank

.It is handled with the app. As it is done with the job alarm starts to buzz.



DC Motor

### 3- PIEZO BUZZER ALARM

A piezoelectric element is a crystal or ceramic that deforms slightly when a voltage is applied to it. So, if you supply an AC voltage at a few kilohertz, it deforms back and forth at the same speed as the AC signal and produces an audible sound. The same effect works in reverse. If you deform a piezo, it generates a voltage. This was the principle of “crystal” microphones and gramophone pickups, probably before your time.

In this project, we are using it to give a signal to stop the motor. When dc motor has done its job and water is filled alarm job is to buzz. When alarm makes sound, motor is switched off manually



PIEZO BUZZER ALARM

## **V- Other components**

### **1-LCD Screen**

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in colour or monochrome.

It displays the number of members in the home with the help of IR sensors. It increases when a person gets in; get notified because of IR sensor at the gate and decreases when person exits due to IR sensor at the exit gate.

### **2-LEDs**

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode that emits light when activated. When a suitable current is applied to the leads, electrons can recombine with electron holes within the device, releasing energy in the form of photons. The low energy consumption, low maintenance and small size of LEDs has led to uses as status indicators and displays on a variety of equipment and installations. This will also be handled by app.

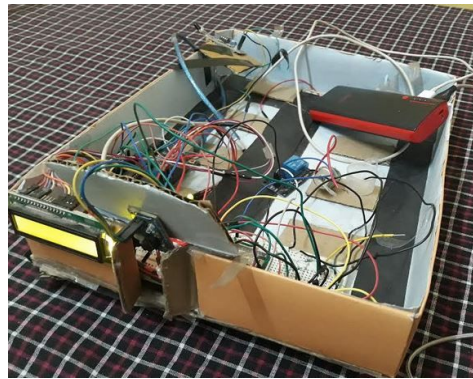
## ***SYSTEM WORKING***

The working of the system consisting of above components implement the smart home. Arduino-UNO which is the centre of the system gets executed by app with the help of NODE-MCU. A Wi-Fi-based home automation system uses a NODE-MCU and mobile app that manages the connected home devices. The users can manage and control the system through mobile app to monitor remotely. NODE-MCU is a bridge of the whole system through which we are connecting the mobile app and the hardware part. There is Wi-Fi pin which is known by mobile app and mobile app connects with it. The android app gets connected through Wifi connection with Node-MCU and through this Wi-Fi module it is running each part whether it is checking the members in the house or doing lights on or off or any function which system is hoping can be done through Application. The IR sensors at the entry and exit of the home are set up so that whenever a person enters or exit it is noted by sensors and total number of members are displayed on the LCD screen. LCD screen count increases by 1 when a person gets in; gets notified because of IR sensor at the gate and decreases when a person exits due to the IR sensor at the exit gate. We are using dc motor execute any task for e.g.: filling the water in the tank. It is handled with the app. As it is done with the job alarm starts to buzz. We are using it to give a signal to stop the motor. When alarm makes sound motor is switched off manually.

## *Hardware Circuit*



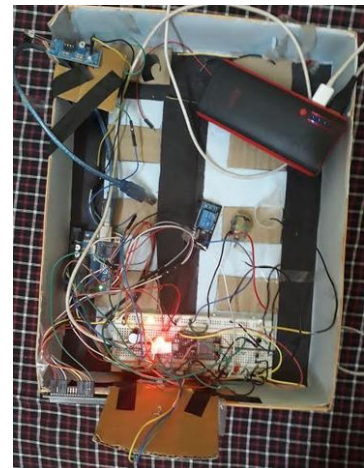
#1 Counting of members inside the house and display it on the LCD screen continuously.



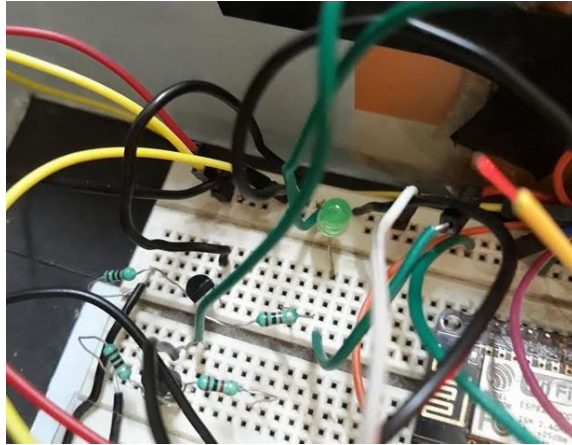
#2 Room light regulated by mobile app and glows according to the no. of members present inside the house in the current situation.

#3 A DC motor which resembles water tank motor.

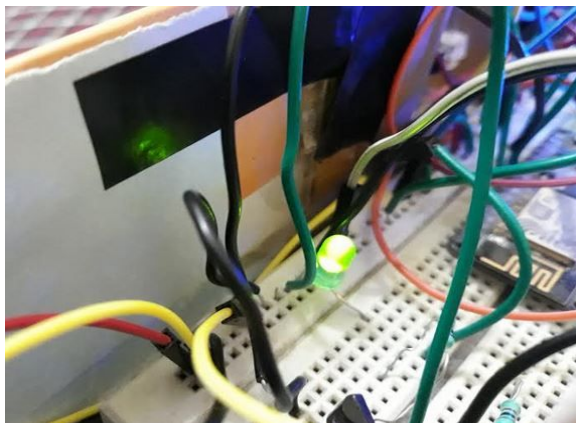
#4 Water tank level measuring and the alarm is raised when the tank is full sending instructions to the mobile Application for the user to pay attention to it.



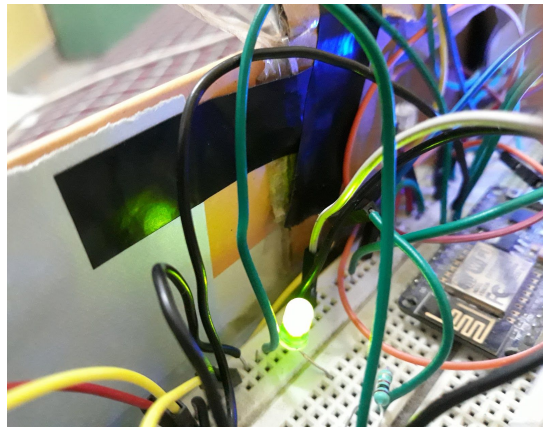
#Room light intensity when-



*Switch Off or No Person in room*



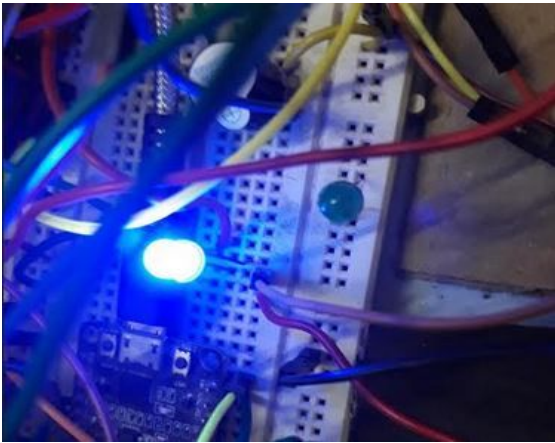
*1 people in room*



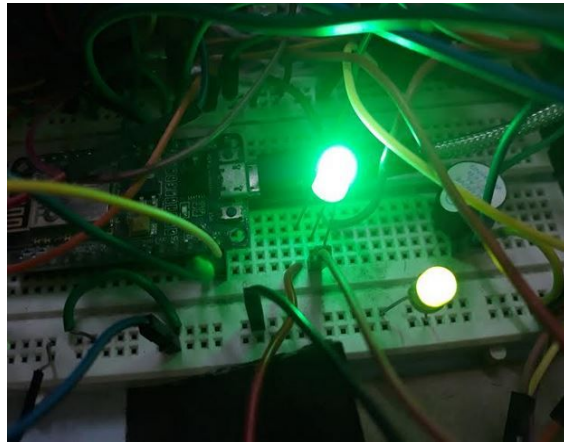
*6 or more people in room*



#Light intensity when DC Motor is-

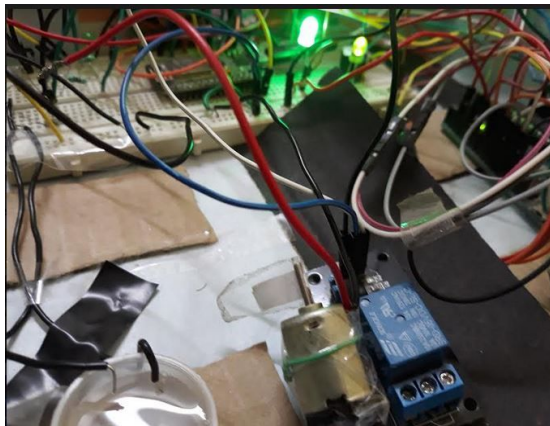


*Motor-OFF*

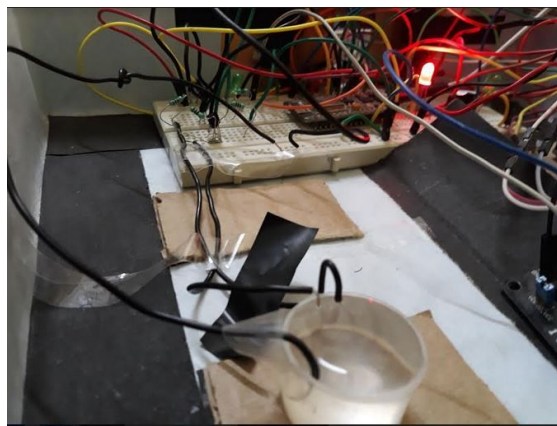


*Motor-ON*

#Light when Water tank is-



*Water tank is not fulfilled*



*water tank fulfilled*

## *Mobile App working*

### #1 Login Portal

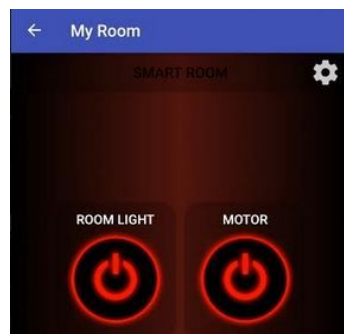
My Room	
UserName:	<input type="text"/>
Password :	<input type="password"/>
IP Address:	<input type="text" value="192.168.43.53"/> <input type="button" value="SET"/>
<input type="button" value="LOGIN"/>	

My Room	
UserName:	<input type="text" value="Nodemcu"/>
Password :	<input type="password" value="*****"/>
IP Address:	<input type="text" value="192.168.43.53"/> <input type="button" value="SET"/>
<input type="button" value="LOGIN"/>	
Connected!!	

Login portal

Authentication Granted

### #2 Switch buttons initially OFF





### #3 water motor-ON



Water Tank - Empty

Water Tank - Half Filled

Water Tank - Full Filled

### #4 Room Light ON



# Codes

## *-- Hardware Code in Arduino --*

```
#include<LiquidCrystal.h>

LiquidCrystal lcd(2,4,6,8,10,12);

int c=0,a=0,i=0,value=40,b=0,g=0;

void setup()

{

  Serial.begin(9600);

  lcd.begin(16,2);

  pinMode(9,OUTPUT);           // analog led output

  pinMode(11,INPUT);

  pinMode(13,INPUT);

  pinMode(7,OUTPUT);           // green signal when MOTOR is ON

  pinMode(5,OUTPUT);           // red signal for DANGER

  pinMode(A4,OUTPUT);           // blue signal when MOTOR is OFF

  pinMode(A0,OUTPUT);           // DC MOTOR OUTPUT

  pinMode(A1,OUTPUT);           // ALARM

  pinMode(A2,INPUT);           // DC MOTOR INPUT from D8(APP)

  pinMode(A3,INPUT);           // ANALOG LED INPUT from D7(APP)

  pinMode(3,INPUT);           // WHEN TANK IS FULL!!

  lcd.print("MEMBERS IN HOUSE");

  lcd.setCursor(0,1);

  lcd.print("ENTRY STARTS");

}
```

```

void loop()

{

  int N,M,X,Y,Z;

  if(c>0)

    M=digitalRead(11);           //EXIT GATE

    N=digitalRead(13);           //ENTRY GATE

    Z=digitalRead(3);             // TANK IS FULL

    X=analogRead(A2);             //DC MOTOR INPUT

    Y=analogRead(A3);             //ANALOG LED INPUT

    if(X>750)

    {

      digitalWrite(A0,HIGH);

      Serial.println("HELLO11");

      Serial.println(A0);

      if(g!=1)

      {

        digitalWrite(5,0);

        digitalWrite(7,1);

        digitalWrite(A4,0);

      }

      if(Z==1) {                  // Raise the alarm when the tank is full

        digitalWrite(A1,HIGH);

        digitalWrite(7,0);

        digitalWrite(5,1);

        digitalWrite(A4,0);

        g=1;

```

```

    }

    if (Z==0)           // again if tank is not full
{
    digitalWrite(A1,LOW);

    g=0;

    }
}

else if(X <=750){

    digitalWrite(A1,LOW);

    digitalWrite(A0,LOW);

    digitalWrite(A4,1);

    digitalWrite(7,0);

    digitalWrite(5,0);

    g=0;

}

if(N==1 && a!=1 )

{c++;

    i=i+value;

    lcd.clear();

    lcd.print("ONE PERSON ENTERS IN HOUSE");

    delay(1000);

    lcd.clear();

    lcd.print("MEMBERS IN HOUSE");

    lcd.setCursor(0,1);

    lcd.print(c);


if(i>=0 && Y>750)

```

```

    analogWrite(9,i);

a=1;

}

if(N==0){

    a=0;  }

if(M==1 && b!=1)

{ c--;

    i=i-value;

    lcd.clear();

    lcd.print("ONE PERSON LEAVES THE HOUSE");

    delay(1000);

    lcd.clear();

    lcd.print("MEMBERS IN HOUSE");

    lcd.setCursor(0,1);

    lcd.print(c);

if(i>=0 && Y>=750)

    analogWrite(9,i);

b=1;  }

if(M==0){

    b=0;}

if(Y<750)           // light OFF from APP

    analogWrite(9,LOW);

delay(500);

}           // END of HARDWARE CODE in ARDUINO

```

## *-- Nodemcu ESP8266 code --*

```
#include <ESP8266WiFi.h>
```

```
#include <ESP8266WebServer.h>
```

```
//Our Wi-Fi ssid and password
```

```
char* ssid = "#Saksham";
```

```
char* password = "havefun!!";
```

```
// username and password for login page in app
```

```
String user = "Nodemcu";
```

```
String key = "nodemcu";
```

```
//initializing variables
```

```
String room_light = "0";
```

```
String mirror_light = "0";
```

```
String tank_half= "0";
```

```
String tank_full = "0";
```

```
String bed_light = "0";
```

```
String fan = "0";
```

```
int tank_half_int= 0;
```

```
int tank_full_int = 0;
```

```
int levels = 0;
```

```
int water_pin = 0;
```

```
static const uint8_t tank_full_pin= 14; //D5
```

```
static const uint8_t tank_half_pin= 12; //D6
```

```
//static const uint8_t room_light_pin= 14; //D5
```

```
//static const uint8_t mirror_light_pin= 12; //D6
```

```
static const uint8_t bed_light_pin= 13; //D7F
```

```
static const uint8_t fan_pin= 15; //D8
```

```
ESP8266WebServer server; //server variable
```

```
void setup() {
```

```
    initializePin(); //call function
```

```
    //Making Connection With network
```

```
    WiFi.begin(ssid, password);
```

```
    Serial.begin(115200);
```

```
    Serial.print("Searching Connection");
```

```
    while (WiFi.status() != WL_CONNECTED) {
```

```
        Serial.print(". ");
```

```
        delay(500);
```

```
    }
```

```
    Serial.println("");
```

```
    Serial.print("IP Address: ");
```

```
    Serial.print(WiFi.localIP());
```

```
    serverSection();
```

```
}
```

```
void loop() {
```

```
    // calling function for checking water in tank
```

```
check_tank();

// put your main code here, to run repeatedly:

server.handleClient();

/*if(levels < 50)

    people = "0";

else if (levels < 100 && levels > 50)

    people = "1";

else if (levels < 150 && levels > 100)

    people = "2"; */

Serial.println(levels);
}
```

```
// for to check tank

void check_tank(){

    tank_full_int = digitalRead(tank_full_pin);

    tank_half_int = digitalRead(tank_half_pin);

    if(tank_full_int == 0){

        tank_full = "0";

        Serial.println("full off");

    }

    else{

        tank_full = "1";

        Serial.println("full on");

    }

    if(tank_half_int == 0)

        tank_half = "0";
```



```
else{  
  
    tank_half = "1";  
  
    Serial.println("half on");  
  
}
```

```
}
```

```
// initializing hardware I/O pins
```

```
void initializePin(){
```

```
    pinMode( tank_full_pin, INPUT);
```

```
    pinMode(tank_half_pin,INPUT);
```

```
// pinMode(room_light_pin, OUTPUT);
```

```
// pinMode(mirror_light_pin, OUTPUT);
```

```
    pinMode.bed_light_pin, OUTPUT);
```

```
    pinMode(fan_pin, OUTPUT);
```

```
// digitalWrite(room_light_pin, LOW);
```

```
// digitalWrite(mirror_light_pin, LOW);
```

```
    digitalWrite.bed_light_pin, LOW);
```

```
    digitalWrite(fan_pin, LOW);
```

```
    levels = analogRead(A0);
```

```
}
```

```
// connectivity for connecting server
```

```
void serverSection(){
```

```
    server.on("/", []() {
```

```
server.send(200, "text/html", "<!DOCTYPE html><html><meta charset='UTF-8'><head></head><body><h2>Smart  
Room</h2><h3><a href='/bed_light'>Bed Light</a></h3><br><h3><a href='/fan'>Fan or Motor</a></h3><br></body></html>");  
});
```

```
// server.on("/room_light", room_light_state);  
  
//server.on("/mirror_light", mirror_light_state);  
  
server.on("/bed_light", bed_light_state); // if bed_light requested call bed_light_state function  
  
server.on("/fan", fan_state);  
  
server.on("/security", security);  
  
server.on("/status", all_state);  
  
server.begin();  
  
}
```

```
/*void room_light_state(){  
  if(room_light == "0"){  
    room_light = "1";  
    digitalWrite(room_light_pin, HIGH);  
    server.send(200, "text/html", room_light);  
  }else{  
    room_light = "0";  
    digitalWrite(room_light_pin, LOW);  
    server.send(200, "text/html", room_light);  
  }  
}  
  
*/  
  
/*void mirror_light_state(){
```

```

if(mirror_light == "0"){

    mirror_light = "1";

    digitalWrite(mirror_light_pin, HIGH);

    server.send(200, "text/html", mirror_light);

}else{

    mirror_light = "0";

    digitalWrite(mirror_light_pin, LOW);

    server.send(200, "text/html", mirror_light);

}

}*/

//To check change status of bedlight
void bed_light_state(){

    if(bed_light == "0"){

        bed_light = "1";

        digitalWrite(bed_light_pin, HIGH);

        server.send(200, "text/html", bed_light);

        Serial.println("light on");

    }else{

        bed_light = "0";

        digitalWrite(bed_light_pin, LOW);

        server.send(200, "text/html", bed_light);

    }

}

}

// to change status of motor
void fan_state(){

    if(fan == "0"){

```

```

        fan = "1";

        digitalWrite(fan_pin, HIGH);

        server.send(200, "text/html", fan);

        Serial.println("motor on");

    }else{

        fan = "0";

        digitalWrite(fan_pin, LOW);

        server.send(200, "text/html", fan);

    }

}

// sending status data to App

void all_state(){

    server.send(200, "text/html",

    "{"'rl':""+room_light+"",'ml':""+mirror_light+"",'bl':""+bed_light+"",'batHalf':""+tank_half+"",'batFull':""+tank_full+"",'fan':""+fan+""}");

}

//login page details call

void security(){

    server.send(200, "text/html", "{"'user':""+user+"",key:""+key+""}");

}

```

-- IOT Smart Home Android App Details --

*Project Shared on Google Drive*

Link- <https://drive.google.com/drive/folders/1e-fj6HUYvnnqecJja2BevsSSTAUxR3f0>

# *Reference*

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