Project: Temperature & Humidity Monitoring and controlling.

Name: Karim Ayyad.

Abstract:

- Due many challenges, it is required to monitor and control temperature and humidity through internet as it get high in many crucial situations such as power-plants, IT-Servers or even for medical and scientific use where controlling the temperature is a mandatory. This project is developed to work as a temperature alarm with multiple procedures to be taken automatically or manually and monitoring the current temperature and humidity connected to an android application. The project (i.e. the device and the application) needs internet connection for sending or receiving the data between the device and the application, also for sending the warning email, in case of reading a critical temperature, which is submitted to the device before, and take automatically a procedure such as turning an air-conditioner on to cool the ambient. Naturally the application makes the user able to control the device.

1. Introduction:

- The project consists of two main parts and both of them communicate with each other. They are the hardware and the android application. They are connected through internet to communicate with each other using an external IoT (Internet of Things) cloud server.

- The sensor in the hardware reads the ambient temperature and humidity, then display it over an LCD and update the values on the android application through Ethernet. It also has 6 digital outputs to control other devices. In addition, there is an email message will be sent in case of over temperature. To achieve this, the hardware is connected to the IoT cloud server and an external server for sending emails automatically.

- Unlike the hardware, the android application is connected only to the IoT server. It also has a user-friendly UI (user interface) which monitors the received temperature and humidity from the device and has 12 radiobuttons (represent outputs and their states).

2. Hardware:

- The core of the hardware is an open-source Arduino Uno, a microcontroller board. An Ethernet shield is added to connect the internet. A temperature and humidity sensor is connected to the hardware to read. An LCD was added to monitor the relative humidity and temperature.

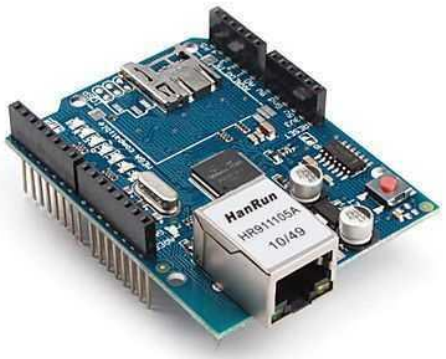
- The hardware is connected to two external servers. The first is SMTP2GO.com, which is used to send mails. The other is Thingspeak.com, an IoT cloud server, used to transfer the data between the Thingspeak.com and the android mobile application.

2.1. Components:

2.1.1. Arduino Uno R3:

- It is an open-source microcontroller that could be programmed by C++ with the official IDE software. Arduino have analog and digital I/O. Interfacing them lead to write and read data from different types of sensors or switches.

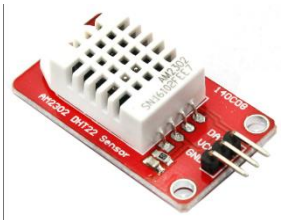
2.1.2. W5100 Ethernet shield:



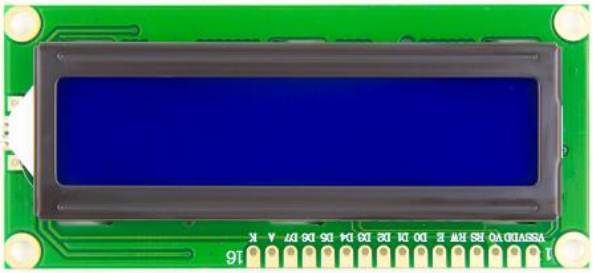
- It’s an Ethernet shield that has RJ45 port to connect to internet. It also has a micro SD card that could store the log of the connection.

2.1.3. DHT22 sensor :

- It’s a temperature and humidity sensor that has 3 pins and requires a power of 3-5v.



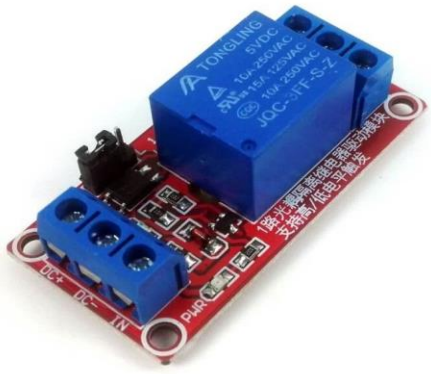
2.1.4. 1602A LCD :



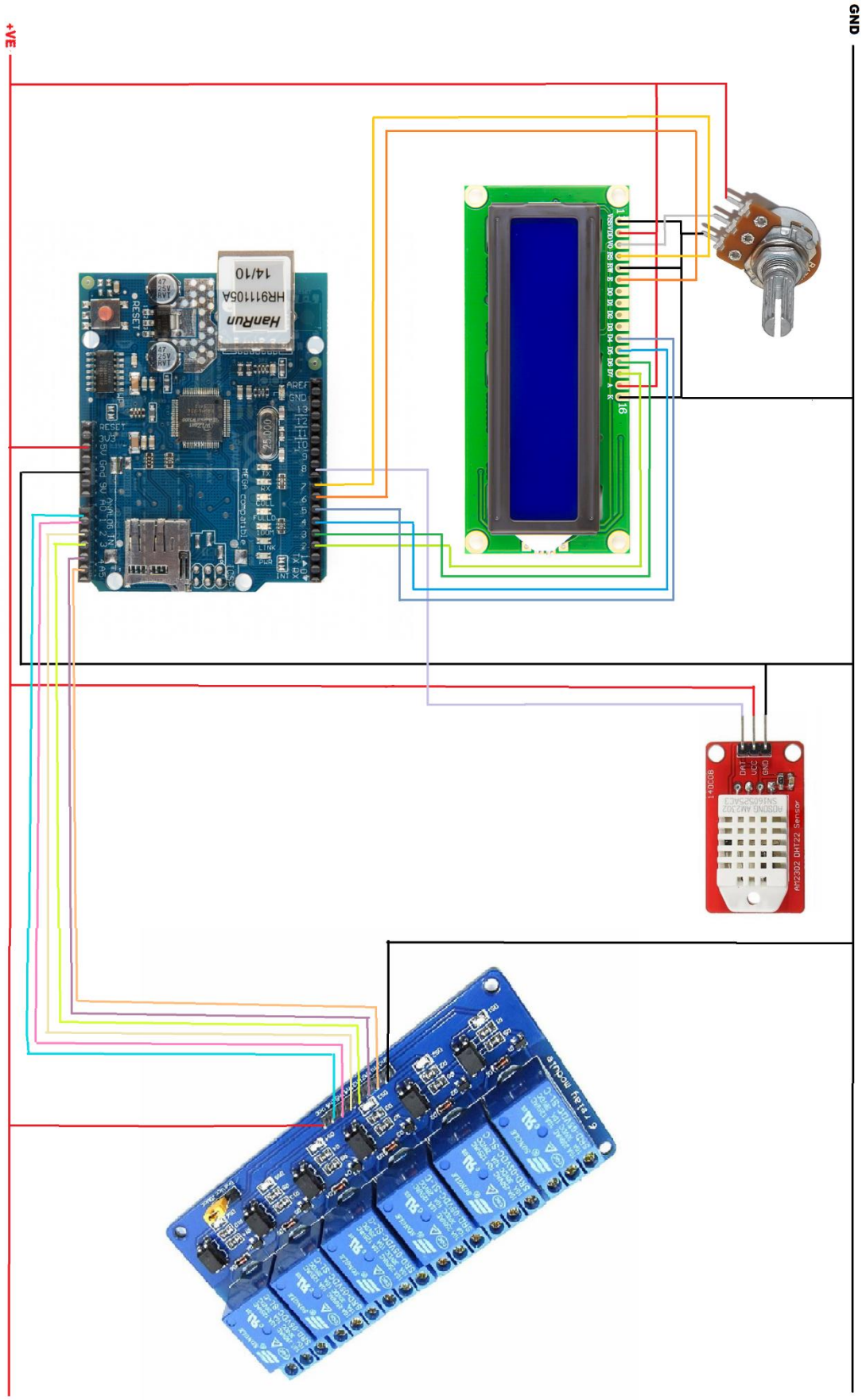
- It’s an industrial character type LCD that can show 16*2, i.e. 32 characters. It has 16 pins that are connected to the Arduino. Pin 2 (third pin) is connected through a potentiometer to adjust the contrast.

2.1.5. Relay module:

- Relays are electromechanical compenents used in controlling. Basically it has a normally-opened point and a normally-closed point. It has 3 input pins, two of them are for power (5v-GND) and the third one is for the input signal from the 6 pins which is being controlled by the application.



2.2. Diagram:

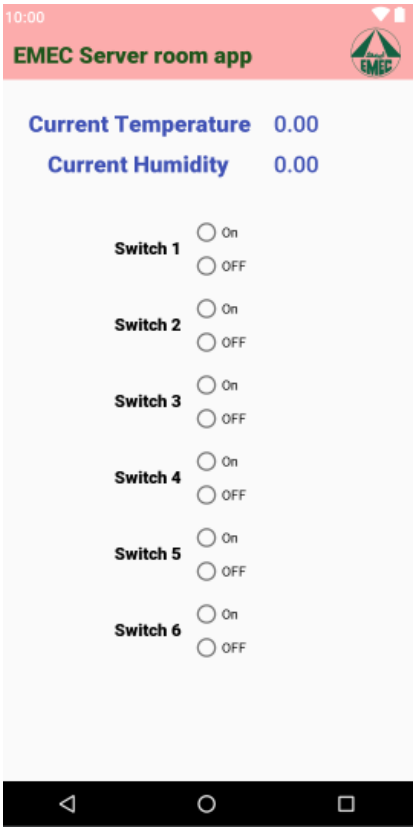


2.3. Bill of Materials:

Type	Price/unit (CZK)	Quantity
Arduino Uno R3	200	1
W5100 Ethernet Shield	580	1
LCD 1602A	119	1
DHT22 sensor	115	1
Potentiometer 10k Ohm	14	1
Jumpers F-M 20cm	2	40
Jumpers F-F 20cm	2	40
Plastic Box 158×90×46	180	1
220Ohm 1/2watt Resistors	1	10
Relay Module 5Vdc – 6 channels	126	1
Total =	1504	

Table1. (The total cost of the device)

3. The android mobile application:



- The application was programmed in Java using Android Studio. It's connected only to the Thingspeak.com server.

- It consists of 12 radiobuttons (a two-state button that can be either checked or unchecked.) that represent state of 6 pins (the relays would be connected to the pins) allowing the user to control them.

- It also has two textviews (an element displays text to the user) connected directly to

the cloud server monitoring the current temperature and humidity.

4. Appendix:

- C++ Arduino code:

```
//Libraries
#include "ThingSpeak.h"
#include <SPI.h>
#include <Ethernet.h>
#include <dht.h>
#include <LiquidCrystal.h>

LiquidCrystal lcd(7, 6, 5, 4, 3, 2);
#define DHT22_PIN 8
dht DHT;
//Variables
bool sent = false; //flag variable to insure that the mail was succefully sent
int number = 0; //in case of errors updating IoT channel

// the server to send mail
char server[] = "mail.smtp2go.com";




byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
// change network settings to yours
// the dns server ip
IPAddress dnServer(-, -, -, -);
// the router's gateway address:
IPAddress gateway(-, -, -, -);
// the subnet:
```

```
IPAddress subnet(-, -, -, -);
//the IP address is dependent on your network
IPAddress ip(-, -, -, -);



EthernetClient client;


void setup()
{ Serial.begin(9600);
  lcd.begin(16, 2);


  lcd.setCursor(0, 0);
  lcd.print("Temp:  Humidity:");


  // Declare the following pins as an output
  pinMode (A0, OUTPUT);
  pinMode (A1, OUTPUT);
  pinMode (A2, OUTPUT);
  pinMode (A3, OUTPUT);
  pinMode (A4, OUTPUT);
  pinMode (A5, OUTPUT);
  Ethernet.begin(mac, ip, dnServer, gateway, subnet);
  ThingSpeak.begin(client);


}
```

```
void loop() {
  while (true)
  { //writing channel id and api write  key
    int x = ThingSpeak.writeFields(--------, "The write api key");

    delay(15000); // Wait 15 seconds to update the channel again
    //receiving data from thingspeak channel and show the feedback on pin
    //channel id , field, readapikey
    int i1 = ThingSpeak.readIntField((--------,, 1, "The read api key");
    int i2 = ThingSpeak.readIntField((--------,, 2, "The read api key");
    int i3 = ThingSpeak.readIntField((--------,, 3, "The read api key");
    int i4 = ThingSpeak.readIntField((--------,, 4, "The read api key");
    int i5 = ThingSpeak.readIntField((--------,, 5, "The read api key");
    int i6 = ThingSpeak.readIntField((--------,, 6, "The read api key");
    //declaring a feedback
    int currentStatus1, currentStatus2, currentStatus3, currentStatus4,
currentStatus5, currentStatus6 ;
    //receiving from app to control the pins
    if (i1 == 1)
    { digitalWrite(A0, HIGH);
      currentStatus1 = 1;
    }
    else   {
      digitalWrite(A0, LOW);
      currentStatus1 = 0;
    }
    if (i2 == 1)
    { digitalWrite(A1, HIGH);
      currentStatus2 = 1;
    }
    else   {
```

```
  digitalWrite(A1, LOW);
  currentStatus2 = 0;
}
if (i3 == 1)
{ digitalWrite(A2, HIGH);
  currentStatus3 = 1;
}
else   {
  digitalWrite(A2, LOW);
  currentStatus3 = 0;
}
if (i4 == 1)
{ digitalWrite(A3, HIGH);
  currentStatus4 = 1;
}
else   {
  digitalWrite(A3, LOW);
  currentStatus4 = 0;
}
if (i5 == 1)
{ digitalWrite(A4, HIGH);
  currentStatus5 = 1;
}
else   {
  digitalWrite(A4, LOW);
  currentStatus5 = 0;
}
if (i6 == 1)
{ digitalWrite(A5, HIGH);
  currentStatus6 = 1;
}
else   {
```

```
      digitalWrite(A5, LOW);
      currentStatus6 = 0;
    }




    // set the cursor to column 0, line (note: line 1 is the second row, since
counting begins with 0):
    lcd.setCursor(0, 1);


    int chk = DHT.read22(DHT22_PIN);
    //Read data and store it to variables hum and temp


    // read humidity
    float hum = DHT.humidity;


    //read temperature in Celisius
    float temp = DHT.temperature;


    //Print on LCD the values
    lcd.print(temp);
    lcd.setCursor(7, 1);
    lcd.print(hum);


    //Print on serial the values
    Serial.print("Humidity: ");
    Serial.print(hum);
    Serial.print(" %, Temp: ");
    Serial.print(temp);
    Serial.println(" Celsius");
```

```
//sending feedback to IoT server and the reads of DHT22
ThingSpeak.setField(1, temp);
ThingSpeak.setField(2, hum);
ThingSpeak.setField(3, currentStatus1);
ThingSpeak.setField(4, currentStatus2);
ThingSpeak.setField(5, currentStatus3);
ThingSpeak.setField(6, currentStatus4);
ThingSpeak.setField(7, currentStatus5);
ThingSpeak.setField(8, currentStatus6);
//checking conncetion
if (x == 200) {
  Serial.println("Channel update successful.");
}
else {
  Serial.println("Problem updating channel. HTTP error code " + String(x));
}

number++;
if (number > 99) {
  number = 0;
}

// The reset condition
if (temp < 27)
{
  sent = false;
}



//The condition of the critical Temperature or humidity
```

```
    if (temp >= 30)
    { //flag
      if (sent == true) continue;
      //send
      sendEmail();
      sent = true;
    }



  }


}



byte eRcv()
{
  byte respCode;
  byte thisByte;
  int loopCount = 0;

  while (!client.available()) {
    delay(1);
    loopCount++;

    // if nothing received for 10 seconds, timeout
    if (loopCount > 10000) {
      client.stop();
      Serial.println(F("\r\nTimeout"));
```

```
      return 0;
    }
  }

  respCode = client.peek();

  while (client.available())
  {
    thisByte = client.read();
    Serial.write(thisByte);
  }

  if (respCode >= '4')
  {
    efail();
    return 0;
  }

  return 1;
}



void efail()
{
  byte thisByte = 0;
  int loopCount = 0;

  client.println(F("QUIT"));

  while (!client.available()) {
    delay(1);
    loopCount++;
```

```
    // if nothing received for 10 seconds, timeout
    if (loopCount > 10000) {
      client.stop();
      Serial.println(F("\r\nTimeout"));
      return;
    }
  }

  while (client.available())
  {
    thisByte = client.read();
    Serial.write(thisByte);
  }

  client.stop();

  Serial.println(F("disconnected"));
}



byte sendEmail()
{
  byte thisByte = 0;
  byte respCode;
  { //connecting
    client.connect(server, 25);
    //checking connection
    if (client.connected()) {
      Serial.println("connected");
    } else {
```

```
  Serial.println(F("connection failed"));
  return 0;
}

if (!eRcv()) return 0;

Serial.println(F("Sending hello"));
// replace -.-.-.- with your Arduino's ip
client.println("EHLO -.-.-.-");

if (!eRcv()) return 0;

Serial.println(F("Sending auth login"));
client.println("auth login");
if (!eRcv()) return 0;

Serial.println(F("Sending User"));
// Change to your base64 encoded user
client.println(F("-------------------------"));

if (!eRcv()) return 0;

Serial.println(F("Sending Password"));
// change to your base64 encoded password
client.println(F("--------------------"));

if (!eRcv()) return 0;
// change to your email address (sender)
Serial.println(F("Sending From"));
client.println("MAIL From: <---------@------.--->");
if (!eRcv()) return 0;
```

```
  // change to recipient address
  Serial.println(F("Sending To"));
  client.println("RCPT To: <---------@------.--->");
  if (!eRcv()) return 0;

  Serial.println(F("Sending To"));
  client.println("RCPT To: <---------@------.--->");
  if (!eRcv()) return 0;



  // change to recipient address
/*      Serial.println(F("Sending To"));
   client.println("RCPT To: <---------@------.--->");
  if (!eRcv()) return 0;
  // change to recipient address
  Serial.println(F("Sending To"));
  client.println("RCPT To: <---------@------.--->");
  if (!eRcv()) return 0;
*/
  Serial.println(F("Sending DATA"));
  client.println("DATA");
  if (!eRcv()) return 0;

  Serial.println(F("Sending email"));

  // change to recipient address
  client.println("To: ----- ----- <---------@------.--->");
  client.println("To: ----- ----- <>");

  //  client.println("To: ----- ----- <---------@------.--->");
  //  client.println("To: ----- ----- <---------@------.--->");
```

```
    // change to your address
    client.println("From: ----- ----- <---------@------.--->");

    client.println("Subject: Warning temperature of server room");
    client.println("Warning : Temperature exceeded 26C");

    client.println("Current Temperature :");
    client.println(DHT.temperature);
    client.println("and current humidity :");
    client.println(DHT.humidity);
    client.println(".");

    if (!eRcv()) return 0;

    Serial.println(F("Sending QUIT"));
    client.println("QUIT");
    if (!eRcv()) return 0;

    client.stop();

    Serial.println(F("disconnected"));

    return 1;

  }
}
```

- Application Layout:

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:id="@+id/EMECControlApp."
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:background="#ECECEC"
    tools:context=".MainActivity">


    <TextView
        android:id="@+id/temperatureTxt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="30dp"
        android:layout_marginTop="35dp"
        android:fontFamily="sans-serif-black"
        android:text="Current Temperature"
        android:textColor="#3F51B5"
        android:textSize="24sp"
        tools:layout_editor_absoluteY="40dp" />

    <TextView
        android:id="@+id/humidityTxt"
        android:layout_width="wrap_content"

        android:layout_height="wrap_content"
        android:layout_below="@+id/temperatureTxt"
        android:layout_marginLeft="50dp"
        android:layout_marginTop="10dp"
        android:fontFamily="sans-serif-black"
        android:text="Current Humidity"
        android:textColor="#3F51B5"
        android:textSize="24sp" />

    <TextView
        android:id="@+id/temperatureUpdate"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="24dp"
        android:layout_marginTop="35dp"
        android:layout_toRightOf="@+id/temperatureTxt"
        android:fontFamily="sans-serif-medium"
        android:text="0.00"
        android:textColor="#3F51B5"
        android:textSize="24sp"
        tools:layout_editor_absoluteY="40dp" />

    <TextView
        android:id="@+id/humidityUpdate"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/temperatureUpdate"
        android:layout_alignLeft="@+id/temperatureUpdate"
        android:layout_marginTop="10dp"
        android:layout_toRightOf="@+id/humidityTxt"
        android:fontFamily="sans-serif-medium"
```

```
        android:text="0.00"
        android:textColor="#3F51B5"
        android:textSize="24sp" />


    <RadioButton
        android:id="@+id/onBtn1"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="200dp"
        android:checked="false"
        android:focusable="auto"


        android:fontFamily="sans-serif"
        android:text="On" />

    <RadioButton
        android:id="@+id/offBtn1"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/onBtn1"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="3dp"
        android:checked="false"
        android:focusable="auto"
        android:text="OFF" />

    <TextView
        android:id="@+id/switch1Txt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="120dp"
        android:layout_marginTop="220dp"
        android:fontFamily="sans-serif-black"
        android:text="Switch 1"
        android:textColor="#000000"
        android:textSize="18sp"
        android:textStyle="bold" />

    <RadioButton
        android:id="@+id/onBtn2"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="280dp"
        android:checked="false"
        android:focusable="auto"
        android:fontFamily="sans-serif"
        android:text="On" />

    <RadioButton
        android:id="@+id/offBtn2"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/onBtn2"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="3dp"
        android:checked="false"
        android:focusable="auto"
```

```
        android:text="OFF" />

    <TextView
        android:id="@+id/switch2Txt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="120dp"
        android:layout_marginTop="300dp"
        android:fontFamily="sans-serif-black"
        android:text="Switch 2"
        android:textColor="#000000"
        android:textSize="18sp"
        android:textStyle="bold" />


    <RadioButton
        android:id="@+id/onBtn3"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="360dp"
        android:checked="false"
        android:focusable="auto"
        android:fontFamily="sans-serif"
        android:text="On" />



    <RadioButton
        android:id="@+id/offBtn3"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/onBtn3"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="3dp"
        android:checked="false"
        android:focusable="auto"
        android:text="OFF" />

    <TextView
        android:id="@+id/switch3Txt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="120dp"
        android:layout_marginTop="380dp"
        android:fontFamily="sans-serif-black"
        android:text="Switch 3"
        android:textColor="#000000"
        android:textSize="18sp"
        android:textStyle="bold" />

    <RadioButton
        android:id="@+id/onBtn4"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="440dp"
        android:checked="false"
        android:focusable="auto"
        android:fontFamily="sans-serif"
        android:text="On" />
```

```
    <RadioButton
        android:id="@+id/offBtn4"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/onBtn4"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="3dp"
        android:checked="false"
        android:focusable="auto"
        android:text="OFF" />

    <TextView
        android:id="@+id/switch4Txt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="120dp"
        android:layout_marginTop="460dp"
        android:fontFamily="sans-serif-black"
        android:text="Switch 4"
        android:textColor="#000000"
        android:textSize="18sp"
        android:textStyle="bold" />




    <RadioButton
        android:id="@+id/onBtn5"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="520dp"
        android:checked="false"
        android:focusable="auto"
        android:fontFamily="sans-serif"
        android:text="On" />

    <RadioButton
        android:id="@+id/offBtn5"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/onBtn5"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="3dp"
        android:checked="false"
        android:focusable="auto"
        android:text="OFF" />

    <TextView
        android:id="@+id/switch5Txt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="120dp"
        android:layout_marginTop="540dp"
        android:fontFamily="sans-serif-black"
        android:text="Switch 5"
        android:textColor="#000000"
        android:textSize="18sp"
        android:textStyle="bold" />
```

```
    <RadioButton
        android:id="@+id/onBtn6"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="600dp"
        android:checked="false"
        android:focusable="auto"
        android:fontFamily="sans-serif"
        android:text="On" />

    <RadioButton
        android:id="@+id/offBtn6"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_below="@+id/onBtn6"
        android:layout_marginLeft="200dp"
        android:layout_marginTop="3dp"
        android:checked="false"
        android:focusable="auto"
        android:text="OFF" />



    <TextView
        android:id="@+id/switch6Txt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_marginLeft="120dp"
        android:layout_marginTop="620dp"
        android:fontFamily="sans-serif-black"
        android:text="Switch 6"
        android:textColor="#000000"
        android:textSize="18sp"
        android:textStyle="bold" />

    <androidx.appcompat.widget.Toolbar
        android:id="@+id/toolbar1"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_alignParentStart="true"
        android:layout_alignParentTop="true"
        android:layout_marginStart="0dp"
        android:layout_marginTop="0dp"
        android:background="@color/colorPrimary"
        android:minHeight="?attr/actionBarSize"
        android:theme="?attr/actionBarTheme"
        app:titleMargin="15dp"
        app:titleTextAppearance="@style/TextAppearance.AppCompat.Large"
        app:titleTextColor="#1D501B" />

    <ImageView
        android:id="@+id/imageView7"
        android:layout_width="81dp"
        android:layout_height="89dp"
        android:layout_alignParentTop="true"
        android:layout_alignParentEnd="true"
        android:layout_marginTop="-17dp"
        android:layout_marginEnd="-2dp"
        app:srcCompat="@mipmap/ic_launcher_foreground" />
```

```
    <TextView
        android:id="@+id/introTxt"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:layout_alignParentStart="true"
        android:layout_alignParentTop="true"
        android:layout_marginStart="14dp"
        android:layout_marginTop="13dp"
        android:fontFamily="sans-serif-black"
        android:text="EMEC Server room app"
        android:textColor="#1E551B"
        android:textSize="24sp"
        android:textStyle="bold" />


</RelativeLayout>
```