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Smart automation based on IoT and GSM module

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ABSTRACT Automation is one of the most advancing section of the industry today. That too, coupled with the Internet of Things (IoT) becomes the most lucrative field of current times. Home automation using Bluetooth module has many constraints and because of that IoT based automation is on the rise. Presently, every system is becoming remote controlled, be it television sets, speakers or any other electronic system for that matter. In conventional control systems, a user was required to carry separate remote controls for different appliances. To overcome this, we have come up with a super convenient automation system with smart switching which can be controlled via Android OS phones. By this, the user will be able to control all the appliances with his/her smart phone. In addition to turning appliances ON/OFF, the user will be able to control and adjust the intensity and speed of the devices also. This is achieved by interfacing GSM and Wi-Fi module to the Arduino board and programming Android application to operate it.

KEYWORD Home Automation, Arduino, Android, GSM module, Internet of Things (IoT), Relay.hh

Introduction

In today's day and age, automation can be found everywhere. Everything is becoming automatic ranging from Cars, Lights, Fans, Television sets, refrigerators, Motors to elevators and doors. Even remotely automated toys are becoming technologically advanced. The concept of remotely controlled appliances is not new. Earlier, Automation systems were made with the help of Bluetooth module. But, it had many constraints like limited range and frequent connection issues. Now, with the emergence of cutting-edge technologies like IoT based automation, Automation industry is poised to achieve more heights. And more and more people are expected to adopt Automation for home as well as industrial systems. And because the devices are remotely connected and operated over the internet from anywhere in the world in the real-time it opens up many possibilities which were thought of as impossible in not so distant past.

Just imagine how much convenience it will cause to users if they can start their ACs in their offices from their home that way they can walk into the office in the atmosphere in which they want. This technology is already proving to be a boon for physically disabled people and aged people. It has improved their quality of life and given them somewhat independence by enabling them todo their work by themselves quite easily for which they might have needed help from the caretaker otherwise.

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Automation

The Merriam Webster dictionary defines automation as "the technique of making an apparatus, a process, or a system operate automatically." In simple words, it is lighting, heating and other electronic components of the home are controlled via the internet or by a smart phone. Automation can be of many types. But the most advanced and widely used type is the Internet of Things (IoT) based automation.

Internet of Things (IoT)

IoT is a broad term that can be defined in many ways. It is a term that is being thrown around by everyone, everywhere to sell their product or to sound technologically advanced.

In a broad sense, It is a network of physical objects or devices that connect and exchange data over the internet using either sensors, API or both.

In the simplest terms, the term IoT refers to everything that is connected to the internet.

IoT based home automation enables the user to control his/her appliances via a smart phone or via the internet irrespective of whether he/she is inside the home or outside. And due to the wide adoption of smart devices today, IoT is on the rise unparalleled to any other type of automation system. More than billions of objects or devices are connected via either private or public network which can sense, share

information, control appliances and communicate via the internet anywhere, anytime in IoT network. IoT has played a significant role in providing affordable and smart automation systems and it is instrumental behind the increased popularity of automation systems in general.

Architecture and components

We have made this system as simple as possible and also cost-effective because our targeted users are villagers. And it is no secret that sometimes farmers have to travel to their farms just to start a motor or other system. And in some remote areas, internet facility may not be available. So, keeping all these things in mind, we've designed our system in two variants. One is intended solely for farms while other is intended for general purpose.

Input-Output Limitations

Input will be in the form of AC and it will operate in the range of 220-250 Volts. And the power consumption for each module will be different as they need different amount of power to operate smoothly. For ESP8266 module, Arduino and GSM module it will be around 0.36W, 0.3W and 1.8W respectively.

Variant 1: GSM module based automation

Working: As discussed earlier, our project is all about providing smart automation system and an essential part of that system is providing SMS mechanism by which user can be sure whether the intended appliance has been turned on or off based on given command. As shown in the block diagram we had used a GSM module and Arduino Uno as main IOT devices which are responsible for the smart automation system. As shown in diagram GSM module and Arduino Uno are connected to each other so that they can send or receive signals when they required.

GSM module contains a SIM card. When a user wants to turn on or turn off various equipment's like Fan, LIGHT, PUMP, MOTOR, etc. then he/she has only to send an SMS to PRE-registered number i.e. the number of SIM card which is in the GSM module from their mobile phone. By sending an SMS to that number GSM module will receive that message and send a signal to the Arduino Uno and thus Arduino will provide a digital signalwhich is thus transferred to the control circuit. The control circuit will send a signal to the driver circuit and driver circuit will drive the relay and thus the selected device will turn on or turn off.

The GSM module and micro controller Arduino Uno are powered by different power supply from the single source using ICs because they need a different power supply to operate.

Load: Load includes all the appliances of the home.

Power Circuit: The purpose and function of power circuit is to create necessary power and transform a power as per the load requirement either AC or DC. The power circuit includes devices which can withstand high voltages and current. The devices through which a power circuit established are MOSFET, IGBT, SCR, TRIAC, RELAY, etc. the power circuit is

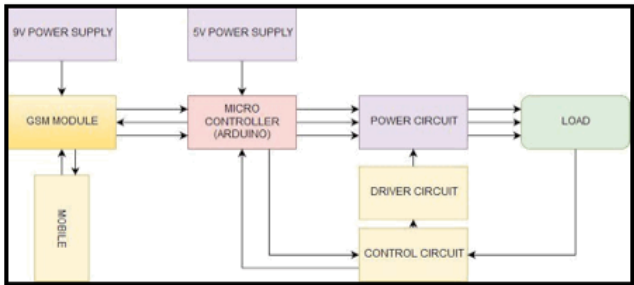Fig.1 Block diagram of GSM module based automation

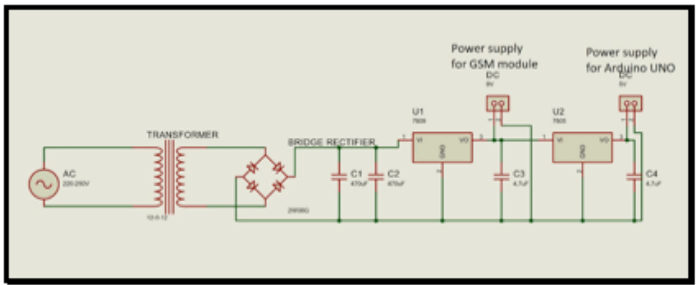Fig.2 Different Power supply from Single Source
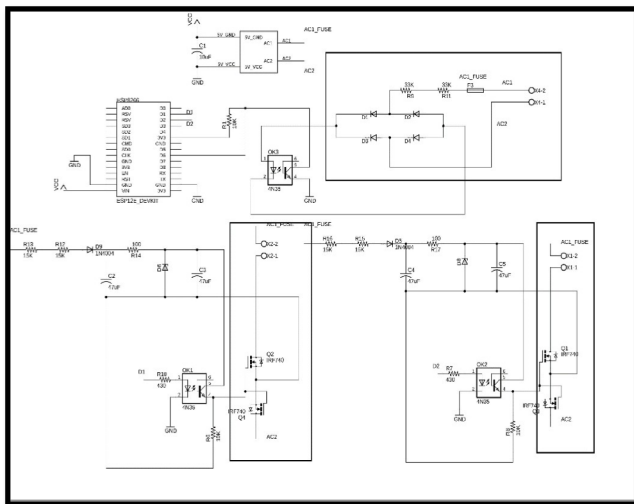

Fig. 3 Power Circuit 1
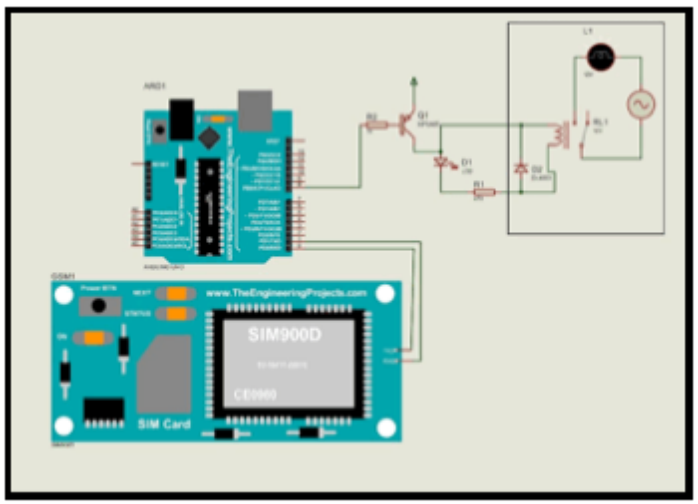

Fig. 4 Power Circuit 2
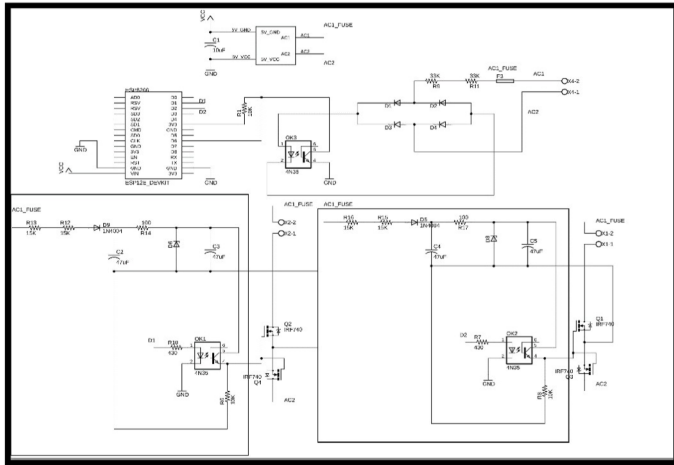
Fig. 5 Driver Circuit 1
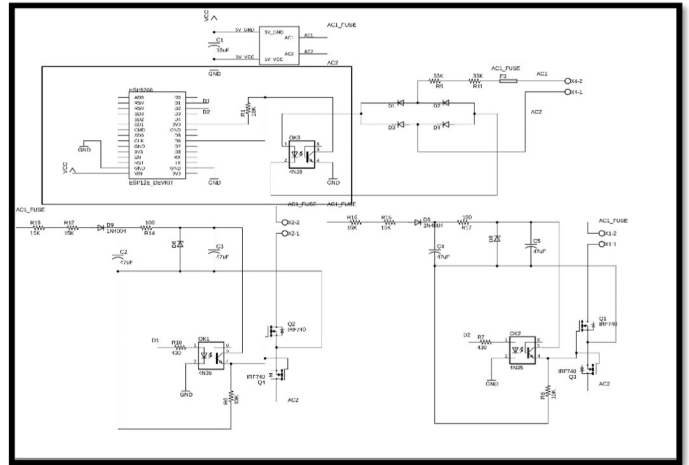
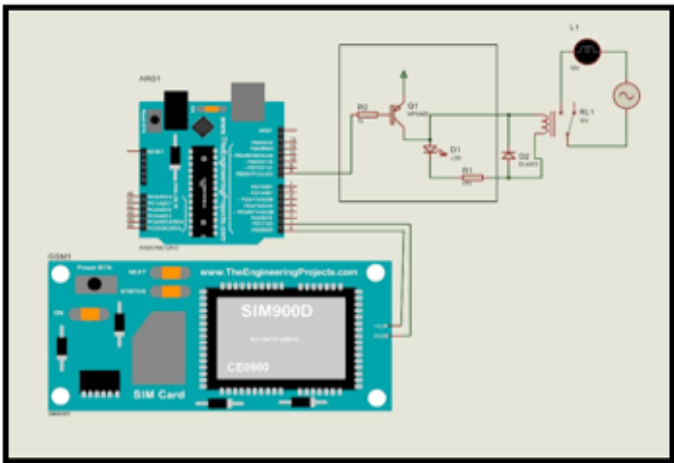

Fig. 7 Control Circuit 1
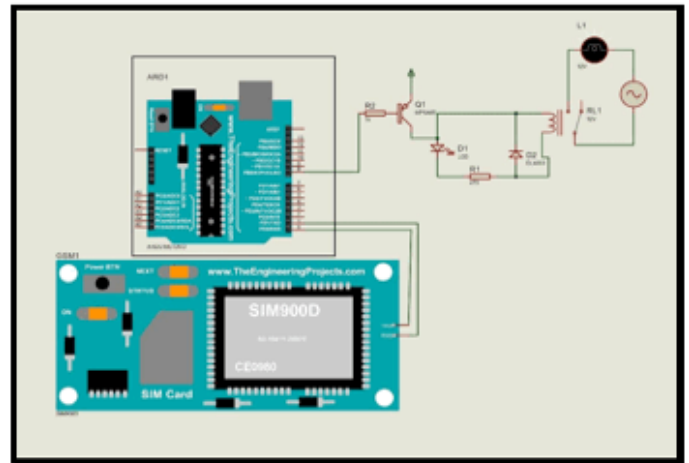

Fig. 6 Driver Circuit 2

Fig. 8 Control Circuit 2

either connected to the AC mains or can be powered through high voltage DC source i.e. BATTERY (Mohan et al., 2007).

Driver Circuit: Driver circuit is usually being used to drive a power circuit since power circuit works on high power and control circuit works on low power so driver circuit isolate both so that both circuit can be protected.

Control Circuit: Control circuit is a low voltage/ current circuit that "controls" larger voltages and currents that supply power to equipment. The functionality of a control circuit is to control the operation of power circuit. They generally include micro-processors, microcontrollers or other well programmed ICs.

Variant 2: Wi-Fi module based automation.

Working: Earlier we have discussed the automation using SMS services here, we will discuss the automation using Wi-Fi module or Wi-Fi services. The ESP8266 Wi-Fi module is the main part of automation here. If a Wi-Fi connection is established in your home or office then this automation is best to implement in your home/office. The initial cost of this system is quite less as compared to GSM-based automation.
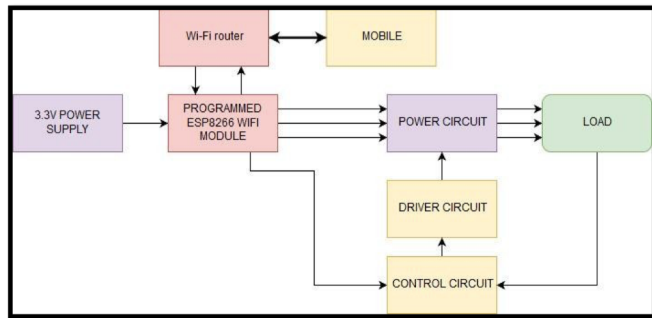
The working of this system is quite similar as that of the GSM-based system the difference is that there we are using SMS service to turn on and turn off the devices here we will use a Web Page to turn on and turn off devices. A different power supply from single Source is provided to power a Wi-Fi module i.e. 3.3V dc and other circuit. When we powered the Wi-Fi module then it will automatically get connected to the Wi-Fi router which is already installed in your home/office. By visiting that website, a user can control their devices or appliances easily by just clicking on ON/OFF button in the application. Wi-Fi module has its own IP address. There are many ways to get control devices from a smartphone i.e. through a web server, through a website, through a Google assistant, through an application, etc. here we have done using website.

A Wi-Fi module is programmed as per the user's requirement and it can be used to operate 8 different appliances from one Wi-Fi module through a single website.

When we click on "On "button in application then it will store in a Google database and from there it is readied by the Wi-Fi module thus it will generate a digital signal

corresponding to the button pressed and that signal is provided to the control circuit and thus the control circuit will send the signal to the corresponding driver circuit and the driver circuit will drive the corresponding Power circuit as per the user requirement.

Fig. 9 Block diagram of Wi-Fi module based automation

How the system gets reconnected: Our system is designed in such a way that it automatically reconnects once the supply is restored.

ESP8266 Wi-Fi module: The ESP8266 is a family of Wi-Fi modules developed by the Chinese company Espressif. It is a System on a Chip, abbreviated simply as SoC with integrated TCP/IP protocol stack. It consists of a Tensilica L106 32-bit micro controller and a Wi-Fi transceiver. It has 11 input/output (I/O) pins. And it has a dedicated analog input for the programming purpose. It is programmable and it can be modified in several ways and that is the reason why this chip is the most prevalent IoT device in the market. In our system, we are using this Wi-Fi module because of its higher reliability and easy programming. (Peter, 2007)

Wi-Fi module acts as a micro web server and hence eliminates the need for the wired connection between the Arduino board and computer which has many advantages. Main advantages are the reduction in size, cost, and increased convenience. The Wi-Fi module will require an active internet connection and it will act as the gateway for the Arduino board to communicate with the internet.
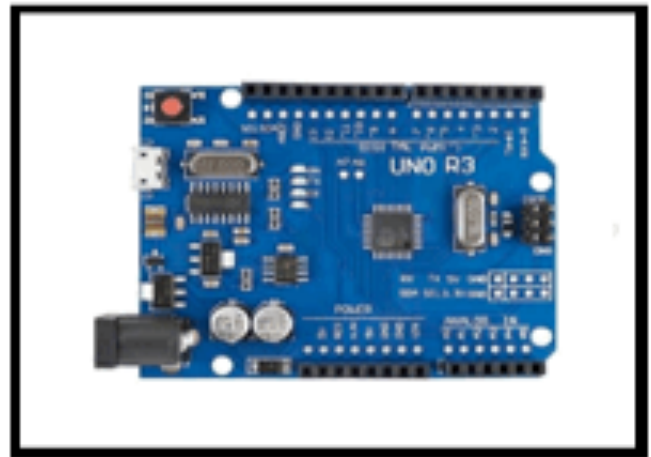
This proposed system is flexible. I.e. apart from the above-listed components, our system can be interfaced with other sensors according to the user requirement.

Arduino (UNO)

The Arduino Uno is an open source, single- board micro controller. The hardware includes 20 pins, a USB connection, a power jack and a reset button. Out of these 20 pins, 14 pins are for digital inputs and other 6 are for analog inputs. Arduino hardware is programmed using a separate programming language, based on C++ with some modifications, and a Processing-based integrated development environment. (Mehta et al., 2007)

Programming the Arduino is very simple and the parent company of the Arduino provides a simple user-friendly software by which users can write code according to their needs and directly upload it to the board.

Fig. 10 Arduino UNO Board

Sample Progrrame

Programe 1

```
"#include "hw_timer.h" #include
"dimmer.h"

void setup()
{
  Serial.begin(115200);

  pinMode(ZERO_CROSSING_INT_PIN,INPUT);

  for(int i=0; i<NUM_CHANNELS; i++)
  {
    pinMode(Drive_Pin[i],OUTPUT);
    digitalWrite(Drive_Pin[i],LOW);
  }

  connectToWiFi();

  WebSocketConnect();
  MDNSConnect();
  HTTPUpdateConnect();

  noInterrupts();

  timer_init();
  attachInterrupt(ZERO_CROSSING_INT_PIN,Zero_Crossing_In
t,RISING);

  interrupts();
}


void loop()
{
```

```
  if(millis() - lastConnectivityCheckTime > 1000)

  {

   if(WiFi.status() != WL_CONNECTED)

   {

    connectToWiFi(); WebSocketConnect();

    MDNSConnect();
   }
   lastConnectivityCheckTime = millis();

  }

  else

  {

   webSocket.loop();

   //yield();


   //OTA

   if (millis() - lastTimeHost > 10)

   {

    httpServer.handleClient();

    lastTimeHost = millis();

   }


   //Update Connected Clients

   currentChangeTime = millis();

   if(currentChangeTime - lastChangeTime> 300 &&

   isSynced == 0)
   {

    String websocketStatusMessage = "A" +
String(Dimming_Lvl[0]) + ",B" + String(Dimming_Lvl[1])
+ ",X" + String(State[0]) + ",Y" + String(State[1]);
    webSocket.broadcastTXT(websocketStatusMessage); //
Tell all connected clients current state of the
channels
    isSynced = 1;

   }

  }

 }"
```

Programe 2

```
"char inchar; // variable to store the incoming

character int Relay = 8;
void setup()

{


  pinMode(Relay, OUTPUT);

  digitalWrite(Relay, LOW);

  // wake up the GSM shield

  Serial.begin(9600); delay(2000);

  Serial.println("AT+CMGF=1"); // set SMS mode to text

  delay(100);

  Serial.println("AT+CNMI=2,2,0,0,0");

  // just to get a notification when SMS arrives &direct
```

```
out SMS upon receipt to the GSM serial out
  delay(100);

}


void loop()

{

  //If a character comes in from the GSM...

  if(Serial.available() >0)

  {

   inchar=Serial.read(); if

   (inchar=='$')

   {

    delay(10);


    inchar=Serial.read(); if

    (inchar=='a')

    {

     delay(10);

     inchar=Serial.read(); if

     (inchar=='0')
     {

    digitalWrite(Relay, LOW);

    Serial.println("Relay OFF");

     }
     else if (inchar=='1')

     {

      Serial.println("Relay ON");

      digitalWrite(Relay, HIGH);
     }
     delay(100);

    Serial.println("AT+CMGD=1,4"); // delete all SMS

    delay(2000);

    }

   }

  }

 }"
```

Limitations

- Internet connection is required. Initial set up cost is comparatively high.
- It might get some time to get used to the system. Internet connection is required.
- Initial set up cost is comparatively high. It might get some time to get used to the system.

Future Scope

Lack of internet connectivity in remote areas is hindering growth of the automation systems in rural areas. But, as internet connectivity is becoming widely available to everyone,

further advanced functions can be implemented on top of this system. We have plans to also include Fault detection, Feedback for faults, Intensity and Speed control etc. As automation industry is in full swing today, in very near future, this features will also become widely available to everyone (Gunge & Yalagi, 2016).

Future Scope

Feedback Analysis

As it is evident from the feedback, nearly 90% of respondents are willing to use IoT based smart automation for their home or industry but only 34.1% have automated systems at home. Which forces us to speculate on the reason behind this (Arvindhan et al., 2017).

On doing further research, we found out that the main reason behind not using automated systems was cost. Then another main reason was lack of connectivity. We've tried to eliminate these two main problems.
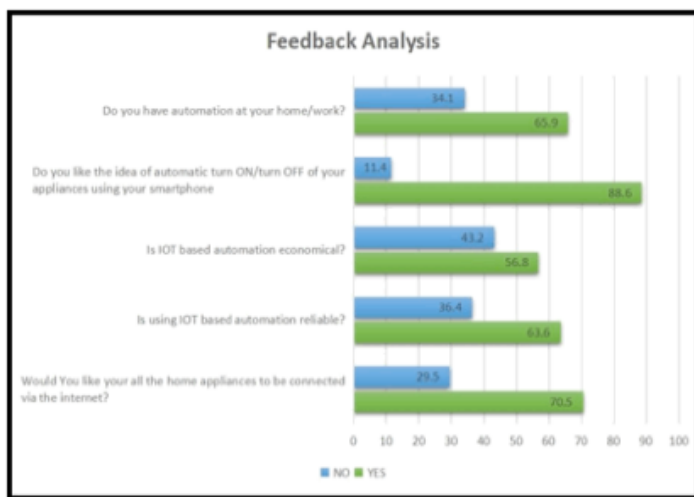
Conclusion

Home automation is the need of the hour, which, the feedback analysis also concludes. In this paper, we have presented two IoT based methods for the same. The first one is based on GSM module and Arduino UNO and the second one is based on a Wi-Fi module. Both of these methods as simple and cost effective to implement and these are not just used to switch ON or OFF an appliance but also to control it remotely (e.g. from your school or office). Such an IoT based automation system not only makes people's lives simpler but also exponentially increases their standard of living.

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Fig. 10 Following is the feedback analysis carried out via Google forms in order to receive public's opinion on our system