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DESIGN AND IMPLEMENTATION OF IOT BASED MONITORING AND CONTROL OF ELECTRICAL APPLIANCES USING GSM/GPRS MODULE

MOSHOOD YUSUF [1] ,SAIDU. A. ADAMU[1,2], & AND L. M. ISAH[3]

[1]Electrical & Electronics Engineering Department, College of Engineering, Kaduna Polytechnic, Kaduna State, Nigeria [2]Computer Engineering Department, Jigawa State Institute of Information Technology, Kazaure, Jigawa State, Nigeria [3]Electrical and Electronics Engineering Department, Federal Polytechnic, K/Namoda.

Abstract

Scarcity of resources is initiating everyone towards energy efficient technologies. Among all these resources, power is one which needs to be monitored and controlled as per the need since electricity consumption is increasing day-by day. Internet of things reduces the effort of human by introducing machine to machine interaction. This work has been designed to implement IoT based electrical appliances monitoring and control system. Power used by various appliances is monitored through an ESP32 microcontroller interfaced to GSM/GPRS module (SIM800L). Power control of home appliances is achieved through actuators such as relays which can be controlled by client with the help of a blynk server. The benefit of this system, that the appliances control mechanism can be done manually or remotely. The designed system enables client to monitor and control the appliances at home from anywhere availing the IoT features of the designed system thereby reducing the wastage of energy.

Keywords*: Router, Internet of Things (IoT), Arduino IDE, Microcontroller (ESP32), GSM/GPRS Module (SIM800L) and Blynk apps.*

INTRODUCTION

IOT or internet of things is an upcoming technology that allows user to control hardware devices through the internet. It is a concept which helps to build a wireless network among the different devices accessed through internet. It is meant to save the electric power and human energy. Basically, IoT creates an ecosystem among devices which makes it remotely accessible and things in IoT represents the devices like sensors, microcontrollers, and mobile phones that is connected to a wireless network. The resulting network is usually referred to Internet of things (IOT) (Ranjithkumar, et al 2020). In this project, IOT is design in order to control electrical appliances through the internet. User friendly interface allows user to easily control these appliances through the internet Worldwide. Control unit of these system is an ESP32 microcontroller. This microcontroller is interfaced with a modem and relays are used for switching the loads. After receiving user commands over the internet, ESP32 processes these instructions to operate the loads accordingly and display the system status on a Smart Phone. Blynk Community Application is use for controlling the electrical appliances all over the world. The method used for controlling is by clicking the button switch on smartphone and trigger the circuit as it receives the input command.

REVIEW OF RELATED WORKS

Design of IoT base home automation using NODE MCU. The system was based on Blynk framework which controlled and monitored appliances via smartphone by using Wi-Fi as communication protocol. All the appliances are connected to the internet via Node MCU. The appliances in the home is interfaced with centralized micro controller NODE MCU for the systematic working. The controller also interfaced with WIFI to receive the control commands from Wi-Fi shield (Wi-Fi hotspot). When the operator clicks on the button present on the apps interface, the Wi-Fi present on the mobile apps will send the data to Wi-Fi present at the microcontroller to turn on the require load (Mohammad, et al 2018).

Design of home automation via Bluetooth using Arduino uno microcontroller. The major component used is Arduino uno, Bluetooth module (HC 06), android phone and step-down transformer. The project allows anyone who has a

Bluetooth enabled Android mobile phone to download an application from the Google Play Store. With the help of this application, a user can control all the appliances in the house via Bluetooth receivers. The proposed system allows the clients to have access to all the appliances in the house including air conditioners, and lights, with a single click on a mobile phone to turn it either ON or OFF (Anastasios, et al 2016).

This research work was based on smart GSM base home automation system. The architecture consists of mobile phone and GSM modem. In their propose system, incoming SMS message is sent from the user phone to the GSM modem as a text message via cellular network. The GSM modem then sends the commands in text mode to the PIC microcontroller using an RS232 interface. They use MAX232 to enable the communication between both the GSM modem and PIC microcontroller by converting RS232 level signals to TTL level signal. Outgoing message from the system containing the home appliances status is delivered to the mobile phone through GSM modem (Rozita, et al 2014).

RF base home automation system was designed to control home electrical appliances, the RF remote(keyfob) was interfaced with microcontroller on transmitter side which sends on/off command to the receiver where loads are connected. By operating the specified remote switch on the transmitter, the load can be turned on/off remotely through wireless technology. He used Arduino IDE software to write and compile programs related to the microcontroller ATmega328. The limitation to this design is Failure to work within a long-distance range. The transmitter being used can only work from the distance of 25-30 meters. That means, it can only control appliances from very little distance. It's also less secure since anyone who gets hold of the Keyfob can access and control the system (Dennis Mwanza;(2016).

SYSTEM DESIGN

The design is broken into hardware and software stages.

Hardware Components

The hardware consists of: Power Supply, ESP 32 microcontroller, Transistor, Resistor, Relay and contactor, 5-volt regulator, SIM800L and Diode

The software designs include: Arduino IDE platform for ESP32 and Blynk apps.

ESP 32 microcontroller

The ESP32 is the successor of ESP8266. It combines wireless capabilities Wi-Fi and Bluetooth. It has a 3.3V voltage regulator that drops the input voltage to power the ESP32 chip. And it also comes with a CP2102 chip that allows the ESP32 to plug to the computer for programming without the FTDI (Future Technology Devices International) programmer. The ESP32 is dual-core, i.e. it has 2 processors. It runs 32-bit programs. The clock frequency can be up to 240MHz and 512 kb RAM (Random-access memory). It also has many peripherals like capacitive touch, ADCs, DACs, UART, SPI, and I2C. The board has two on board buttons ENABLE and the BOOT button. It is an open-source resource and plug-and-play modules that support thousands of compatible boards and sensors. It has everything needed to support the microcontroller.

Relay

Relays are the switches which aim at closing and opening the circuits electronically as well as electromechanically. It controls the opening and closing of the circuit contacts of an electronic circuit. The relay in this design was used to energized the coil of the contactor.

Contactor

Contactors are specialized form of relay capable of switching higher power loads such as motors, lighting and electric heaters. The contactor was used to control twenty fans due to its capability of withstanding higher power.

SIM800L

The SIM800L is a Quad-band GSM/GPRS module, that works on frequencies GSM850MHz, EGSM900MHz, DCS1800MHz and PCS 1900MHz where it can meet all the space requirement in user applications such as smart phone, PDA and other mobile devices. It has a microSIM slot, antenna for the network signal, microphone, speaker pin outs and ring. The power supply requirements for this module is 3.4 to 4.4V DC with the minimum 2A.

Software requirements

Arduino IDE

Arduino Integrated Development Environment (IDE) is a cross-platform application which represents the programming medium between the user and the board. It supports C and C ++ languages using special code structuring rules. We used the Arduino IDE in our work for Writing and compiling programs for the ESP32 development board.

Blynk apps

The Blynk application was mainly designed for the Internet of Things (IoT). It controls hardware like Arduino, Raspberry Pi, nodeMCU. There are three major components in the platform: Blynk App, Blynk Server and Blynk Libraries. Blynk app is used to create interfaces for projects using various widgets. Blynk server is responsible for all the communications between the smart phone and hardware kit. Blynk Libraries are used by popular hardware platforms that enable communication with the server and process all the incoming and out coming commands. The block diagram of the IoT system is shown in figure1.

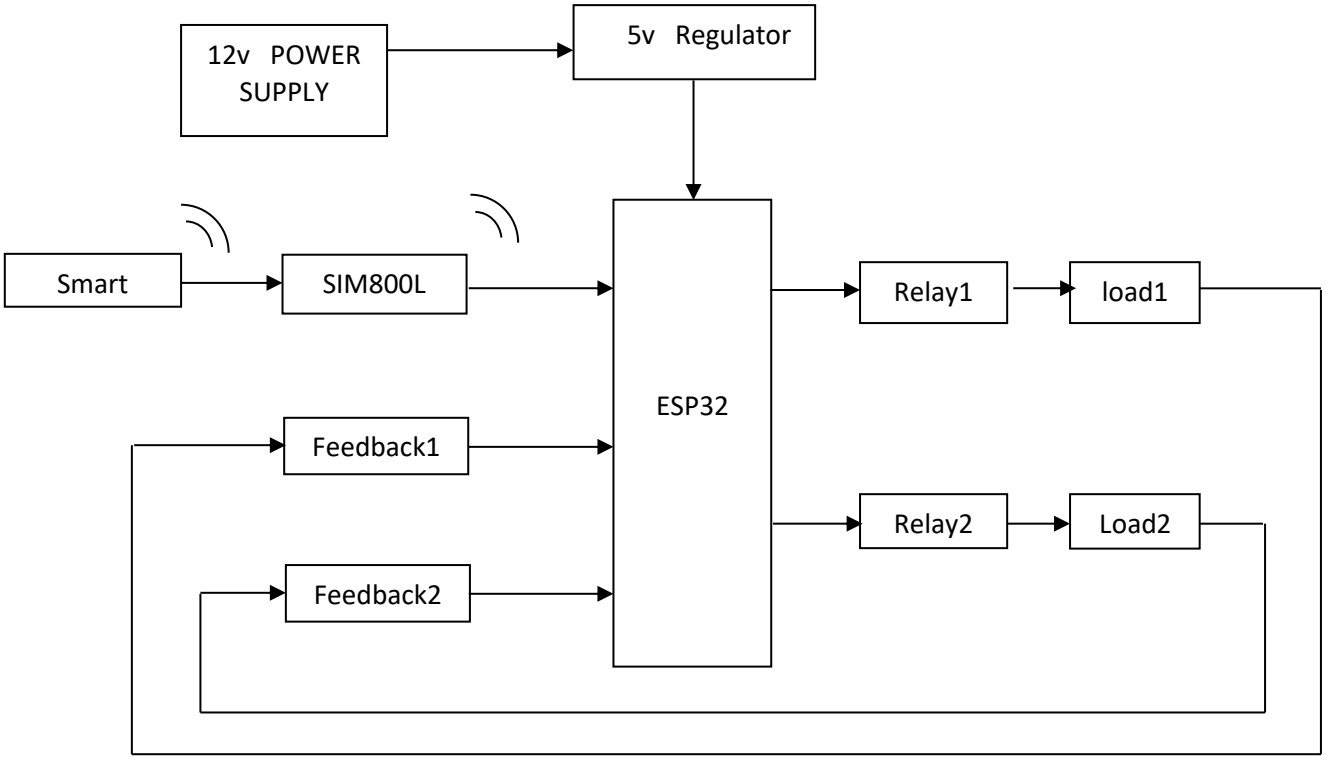

Figure 1: Block diagram of an IOT system using ESP 32 microcontroller

System Operation Principle

The project is a concept to control home appliance over internet. The program developed through Arduino IDE is used as an interface between blynk app and ESP32 microcontroller. The developed program been uploaded in to ESP32 microcontroller via Arduino IDE is configured to connect the module to blynk server and router. The unique ID provided by blynk has been configured with the blynk apps to communicate with the specific remote wifi module and the blynk app is modified by including on/off switch needed to trigger the relays connected to the input pins of the ESP32 module remotely. The appliances are interface with centralized ESP32 microcontroller. The controller has an inbuilt Wi-Fi to receive the control commands from SIM800L and through blynk servers, those appliances can be trigger. The operator will be provided with the blynk app on a Wi-Fi enable smart phone. When the microcontroller and a SIM800L is powered on, wireless connection between the two system is established and ready to receive data over internet from mobile apps. When the user sends a command by clicking the buttons present on the app interface, the data is received by the SIM800L through blynk server and this data is in analogue form which is converted from analogue to digital converter by SIM800L for information to be process. After the SIM800L process the information, it converts the digital data to analogue signal and transmitted to the ESP32 microcontroller and this data is demodulated and converted to digital signal and the signal is sent to the relay that controls the appliances. The circuit diagram of the IoT system was shown in figure2.

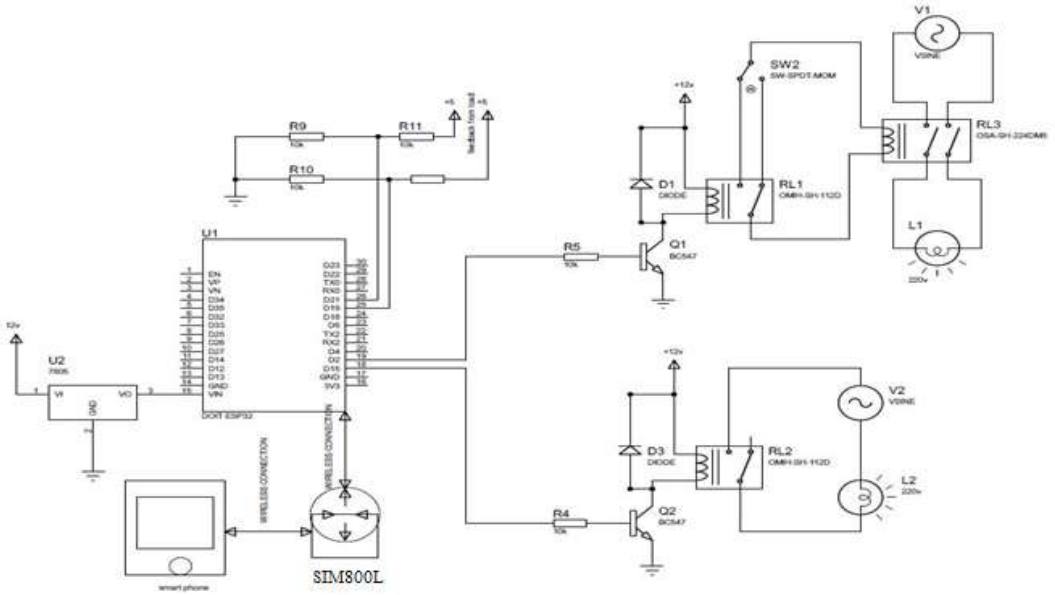

Figure 2: Circuit diagram of the IoT System.

Flow Chart

Flow chart is a graphical representation of steps. It shows steps in sequential order and is widely use in presenting the flow of algorism. The flowchart of the system is shown in Figure 3 below.

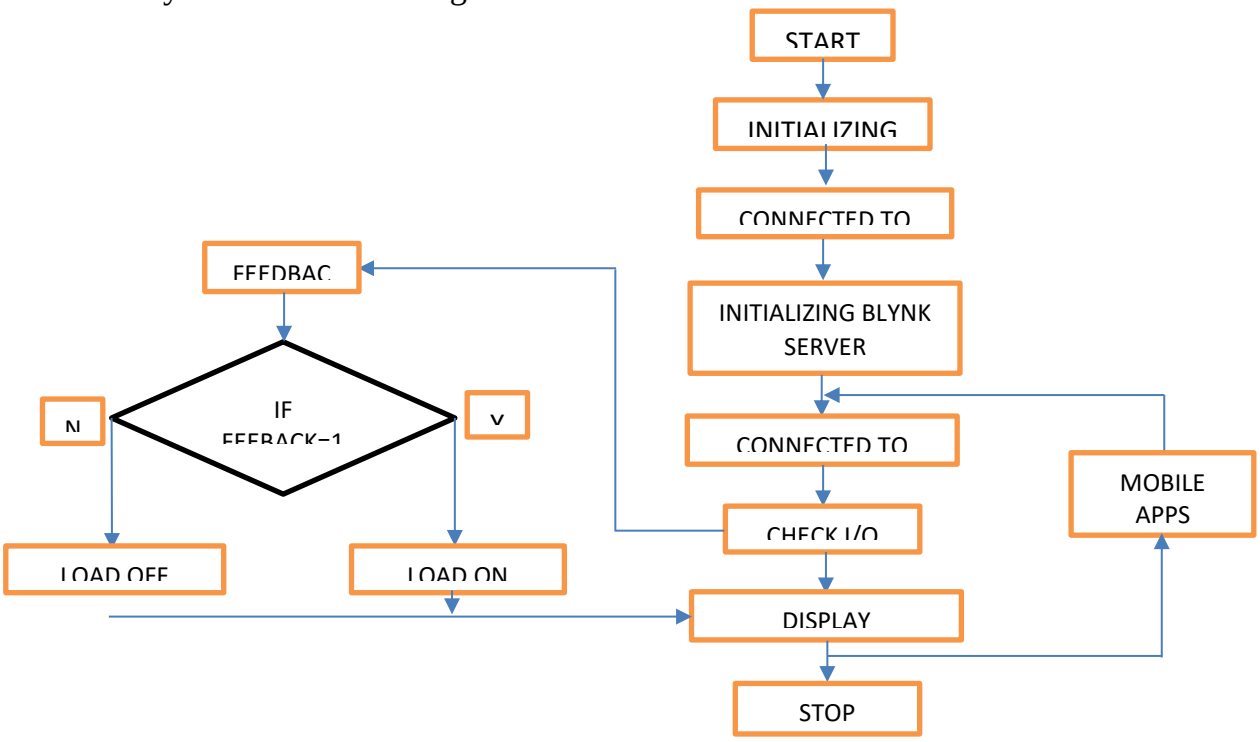

Figure 3: Flowchart of the IoT system.

BLYNK APPS IMPLEMENTATION

Download Blynk app on phone from Google play store and install it. After installing, create an account in this app, you may use your current Gmail account. After creating account, a window will open, in this click on New Project. Now give project name according to your choice and in device choose ESP32 Dev Board and in Connection type choose Wi-Fi and then click on Create as shown in Figure 4 bellow. Now a window will come which shows that your authentication token which you will need later sent to your concerned mail id to which you created your account. You can open email to check authentication key. Tap on the widget to change its settings. There, you can change the name, size, text size, and color of the gauge

When the settings are done, the app is ready to work with. On pressing Play button, it will switch from EDIT mode to PLAY mode where user can interact with the hardware. In PLAY mode, user will not be able to drag or set new widgets, press STOP to get back to STOP mode.

Figure 4: Blynk setup

Monitoring the Appliances in Blynk apps

The measured data from the sensors is displayed on the Blynk apps which signify the user about the load state. The following steps is required to set up the display unit on the Blynk apps as shown in figure 5.

On the blynk apps plat form, tap anywhere on the canvas to open the widget box. All the available widgets are located here. Tap on the canvas to open up the widget box. Now pick a gauge. Tap and drag the widget on to the canvas. Tap on the widget to change its settings. Select the pin name were the sensor was located on the microcontroller. After that, Change the name, size, text size, and color of the gauge.

Figure 5: Setting up the display feedback. Figure 6: Control page

Blynk apps for Controlling Appliances

The blynk apps was setup in such a way that when the control page as shown in Figure 6 opens the user can control lights and fans by selecting button on or off.

when user clicked the on or off button, it sends a command for controlling channels of relays.

Client-server Communication

The client-server communication is done by using blynk server with Wi-Fi communication protocol. The commands and arguments are passed in between client and server.

EXPERIMENTAL SETUP

The entire system is set up as shown in the Figure 7. The system consists of Esp32 microcontroller, router and contactors. 20 ceiling fans and 200w bulb were controlled using contactors.

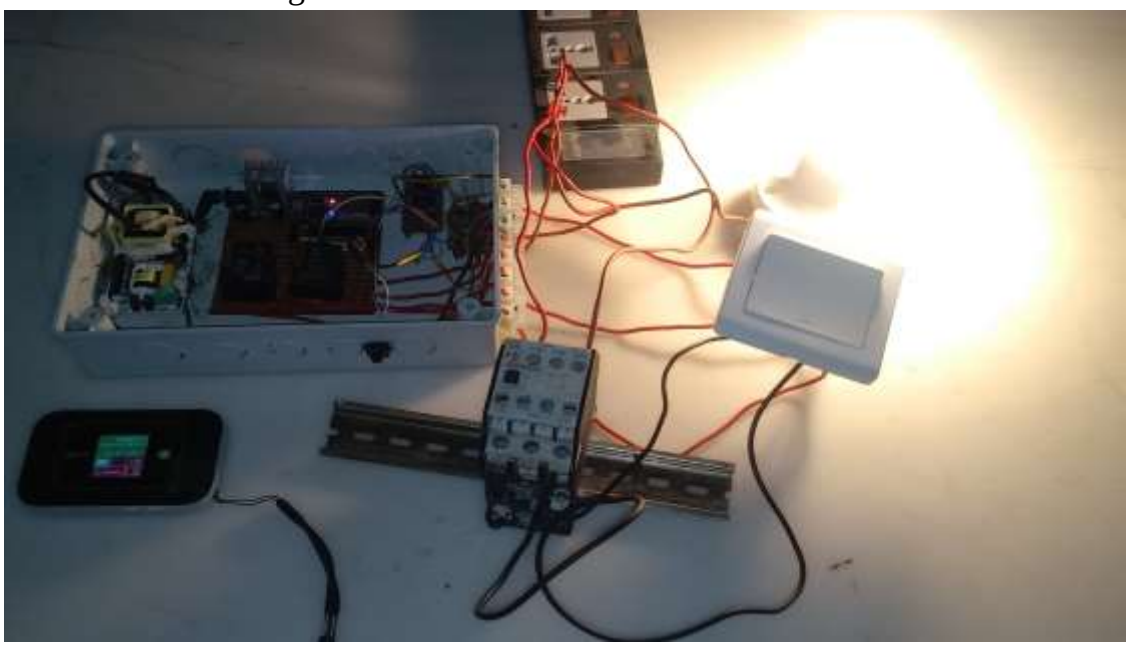

Figure 7: Experimental Setup of the IoT System.

RESULTS

The speed at which the module responds to the command been sent by the mobile app depends on the strength of the internet network. But base on our test, the load takes one to three seconds. The feedback unit sent a signal to the mobile app which serves as a notification whenever the load is powered. The connection between the router and the ESP32 module takes three to seven seconds after which the module and the router were turned ON.

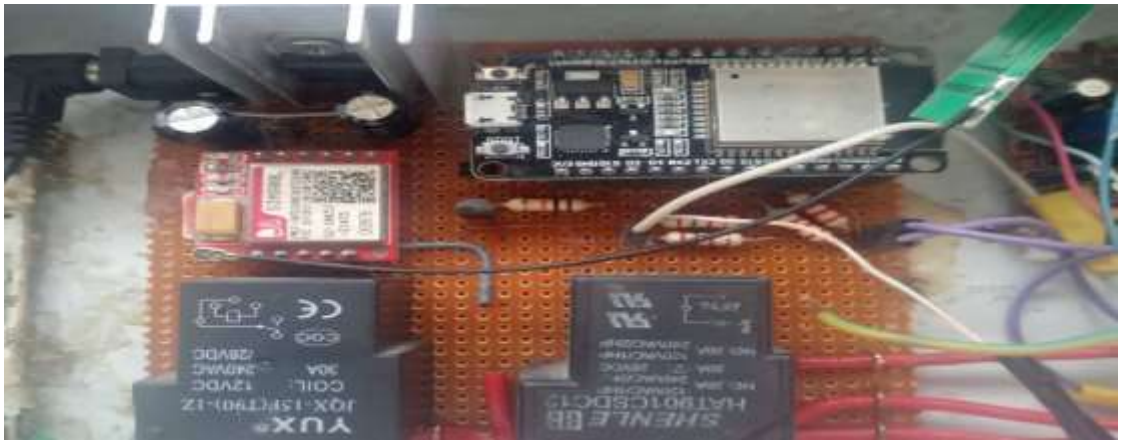

Figure 8: IoT System Circuit Board.

CONCLUSION

The results show that when tested with designed system, the average energy consumption of the appliances is reduced since they are turned off when unused. By employing the proposed IoT system, the total energy consumption is reduced. On a whole in a year considerable percent of energy can be saved in residential and office building by implementing Smart Appliances monitoring and control System through IoT.

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