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GSM Based Home Automation System

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Abstract- Home automation makes it possible for electrical appliances (such as lighting systems, washing machines, and refrigerators) to be easily accessed and effectively controlled. The key reasons behind home automation are making peoples' lives easy, driven more by technology and effectively managed. Among others, home automation systems available are either based on Bluetooth technology, ZigBee technology, Infrared Remote (IR) controller, or Radio Frequency (RF) technology. Though these systems are good, unfortunately, they are only effective for short distances (100 meters maximum) automation within a particular locality. This posed a big challenge/risk of electrical disaster (such as fire outbreak) to people outside their vicinities that mistakenly left their appliances ON/OFF, as the case may be, and could also lead to energy wastage for appliances left connected to the mains for a period longer than required. Hence, the need for an effective means of remotely controlling home appliances beyond ones' vicinity. However, this paper proposed a GSM based home automation system as a means to address the aforementioned issues. The system uses SMS to send commands in order to remotely turn on and off electrical devices. System development involves implementing the different hardware modules (power supply, GSM, microcontroller, relays, and loads) making up the system as well as programming the system controller (PIC16F877A). The result of the system after testing showed that the system is very effective in the remote control of electrical appliances, only that an average delay of 19 seconds was observed before the switching takes place.

Keywords: GSM Based, Home Automation, Microcontroller, Smart Home

1. Introduction

According to both Groover and Rifkin, as cited in [1], automation is the technology that allows little or no human intervention when controlling a device or a process. [2] simply defined home automation as automating the activities of the home, household, or housework. Automating a home makes it possible for electrical appliances (such as lighting systems, washing machines, and refrigerators) to be easily accessed and effectively controlled [3]. Another name used for home automation is smart home as used in the report of [4]. The authors describe it as a home, furnished with electrical appliances, and accessed remotely with the help of an internet or a smartphone. The key reasons behind home automation are making peoples' lives easy, driven more by technology and effectively managed [5]. Today, home automation is an emerging new technology utilised by both the public and the private domains to ease peoples' standard of living and also end unanticipated casualties [3].

Among others, home automation systems available are either based on Bluetooth technology [6], ZigBee technology [7], Infrared Remote (IR) controller [8][9] or Radio Frequency (RF) technology [10][11]. Though these systems are good, unfortunately, they are only effective for short distances (100 meters maximum) automation within a particular locality. Furthermore, while the IR based requires line of sight to effectively work, [12] stated that the range and spectrum availability is an issue for the RF-based as this must be accounted for. These posed a big challenge/risk of electrical disaster (such as fire outbreak) to people who happen to be outside their vicinities and mistakenly left their appliances ON/OFF, as the case may be. In the same vein, this could also lead to energy wastage when appliances are mistakenly left

connected to the mains for a period longer than required as highlighted by [1]. Hence, the need for an effective means of remotely controlling home appliances beyond ones' vicinity. However, this paper proposed a Global System for Mobile Communication (GSM) based home automation system as a means to address the aforementioned issues. Few key advantages of the GSM-based are wider coverage (as appliances can be controlled from anywhere in the world), greater availability, and security [12].

1.1 Related Works

[6] proposed a home automation system that is based on Bluetooth technology. An Arduino Bluetooth (BT) board is used to connect electrical appliances through relays. A Bluetooth enabled cell phone is used to wirelessly communicate with the Arduino BT board to control the appliances. The system functionality was tested to cover less than 50 meters in a concrete building and range of 100 meters maximum, in an open space.

[7] developed a voice based home automation system using ZigBee technology. At the transmitter side, a microcontroller is used to transmit voice command from microphone via ZigBee transmitter. At the receiver side, the transmitted signal is received by a ZigBee receiver, and fed into another microcontroller for onward processing, and control of the connected appliances through relays. The system also detects presence of smoke, and sends message to user's mobile phone. However, the drawback associated with this system is low communication range (around 10 meters) due to ZigBee technology.

[8] proposed a system for controlling home appliances based on IR technology. An IR remote is used at the transmitter section to send commands to an IR receiver. At the receiver section, the received signal by the IR receiver is fed to an Arduino Nano ATmega 328 microcontroller. Thereafter, the microcontroller controls the appliances through relay and triacs. This system also has a low communication range of 10 meters maximum.

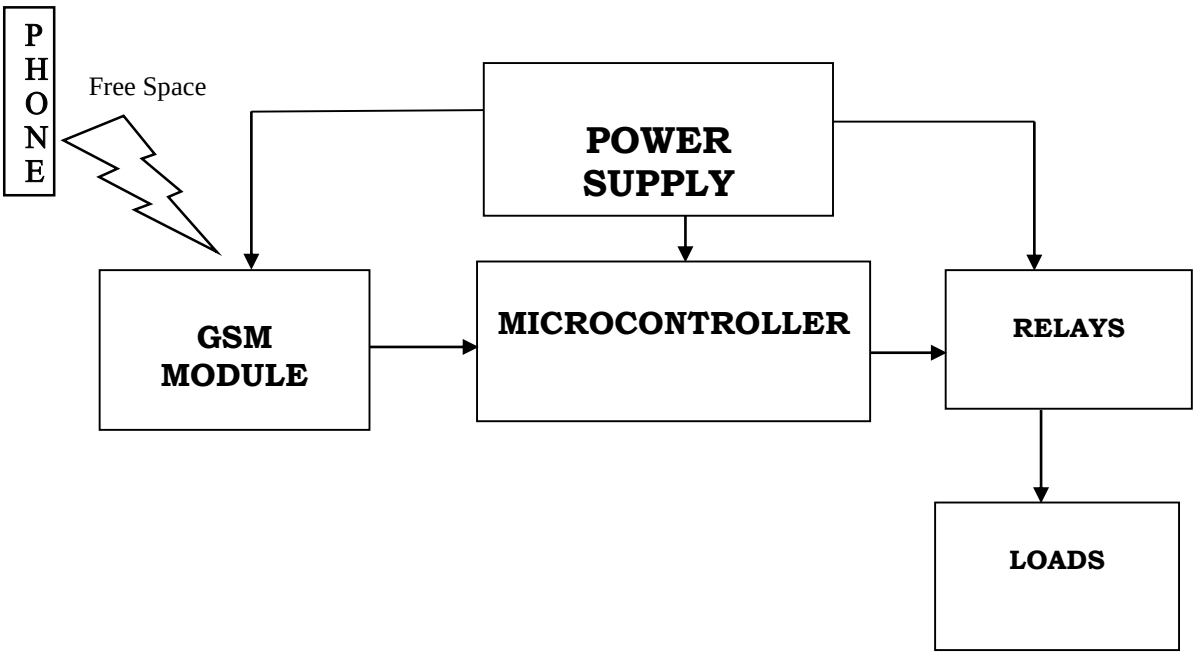


Figure 1. System block diagram.

2. Methodology

The system development involves implementing the hardware modules such as power supply, GSM, microcontroller, relays and loads as shown in the system block diagram in Figure 1 as well as programming the microcontroller unit. The system process flow is as shown in Figure 2.

As seen in Figure 2, when power is supplied to the system, the GSM module keeps waiting to receive an SMS command. As soon as a command is received, it is being decoded by the GSM module, and sends it to the microcontroller for onward processing. The microcontroller then checks to see if the command is a valid one or not. For a valid command, the microcontroller turn on/off the relay which in-turns switch on/off a particular load. Thereafter, the system continues to wait for another command. On the other hand, if it is an invalid command, the system goes back to continue to wait for another SMS command. The whole process continues in that manner.

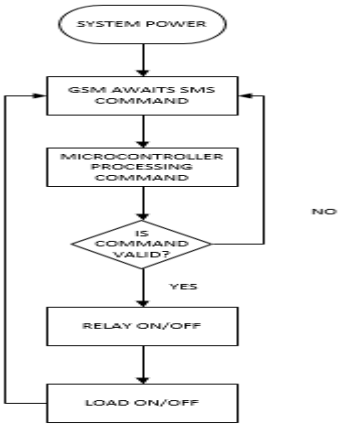


Figure 2. System process flow

2.1 Power Supply

In the power unit, a 220/240V, 50 Hz AC is converted to 5V and 12V DC. While the 5V DC powers the GSM module and the microcontroller, the 12V DC powers the relay module that switches ON/OFF the connected loads.

2.2 GSM Module

SIM800L [13] is used in this unit. This module is used to receive the SMS sends by the user, decodes it, and transmits it to the microcontroller for onward execution of the instruction. A buffer IC (74HC14) is also used to boost the transmitter signal (TX) from the SIM800L to the microcontroller receiver pin (RX) for compatibility.

2.3 Microcontroller

The popular powerful PIC16F877A microcontroller [14] is used. It features 40-pins (DIP), 5-input/output ports, ADC module with 8-channels (input) and 8k program (flash) memory among others. The microcontroller executes the specific instruction(s) sent by the user that has been decoded by the GSM module. It then switches ON/OFF the corresponding relay(s) and consequently the load(s)). *MikroC* language is used in writing the program that the microcontroller runs.

2.4 Relays

Relay is simply an electrical switch that allows a small current flow circuit to control a higher current circuit [1]. This is seen in this work where the small current from the microcontroller is used to control the loads (with higher current consumption) with the help of the relay switch as an intermediary. The popular relay driver (ULN2003) is used as an interface between the microcontroller and the relay switch. This is due to the low output current of the microcontroller which lacks the ability to directly source for the relay switch.

2.5 Loads

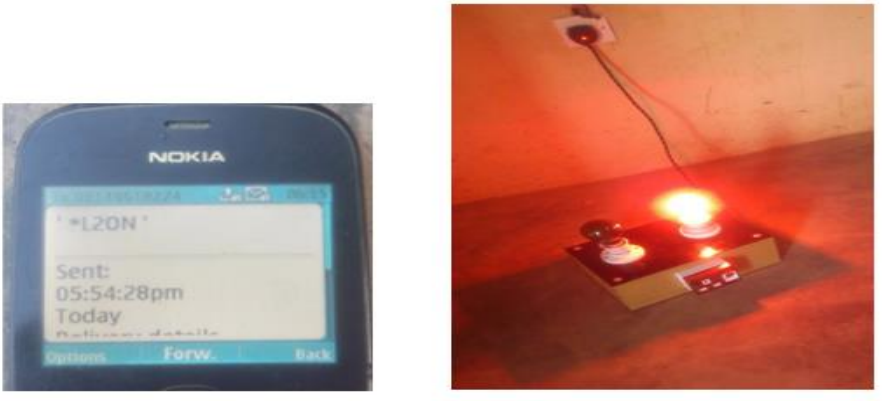
The loads are the electrical appliances to be remotely controlled being connected to the system. This includes a television set, bulb, refrigerator, and any other electrical appliance requiring a 220/240V 50Hz AC power source. This unit has slots for two bulbs and two other sockets outlets in which other electrical appliances can be connected.

3. Results and Discussion

The system was tested by remotely switching ON/OFF the loads connected to it. To switch ON/OFF a load, a code in the format ' *L(load number)ON ' for switching ON and ' *L(load number)OFF ' for switching OFF, is sent to the system. For example, Load 1 is switched ON by sending ' *L1ON ' to the dedicated SIM card number in the system GSM module and ' *L1OFF ' is used when switching OFF. This is illustrated in Figure 3. However, while Table 1 gives the time taken for each load to be switched ON/OFF after sending the corresponding code, Figure 4 and Figure 5 respectively give the graphs for the time taken to switch ON and switch OFF the loads.

Table 1. Time taken for each load to switched ON/OFF

S/N	Loads	Code to Switch ON	Time taken to ON (Sec)	Code to Switch OFF	Time taken to OFF (Sec)
1.	Bulb 1	' *L1ON '	21.09	' *L1OFF '	19.79
2.	Bulb 2	' *L2ON '	14.92	' *L2OFF '	13.93
3.	Outlet 1	' *L3ON '	11.43	' *L30FF '	18.98
4.	Outlet 2	' *L4ON '	17.77	' *L4OFF '	33.24



(a) Snapshot showing switching ON code sent and the system response

(b) Snap shot showing switching OFF code sent and the system response

Figure 3. Snapshots of system response based on the corresponding code sent

It is seen from the plotted results in Figure 4 and Figure 5, that both graphs are curves and not linear along the origin. This shows that a little delay (averagely 19 seconds) is experienced before the switching takes place. This is possibly due to the network of the GSM service provider, which may be attributed to weather condition or poor signal strength. However, the system still proves to be very effective in the remote control of the appliances.

4. Conclusion

In this paper, the development of a GSM-based home automation system is presented. The system enables one remotely control electrical appliances requiring 220/240V 50Hz power source (such as refrigerators and water heaters) from anywhere in the world. This is achieved by simply sending an SMS command to a dedicated SIM card embedded in the system. It is recommended that the system is enhanced to provide feedback to the user in other to know the system status after each controlled operation carried out.

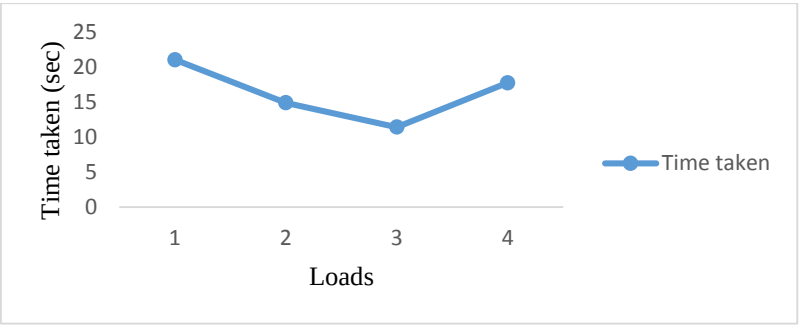


Figure 4. Graph of Time taken to switch ON loads against the loads

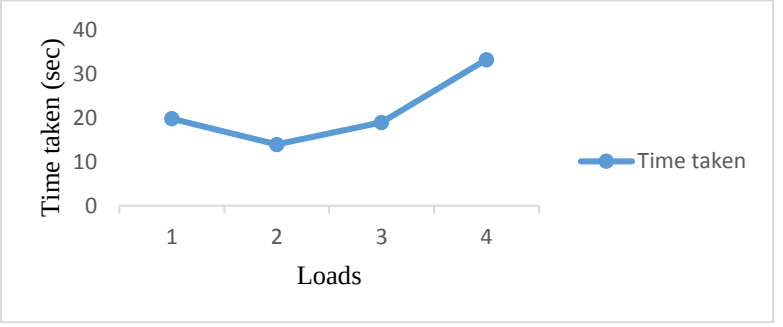


Figure 5. Graph of Time taken to switch OFF loads against the loads

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