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Smart Short Message Service Based Technology for Electrical Home Appliances Control.

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Abstract – Control of electrical home appliances is a major concern in every home. This makes people using electrical appliances to search for a simple, reliable and cost-effective way of controlling electrical energy appliances. Furthermore, controlling devices at a distant or remote location tends to be challenging. Hence, this paper put forth a smart Short Message Service (SMS) based technology device which can enable the user to control their home appliances from a remote location by send a particular code through SMS from their cell phone. The encoded message sent through the SMS is decoded in the Microcontroller and activate a specific relay to perform the desired operation. The operations which can either be to switch ON or OFF a particular or group of appliances. SMS is sent through four different network operators which are MTN, GLO, AIRTEL & ETISALAT and average time taken for each network to activate the device are recorded. The result shows that the average time taken is 1.25, 1.89, 1.89 and 2.70 seconds for MTN, GLO, AIRTEL, and ETISALAT respectively. In conclusion, the MTN Subscriber Identification Module (SIM) was used because of its fast speed of SMS delivery to activate the device. The device is working perfectly as designed and can be useful at homes, industries, laboratories, offices, hospitals, etc. This will invariably ease the problem of controlling electrical appliances, reduce the cost of electricity bills and guarantee the safety of lives.

Keywords: Appliances, Control, Microcontroller, Module, Network, SMS.

1. Introduction

In today's fast changing world, everything is becoming economical, portable and mobile. The mobile handset has become one of the most famous achievements in the world. These have made lives much simpler and connected, almost everyone is familiar with its usage, and has provided a lot of benefit (Richa et al., 2012). The numerous different kinds of technology ideas for Short Message Service **(**SMS) based device control as made the utilization of different electrical gadgets to become simpler and more interactive. Using SMS for controlling various types of electronic appliances actually represents the second generation of mobile communication. (Richa et al., 2012).

In recent years, this new development that allows people to manage consciously home energy appliances and to advance their behaviour in order to reduce energy consumption is the smart technology. This concept has gained importance due to four factors (Liang, Schweitzer and Xu, 2013) (a) the fast progress and miniaturization observed in semiconductor technology resulting in a proliferation of computing and electronic devices in our everyday lives; (b) the exponential growth of microcontrollers unit (MCU's) processing power; (c) the integration of advanced signal conditioning in very small sensor nodes that can measure and store data using complex processing techniques; and (d) the rapid development and progress of wireless technologies such as SMS for near and far locations and low power applications (Tiago et. al., 2015). All the four factors are generating great outcomes.

The increase in the level of technologies related to wireless communication has led to the emergence of several engineering designs to aid the human requirements (Tiago et. al., 2015). As it is all known that

SMS device control as play some crucial role in developing country like Nigeria and implementing this device to enhance simple control for all electrical gadget is the basic idea of this project. The idea of portable, multipurpose, cost-effective design to control the ON/OFF mechanism of various devices in the field via short message service (SMS) was developed. (Hassan, 2016). Hence, the SIM module utilize in this work is SIM 900.

In the previous researches conducted on smart home appliances, controlling there were less studies concerning the use of relay driver to speed up the rate of control the appliances which when used invariably increases the efficiency of the system. Rozita et al., (2013) works on smart based home automation system (HAS) to control a targeted system away from home using the frequency bandwidth, a micro controller and RS 232 is used to connect microcontroller. The circuit is connected to the load via a relay without the use of relay driver. Another research on smart home control and monitoring system using smart phone, Android app and an embedded micro web server, having internet protocol connectivity to access and control the numerous home appliances over a remote distance fails to utilize relay driver for the system fast response. (Piyare and Lee, 2013). Dhiraj (2016) implemented a speech-based control home appliance using ARM II Raspberry Pi, HC-05 bluetooth module, Microcontroller board, passive infrared, SIM 900 and GSM Modem for controlling the home appliances. It employs phyton programming language for developing the necessary software required for the smooth operation and interfaces the load with the use of two separate relays without driver. Sukhen Das et al., (2016) presented a reliable and affordable smart home automation system based on sophisticated bluetooth wireless technology and smart phone connected to Arduino UNO, allowing the user to monitor and control different appliances such as servo motors and DC motors but the limitation is that no relay or relay driver was used in the design. Neetu & Mankad (2017) employ the use of a bluetooth terminal application with MIT App Inventor to establish a connection between the mobile bluetooth and bluetooth module, it employed a 4-digit postcode to control various home appliances using four relays but fails to incorporate relay driver for fast activation of the loads In this paper, Smart SMS based technology electrical home appliances control has been well equipped with a digital information display, Microcontroller, SIM module as a signal sensor and a relay driver ULN 2803 which increases speed and efficiency of operation of the relay better operation.

2. Design Methodology

Etching of bare copper board to make a printed circuit board (PCB) for the power supply circuit for SIM module and control circuit was made. Interfacing of microcontroller with the SIM module (900) and uploading of Hex file in to the microcontroller was done. Construction of the control stage with the incorporation of relay driver and circuit casing for proper package was achieved. The block diagram of the design is as shown in Fig. 1.

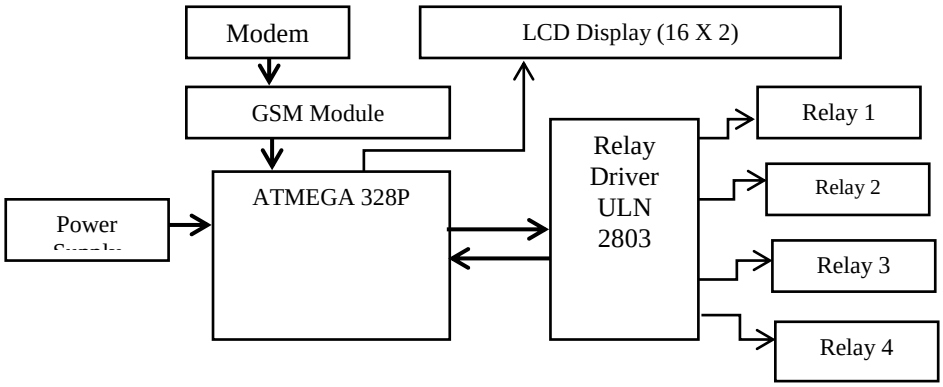

Fig. 1. Block diagram of Appliances Control.

2.1 SIM Module (Sim 900A).

SIM 900 is a complete Quad- band GSM / GPRS MODULE as shown in Fig. 2. It works on frequencies 850/900/1800/1900 MHz. The Modem consists of RS232 interface, which allows users to connect PC as well as microcontroller with RS232 Chip (MAX232). The baud rate is configured from 9600-115200 through AT command. The GSM/GPRS Modem is having internal TCP/IP stack to enable the connection with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application. The onboard regulated power supply allows interconnection to wide range unregulated power supply. The MODEM allows audio calls, SMS, Read SMS, attend to incoming calls and internet though simple AT command (Rhydolabz, 2013).

Fig. 2. SIM module (SIM900).

2.2 ATMEGA 328P Microcontroller.

ATMEGA 328P Microcontroller (sometimes abbreviated MC or MCU) as shown in Fig. 3. is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. The Atmel AVR core combine a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetical Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughout up to ten times faster than convectional complex instruction set computer (CISC) microcontrollers (Acharyya,2016). It provides the following features 8kbytes of in-system programmable Flash with Read- While-Write capabilities and allows Interface to a 6- channel analogue to digital converter. (Atmel8-bit , 2013).

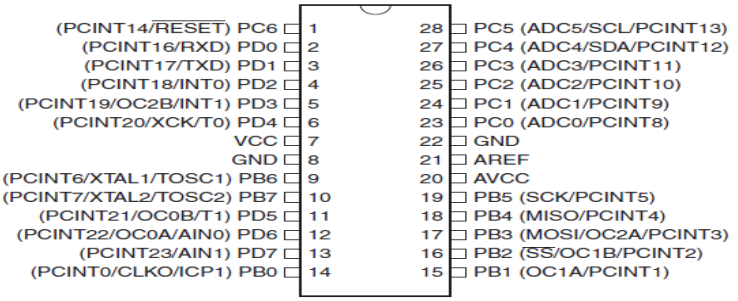

Fig. 3. Pin configuration of ATMEGA 328P Microcontroller.

2.3 *ULN 2803 IC.*

The ULN2803A device is a 50 V, 500 mA Darlington transistor array. The device consists of eight NPN Darlington pairs that generate high voltage outputs with common-cathode clamp diodes for switching relay loads as shown in Fig.4. Each Darlington pair has current rating of is 500 mA across the collector. It is mostly connected for high current loads in such as in relay drivers, lamp drivers etc (components101.com, 2018).

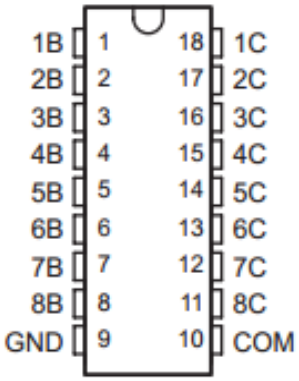

Fig. 4. Pin Configuration of ULN2803

2.3.1 Description of ULN 2803

Each channel of ULN2803 consists of Darlington connected NPN transistors that creates the effect of a single transistor with a very high current gain. The very high β allows for high output current drive with a very low input current, essentially equating to operation with low General-Purpose Input / Output (GPIO) voltages. The GPIO voltage is converted to base current through the 2.7 kΩ resistor connected between the input and base of the pre- driver Darlington NPN. The diodes connected between the output and COM pin are used to suppress the kick-back voltage from an inductive load that is excited when the NPN drivers are turned off (stop sinking) and the stored energy in the coils causes a reverse current to flow into the coil supply through the kick-back diode as shown in Fig. 5. (components101.com, 2018).

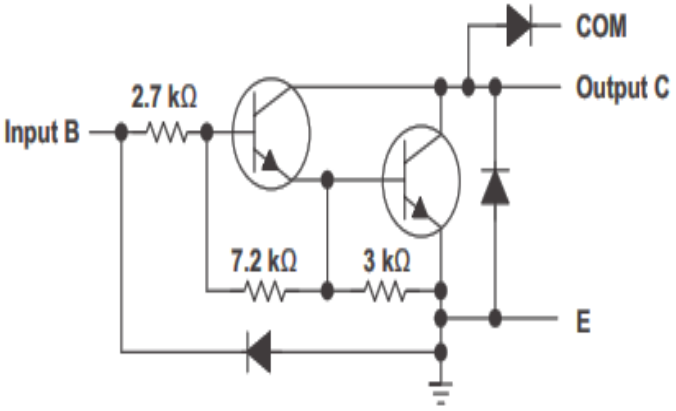

Fig. 5. Internal description of a block of ULN 2803.

2.3.2 Features of ULN 2803.

i. Internal frequency compensated.
ii. Large DC voltage gain: 100 dB.
iii. Very low supply current per operator essentially independent of supply voltage.
iv. Low input bias current: 20 nA (temperature compensated).
v. Low input offset voltage: 2 mV.
vi. Differential input voltage range equal to the power supply voltage.
vii. Large output voltage swing 0 V to (VCC – 1.5 V). (Embetronicx.com, 2019)

2.4 Circuit Description.

Connections of this SMS based device control circuit are quite simple, a liquid crystal display is used for displaying status of different electronic device connected to this gadget which is directly connected to microcontroller (Atmega 328) in 8-bit mode. Data pins of LCD namely RS, EN, D4, D5, D6, D7 are connected to digital pin number 6, 7, 8, 9, 10, 11. And Rx and Tx pin of SIM module is directly connected to the Rx and Tx pin which are the transmitting and receiving pins) of the microcontroller respectively as shown in Fig. 6. GSM module is powered by using a 12V adaptor. Three numbers of 5V SPDT relays are used for controlling different electrical appliances such as fan, lamp, radio set, computers etc. And relays are connected to the microcontroller pin number 3, 4 and 5 through relay driver ULN2003 for controlling the electronic gadgets respectively. Fig. 7. shows the physical layout of the SMS based device control circuit.

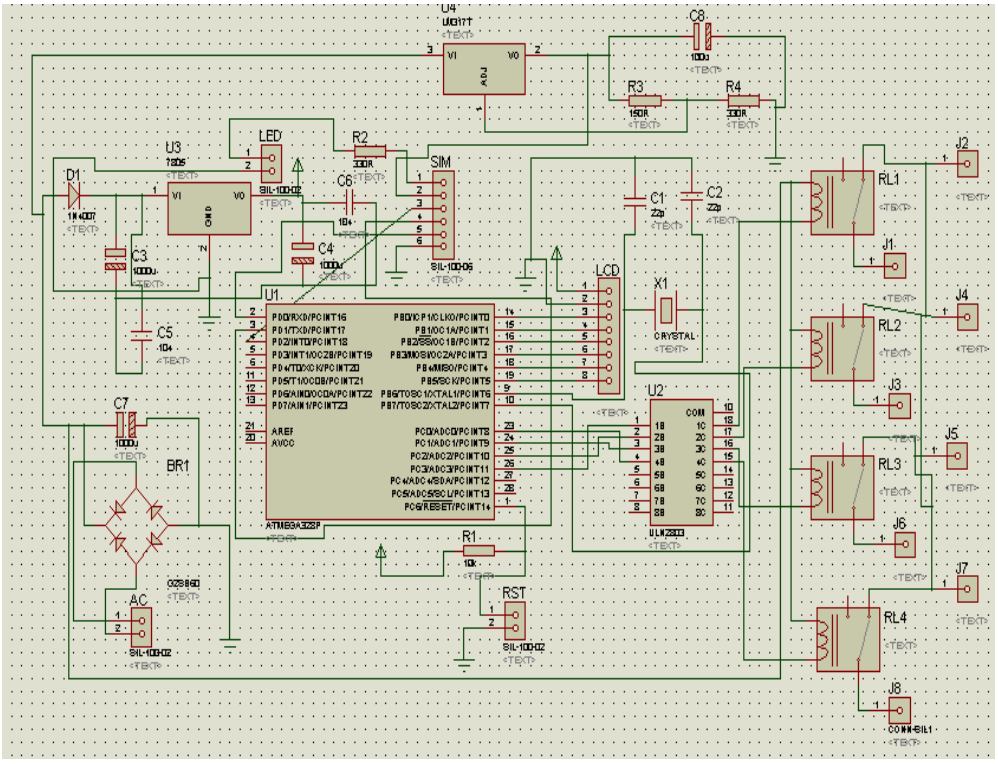

Fig. 6. Circuit diagram of the appliances control.

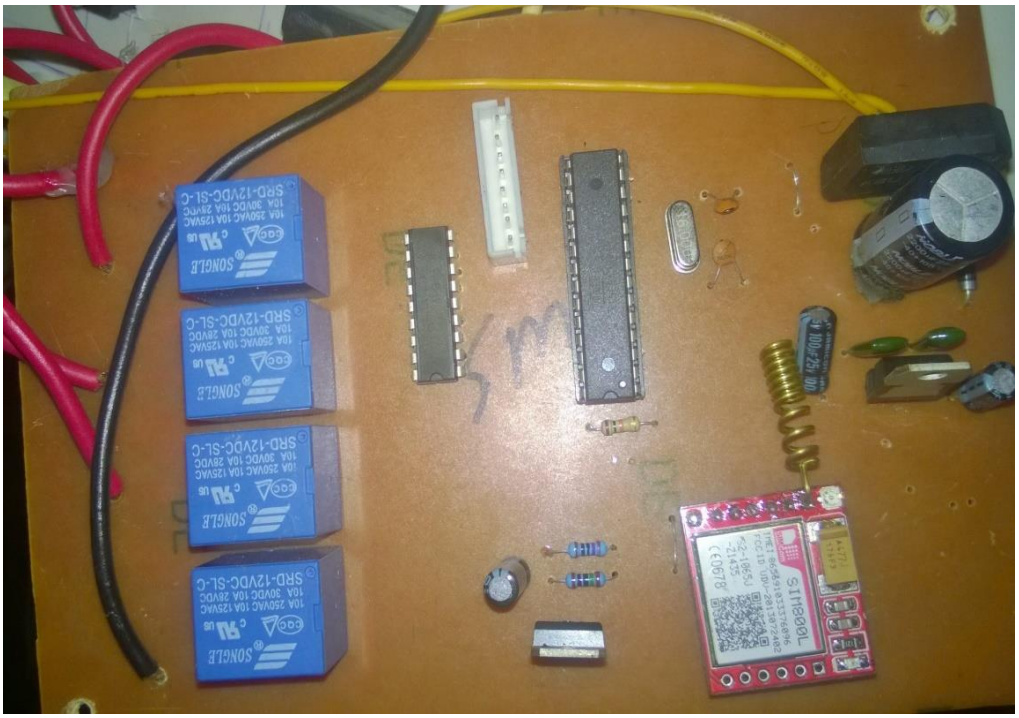

Fig. 7. Physical layout of the SMS based device control circuit.

2.5 Interfacing of the SIM module with the Microcontroller.

SIM module is used is used to interact with GSM network using a computer system. GSM module only understands AT commands, and can respond accordingly. The most basic command is "AT", if GSM respond OK then it is working good otherwise it responds with "ERROR". There are various AT commands like ATA for answer a call, ATD to dial a call, AT+CMGR to read the message, AT+CMGS to send as SMS, AT+CMG to select text mode and ATE 0 - For echo off etc. AT commands was followed by Carriage return i.e. (0D in hex), like "AT+CMGS". A prefix command string "#a." was used. This prefix is used to identify the main command that is coming next to it and * at the end of string indicates that message has been ended. When we send SMS to SIM module by a phone mobile, then SIM module receives that SMS and sends it to the AVR microcontroller (Atmega 328), the microcontroller reads this SMS and extracts main command from the received string and stores the data in a variable. After this, microcontroller compares this string with predefined string. If match occurred then this microcontroller transfers the signal to relay via relay driver ULN2003 for turning ON and OFF the home appliances. Hence, relative result also prints on 16 x 2 LCD by using appropriate commands.

2.6 Uploading of Programming Code into the Microcontroller.

Uploading of a source code (HEX file) into a microcontroller was done by using an AVR flash programmer which grant the access of sending the source code into the microcontroller. Activation and deactivation code for the design is as shown in table 1.

Table 1. Activation and Deactivation code of the design.

S/N	*Message*	*Operation*
1.	#a0	DV1 OFF
2.	#a1	DV1 ON
3.	#a2	DV2 ON
4.	#a3	DV2 OFF
5.	#a4	DV3 ON
6.	#a5	DV3 OFF
7.	#a6	BULB ON
8.	#a7	BULB OFF

Calculation of Activation time.

Average value of time used $= \frac{\Sigma\,(\text{total time taken})}{number\ of\ time\ recorded}$

3. Result and Discussion.

The description of test, measured value and remark on the design is as shown in Table 2.

Table 2. Test result.

S/N	*Description of Test*	*Measured value*	*Remark*
1.	Power supply output voltage	12 V	Satisfactory
2.	Voltage regulator output	5 V	Satisfactory
3.	Microcontroller output	5 V, 1 A.	Satisfactory
4.	Crystal Oscillator frequency	16 M Hz.	Satisfactry

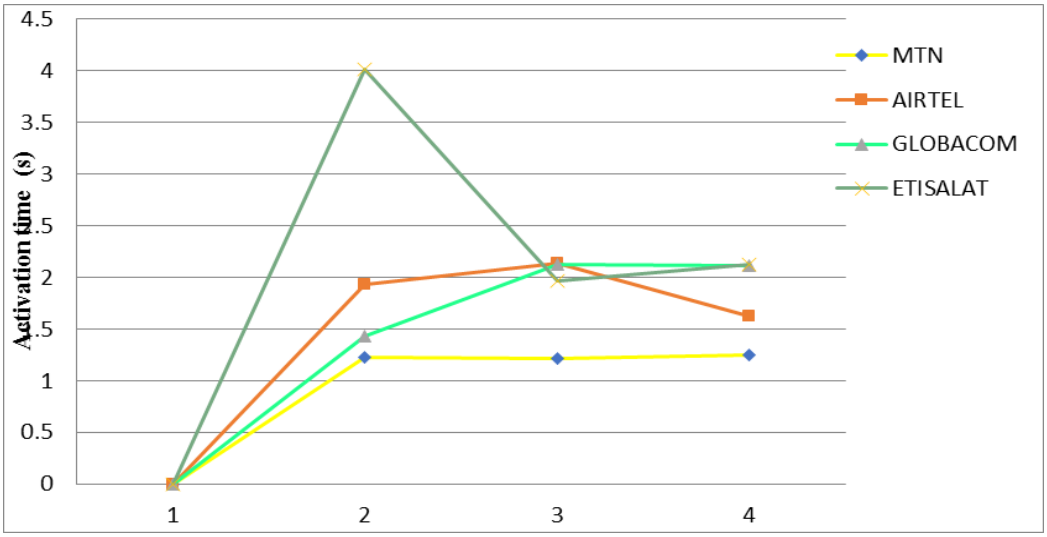

Fig. 8. Activation time of different networks t to deliver message.

The supply output voltage from the transformer after rectification and filtering was measured to be 12 V which is satisfactory to the design. The ATMEGA 328 microcontroller used required stable 5V DC supply. Therefore, a 7805-voltage regulator IC which is capable of producing a stable 5V output supply from 12 V supply was used to powered the microcontroller and the output voltage and current was measured to be 5V and 1A respectively which is satisfactory for successful operation of the design. Crystal oscillator frequency was measured to be 16 MHz which is satisfactory for the design.

Form the above result, the average time taken by MTN (colour yellow), GLO (colour light green), AIRTEL (colour brown), ETISALAT (colour dark green) are 1.23, 1.89, 1.89, 2.70 seconds respectively. This means that MTN SIM (colour yellow) network has the shortest time taken while ETISALAT (colour dark green) network has the highest time taken to deliver SMS to operate the device. GLO and AIRTEL network have the same time taken.

4. Conclusion

The SIM module is integrated with microcontroller to give a single compact with affordable low cost, secure, accessible, auto-configurable, remotely controlled solution for automation of home electrical appliance by sending an SMS using a particular code through a network. It was concluded that the device is working perfectly as designed. MTN SIM network was inserted into the SIM module because of its fast speed of SMS delivery to the device. This project can be useful in homes, laboratories, offices, hospital, hotels, companies, restaurants, religious canters etc. to prevent wastage of electricity and fire incidents which invariably reduces cost of electricity bills and also guarantee safety of lives and properties.

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