The Low Cost Remote Control for Electrical Appliances using AT89S51

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ABSTRACT
This paper demonstrates a novel method for switching ON/OFF the electrical appliances remotely from anywhere in the world. The method demonstrated in this paper uses a Microcontroller based system to control the devices connected through it by sending a text message. The GSM Modem acts as a trans-receiver for receiving the commands and sending the completion report. The GSM Modem is configured by the AT Commands to send/receive text messages and to communicate with the Microprocessor. The components used in this method cost very low, so this method is quite affordable.

General Terms
Remote Control, GSM Module, Switching, Microcontroller, Appliances.

Keywords
GSM, LCD, Microcontroller, Relay, Text Message.

1. INTRODUCTION
The innovations and the advances in the technology provide the convenience to the people. Be it from the information at the fingertips or the ease of living, the technology has made us live a convenient and comfortable life. From the innumerable gifts of the technology, this paper demonstrates the controlling of home appliances remotely using a cell phone. The home/office appliances consume the electrical power for their operation. To conserve the electricity, these devices must be turned OFF when not required. The switching of the electrical appliances is mostly done manually, though there are methods for remote switching. The method demonstrated in this paper is the low cost affordable system to perform the switching remotely using a Microprocessor based control unit and a cell phone for initiating the command. The receiver in the controlling circuitry being the GSM Modem. GSM Modem receives the text message from the user cell phone and sends it to the microcontroller which after analysis performs the required action and sends back the completion report. [1] [2]

2. OVERVIEW
The technology has been employed for the remote operation for the devices:
DTMF Based Remote Device Switching: The remote switching of the electrical appliances has been achieved by using the Dual Tone Multi Frequency. [1]
GSM Based Irrigation Control System: The purpose is to get SMS alerts whenever the status of the device changes to ON or OFF. [5]
GSM based Highway vehicle traffic monitoring system: Its purpose is to monitor the vehicles moving on highways at remote locations. This uses infrared/laser sensor system to count the number of vehicles passing in both the directions. The vehicle count is logged by the microcontroller. This information is sent to the user over GSM modem.

3. SYSTEM DEVELOPMENT
3.1 Block Diagram
The block diagram of this low cost remote control for electrical appliances is given below in Figure 1.

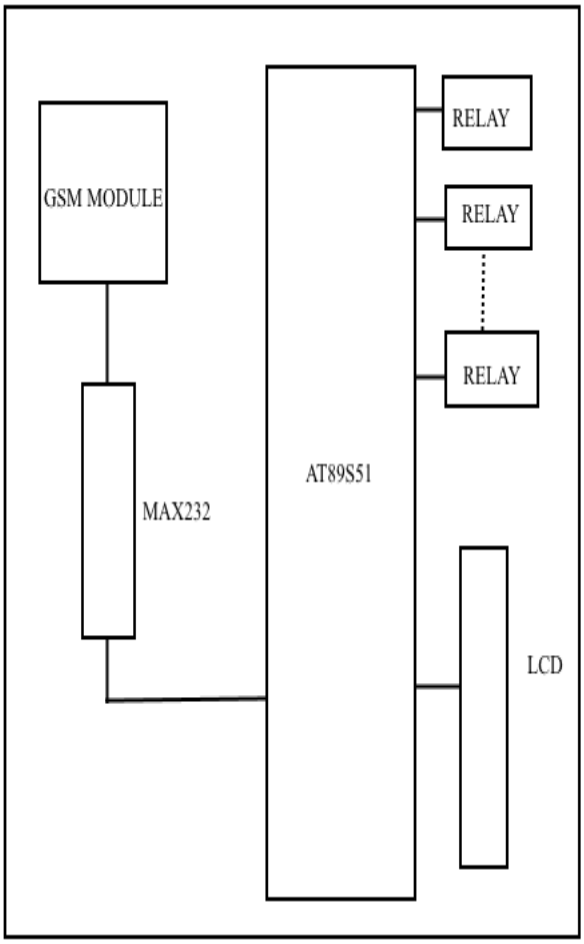

Figure 1: Block diagram of the Remote Control System

In the above block diagram the main components are listed: Microcontroller, GSM Modem, and Relay. The GSM Modem receives the text message sent by the user. This received message is forwarded to the microcontroller for analysis. The GSM Module and Microcontroller are connected via MAX232. The Microcontroller compares the received text message with the already programmed keywords, if these are match the required action will be performed.

3.2 Circuit Diagram

The circuit diagram for the remote control system is given below in figure 2:

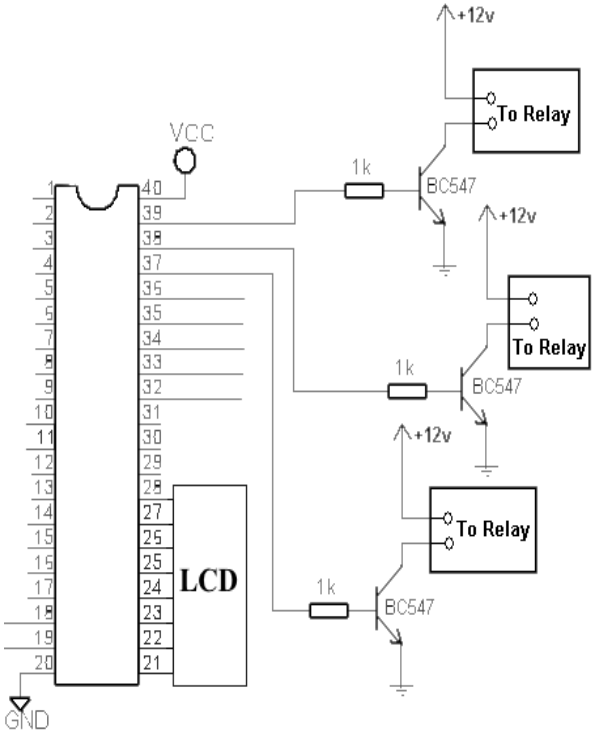

Figure 2: Diagram for connecting Relays, LCD and the Microcontroller AT89S51.

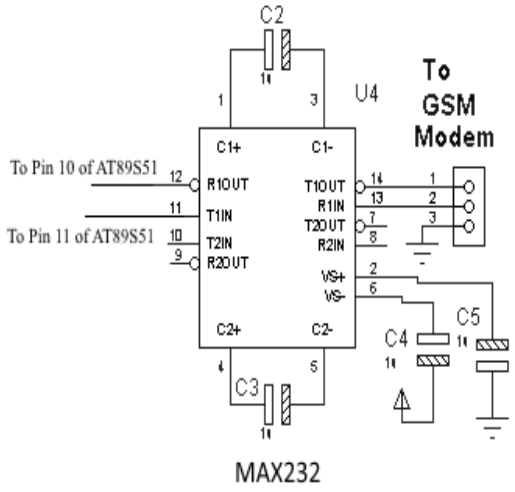

Figure 3: Circuit Diagram for interfacing GSM Module and AT89S51

The circuit diagram in figure 3 shows the interfacing of GSM Module and the AT89S51 using level shifter MAX232.

In this circuit diagram, the components used are: Microcontroller, GSM Module, MAX232, Relays, Transistors, LCD, etc. The Microcontroller used in the circuit is AT89S51, and the GSM Module used is SIM900. These are the low cost components, so the system is quite affordable.

4. ARCHITECTURE

The block diagram of this low cost remote control system of electrical appliances has been given. The main components are:

4.1 Microcontroller (AT89S51)

The AT89S51 is a high performing microcontroller. It has the word length of 8 bits. This microcontroller is manufactured by the Atmel and is compatible with the current industry standards. This is a very low cost microcontroller. The AT89S51 has following features: 128 bytes of RAM, 4 kilobytes of ROM, 32 I/O pins, and two 16 bit timers/counters. The serial port provided on the AT89S51 Microcontroller is used to interface it with the GSM Module via MAX232 level shifter.

The Microcontroller in this system is programmed to continuously scan the serial port for any incoming data. The data (text message) when received is compared to the keywords already programmed to check for a match. If there is s match the required action is performed. When a command for switching ON the device connected at PIN 0.0 is received, the respective PIN is turned high. The device is connected to the Microcontroller through a Relay. After this the acknowledgement is sent to the GSM Module for the action performed. [3]

4.2 GSM Module

GSM stands for Global System for Mobile Communications. It is a digital mobile telephony system. The technology used is the slight variation of the Time Division Multiple Access (TDMA). GSM represents more than 80% of the Global Mobile Communications. In India GSM uses 900MHz and 1800MHz, while 2100MHz is used for UMTS. In the system demonstrated in this paper SIM900 GSM Module working on 900MHz was used. This Modem uses a SIM Card capable sending and receiving text messages. This GSM Module is configured to forward the received text message to the microcontroller. The configuration is done by the Windows Hyper Terminal or any other terminal program. The GSM Module and the Microcontroller are interfaced serially using a MAX232 Level Shifter. The GSM Module used works on the RS232 standard while the Microcontroller operates on the TTL Logic. So the voltage level shifter is required which is realized by the MAX232. The GSM Modem supports the AT Commands (Attention Commands). These commands instruct the modem what to do. In this system, the modem has to send and receive the text messages, so the commands are:

AT+CMGR: Read new message from a given memory location.

AT+CMGS: Send message to a given recipient.

Similar commands are used to instruct GSM Module for other tasks.

When the switching is done, the Microcontroller sends the acknowledgement to the GSM Module. And the GSM Module sends the SMS to user cell phone informing the action completion. [6]

4.3 LCD

LCD stands for Liquid Crystal Display. The most commonly used LCDs found in the market today are 1 Line, 2 Line or 4 Line LCDs which have only 1 controller and support at most of 80 characters. Standard LCD module from LAMPEX is used for the DISPLAY. It displays the incoming message when received.

4.4 MAX232

The GSM Module used in this system operates on the RS 232 standard. But the Microcontroller AT89S51 operates on the Transistor-Transistor Logic (TTL). In order to interface both these devices and make them to communicate, voltage level translator is required. For this purpose MAX232 Level Shifter is used in this system. MAX232 was first created by Maxim Integrated Products that converts signals from a TIA-232 (RS-232) serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The advantage of MAX 232 is that it needs only single 5V single power supply, rather than requiring several supplies of different voltages.

The Voltage Shifting for RS232 and TTL is shown in table1:

Table: 1 Voltage Shifting for RS232 and TTL

RS232 Standard	TTL Logic
+3V to +15V	0V (Logic 0)
-3V to -15V	+5V (Logic1)

4.5 RELAYS

Relays are the electrically operated switches. Relays are used to control high rated circuitry by a low power one. Relays are also used where the electrical isolation of control circuit and the target circuit is necessary. For controlling the home electrical appliances by a low power microcontroller based circuitry Relays are used as the switching elements. The 12V Single Pole Double Throw (SPDT) Relays are used in this system to achieve the switching. These relays are driven by the signal from the microcontroller pins (output port) using the Transistor as the Relay Driving Circuit. The Relay Driver Circuitry is shown in figure 4.

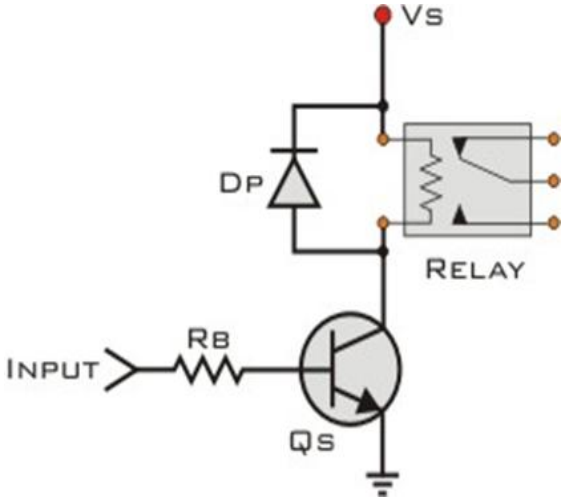

Figure 4: Relay Driver Circuit for Switching

The Transistor used is NPN BC547, the diode used is IN4007 and the resistor is 1kΩ. [7]
The base of the transistor is connected to the microcontroller pin to achieve its switching which in turn controls the Relay operating from a +12V supply. When the Relay is to be energized, the transistor is driven in saturation mode, the series resistor controls the base current. [4]

5. ALGORITHM

The Algorithm for switching ON/OFF the electrical appliances using the above mentioned components connected as per the given circuit diagram:

Step 01: Start

Step 02: Clear all the registers

Step 03: Initialize LCD

Step 04: Display 'WELCOME' message on LCD

Step 05: Read the SMS from GSM modem

Step 06: Check if input is = DEVICE1ON

Step 08: If YES, then turn on first relay.

Step 09: If NO, then check input is = DEVICE1OFF

Step 10: If YES, then turn off first relay.

Check for text string for all the relays connected, in this demo unit, 4 relays were used to control 4 devices by it.

6. FLOWCHART

The following Flow Chart describes the operation of the low cost remote control of electrical appliances:

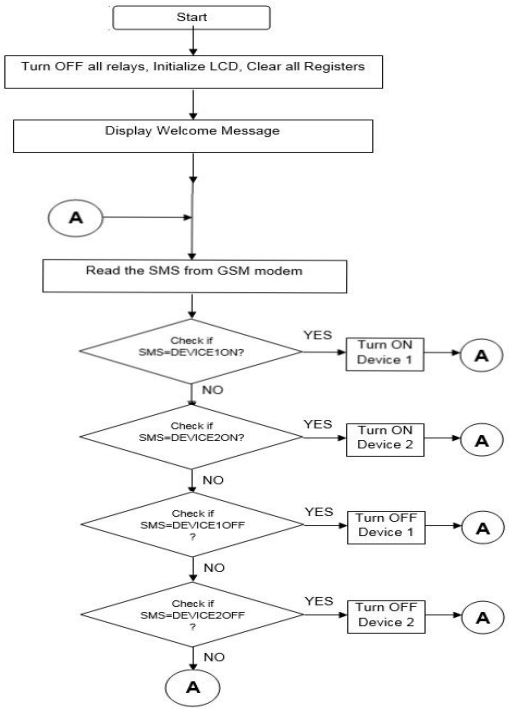

Figure 5: Flow Chart Algorithm showing the operation of Remote Control Electrical Appliance

7. RESULTS

The system described in the paper was assembled and put to use for the results and the analysis.

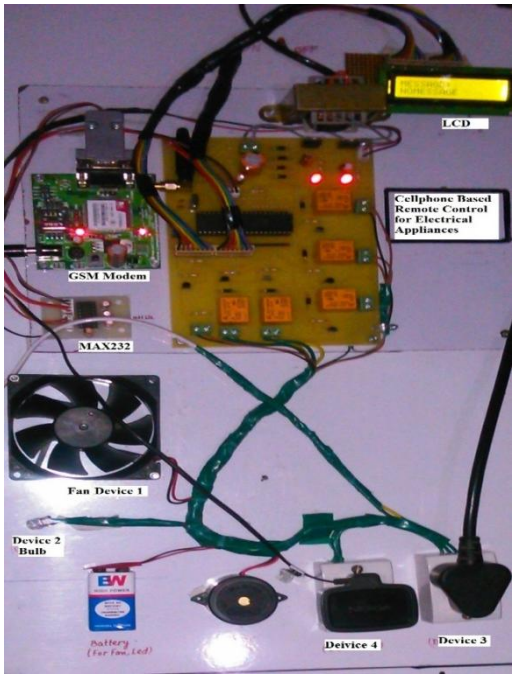

Figure 6: Remote Control System practically tested for DC and AC Devices

In this system four devices were connected through four relays for controlling them remotely. The connected devices are fan, LED Bulb, and 2 general purpose sockets. These two general purpose sockets can be used to charge mobile and also laptop. All the appliances were connected and its functionality was checked.

The Microcontroller Program for the operation of the system was written in Keil µVision and then burned to the AT89S51.

The tests were conducted the following way:

1. The message was typed from the user cellphone and send to the SIM Card installed in the GSM Module.
2. The GSM Module received the message and forwarded it to the microcontroller serially.
3. The microcontroller analyzed the message by the above given algorithm.
4. If the message is matched with the keywords programmed in the ROM of AT89S51, the required action of turning the particular PIN of Port 0 High or Low is done.
5. The pins are connected to the relays via a transistor, the high or low signal at pin (or base of transistor) determines whether the transistor remains ON or OFF.
6. The Relays operating from a 12V supply are connected through the transistor thus turning ON or OFF accordingly with the transistor.
7. The device which is connected to the supply through the relay, thus switching the, signal whether ON or OFF remotely, is send via a text message.

Thus the appliances are remotely switched ON/OFF using a microcontroller based system whose result is shown in table 2.

Table 2: Switching result based on microcontroller system.

S No	SMS String	µC Pin/Relay Driver	Device	Function
1	DEVICE1ON	39/High	Fan	Turn on
2	DEVICE2ON	38/High	Bulb	Turn on
3	DEVICE3ON	37/High	Charger 1	Turn on
4	DEVICE4ON	36/High	Charger 2	Turn on
7	DEVICE1OFF	39/Low	Fan	Turn off
8	DEVICE2OFF	38/Low	Bulb	Turn off
9	DEVICE3OFF	37/Low	Charger 1	Turn off
8	DEVICE4OFF	36/Low	Charger 2	Turn off

8. ADVANTAGES

The model for low cost remote control of electrical appliances demonstrated in this paper has many features and advantages:

1. The operation of this system is very convenient.
2. This system can be operated from any location having cellular connectivity.
3. Action completion report is sent back to the user.
4. The switching is almost instant (time required to deliver SMS).
5. This system can be used for controlling DC as well as AC devices.

9. CONCLUSION

Mobile Phones are now the indispensable part of life. Everyone has got the one or has access to one. This paper demonstrated the method for controlling the electrical appliances remotely from any location having the Mobile Network Service. This method is an amendment to the already available controlling units. If the cost estimation is done, the GSM Module costs around □ 700, the AT89S51 about □ 100, and relays, MAX232, transistors and resistors, they all are available for a maximum of □ 100 in India. Thus this complete system can be assembled for less than □ 1000 and control many devices connected through the available 4 ports of the AT89S51.

10. REFERENCES

[1] Sanaullah, "Development of a Cell Phone based Remote Control System: an Effective Switching System for Controlling Home and Office Appliances". International Journal of Electrical & Computer Sciences IJECS-IJENS Vol: 09 No: 10 p23-29.

[2] Ahmed, "Innovative Cost Effective Approach for Cell Phone Based Remote Controlled Embedded System for Irrigation" IEEE Conference 3-5 June 2011, Katra J&K.

[3] Mazidi, The 8051 Microcontroller, 2nd Edition, Pearson India

[4] Gupta, J. B. "Electronic Devices and Circuits", Katson Books

[5] Patil, Pratik A., et al. "Prototype for automatically navigated water irrigation system."

[6] Sunrom.com,. (2016). GSM Modem - RS232 - SIM900A [1122] : Sunrom Electronics. Retrieved 11 February 2016, from http://www.sunrom.com/p/gsm-modem-rs232-sim900a

[7] Circuitstoday.com,. (2011). *Working of Relays-How Relay works,Basics,Design,Construction,Application*. Retrieved 11 February 2016, from http://www.circuitstoday.com/working-of-relays

[8] Dong-ying Ju; Rui Zhong; Takahashi, M.; Saitama Inst. of Technol., Saitama. Development of Remote Control and Monitor System for Autonomous Mobile Robot Based on Virtural Cell Phone Innovative Computing, Information and Control, 2007. ICICIC '07. Second International Conference ISBN: 0-7695-2882-1

[9] Ahmed,V.; Ladhake,S.A.; Electron. Eng. Dept., Babasaheb Naik Coll. of Eng., Pusad,India. Innovative Cost Effective Approach for Cell Phone Based Remote Controlled Embedded System for Irrigation Communication Systems and Network Technologies (CSNT), 2011

[10] Sagarika Pal1, Niladri S. Tripathy11Department of Electrical Engineering, National Institute of Technical Teachers Training and Research, Kolkata. Remote Position Control System of Stepper Motor Using DTMF Technology.International Journal of Control and Automation Vol. 4 No. 2, June, 2011.

[11] http://www.atmel.com/dyn/resources/prod_documents/doc0265.pdf