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Design and Development of Smart Switching System for Controlling Home Appliances

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***Abstract*—** The world is changing day by day. We are moving from analog to digital system in almost every field. If we say for example, our old Television system has now been replaced by digital Television system. Even our cellular phones are becoming smarter. To make our home smarter and digital there are several projects going on. In this work we have designed & developed a prototype for home automation where one can control, monitor and remotely access their home appliances. In this project we have replaced our old switches used in switch board by digital keys. One can control their home appliances even they are not present in their home by their mobile phone and can also get the status of the appliances and power, through their mobile phone. This system will not only give the control of their home appliances, it will also make home smarter digital system and help peoples to keep away from electric shock.

***Keywords*—**89C52 Microcontroller, DTMF Decoder, GSM Module,Optoisolator, Triac.

I. INTRODUCTION

With the advancement of technology complex tasks are becoming simpler and devices are becoming small in size. It gives us a well looking GUI through which we can communicate with our digital system easily and perform the tasks. The world is changing and shifting to the digital components. Now the old filament bulbs are being replaced by LED bulbs, Tube lights by LED Tube and LED Stripes which are showing very efficient results with less power and high brightness. That is why we are trying to make our home a digital system. The project gives the digital design and features in one's home and will make an automated digital system. The primary objective of this project is to remotely access the home appliances (on/off) through mobile phone and check status whether they are switched on/off. The old traditional switch board will be replaced by digital board. The system will also have the power failure indicator by which one will be informed that there is no power or load shedding.

This paper is organized as follows: In section II, the GSM Module is described in brief. Section III describes the design and operation of the system. In section IV, we have described the technical details of the developed prototype system. In section V, the applications of the system

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II. GSM MODEM IN BRIEF

GSM stands for Global System for Mobile Communication which serves a worldwide communication network. The heart of this modem is the SIM900A [1] Chip and it has a built in RS232 interface which allows connecting with PC as well as microcontroller through Rx and Tx pins. It works on frequencies 900/1800 MHz and can be controller via AT Commands provided by the manufacturer. The communication rate, also known as the baud rate, can be configured from 1200 bps to 115200 bps through AT Commands. This Modem is having internal TCP/IP stack that enables one to connect with internet via GPRS. It provides us various services like voice calls, sending SMS, FAX and GPRS etc. All the features available to this Modem can be controlled by AT Commands.

A. Brief working of GSM Module

Unlike mobile phones, a GSM Modem does not have a keypad and display to interact with. It just accepts certain commands through a serial interface and acknowledges for those. These commands are called as AT commands. There is a list of AT commands [2] to instruct the modem to perform its functions. Every command starts with "AT". That's why they are called as AT commands. 'AT' stands for attention.

For example, if we want to call a number then we have to instruct the Modem via AT Command as

ATD+91XXXXXXXXXX; Here D stands for dial. Similarly to receive a call ATA and to hang a call ATH where A stands for answer and H stands for hang up.

In our project, this module is used to receive call to get the DTMF signals for controlling the home appliances.

III. DESCRIPTION OF THE SYSTEM

In our designed prototype, there will be a digital switch board made of Optoisolator and Triac, GSM Modem (Fig.1), DTMF decoder. The GSM Modem detects the call coming from user and receives it after two rings. The DTMF decoder detects DTMF tones and gives a four bits output depending on the DTMF signals. This outputs help to control the home appliances and notify the current status using the microcontroller and the GSM modem. The Optoisolator is used to electrically isolate the DC part of the system from the AC. The Triac is used to trigger the AC appliances.

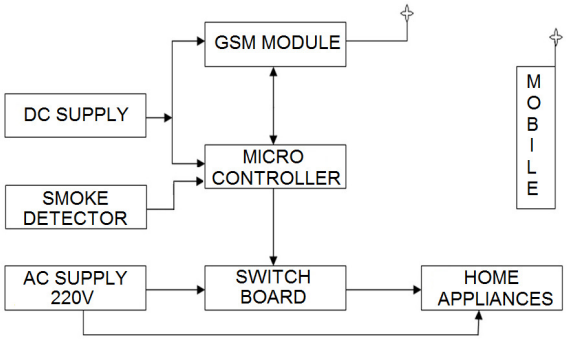


Fig. 1. Block diagram of the system.

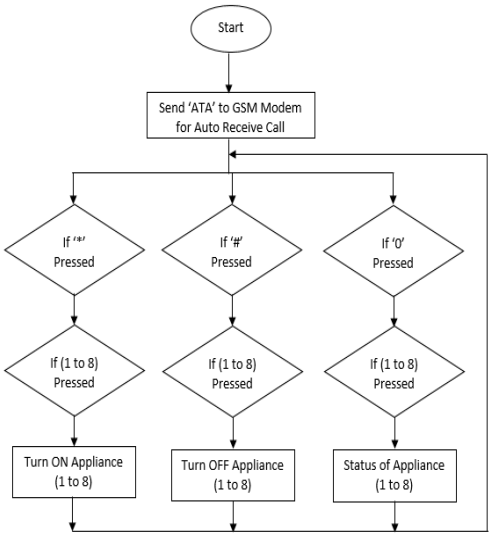


Fig. 2.Flowchart

A. *Steps of Operation*

1. To access the Home Automation System the user need to call the number (Ex:+91XXXXXXXXXX) which is being used in the Automation Module.
2. If the call is connected the user will be able to hear ringing. After two rings, the connection will be automatically established with the System.
3. When the user is connected with the System he can perform three basic operations which are, checking status of a particular appliance, turning on a particular appliance and turning off a particular appliance.
4. While connected, if the user press * key and then a key (1 to 8) in the phone's keypad, the corresponding connected appliance will be turned on.
5. If the user press # key and then a key (1 to 8) in the phone's keypad the corresponding connected appliance will be turned off.
6. To get the status of any appliance one can press 0 and then a key (1 to 8), the corresponding status of the appliance will be informed by a tone or tone pattern.

Note:
Single beep: The corresponding appliance is On.
Double beep: The corresponding appliance is Off.

IV. IMPLEMENTATION OF THE SYSTEM

We have implemented this system using GSM SIM900A Module, 89C52 Microcontroller, Optoisolator, Triac, DTMF decoder. The basic building block diagram of the system is shown in Fig. 1.

A. *SIM900A Module*

The SIM900A Module is the heart of the system to communicate with mobile phones. In this project, it is used to send SMS as notifications. Earlier we have already discussed that this modem can be controlled via "AT" commands. Here we are using the "AT" commands that are specific to send and receives SMS. The "AT" commands are being sent from the microcontroller which is communicating with the modem by 9600 bps baud rate. For communication purpose it uses the standard serial (RS232) interface. The Rx, Tx and Gnd pins of the modem are connected with controller Tx, Rx and Gnd pins. The

controller uses the UART protocol to instruct, send and receive from the modem. The development board for this module that we have used in this project is shown below (Fig.4).

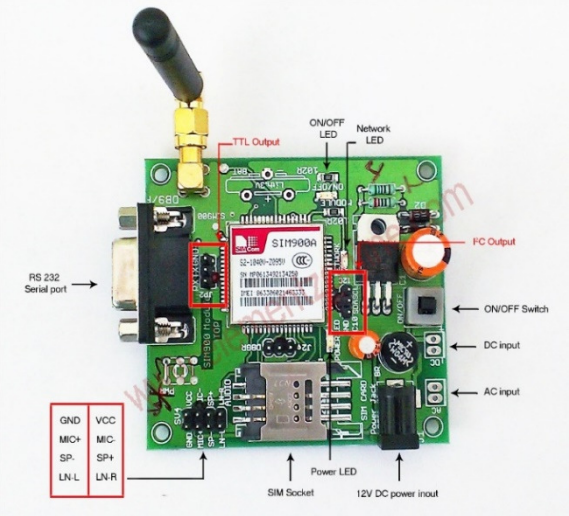


Fig.4 .GSM Development Board

B. 89C52 Microcontroller

The Intel MCS-51(commonly referred to as 8051) is a Harvard architecture, CISC instruction set, single chip microcontroller (µC) series which was developed by Intel in 1980 for use in embedded systems. The 8051 architecture provides many functions (CPU, RAM, ROM, I/O, interrupt logic, timer, etc.) in a single package [3].

i. 8-bit ALU and Accumulator, 8-bit Registers (one 16-bit register with special move instructions), 8-bit data bus and 2×16-bit address bus/program counter/data pointer and related 8/11/16-bit operations; hence it is mainly an 8-bit microcontroller.

ii. Boolean processor with 17 instructions, 1-bit accumulator, 32 registers (4 bit-addressable 8-bit) and up to 144 special 1 bit-addressable RAM variables (18 bit-addressable 8-bit).

iii. Multiply, divide and compare instructions

iv. 4 fast switchable register banks with 8 registers each

v. Fast interrupt with optional register bank switching

vi. Interrupts and threads with selectable priority

vii. Dual 16-bit address bus – It can access 2 x 216 memory locations – 64 KB (65,536 locations) each of RAM and ROM

viii. 128 bytes of on-chip RAM (IRAM)

ix. 4 KB of on-chip ROM, with a 16-bit (64 KB) address space (PMEM).

x. Four 8-bit bi-directional input/output port UART (serial port)

xi. Two 16-bit Counter/timers

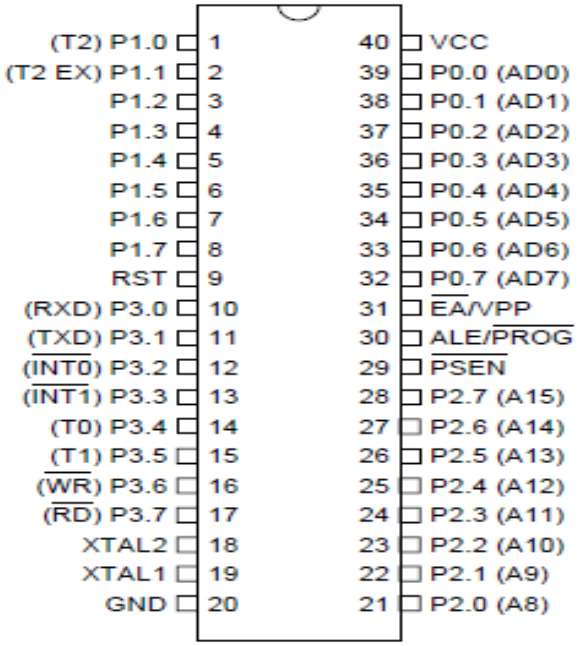


Fig. 5.Pin Diagram of 89C52

C. DTMF Decoder

The HT9170 [4] series are Dual Tone Multi Frequency (DTMF) receivers integrated with digital decoder and band-split filter functions. TheHT9170B andHT9170D types supply power-down mode and inhibit mode operations. All types of the HT9170 series use digital counting techniques to detect and decode all the 16DTMF tone pairs into a 4-bit code output. Highly accurate switched capacitor filters are employed to divide tone (DTMF) signals into low and high group signals. A built-in dial tone rejection circuit is provided to eliminate the need for pre-filtering.

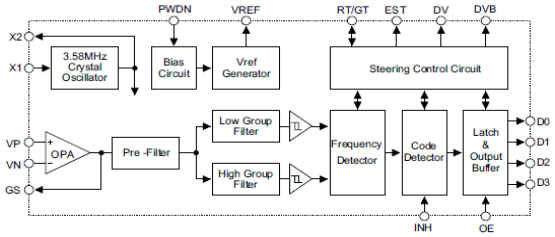
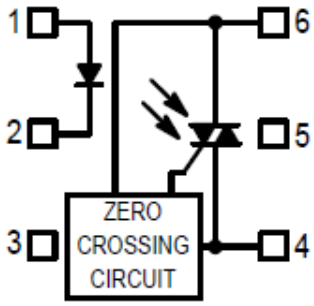


Fig. 6.Block Diagram of DTMF Decoder

D. *Optoisolator*

The MOC3041, MOC3042 and MOC3043 devices [5] consist of gallium arsenide infrared emitting diodes optically coupled to a monolithic silicon detector performing the function of a Zero Voltage Crossing bilateral triac driver. They are designed for use with a triac in the interface of logic systems to equipment powered from 115 Vac lines, such as solid–state relays, industrial controls, motors, solenoids and consumer appliances, etc.

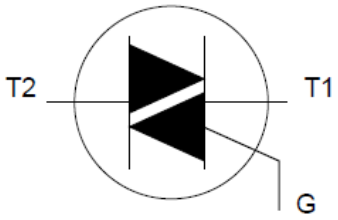


1. ANODE
2. CATHODE
3. NC
4. MAIN TERMINAL
5. SUBSTRATE
   DO NOT CONNECT
6. MAIN TERMINAL

Fig. 7.Coupler Schematic.

E. *Triac*

Passivated triacs [6] in a plastic envelope intended for use in applications requiring high bidirectional transient and blocking voltage capability and high thermal cycling performance. Typical applications include motor control, industrial and domestic lighting, heating and static switching.



PIN	DESCRIPTION
T1	main terminal 1
T2	main terminal 2
G	gate

Fig. 8.Schematic and Pin Description of Triac

F. *Embedded C Language*

The entire logic of this system is developed in Embedded C language (Keil Software). It is similar to C programming language and it uses the same procedure that of C to develop any logic in coding.

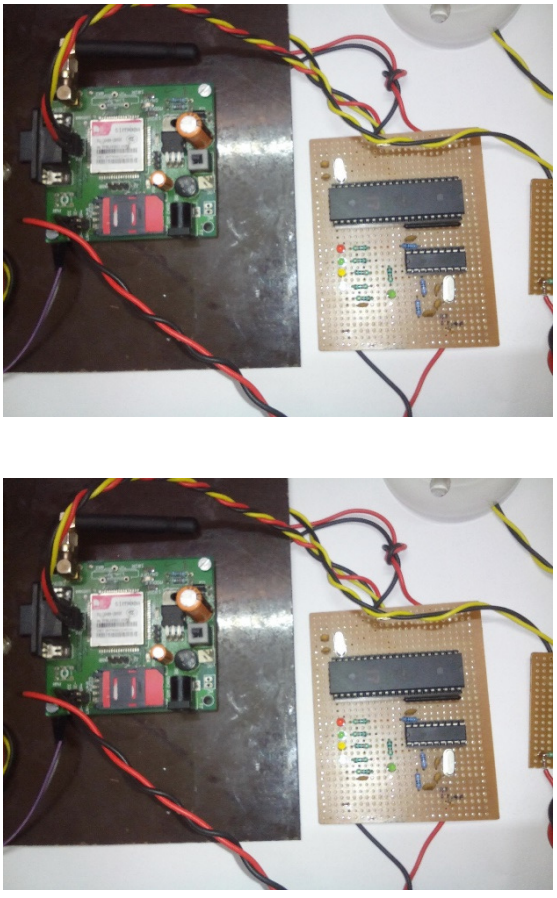


Fig. 9.Photograph of the developed System.

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