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# SMART AND INTELLIGENT ENERGY MANAGEMENT SYSTEM USING GSM TECHNOLOGY

ADITYA NARIAN*

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## *Abstract*

*Home automation has been an important issue throughout the last two decades. Many solutions have been reported and implemented. A power line communication network infrastructure for smart home was reported by Lin and his team.[1] The team used the existing electrical wiring and outlets as the medium for data communication within the home where no new wires are needed and many access points are available around the house. Other systems used conventional phone line for monitoring and controlling home appliances. Most recently, Internet and wireless communications have been utilized in home automations. With the recent development in mobile computing devices and mobile networks, new and better solutions can be developed to make home automation more convenient and accessible on the base of 24/7 from anywhere at any time.[2] This paper presents design of a standalone embedded system that can monitor and control home appliances remotely using built in input and output peripherals and GSM modem. The system allows the home owner to monitor and control his house appliances via his mobile phone set by sending commands in the form of SMS messages and receiving the appliances status as well. This system also provides human presence in the home, by promptly sending SMS to a system registered person.*

*Keywords :* Intelligent, Microcontroller, GSM Interfacing, PIR Sensors.

## *I. Introduction*

It is true that every electronic gadget that is used in daily life right from a PC keyboard to a refrigerator is an Embedded System. Generally Embedded Systems are widely used for domestic, scientific, industrial applications. The "Remote on/off controlling and monitoring of Electrical Appliances Using

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Microcontroller/Mobile Technique as a Controller is one of such embedded applications.

GSM stands for Global System for Mobile Communications. The GSM modem is a serial device that is very similar to a mobile phone. The design uses a GSM modem for operating different devices in a home automation through a SMS. The modem uses few AT commands. AT commands are instructions used to control a modem. AT is the abbreviation of ATtention. Every command line starts with "AT" or "at" for its various actions.

This device also controls individual devices, if any human is detected, i.e., if any human is detected, it switches ON the predefined device and sends a intimation SMS to the concerned predefined mobile number's. And if no human is detected, it automatically switches OFF that device within predefined set time.[3] The system block diagram is shown in fig 1.

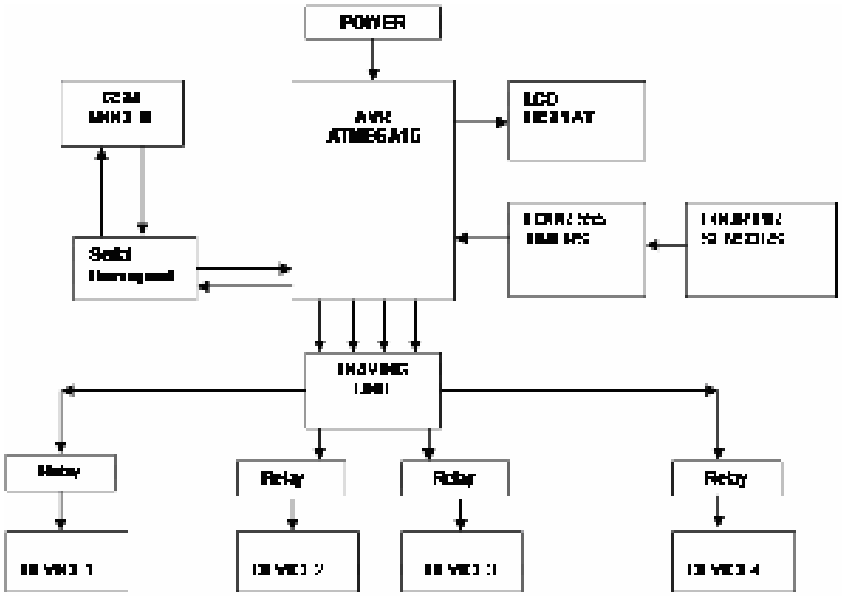


Fig. 1 System Block Diagram

## *II. Smart and Intelligent Systems Hardware*

The major hardware interfaces to microcontroller are LCD display, PIR sensors (Passive Infrared Sensors), modem (GSM), etc. Also the appliances are interfaced to the micro controller that is to be controlled. The design uses RS-232 protocol for serial communication between the modem and the micro controller. A serial driver IC is used for converting TTL voltage levels to RS-232 voltage levels. The devices that can be interfaced to the micro controller are any 1-Φ devices. Also the corresponding driver ICs and switching circuits are used for operating devices.

When a message is sent to the number in the modem from a remote place, accordingly the devices are either on or off. For example an SMS – "1ON" is sent, the first device is ON and similarly other operations are performed. The highlight of the design is that it can also sends a return message indicating the status of the devices.

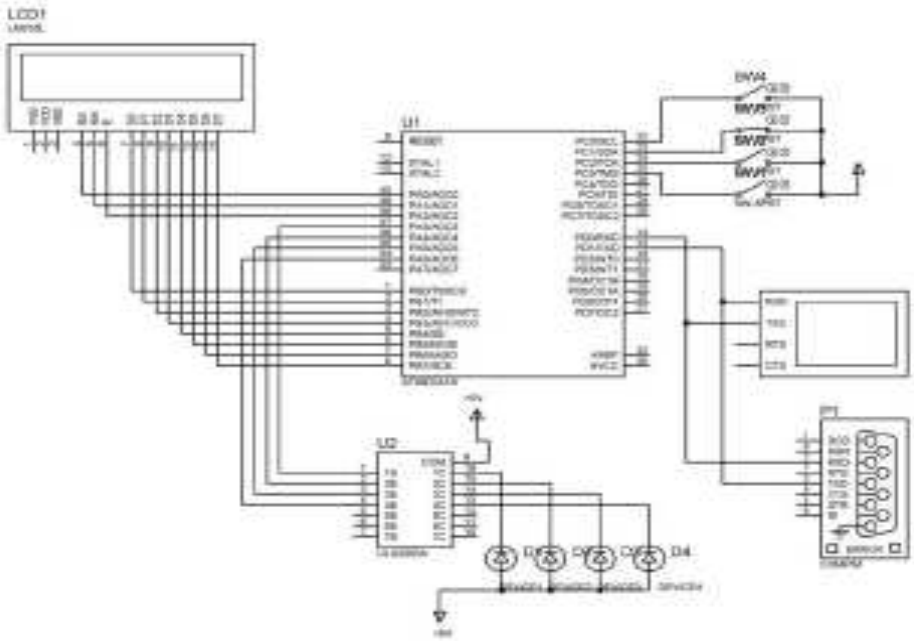

Fig. 2 System Circuit Diagram

The hardware includes the following components :

(i) Power supply circuit
(ii) Microcontroller AVR ATmega16 (iii) Liquid crystal display (16*02 LCD) (iv) RS 232 converter (IC MAX 232)
(v) GSM Modem
(vi)PIR Sensors and 555 timers

*(i) Power Supply Circuit* : The microcontroller and other devices get their power supply from the power circuit as shown in fig 3. The power supply circuit is being used for converting 220v AC supply to 5v DC

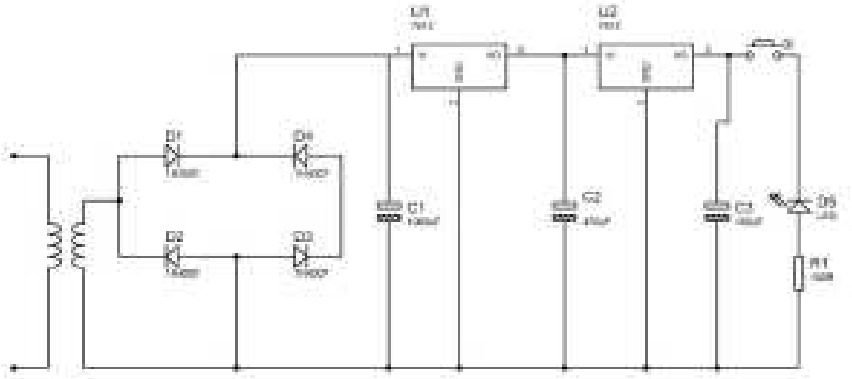

Fig 3. The Power Supply Circuit

These regulators can provide local on-card regulation, eliminating the distribution problems associated with single point regulation. Each type employs internal current limiting, thermal shut-down and

safe area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1 A output current.

Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltage and currents.

*(ii) Microcontroller ATmega16* :The ATmega16 is a high performance low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 allows the system designers to optimize power consumption versus processing speed. The important features are listed below: [6]

a) Advanced RISC Architecture
- 131 Powerful Instructions. Most Single clock Cycle Execution
- 32x8 General Purpose Working Registers
- Fully Static Operation
- Up to 16 MIPS Throughput at 16MHz

b) High Endurance Non-volatile Memory segments
- 16K Bytes of In-System Self-programmable Flash program memory
- 512 Bytes EEPROM
- 1K Byte Internal SRAM
- Write/Erase Cycles: 10,000 Flash / 100,000 EEPROM.
- Data retention: 20 years at 85°C/100 years at 25°C. c) Programmable serial USART

d) I/O and operating voltage
- 40 pin PDIP
- 32 programmable I/O lines.
- Operating voltage 4.5v-5.5v.

The microcontroller plays a vital role in the system and is the heart of this circuit. It has been programmed in such a way that if any individual enters the room the PIR sensors will detect and give an interrupt to the microcontroller, the controller then will switch on the device and give appropriate AT(A) commands to the modem to send the alert SMS to the owner mobile. LCD is connected to microcontroller in 8 bit data mode. Before displaying anything in LCD microcontroller will control the LCD initialization and select the data register and command register according to the purpose.

Relay and sensors are controlled by the microcontroller using single pins. Making a pin high or low would actually switch on and off the devices. Thus the microcontroller synchronizes and directs all the activities between all the hardware components such as modem, LCD, relays sensors.

*(iii) LCD (Liquid Crystal Display):* The most common type of LCD controller is the Hitachi 44780 that provides a relatively simple interface between a processor and an LCD.

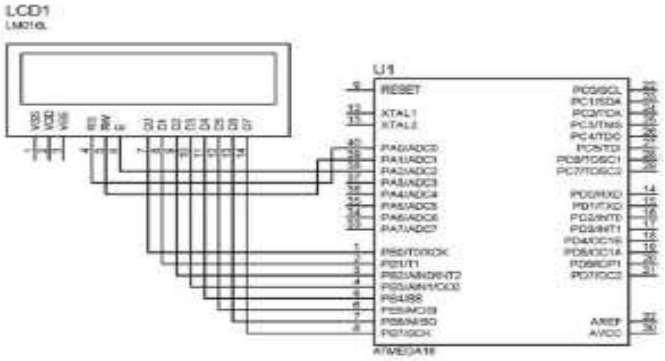


Fig. 4 Interfacing the LCD with ATmega16

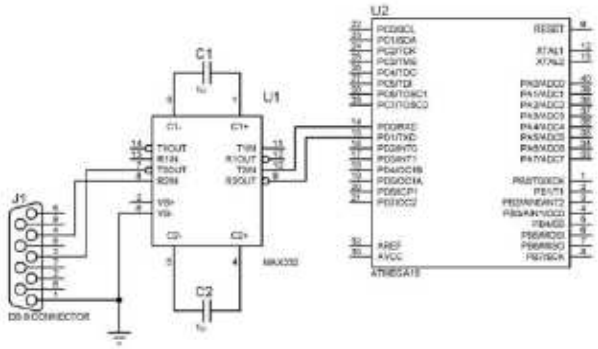


Fig. 5 Interfacing of MAX232 for RS232 conversion

Inexperienced designers do often not attempt using this interface and programmers because it is difficult to find good documentation on the interface, initializing the interface can be a problem and the

displays themselves are expensive. Ref fig. 4, LCD used has Two-line display with each line having 16 characters. There are 16 pins on the LCD. 8 pins are connected to microcontroller for data; three pins for register select, write and enable; 4 pins for input power and ground and 1 pin for contrast control.

*(iv)RS 232 Protocol and Converter (MAX 232N):* This is the device, which is used to convert TTL/ RS232 vice versa. The IC used is MAX 232N. The main role of the RS232 chip is to convert the data coming for the 12-volt logic to 5 volt logic and from 5 volt logic to 12 volt logic as shown in fig. 5.

RS-232 was created for the purpose of interface between Data Terminal Equipment (DTE) and Data Communications Equipment (DCE) employing serial binary data interchange. So as stated the DTE is the terminal or computer and the DCE is the modem or other communications device. The standard voltage range on RS-232 pins is 15V to +15V.This voltage range applies to all RS-232 signal pins. The total voltage swing during signal transmission can be as large as 30V. In many cases, RS-232 ports will operate with voltages as low as _5V to +5V. This wide range of voltages allows for better compatibility between different types of equipment and allows greater noise margin to avoid interference. Because the voltage swing on RS-232 lines is so large, the RS-232 signal lines generate a significant amount of electrical noise. It is important that this signal does not run close to high impedance microphone lines or audio lines in a system. In cases where you must run these types of signals nearby one another, it is important to make sure that all audio wires are properly shielded.

RS 232 Converter (MAX 232N) is an IC to convert the TTL voltage levels into RS 232 level and vice versa, Maxim Corporation develops this chip. In this case MODEM is communicating with the microcontroller through a serial port, the microcontroller will send the commands to the modem through RS 232. Thus to make the modem compatible with the microcontroller for serial communication we are using the RS232 converter.

*(v) GSM Modem* : Siemen's GSM Smart Modem is a multi-functional, ready to use, rugged unit that can be embedded or plugged into any application. The Smart Modem can be controlled and customized to various levels by using the standard AT commands. The modem is fully type-approved, it can speed up the operational time with full range of Voice, Data, Fax and Short Messages. The modem comprises the following interfaces:

- LED Function including operating Status
- External antenna
- Serial and control link
- Power Supply ( Via 2 pin Phoenix tm contact)
- SIM card holder

*(vi) PIR Sensors and 555 timers*: PIR sensors (Passive Infra Red sensor) are used to detect the presence of any individual. Sensors are used to detect the movement and give a signal to the 555 timers continuously. The timers generate an interrupt at regular intervals for the microcontroller. On receiving the interrupt the microcontroller acts accordingly.

## *III Interfacing of Devices with ATMEGA16 Microcontroller*

### *A. Pin Connections*

Some important pin connections of microcontroller are listed below:

a) The devices are connected at pins A.3, A.4, A.5 and A.6.
b) PIR sensors are connected at pins C.0, C.1, C.2 and C.3.
c) All 8 pins of PORT B are connected to the data lines of the LCD.
d) Pins A.0, A.1 and A.2 are used for providing select, enable and write signals to the LCD.

e) Pins D.1 and D.0 are connected to the modem through AX232 for the purpose of serial communication. The hardware connections were completed as per the circuit diagram and explanation given earlier.

### *B. Setting the baud rate*

The next most important step was to set up a suitable baud rate for the transmission of commands to the modem. The baud rate was selected to be 9600 bits per second which is the universally accepted and the maximum offered by the modem used. The selected baud rate (BAUD) along with the frequency of the oscillator (FOSC) used is fed to the MYUBRR register of microcontroller as per the following formula:

MYUBRR = (FOSC/16) / BAUD – 1

MYUBRR is a special internal register which needs to be loaded with the baud rate and frequency of the oscillator before setting up the serial transmission.

### *C. Establishing serial communication*

As shown in diagram pin D.0 is used for receiving and D.1 is used for transmitting the bits to the modem. The status of this data transfer is displayed in the status registers UCSRA, UCSRB and UCSRC (Universal Status and Control Register). These are 8 bit registers and each bit conveys some specific information about the status of task on serial. Thus these registers are used while programming for indicating the receipt of some message from the modem as also for transmitting the commands to the same

### *D. Establishing the display*

The LCD is connected as per the fig 3. It is controlled by the microcontroller through LCD commands. The important LCD commands used are listed as per the appx. The LCD differentiates between a data and a command through its select pin. If the microcontroller makes the select pin low then it assumes the bits on its data lines as a command and performs suitable action such as clear screen, cursor blinking etc. However if the microcontroller makes the select pin high then the LCD displays the bits that it receives on its data lines.

### *E. Interfacing of the sensors*

The PIR sensors continuously generate a signal on detecting any movement. This signal is then fed to the 555 timer which generates an interrupt for the microcontroller informing it of the detection.

The timer after a specified interval once again checks for the sensors to generate a suitable interrupt. Thus the microcontroller receives interrupts from the timer only at specified intervals. This is done because the processing speed of the microcontroller is not sufficient to accept continuous signal from the sensors.

The pins of the microcontroller are connected to ULN 2003 as shown in fig 6. This IC converts 5v from the microcontroller to 12v signal for the operation of relays.

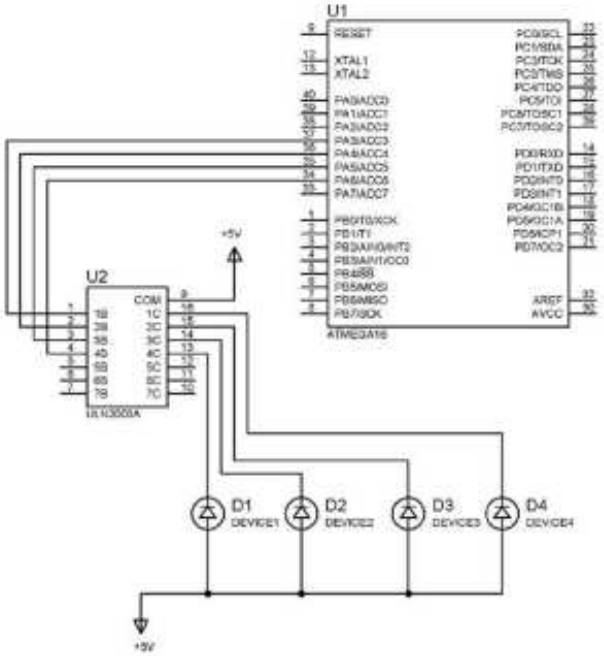


Fig 6 Interfacing of Devices with ATmega16

## *IV. System Operation*

Once a valid SIM card with sufficient talk time is inserted into the modem the device can be operated in the following simple steps:

a) Switch on the modem power supply and wait for 30s for it to initialize.
b) Switch on the power supply of the device. Look at the LCD display to see what commands the microcontroller is sending to the modem to read any message in its in box.
c) Simply send the pre coded message for any of following actions
d) Switching on/off any particular device. ii) Obtaining the status of all the devices.
e) When any individual enters the room in your absence the PIR sensors detect the same and automatically switch on the device. At the same time a message is received at your mobile indicating the change in status.

With this device one can switch-ON, OFF or Restart some Linux servers, ADSL modems, Printers, Door with electric Lock, Garage door, House lights, Water pumps, electric sunshade, Block the engine of your car or your motorcycle, at the steal case and much more.

The device serve the purpose of wireless control of many electronic and electrical gadgets and makes the human life better and easier.

## *IV Conclusions*

Smart and Intelligent Energy Management System Using GSM Technology circuit is tested in the laboratory and found working very satisfactorily. This device can be used to monitor home or office appliances and one can avoid unnecessary running of the devices and which in turn help to reduce energy bills. Secondly the device can also be used to detect tress passers in a protected area or home or office and rise the alarm to an authorized person or group of people by sending a SMS to their respective mobiles.

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