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GSM Based Home Automation System

[1] Amit Kumar, [2] Ankur Sinha

[1], [2] Department of Electronics and Communication Engineering, Galgotias University, Yamuna Expressway Greater Noida, Uttar Pradesh

[1] amitkumar@galgotiasuniversity.edu.in, [2] ankur.sinha@galgotiasuniversity.edu.in

Abstract: "This research work investigates the potential of 'Full Home Control', which is the aim of the Home Automation Systems in near future. The analysis and implementation of the home automation technology using Global System for Mobile Communication (GSM) modem to control home appliances such as light, conditional system, and security system via Short Message Service (SMS) text messages is presented in this paper. The proposed research work is focused on functionality of the GSM protocol, which allows the user to control the target system away from residential using the frequency bandwidths. The concept of serial communication and AT-commands has been applied towards development of the smart GSM-based home automation system. Home owners will be able to receive feedback status of any home appliances under control whether switched on or off remotely from their mobile phones. PIC16F887 microcontroller with the integration of GSM provides the smart automated house system with the desired baud rate of 9600 bps. The proposed prototype of GSM based home automation system was implemented and tested with maximum of four loads and shows the accuracy of ≥98%."

Keywords: Intelligent system, Home automation, Global System for Mobile Communication (GSM), PIC microcontroller, Short Message Service (SMS).

INTRODUCTION

From last few years home security is an essential requirement of households to keep home safe from intruders to get rob. So the researchers and companies try to implement algorithms and made some gadgets that keep your home safe from intruders. This leads to advance technology that make your home intelligent or modern, which called as Home Automation System. With this technology house owner can control other appliances as well like lighting system, dimming, electrical appliances and many more [1]. Now a day's wireless technology is used to control home appliances instead of wired topological connection. GSM (Global System for Mobile Communication) technology makes used to communicate input signal from appliances to output message on device [2]. That means after detection of any intrusion GSM Modem sends the appropriate message to house owner's phone. The signals or data which is comes from sensors or other equipment digitize it by GSM module and send it to receiver

[3]. Home automation or home security system offers many benefits. After so many researches the main focus is given on GSM based home security. It is very easy to install and having a very less cost. Basically it installed inside the room, as soon as the laser network got cut by any intruder the sensor detects this and sends it to ATmega16 microcontroller and action takes place according to piece of code written on the chip and GSM module sends the message to owner's cell phone [4].

HARDWARE AND SOFTWARE REQUIRED

1. Hardware requirements:

ATmega16 Microcontroller , SIM900 GSM Modem 12V, 1A DC Adapter ,6-Pin Switch ,IC 7805 ,12V Buzzer, BC547 Transistor , 1N4007 Diode ,12V Relay ,Bulb Holder , 10 W Bulb ,330 Ohm Resistor ,1K Ohm Resistor ,100 uF Capacitor,

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Light Dependent Resistor(LDR) ,Laser Torch, Small Mirror pieces – As per requirement.

2. Software requirements:

ATMEL Studio 4 or higher, SinaProg

3. Programming language:

Embedded C: Embedded systems are designed to do some specific task, rather than be a general-purpose computer for multiple tasks [5]. Some also have real time performance constraints that must be met, for reason such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs.

An embedded system is not always a separate block - very often it is physically built-in to the device it is controlling. The software written for embedded systems is often called firmware, and is stored in read-only memory or flash convector chips rather than a disk drive. It often runs with limited computer hardware resources: small or no keyboard, screen, and little memory[6]. Figure 1 describes the architecture of the system.

CHARACTERISTICS OF EMBEDDED SYSTEMS

Low cost and Less Power consumption, Programs on an embedded system must run with real-time constraints with limited hardware resources, Embedded systems are routinely expected to maintain 100% reliability while running continuously for long periods, sometimes measured in years [7].

I. Applications of Embedded Systems:

Military and aerospace software applications, Communications application, Industrial automation and process control software, Electronics applications and consumer devices.

II. Microcontroller Unit:

Microcontroller can be termed as a System on a Chip computer which includes number of peripherals like RAM, EEPROM, Timers etc., required to perform some predefined task. There are number of popular families of microcontrollers which are used in different applications as per their capability and feasibility to perform the desired task, most common of these are 8051, AVR and PIC microcontrollers.

Parameters	8051	PIC	AVR
Speed	Slow	Moderate	Fast
Memory	Small	Large	Large
Architecture	CISC	RISC	RISC
ADC	Not Present	In built	In built
Timers	In built	In built	In built
PWM Channels	Not Present	In built	In built

AVR is an 8-bit microcontroller belonging to the family of Reduced Instruction Set Computer (RISC). In RISC architecture the instruction set of the computer are not only fewer in number but also simpler and faster in operation. The other type of categorization is CISC (Complex Instruction Set Computers).

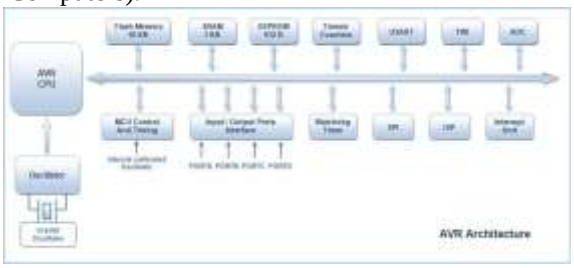

Figure 1: Architectural Diagram Of At Mega 16

1. Features of ATmega16:

In our journey with the AVR the working on Atmega16 microcontroller, this is a 40-pin IC and belongs to the mega AVR category of AVR family. Some of the features of Atmega16 are: 16KB of Flash memory, 1KB of SRAM, 512 Bytes of EEPROM, Available in 40-Pin DIP, 8-Channel 10-bit ADC , Two 8-bit Timers/Counters, One 16-bit Timer/Counter ,4 PWM Channels ,In System Programmer (ISP) ,Serial USART ,SPI Interface ,Digital to Analog Comparator. Fig 1 shows the architectural diagram of AT mega 16.

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Atmega16 Following points explain the building blocks of Atmega16 architecture:

Atmega16 has four (PORTA, PORTB, PORTC and PORTD) 8-bit input output ports. Flash ROM or simple flash memory is used to store the program dumped or burnt by the user on to the microcontroller. It can be easily erased electrically as a single unit. Flash memory is non-volatile i.e., it retains the program even if the power is cut-off. Atmega16 is available with 16KB of in system programmable Flash ROM [8]. Byte Addressable EEPROM is also a nonvolatile memory used to store data like values of certain variables. Atmega16 has 512 bytes of EEPROM; this memory can be useful for storing the lock code if the designing an application likes electronic door locks. SRAM: Static Random Access Memory, this is the volatile memory of microcontroller i.e., data is lost as soon as power is turned off. Atmega16 is equipped with 1KB of internal SRAM. A small portion of SRAM is set aside for general purpose registers used by CPU and some for the peripheral subsystems of the micro-controller [9].

Internal Calibrated Oscillator is defined as Atmega16 that is equipped with an internal oscillator for driving its clock. By default Atmega16 is set to operate at internal calibrated oscillator of 1 MHz .The maximum frequency of internal oscillator is 8Mhz. Alternatively, ATmega16 can be operated using an external crystal oscillator with a maximum frequency of 16MHz. In this case you need to modify the fuse bits. Atmega16 is equipped with an 8 channel ADC (Analog to Digital Converter) with a resolution of 10-bits. ADC reads the analog input for e.g., a sensor input and converts it into digital information which is understandable by the microcontroller [10]. Atmega16 consists of two 8-bit and one 16-bit timer/counter. Timers are useful for generating precision actions for e.g., creating time delays between two operations. Watchdog timer is present with internal oscillator. Watchdog timer continuously monitors and resets the controller if the code gets stuck at any execution action for more than a defined time interval.

Atmega16 consists of 21 interrupt sources out of which four are external. The remaining are internal interrupts which support the peripherals like USART, ADC, and Timers etc. Universal Synchronous and Asynchronous Receiver and Transmitter interface is available for interfacing with external device capable of communicating serially (data transmission bit by bit). Atmega16 is equipped with 32 general purpose registers which are coupled directly with the Arithmetic Logical Unit (ALU) of CPU [11].

AVR family of controllers have In System Programmable Flash Memory which can be programmed without removing the IC from the circuit, ISP allows to reprogram the controller while it is in the application circuit. Atmega16 is also equipped with a Digital to Analog Converter (DAC) interface which can be used for reverse action performed by ADC. DAC can be used when there is a need of converting a digital signal to analog signal. The most common source of power supply these days is the AC mains, because it is more efficient and economical to generate and transmit AC power[12]. However, DC voltage/current is required for the satisfactory operation of a wide variety of electronics equipment using solid state devices, such as diode, transistors and ICs. But of the operation of most of the electronic circuits. Hence it is necessary to convert AC power into DC power. For conversion of AC power into DC power, a SMPS circuit is used which converts 220V AC into 12V DC. This 12V DC is further regulated to 5V and 3.3V using different voltage regulators, as the different sections of our project requires.

2. Voltage Regulators:

Voltage regulators produce fixed DC output voltage from variable DC (a small amount of AC on it). Normally the output is fixed by connecting the voltage regulator at the output of the filtered DC. It can also use in circuits to get a low DC voltage from a high DC voltage.

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There are two types of voltage regulators

Fixed voltage regulators (78xx, 79xx)
Variable voltage regulators (LM317)

In fixed voltage regulators there is another classification

Negative voltage regulators
Positive voltage regulators

Negative Voltage Regulators:

Mostly available negative voltage regulators are of 79xx family. The mainly available 79xx IC's are 7905,7912 1.5A output current ,short circuit protection, ripple rejection are the other features of 79xx IC's.

Positive Voltage Regulators:

This includes 78xx voltage regulators. The most commonly used ones are 7805 and 7812. 7805 gives fixed 5V DC voltage if input voltage is in (7.5V-20). You may sometimes have questions like, what happens if input voltage is <7.5 V or some 3V, the answer is that regulation won't be proper. Suppose if input is 6V then output may be 5V or 4.8V, but there are some parameters for the voltage regulators like maximum output current capability, line regulation etc. won't be proper. Remember that electronics components should be used in the proper voltage and current ratings as specified in datasheet. You can work without following it, but you won't be able to get some parameters of the component. Fig 2 shows the diagram of voltage regulator.

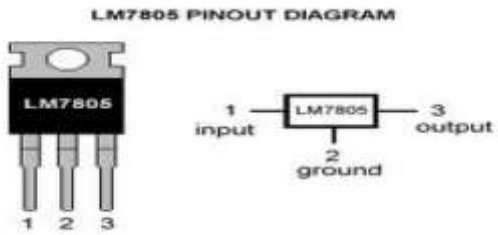

Figure 2: Diagram of Voltage Regulator

Many of the fixed voltage regulators have 3 leads and look like power transistors, such as the 7805 (+5V 1A) regulator shown on the above. If adequate heat sinking is provided then it can deliver up to maximum 1A current. For an output voltage of 5v-18v the maximum input voltage is 35v and for an output voltage of 24V the maximum input voltage is 40V. For 7805 IC, for an input of 10v the minimum output voltage is 4.8V and the maximum output voltage is 5.2V. The typical dropout voltage is 2V.

3. GSM Modem:

A GSM modem is a wireless modem that works with a GSM wireless network. A wireless modem behaves like a dial-up modem. The main difference between them is that a dial-up modem sends and receives data through a fixed telephone line while a wireless modem sends and receives data through radio waves. Like a GSM mobile phone, a GSM modem requires a SIM card from a wireless carrier in *order to operate.*

4. SIM Card Interface:

You can use AT Command to get information in SIM card. The SIM interface supports the functionality of the GSM Phase 1 specification and also supports the functionality of the new GSM Phase 2 + specification for FAST 64kbps SIM (intended for use with a SIM application Tool-kit). Both 1.8V and 3.0V SIM Cards are supported. The SIM interface is powered from an internal regulator in the module having nominal voltage 2.8V. All pins reset as outputs driving low.

PRINCIPLE OF OPERATION

Computers use AT commands to control modems. Both GSM modems and dial-up modems support a common set of standard AT commands. GSM modem can be used just like a dial-up modem. In addition to the standard AT commands, GSM modems support an extended set of AT commands. These extended AT commands are defined in the GSM standards. With the extended AT commands, various things can be done:

- Reading, writing and deleting SMS messages.

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- Sending SMS messages.
- Monitoring the signal strength.
- Monitoring the charging status and charge level of the battery.
- Reading, writing and searching phone book entries.

The number of SMS messages that can be processed by a GSM modem per minute is very low—only about six to ten SMS messages per minute.

5. Relay:

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical [13].

The coil will be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage a protection diode is connected across the relay coil. In case of working of relay and switch contacts. A lever on the left is attracted by magnetism when the coil is switched on. This lever moves the switch contacts. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

The relay's switch connections are usually labelled COM, NC and NO:

COM = Common, always connect to this; it is the moving part of the switch.

NC = Normally Closed, COM is connected to this when the relay coil is **off**.

NO = Normally Open, COM is connected to this when the relay coil is **on**.

Connect to COM and NO if you want the switched circuit to be **on when the relay coil is on**.

Connect to COM and NC if you want the switched circuit to be **on when the relay coil is off**.

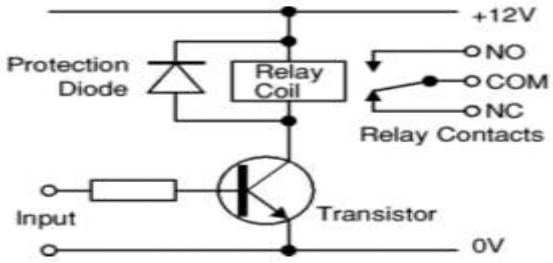

Figure 3: Diagram of Relay

When Relay actuates, it draws much more current which a microcontroller pin cannot provide. So there is a chance of I/O pin damage. To prevent this Transistor is used to drive the Relay [14].

6. LDR (light dependent resistor) :

A Light Dependent Resistor (LDR) or a photo resistor is a device whose resistivity depends on the falling photons on it. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a LDR, one of the most commonly used symbol is shown in the figure. The arrow indicates light falling on it. When light falls on it, the resistance across it decreases, so that current can pass through it and vice versa.

7. Laser Light

A laser is a device that emits light through a process of optical amplification based on the stimulated emission of electromagnetic radiation. The term "laser" originated as an acronym for "light amplification by stimulated emission of radiation". A laser is a coherent and focused beam of photons; coherent, in this context, means that it is all one wavelength, unlike ordinary light which showers on us in many wavelengths.

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WORKING OPERATION

The idea behind this project is to use the existing GSM infrastructure. So, all the operations involve the GSM system. The project consists of two sections.

- Security Breach alert system
- Home appliances control system

These two systems utilize the GSM Features and make our home a SMART HOME.

1. Working Of Security Breach Alert System:

A laser light is used here as the light source for the Security System. The laser beam falls on the small mirrors and reflects. At the end of this beam a LDR is used on which the laser beam falls continuously. The Microcontroller continuously reads the analog values from the LDR. Whenever any intruder enters the room, the laser net got cuts. As a result light falling on the LDR gets disturbed. This disturbance can be detected by the Microcontroller. Then the Microcontroller (ATmega16) sends a Message to the Owner of our house through the GSM Modem and sounds an alarm, so that neighbours can also know the unauthorized entry inside the house. There is a 'stop' switch to stop the alarm.

2. Working of Home Appliance Control System:

When a SMS is sent to GSM module by Mobile, then GSM Modem receives that SMS and sends it to microcontroller. Now microcontroller reads this SMS and extract main command from the received string and stores in a variable. After this, microcontroller compares this string with predefined string. If match occurred then microcontroller sends signal to relay via relay driver for turning ON and OFF the home appliances. Here in this project 4 low watt bulbs are used for demonstration which indicates Fan, Light, TV and etc.

CONCLUSION

Everywhere the technology is pushing the devices to evolve into much better than their previous ones. Remote controlling of home appliances is yet another evolution of its earlier controlling of only one device remotely. Not only is it cheap to implement but also has several advantages over security and control for the user. This document presents a mobile controlled and user-friendly approach to the available home automation system. This system can easily be implemented because of its wireless communication standards. Recently, the home automation industry is a very exciting area that is growing quite rapidly and requires a large array of technologies that can be realized in the smart home concept. Design and implementation of smart GSM house were considered in this project.

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