Home Automation Using Global System for Mobile Communications (Gsm)

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Abstract – The development of the new technologies in the field of electronics has brought tremendous changes in the day to day life of every human being. They have entered the fields like industry, medicine, telecommunication and also home automation. Modern houses are gradually shifting from conventional switches to centralized control system. The system has been experimentally tested for both sensing and controlling purposes first with serial port of the Personnel Computer (PC), then in a real time using Global System for Mobile Communications (GSM). The method discussed in the paper is novel and has achieved the target to control home appliances remotely using the SMS-based system satisfying user wishes and necessities.

Index Terms – GSM, home automation, Personnel Computer, telecommunication.

1. INTRODUCTION

Home automation referred to as 'Intelligent home' or 'automated home', indicates the automation of daily tasks with electrical devices used in homes. This could be the control of lights or more complex chores such as remote viewing of the house interiors for surveillance purposes. The emerging concept of smart homes offers a comfortable, convenient and safe and secure environment for occupants. These include automatic load controlling, fire detection, temperature sensing, and motion detection and lock system etc. Smart home automations gives the owner of a home an ultimate control over his or her home by automating lighting system, dimming, electrical appliances. Smart automated homes connect all the devices and appliances in user's home so they can communicate with each other. Most of the system make use of a web server and mobile communication for controlling the home appliances.

Home automation systems are developed in recent years that make use of emerging technologies for the development. Home automation has become a one of the upcoming field that introduces many technologies for making the automation easy and with good performance.

To design and deployment of a GSM-based distributed control application platform for industrial automation. New control applications can be created and existing control applications can be reconfigured and tuned on the fly. The main objective of this research is to design and a GSM-enabled distributed control application platform for industrial automation and also for home appliances. This research is designed to be executed in the modes as [1]:

1. Stand alone mode that is H.W connected to the server system

2. GSM Mode that is H.W connected to the GSM and accessible from mobile.

This system will be implemented using Nexys2 circuit board which is a complete, ready-to-use circuit development platform based on a Xilinx Spartan3E FPGA. Its onboard high-speed USB2 port, 16Mbytes of RAM and ROM, and several I/O devices and ports make it an ideal platform for digital systems of all kinds. The USB2 port provides board power and a programming interface.

2. REVIEW OF TECHNOLOGY USED AND APPLICATIONS

Al-Ali & Al-Rousan introduced a low cost Java-Based Home Automation systems [2] based on PC-based home server. Various devices are connected to the input/output ports of the microcontroller and their status is send to the server whether they are on or off. The monitoring and control software engine is based on the combination of Java Server Pages, JavaBeans, and Interactive C. The system is scalable and that is any number of devices can be added with no major changes to its design. Password protection is used to stop unauthorized users from accessing the appliances at home. If the Internet connection or the server is not working, the embedded system board still can control and operate the appliances locally.

Studies in [3] [4] has some examples of web based automation systems. These systems are low cost and flexible with the increasing variety of devices to be controlled. These systems can be controlled from anywhere in the world provided internet access is available.

Wijetunge et. al. [5] proposed remote controlled systems that can control home appliances from a PC using Bluetooth technology. In this work, a general purpose controlling module

is designed which has the capability of controlling and sensing up to five devices simultaneously. The Bluetooth module can manage both analog and digital devices provided with suitable interfaces designed by the manufacturer. The server can communicate with many such modules simultaneously. Similar systems using Bluetooth technology are also explained in [6] [7]. These systems cannot be controlled by a cell phone.

To provide greater mobility R. Piyare and M.Tazil [8] proposed a Bluetooth based Home Automation System using Cell phone. This system is a low cost secure system in which the communication between mobile and home appliances is wireless. Appliances at home are connected to the Arduino BT board. Additional devices can be connected into the system by making little modifications. Since the cell phone script is written in Python, it is portable and can run on any mobile using Symbian Operating System platform. The users are expected to acquire password for the Arduino BT and the cell phone to access the home appliances. This adds a protection from unauthorized users.

A similar system for remote monitoring and control using cell phone is explained in [9]. Microcontroller system send signals through its ports to switch on/off appliances like AC, lights, fan, siren, etc when commands for the same are received from user cell phone . The sensors used in the system are microphone, temperature sensor and passive infrared (PIR) intrusion detector sensors. The system informs user about any abnormal condition through missed call or SMS using Bluetooth. However Bluetooth technology has been proved to be the cheapest technology, it has a limitation where distance is a concern. It can link devices within a range of 10m to 100m at the speed of up to 3Mbps depending on the Bluetooth device class so remote monitoring and control is not possible while using this technology.

Khushwinder Gill [10] proposed a Zigbee based Home Automation System. The system allows home owners to monitor and control connected devices in the home, through a variety of controls, including a ZigBee based remote control, and any Wi-Fi enabled device which supports Java. Additionally, users may remotely monitor and control their home devices using any Internet enabled device with Java support.

In [11] DTMF based Remote Control System is proposed. In this work, the teleremote system has been installed. The system uses DTMF tones. The decoder decodes the DTMF tones generated by the keypad of a commercial landline or mobile set. No PC is required for monitoring when using DTMF technology. However DTMF does not utilize the network resources efficiently as it takes several seconds to send instructions.

A mobile embedded system using RFID technology [12] has been proposed as aid in education system. The presented solution offers possibility for the students to go through the class material without guidance from the teacher and still receive help in their learning process. The system has four parts-touch sensitive LCD screen, RFID reader, Ethernet module and online database. The touch screen was used for easy interaction between the students and the electronic system.

The limitation of both the systems is that they only allow for acquisition of data from a single remote monitoring unit with no control facility added to it.

A.Alheraish [13] proposed a design of Home Automation System based on GSM. To enable its use in several applications, this design integrates the device to be controlled, the microcontroller, and the GSM module. This paper implements a complete M2M (Machine to machine or man to machine system) over a GSM network. The controller processes the incoming data from RS-232 by running a visual C++ program, and sends data via M2M module to control any connected device. The M2M module GM47 is developed by Sony Ericsson. It is intended for use in 900/1800 and 850/1900 MHz GSM bands respectively. The module is used to make a connection to the GSM network and send and receive SMS and GPRS services and to make a voice calls as well.

Wael M El-Medany [14] et. al. proposed a GSM-Based Remote Sensing and Control System using FPGA. The system is based on designing and implementing an FPGA chip that is interfaced with a GSM modem to work together as a remote security and control system at the same time. The hardware of the chip has been designed using VHDL and has been tested using Xilinx FPGA.

The system in [15] proposes Remote Monitoring and control Systems based on GSM. GSM network is a medium for transmitting the remote signal and communication takes place between monitoring centre and remote monitoring station. The central monitoring station performs real time control, alarm and data processing and also manages database.

A wireless-GSM based Home Security System is proposed in [16]. This system is a low-power consumption remote home security alarm system developed by applying WSN and GSM technology which has the ability of wirelessly sending and receiving data, and can send a SMS to the user's mobile when some dangerous condition has been detected. This system consists of the MCU-based home wireless control center, one WSN center node module, and several data collecting nodes, GSM module, GSM network and mobile phone. The WSN data collecting node modules are connected with pyroelectric infrared detector, temperature sensor, smoke detector and gas sensor separately. The system software is developed in C51 language. This system also has a practical value in other fields where remote monitoring is required such as irrigation, temperature measurement etc.

Another application using GPRS is given in [17]. A mobile-based approach is be used for efficiently collecting required data leading to accurate, low-cost, non-laboratory based early detection of CVD risk in Indian context. The design consists of three level architecture - A mobile client, central server (a medical record system) and a middle layer which connects the mobile client and the server so that mobile and server can communicate with each other efficiently. Collected data is buffered locally on the phone and uploaded, using GPRS, to the central server for further analysis, based on available cellular connectivity. GPRS possess many advantages such as wide coverage, High transmission rate, accuracy etc. [18] Proposes a scalable water monitoring system capable of estimating water flow rate using wireless sensor network technology. The design combines the pre-installed inline flow meter with non-intrusive inexpensive vibration based sensors in order to provide an accurate per pipe flow rate. Another application using wireless sensor network is given in [19]. The main contribution of this paper is the design of a sensor network optimized for rapid deployment during periods of volcanic unrest and provides real-time long term volcano monitoring.

3. METHODOLOGY

The security system tool is developed to enhance the security features of our home. With the presence of this tool, the crime rate that is rising year by year is hoped to be reduced. Hardware of the system contains sensors, Atmega644p microcontroller, sim548c (GSM module), Buzzer, in system programmer and relays to control the appliances. The block diagram of the system design is shown in Figure 1.

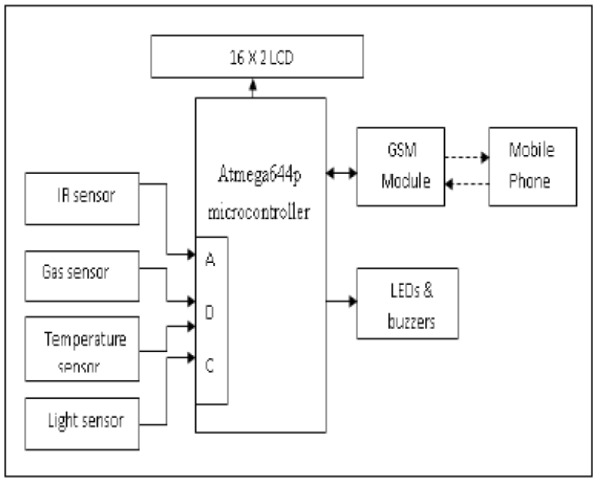

Figure 1: The Block Diagram of the System Design

A. The 8051 Microcontroller Microcontrollers are computers that are designed to carry out a specific function. They are embedded in other computer or machine. They carry out their functions by taking inputs from the devices they are incorporated into. They have the ability of turning the appliances ON and OFF based on the SMS sent to the phone connected to the microcontroller. In this design, an Atmega644p micro-controller is employed. It comes in a 40-pin dual in-line package (DIP) with internal peripherals. The 40 pins make it easier to use the peripherals as the functions are spread out over the pins. Figure 2 shows the Atmega644p pin diagram. Some of the features of 8051 microcontroller are: 1. It has 64 kB of on-chip memory. 2. It has 128 bytes of chip data memory. 3. It has 4 register banks 4. It has 128 user defined software flags 5. It has 8-bit data bus 6. It has 16-bit address bus 7. It has 32 general purpose registers each of 8-bits 8. It has 2 16-bit timers 9. It is equipped with 3 internal and 2 external interrupts 10. It has 4 8-bit ports 11. It has a 16-bit program counter and data pointer.

B. GSM Module Unit

A SIM548C based quad band GSM module which supports GPS technology for satellite navigation is used. It provides GPRS multi-slot class10 / class8 capabilities and supports GPRS coding schemes CS-1, CS-2, CS-3, and CS-4. This module takes care of all your GSM- GPRS based communication requirements as well as provides live GPS data. There is an attached FT232RL USB interface for serial communication with PC or other serial devices. This USB port is also interfaced with the microcontroller. When connected to a PC, the port presents itself as a virtual serial (RS232) port. An HD44780U based LCD is embedded onboard (operates in 4-bit mode) interfaced with the microcontroller. A 10-pin programming interface is used to transfer (flash) the programs (in form of .HEX files) to the microcontroller. Another 10 pin header is attached to serves as the interface to external input sources (sensors) or output devices (LEDs).

C. Sensors Used In the System Infrared (IR) sensors are used to detect the intruder. They are used at doors and at windows. The IR pair that is IR transmitter and IR receiver detects the obstacle within the range of 5-6 feet. The LM35 is used as temperature sensor whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. It gives linear output 10.0 mV/0 C as scale factor. Light Dependent Resistor (LDR) is used as a light sensor to sense the light intensity in the room. LDR gives the output voltage corresponding to the light intensity.

D. Mobile Phone Mobile device communicates with the GSM Modem via radio waves. The mode of communication is wireless and mechanism works on the GSM technology. Cell phone has a SIM card and a GSM subscription. This cell phone number is configured on the system. User transmits instructions via SMS and the system takes action against those instructions.

E. LCD We used 16x2 alphanumeric Liquid Crystal Display (LCD) which means it can display alphabets along with

numbers on 2 lines each containing 16 characters. Figure 2 shows the Flow Chart of the system.

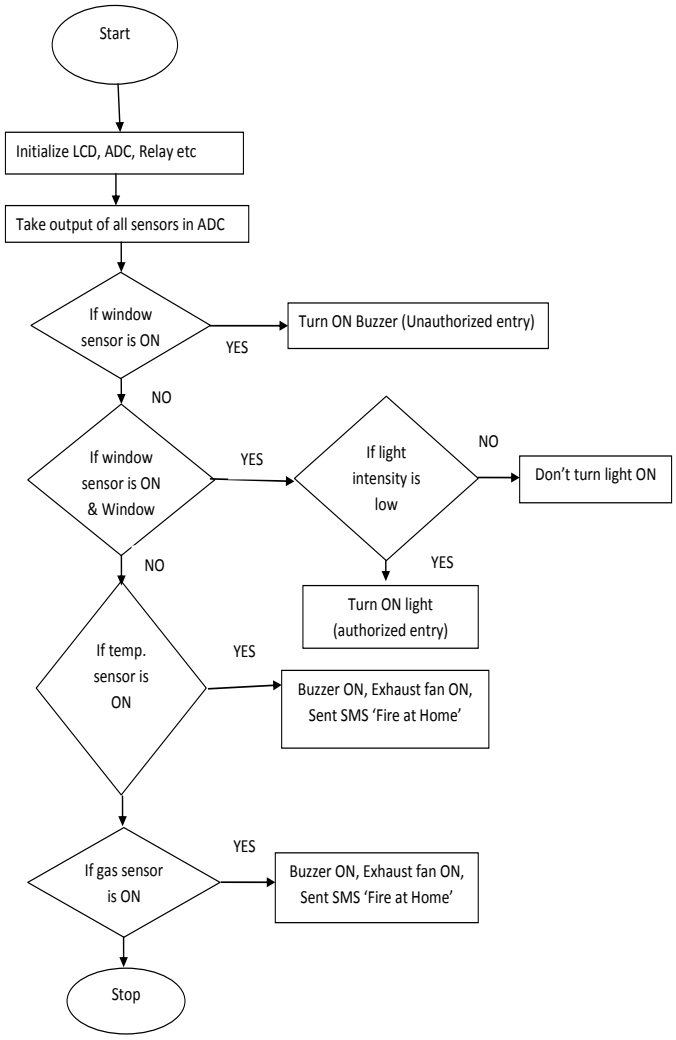

Figure 2: System Flow Chart

4. OPERATION OF THE SYSTEM

The system works as a remote sensing for the electrical appliances at home or industry to check whether it is on or off, at the same time the user can control the electrical appliances at home by sending SMS (Short Messaging Service) message to the system, for example turning on the AC before returning home. In case of fire/security the chip will receive signals from the different sensors in the monitoring place and acts according to the received signal by sending an SMS message to user's Mobil Phone, it also works as automatic and immediate reporting to the user in case of emergency for home security, as well as immediate and automatic reporting to the fire brigade and police station according to activated sensor to decrease the time required for tacking action.

5. SIMULATION RESULTS

The system has been experimentally tested for both sensing and controlling purposes first with serial port of the PC, then in a real time using GSM. Figures (3 - 4) show the simulation results for the control Unit and sensing unit. Figure 4 shows the simulation for the sensing Unit which sends parallel data to UART Transmitter; the parallel data represents the ASII code for the characters; the character could be a message or an AT commands. Figure 4 shows the expanded output of sensing unit.

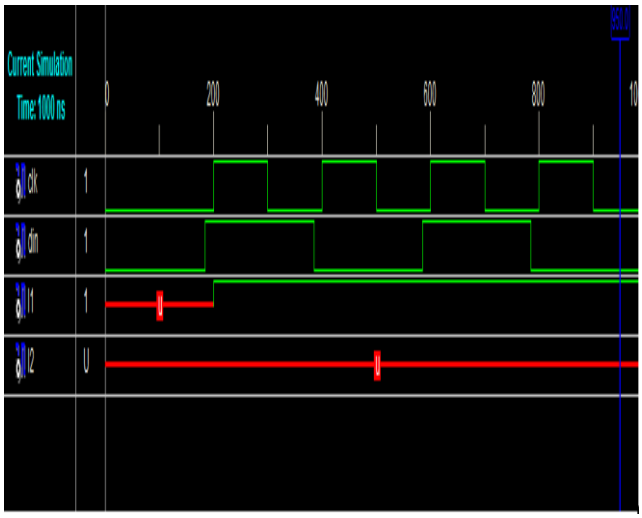

Fig.3 Simulation result of control unit

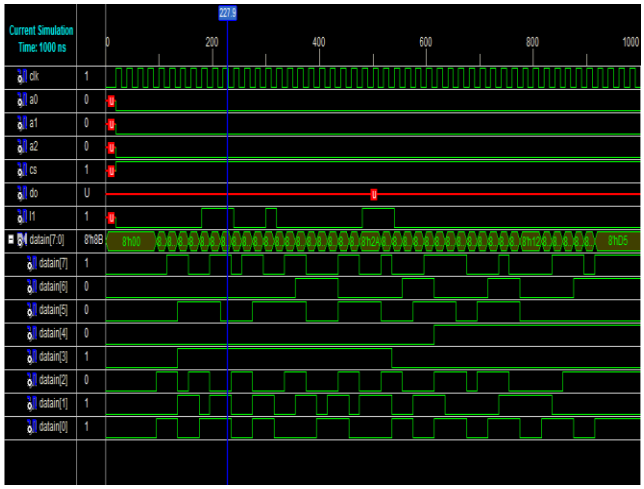

Fig.4 Extended simulation result of sensing unit

In the simulation we show the transmitted data in the form of characters but in hardware implementation it is stream of bits that represent the ASCII codes of the characters.

In Figure 3, the simulation results of control unit is show This project is implemented mainly in real time applications using some led relays for explaining the domestic control.

And for some industrial control, in this project one potentiometer used, every time the program scans the values of the device and if any threat occurs (say here it is assumed the value of .8 as a critical value) immediate action will be taken and intimated to the concerned scientist or technical person through SMS.

This system can be implemented in stand lone mode and GSM real time mode. Since this project is implementing through GSM, it can be controlled form anywhere in the world and there is no distance limitation.

6. CONCLUSION

Monitoring systems are common place in many areas of industry. It is essential that home privacy is protected always and no outsider can affect it by any means. Thanks to the recent trends in home security, there's no need to worry about home security any longer, as security systems are here to take of care of it. Home security system is the best burglar deterrent one can have. A Home Security System should provide security and safety features for a home by alarming the residents from natural, accidental and/or human dangers such as: fire, flooding, theft, animals invading etc. We have presented low cost, safe, universally available, auto-configurable, remotely controlled solution for automation of homes has been introduced. The method discussed in the paper is novel and has achieved the target to control home appliances remotely using the SMS-based system satisfying user wishes and necessities.

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