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Xtreme Application: A User Interface System for Home Appliances with Cellular Phones

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***Abstract*— In this research work, we implemented the Home Automation System for controlling and monitoring the devices directly from computer screen or from a cell phone for having complete, on-command or pre-programmed control of nearly any electronic or mechanical devices in the home, school, college and especially in the industry. This software will be useable by any computer that has communication (parallel) port and serial port. In case of remote location, we can use the normal cell phone for controlling and monitoring the devices. We have made use of GSM Mobile technology by which we can control our house with our voice, personal computer, timer, or touch screens remote and make our life much simpler and safer.**

***Index Terms*— Cellular Phone, Applications, GSM and Communications**

I. INTRODUCTION

BUILDING Automation System is a combination of hardware and software, it provides a control for different electrical and mechanical appliances in our homes or offices, so that we may be able to handle different devices either from a control room, or from a remote location via the ordinary GSM cellular network [1], [2] using cell phone by just sending a single preformatted SMS [12] and we don't have to go to run on/off and regulate them. Further more it will provide certain level of security measures like a surveillance system.

We want to implement the Building Automation System for controlling and monitoring the devices directly from Computer Screen or from a cell phone for having complete, on-command or pre-programmed control of nearly any electronic or mechanical devices in the home, school, college and especially in the industry.

A. Problem Definition

To develop a system that will allow user to control different electrical and mechanical devices connected in a building through a remote location using cell phone just within a second or two.

As Building Automation System is a combination of hardware and software so for the interaction between two hardware modules that is one for the GSM modem [2] or cell phone and the other one for the Electrical devices we need a 3rd system whose job would be to make that interfacing possible and to manipulate the flow of necessary information flow [3]. And that interfacing module is a software program. So over all the system consist of three modules two hardware and one software modules.

But as we broken down the system solely according to its functional flow, we found different modules then that of we devised earlier. So as we carried on further studies we came to know that modularization according to functionality would be better because we can apply OO approach on them and can carry on our further work according to that by keeping similar kind of functionalities in one module. That will provide easy managing and will reduce complexity, which will help us during troubleshooting by easily tracking the exact location of the problem. So here is a brief description of each module that is divided functionality wise (Fig. 1):

- *Sending and receiving data from GSM modem or cell phone:* GSM modem can be connected to computer through serial port, infrared port or Bluetooth wireless technology [8]. The computer will send and receive necessary data from modem i.e. read or send SMS [13] or read address book etc. So managing that communication at certain configuration would be the part of this module
- *Manipulating the data taken from GSM modem:* As the data read from the modem will be different in format [9] so converting that data to system readable format so that further action can be performed on it, would be the job handled by this module
- *Sending and receiving data from electrical circuit responsible for controlling devices:* The work of this module would be performing necessary set of operations properly that are ordered as a command from the GSM modem. This module will make possible the communication between the software and the hardware. The hardware circuit can be connected to computer through parallel port. So configuring communication between serial port and computer will be the part of this module

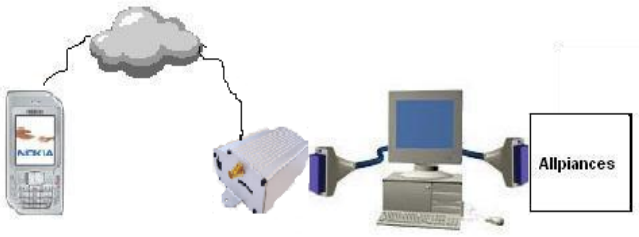

Fig. 1. System Overview

B. What is Home Automation?

As implied, Building Automation is the technological field which deals with automation within the home or the office.

Futuristic control of home is not science fiction anymore and is actually quite affordable. This technology has brought us into the twenty first century with a bang. The home elements eligible for automation are numerous and their numbers increase every day.

Now we can control our house with our voice, personal computer, timer, or touch screens remote and make our life much simpler and safer. We will explore the different options that are available to us for home automation and security. We can turn our house into the home of the future. Live like the Jet Sons with voice activation, timed activity and remote control for all of our home appliances. Open drapes, turn on lights, water our plants, control our stereo and feed our pets with automated ease i.e. we can have a house that caters to our every need. The command signals travel over the existing power lines in our home, eliminating the need for expensive rewiring.

C. Advantages and Scope of the Project

This project is capable to control electrical and mechanical devices. Now it is capable of controlling 4 Air conditioners, 4 fans, 4 Lights, 4 any other devices and 2 infrared red sensors. This software will be useable by any computer that has communication (Parallel) port and serial port. In case of remote location, we can use the normal cell phone for controlling and monitoring the devices.

We believe it is what we all want it to be. For some, it could be as simple as automatic timed control of a few lights and appliances. For others intelligent security feature may be the most important.

Whole house audio/video is another feature that can make your house smarter.

A smarter house has many benefits .It saves energy and helps the environments through intelligent control of lighting, heating and cooling. A smarter house can protect our family and possessions from an increasingly violent and crime ridden society through sophisticated security and surveillance systems. Home theater systems allow us to enjoy music and video from anywhere in our house. The elderly and disabled can have full control of the home from their fingertips. We'll save money on our energy bill! We'll never again get up to turn off forgotten lights we'll never come home to a dark house we'll have peace of mind knowing the house will call you if there's a problem.

We'll never have to worry whether or not you left the iron on, or closed the garage door. We'll be able to call home and turn the spa on so it's ready when we arrive.

II. BACKGROUND SYSTEM STYDY

Before the software design commences it is necessary to conduct a deep study of the system that is to be developed. The system study is carried so that the designers have a better idea of the thing they are going to design.

The system that is to be developed is a combination of both hardware and software and need extensive study of following things.

A. SMS Format

The SMS message [14], as specified by the ETSI organization (documents GSM 03.40 and GSM 03.38), can be up to 160 characters long, where each character is 7 bits according to the 7-bit default alphabet. Eight-bit messages (max 140 characters) are usually not viewable by the phones as text messages; instead they are used for data in e.g. smart messaging (images and ringing tones) and OTA provisioning of WAP settings. 16-bit messages (max 70 characters) are used for Unicode (UCS2) [4], [5], [6] text messages, viewable by most phones. A 16-bit text message of class 0 will on some phones appear as a Flash SMS [15] (aka blinking SMS or alert SMS).

B. Interfacing

Interfacing is very broad meaning word. In computers interfacing is actually connecting two or more than two peripherals to do a specific job. All controllers, processor, memory and expansion cards are interfaced to each other. In this paper, interfacing is the name of connecting hardware (electronics circuits) [10] to computer via parallel port. Now one thing is important to some new peoples that what port is.

C. Serial Communication

Serial Communication is a popular means of transmitting data between a computer and a peripheral device such as a programmable instrument or even another computer. Serial communication uses a transmitter to send data, one bit at a time, over a single communication line to a receiver. You can use this method when data transfer rates are low or you must transfer data over long distances. Serial communication is popular because most computers have one or more serial ports, so no extra hardware is needed other than a cable to connect the instrument to the computer or two computers together.

The concept of serial communication is simple. The serial port sends and receives bytes of information one bit at a time. Although this is slower than parallel communication, which allows the transmission of an entire byte at once, it is simpler and can be used over longer distances. For example, the IEEE 488 specifications for parallel communication state that the cabling between equipment can be no more than 20 meters total, with no more than 2 meters between any two devices; serial, however, can extend as much as 1200 meters.

Typically, serial is used to transmit ASCII data. Communication is completed using 3 transmission lines: (1) Ground, (2) Transmit, and (3) Receive. Since serial is asynchronous, the port is able to transmit data on one line while receiving data on another.

D. Introduction to Parallel Port

If you look at backside of your desktop computer or laptop you will see a 25-pin female D type connector. Female connector means that the connector has holes where some pins can be inserted. We call it D type because its one side is longer than other so it looks like "D". The connector has two rows of holes. One row is of 13 holes and other of 12 holes. This connector is your parallel port.

Because it was designed to communicate with printers so it is also called printer port. Now a days printer port can be use to communicate many other peripherals rather than printers, like scanners, plotter or external storage devices.

E. Electronic Components

Although there are almost unlimited numbers of applications for electronics, all applications use basically the same types of electronic components. This section introduces the most common type found in this project.

Electronic components are categorized as being either passive or active.

Resistors, capacitors, and inductors are examples of passive components, whereas diodes, transistors, and vacuum tubes are examples of active components. Active components are capable of rectifying, amplifying or changing energy from one form to another. Passive components, on the other hand, can control energy, but they cannot amplify or modify it.

1). Relays

A relay is electromechanical device, which operates on the basis of electromagnetic induction. It uses either an ac or dc actuated electromagnet to open or close one or more sets of contacts. Relay contacts, which are open when the relay is not energized, are called normally open (No) contacts. Conversely, relay contacts, which are closed when the relay is not energized, are called normally closed (NC) contacts.

2). Capacitors

A capacitor is a component that is able to hold or store an electric charge. Its physical construction consists or two metal plates separated by an insulator. In general, capacitors are used to block direct current (dc) but pass alternating current (ac).

3). What is a Microcontroller?

A microcontroller (MCU) is a computer-on-a-chip, or, if you prefer, a single-chip computer. *Micro* suggests that the device is small, and *controller* tells you that the device might be used to control objects, processes, or events. Another term to describe a microcontroller is *embedded controller,* because the microcontroller and its support circuits are often built into, or embedded in, the devices they control.

It is a type of microprocessor emphasizing self-sufficiency and cost-effectiveness, in contrast to a general-purpose microprocessor (the kind used in a PC). A typical microcontroller contains all the memory and interfaces needed for a simple application, whereas a general purpose microprocessor requires additional chips to provide these functions.

- Microcontroller can be very fast. Microcontroller speeds are now approaching 1GHz. While slower then a P4, this is still very fast. Microcontrollers also typically can execute many instructions in a single clock cycle (just like a processor in your PC).
- Many Microcontrollers have immense feature sets, including Analog-Digital converters, serial ports, Flash controller, and USB support, all devices that are not normally included on the die of a normal CPU.
- While many Microcontrollers are inexpensive, there are also many that would rival the prices of today's CPUs.
- Microcontrollers are designed to be much more reliable then the CPU in your computer. They are used in industrial environments where temperatures can go from one extreme to the next in the matter of minutes. They also have a fairly wide tolerance of voltages and radiation.

III. PROPOSED SYSTEM ANALYSIS AND DESIGN

A. Requirement Analysis

Requirement analysis is the process of determining who the user is, how many people are going to use the software and what function the project is supposed to perform. Limits and boundaries of the system are chalked out in this phase. In this phase, analysis is performed of the environment in which the software is intended to be used. This is a vital stage. The more precise this phase is done, the more lucrative the consequences are. A Software Engineer should have an effective capability to comprehend the problem vigilantly and accurately. After the conclusion of this study, a report is submitted to the client who after thorough study and scrutiny grants permission to develop the software. The cost and benefits of the proposed system are the only factors, which will determine whether the task should be accomplished, or not.

1). Software Requirements

Following are the requirements according to software aspect of the system.

- Establish communication between GSM modem and the Software.
- Establish communication between Electrical devices and the Software.
- Generate a unified command set [11].
- Send and Receive SMS [13].
- View, add, delete & update Phone book entries.
- View, add, delete & update Messages entries.
- Chat facility.
- Complete log of every activity.

- View and change the status of electrical devices.
- There must be way to translate the command message into a command set.

2). Hardware Requirements

Table 1 gives the hardware requirements of the system.

B. Proposed System Data Flow Diagrams

When examining an existing information system or analyzing the information that is going to be designed, it is important to recognize what the data is, where the data comes from, how it passes from one point to another within the information system, and how it will be used by the intended audience or user. The following data flow diagrams (DFD's) represent the movement of data within the system. They concentrate less on the actual functions and data constructs of programmers and more on the general processes inherent to the overall system. We started at the top of the system and moved deeper into the processes to the underlying database tables.

The amount of detail specified in this document will include a level two representation for most functions and a level three where necessary.

All diagrams include references to additional levels when applicable. Expanded functions are referenced using numbered tabs, which provide the corresponding diagram number.

Table 1: Hardware Requirements for the System

Hardware Resources	Minimum	Recommended
PC	1	1
CPU	P-III	P-III and above
Electrical Appliances	4	16
Microcontroller 89c51	1	1
Mobile or GSM modem	1	1
DKU-5 serial cable	1	1
ULN 2004 ICs	1	2
Hardware Resources	**Minimum**	**Recommended**
Capacitors, Transistors, Resisters, Cables, Soldering wire, solder etc		
Parallel port cable	1	1
Relays	4	16
Storage Capacity	50 MB approx.	50 MB approx.

1). Context Level Diagram

Fig. 2 – Fig. 4, show the overall structure of the proposed system, and their interaction with the different modules.

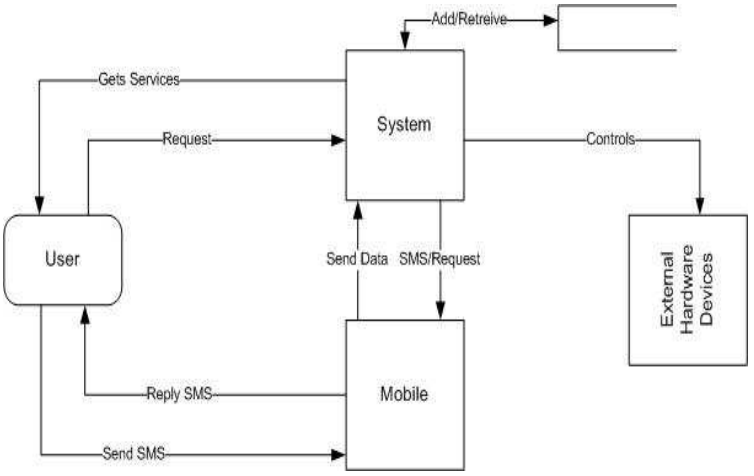

Fig. 2. Context Level Diagram of the Proposed System

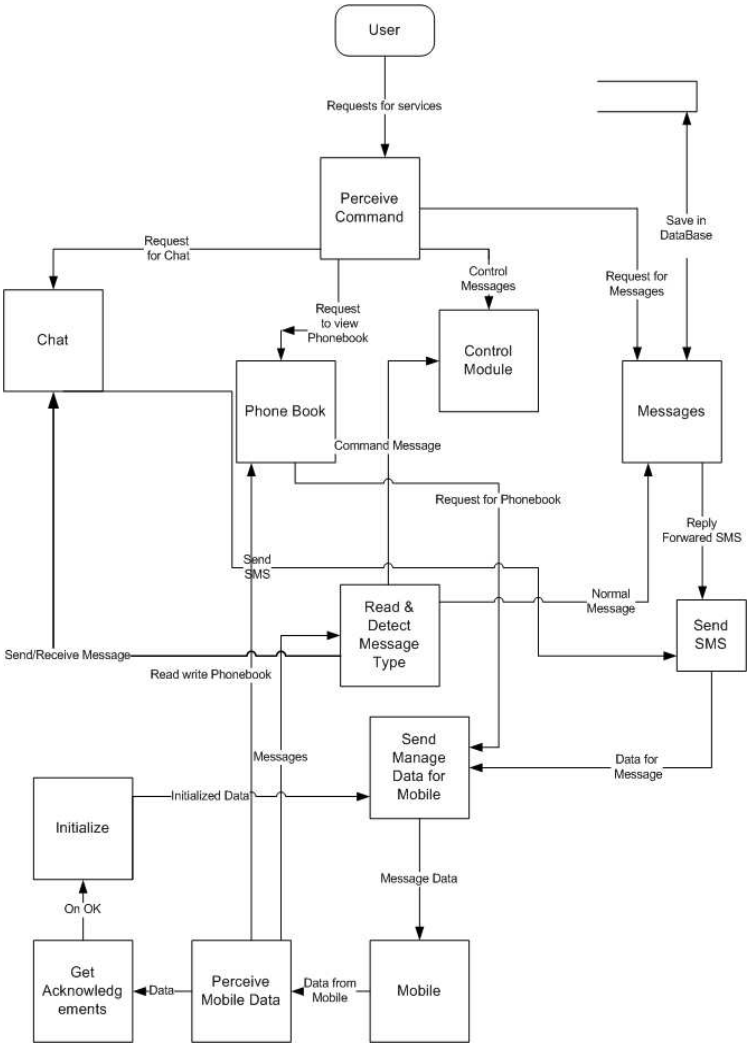

Fig. 3. Context Level Diagram of the Proposed System

Fig. 4. DFD for Controlling Electrical Devices

C. Proposed System Hardware Design

As the system is amalgam of software & hardware for controlling different appliances, so there is a need of hardware that can work accordingly. As mentioned in the system study the various hardware components are utilized to design a hardware circuit for controlling devices (Fig. 5 and Fig. 6).

1). Device Controlling

The core thing that the software does is controlling devices through SMS. Assuming that S/W has right now the correct message and it has to do the device controlling .The devices are controlled in two ways.

- Through SMS
- Through PC

Device controlling has two main modules that are status and control device. The S/W can control unto 16 devices at the same time. And if designed to do so and can easily be upgraded for further enhancement in the devices. When ever we give command to request for status, the S/W checks the status of the device any reply the user with the current status of devices connected.

When ever S/W receive a control SMS it will check its completeness and correctness. If it is correctly formatted then it will do accordingly with the devices. The parser written is power enough that it only performs correct part of the command even if most of the command part is false. The S/W helps the user even to monitor the status of devices connected, through visual details mentioning the status of devices. Using visual details a user can change the status of devices accordingly

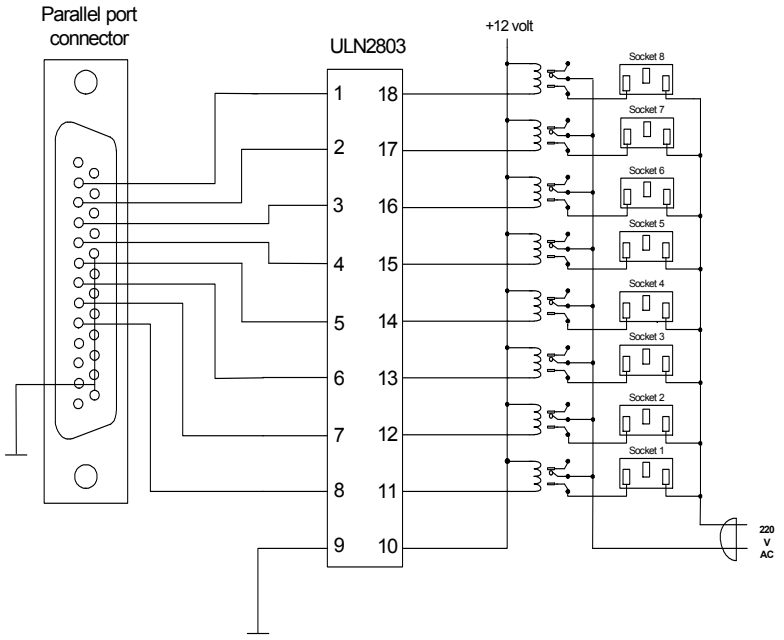

Fig. 5. Initial Electrical Circuit for controlling different device

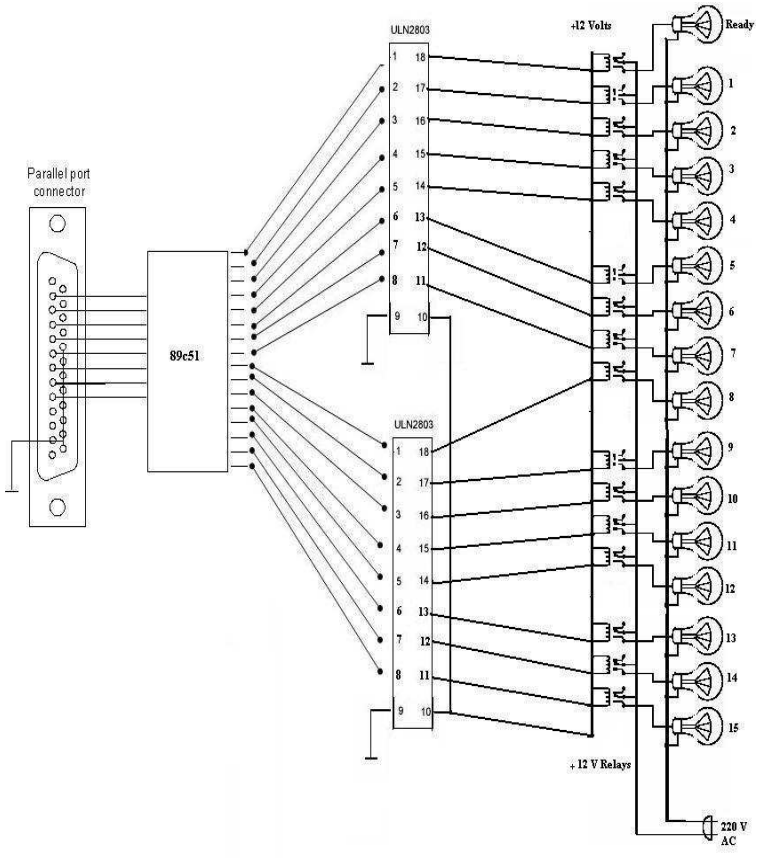

Fig. 6. Final Circuit for controlling different device

IV. CONCLUSION

We explored the different options that are available to us for home automation and security. We can turn our house into the home of the future i.e., we can open drapes, turn on lights, water our plants, control our stereo and feed our pets with automated ease. The proposed system will be used on windows operating system for the time being, later if future concerns it can be taken to an embedded system by using microcontroller by removing the layer of the computer that will make it a commercial system.

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