

A System for controlling remote devices through the Internet, SMS and Telephone Network

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ABSTRACT

This paper presents an affordable, reliable and secure computer based system that remotely controls remote devices using different Medias, such as Internet, SMS and telephone line. The system consists from hardware circuit that can be attached to the PC parallel port and used to connect the remote devices to the PC. Supporting software is developed using Visual Studio .net 2005 technology. The software enables the system to receive the remote commands via the internet, SMS and telephone line and control the connected devices accordingly. The system is designed to be flexible, cheap and affordable. The system is tested by implementing e-home automation system that controls devices used in home such as appliances, camera, garden sprinklers etc. and proved to be reliable and efficient.

Keywords: Remote device Automation, E-home, SMS Based System, ATAPI, Web Based System.

1- INTRODUCTION

The new communication media such as the Internet, Mobile networks and traditional telephone network are widely available. These media can be used in controlling remote devices. Each type of media has its own characteristics in term of availability, flexibility and cost. In order to make an efficient system it is necessary to support many types of media in controlling a remote device.

1-1 Significant Works

Much research works had been done in the area of controlling remote devices [1]. Most of these

works [2], [3], [4] are done using one media such as the Internet. Electronics production companies had developed products that can remotely control home appliances. Markets now are filled with different types of such products. They categorized into two types, computer-based systems and stand alone systems. Although a wide variety of features are available in these products, the cost and flexibility is still a major issue. Also most of these devices use the internet as the only medium to control the remote devices [5], [6], [7], [8].

1-2 Thought and Plan in our Approach

This paper describes a system that to develop an affordable, reliable and secure computer based system that remotely controls home appliances using different media, such as internet, Short Message Service (SMS) and telephone line. The system is windows based and work with the help of Visual Studio .net 2005 technology [9]. Trying to design an affordable and powerful system, no costly hardware nor software is involved in the system. The flexibility of the system was set up by providing three different control media, the Internet, SMS and telephone network a feature that is not found in other systems available.

1-3 Prototype

In order to test the proposed system, a prototype that automates the devices in a hypothetical home is used. In our paper we will refer to this prototype as the "system". The prototype is designed to control 9 different devices in a single storey house. The house consists of 4 rooms, kitchen, garage and small garden. For simplicity, three devices from the sitting

and the bed room have been selected to be controlled by the system. The devices are Lights, AC, and fan. In addition, the system will control the house main gate, garage door, and the garden water system.

2- REMOTE SYSTEM CATEGORIES

Remote systems can be divided into three general categories based upon their need for a PC: PC-based systems, standalone system and hybrid system.

2-1 PC-based system

A PC-based system is one that requires a PC to be running at all times. There are two types of PC-based systems, distinguished by whether the PC is used for other purposes besides remote system control: **Dedicated PC**, where the computer is used only for controlling remote devices and no other programs are run. In **Shared PC**, in addition to running the automation software, the computer is used for other purposes. There are a wide variety of features available in today's PC-based systems. While there are some features of PC-based systems that are impossible on standalone systems, many are easier and more common on PC-based systems. Examples are: Voice recognition, Internet access (stock quotes, weather data, sports scores, news, etc.), E-mail capabilities, and Telephone/voice mail processing, PC-based control screens, Accessing other PC programs, Software customization.

2.2 standalone systems

A standalone system is one that operates without a PC (although a PC may be required to initially program it). Here a special control board is designed to control the home equipments.

2.3 hybrid systems

A "hybrid" system is one where a standalone system is used in conjunction with PC-based software. Usually, the standalone piece performs most of the

basic home automation functions, and will operate even when the PC is off. The PC software is used to add capabilities that don't exist in the standalone equipment. Such systems combine the capabilities of the other systems, usually giving the maximum overall performance.

3 SYSTEM COMPONENTS

The proposed system is a PC-based system. It consists of a hardware and software parts. The hardware design is done to insure that it will be compatible with the different software applications used. The software design includes three different applications: Telephone panel, SMS panel and Website which will work together to achieve the desired reliability.

3-1 Hardware Design

The hardware design consists of an interfacing circuit that connects the home appliances to the PC. The circuit is deigned to handle commands that could be sent from the parallel port [9]. The commands will choose a specific home appliance, then controlling it accordingly. From the 25 pins in the parallel port, the data pins (2 to 9) are used to send the required commend to the circuit. The interfacing circuit consists from a decoding circuit (forward circuit) and the switching circuit.

3-1-1 The decoding circuit

The decoding circuit will receive the signal from 7 of the 8 data pins of the parallel port. The data is used as an address for each device. One of the parallel port's data pins is used as a switch-enable. The other 7 data pins are used to send signals to a decoder in the decoding circuit. The output of the decoder is linked with the clock of the device's latch. The switch-enable is connected to the date-in of each device's latch. So that, in order to switch-on a device, the switch-enable is set to high during the positive edge trigger of the device's latch clock .

3.1.2 Switching Circuit

The switching circuit consists of two main components, Optoisolator (optical coupler) and Traic. The input of the switching circuit is taken from the latch's output of each device in the decoding circuit. The device will be switched on or off depending on the result stored in the latch.

3-2 Software Design

In order to control the devices using different means, special software interfaces has been designed for controlling the e-home using the Internet, SMS, and telephone line.

3-2-1 Software Requirements

a- Shared Database

To insure the association between the different means of controlling, the three software interfaces will work concurrently with a shared database. The database, shown in figure (1), used to record the current status of the devices. Therefore, the three interfaces will update the database whenever any command sent from any of one them. Accordingly, any action done from one of these interfaces will be known by the other two interfaces.

Pass		Home		Rooms	
PK	ID	PK	Utility	PK	Room
	Password		Gate Garden Garage		Lights Fan AC

Fig 1: The database files

Anyhow, this database could be modified to be able to support more or less devices depending on the number of devices that need to be involved in the system.

b- Telephone Interface

Telephone is another mean of communication for the circuit in. In order to connect a PC running windows, a programming interface should allow the computer to access the telephone connection, and this is what TAPI exactly do.

TAPI is short for Telephony Application Programming Interface, developed by Microsoft and Intel [10]. It is a set of files and specifications for using telephony services under Windows environments. TAPI defines standards for simple call control and for manipulating call contents. It support both speech and data transmission. In addition, it allows all kinds of telephone usage from the simple telephone call to the international email to be developed within applications developed for Microsoft Windows.

c- Modem Tools

As mentioned earlier, the interface program will be directly in contact with the modem. Through the modem tools, this interface will be able to use the TAPI standards to customize the modem features. Modem Tools is an **ActiveX** package [11] developed by Netpoint Company. It contains two **OCX** components Modem Phone and Modem Wave. Modem Phone OCX allows any TAPI compliant voice modem to be used to answer or make voice calls. It abstracts TAPI to a straight forward telephone object that can be easily controlled by our interface program. Modem Phone has the ability to: detect incoming ringing, answer incoming voice calls, support caller ID, perform remote key DTMF detection, and control the speaker phone functions and modem volume.

Modem Wave OCX uses low level API's with multiple buffers and allows the playing and recording of wave files to the telephone line, continuously streaming audio wave data to and from the hard drive, and it is designed for the shortest delay possible on the start of wave playing and recording. There is no restriction to the record/playback time other than hard disk space.

d- ActiveXperts SMS and Pager Toolkit

SMS and Pager Toolkit is an ActiveX/COM component. It provides SMS and Pager messaging functionality. With this Toolkit, SMS messages can be sent and received via a:

- GSM modem
- GSM phone
- SMPP compliant SMSC provider
- Hayes compatible modem

SMS and Pager toolkit features the following:

- Send alphanumeric text SMS messages
- Receive SMS messages
- Support for GSM modems and GSM phones to send and receive SMS messages
- Support Windows 'Phone and Modem devices' and direct COM ports

e- .net Compact Frame Work

The .NET Compact Framework is a hardware-independent environment for running programs on resource-constrained computing devices, encompassing personal data assistants (PDAs) such as the Pocket PC, mobile phones, set-top boxes, automotive computing devices, and custom-designed embedded devices built with the Windows CE operating system. The .NET Compact Framework is a subset of the .NET Framework class library and also contains classes exclusively designed for it. It inherits the full .NET Framework architecture of the common language runtime and managed code execution.

The .NET Compact Framework provides the following key functionalities:

- Run programs that are independent of hardware and operating systems.
- Supports common network protocols, and connects seamlessly with XML Web services.
- Provides developers with a model for targeting their applications and components to either a wide range or specific category of devices.
- Provides benefits of design and optimization of limited system resources.
- Obtains optimal performance in generating native code using just-in-time (JIT) compilation.

The .NET Compact Framework supports Visual Basic and Visual C# development.

3-2-2 e-Home Telephony Software

The telephone based controlling is mainly depending on receiving command from the telephone line and passing it to the circuit. Thus, at the server side we should have an interface that is able to handle the call. This interface should be able to connect directly with the modem. The interface program using TAPI standards can be written in different languages like Visual Basic, C++ and C#. Before receiving the command from the telephone line and doing the appropriate order, a procedure should be done by the interface program at the server side before and during the call, the program should be able to:

- Detect and open the modem

- Detect and answer the call after required number of rings
- Play a sound file to the telephone
- Receive the pressed digit by the remote party (Detect DTMF tones)
- Send the appropriate command to the circuit

In order to create an Interactive Voice Response (IVR) program that meets the requirements of the previous procedure, Visual basic with Modem tools have been chosen to write the program code.

3-2-3 SMS Program Interface

Since SMS technology is readily available and because of the ever-expanding use of mobile telephones around the world, the e-Home system is supported with this technology.

SMS (Short Message Service) is a service available on digital GSM networks allowing text messages of up to 160 characters to be sent and received via the network operator's message center to a mobile phone, or from the Internet, using a so-called "SMS gateway" website. If the phone is powered off or out of range, messages are stored in the network and are delivered at the next opportunity. SMS has an extremely reliable infrastructure, which is currently used for cellular telephones, internet SMS gateways and fixed lines communication. SMS text messages are divided into four classes based on GSM7BIT standard:

- Class 0: A text message that is immediately displayed on the screen of the phone and it is not saved in the memory of the phone.
- Class 1: A text SMS message that indicates that the message should be stored on the Device.
- Class 2: A text SMS message that indicates that the message should be stored on the SIM card.
- Class 3: A text SMS message that indicates that the message should be sent to the terminal equipment (TE) attached to the phone.

In this work, SMS Class 1 messages are used to receive commands and interact with the user by sending back acknowledgment and error messages. It will also provide an optional easy user interface on a PDA to minimize the user errors. The SMS program consists of two parts. The first part is the one that is installed on the controlling computer and controls the circuit (e-Home PC SMS Interface Panel). The other part is optional and is installed on a Pocket PC (e-Home PPC SMS Panel).

The e-Home PC SMS Interface Panel is essentially based on receiving SMS command messages from an SMS enabled device over a GSM network. Then, it processes these commands and does the desired actions. The following is a list of actions performed by the e-Home PC SMS Interface Panel:

- Receive SMS command messages.

- Send an output to the circuit through the parallel port.
- Update the database.
- Send acknowledgments and errors SMS messages.
- The e-Home PC SMS Interface Panel is also capable of:
 - Detecting SMS enabled devices connected to the PC through Serial cable, Infra Red or Bluetooth.
 - Viewing received SMS messages.

In order to create an Interactive PC SMS Interface program that meets the previous mentioned points, Visual Basic .net 2005 with ActiveXperts SMS and Pager Toolkit is used.

Since it is hard for a user to memorize a certain format for the SMS command messages, the e-Home PPC SMS Panel simplifies the way of sending SMS command messages for the user.

In order to create such an application, Visual Basic .net 2005 is used with the aid of .net Compact

Framework for Pocket PC embedded in the PPC device and SMS API.

3-2-4 Website design

The website designed to be secure, easy for navigation, easy to use. Therefore a powerful graphic tools and programming languages has been involved in the design. Site contents divided into two parts, images which contain all the house parts in jpg format to reduce the size, and Multimedia which contain introduction flash, rooms' flash movies, sounds and flash plug-ins.

3-2-4-1 Website Design Architecture

The design divided into several phases. The first phase is programming using HTML. The second phase is the connection with the data base to insure the association with the SMS and telephone interfaces. The last phase is connecting the site to the circuit through the parallel port using in/out driver. Fig (2) shows the architecture and the site's flowchart.

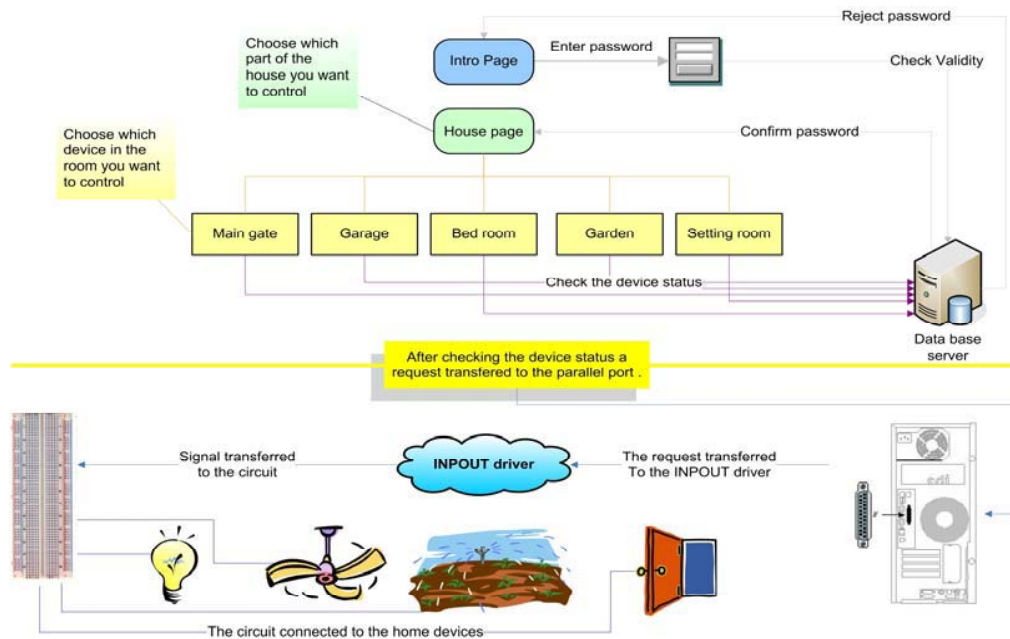


Figure 2: Flow chart of the site

3-2-4-2 Sending Orders

When you select a part of the main house a check status function will automatically send a request to check the status of the devices related to it. This operation is not done very quickly so it's not noticed.

If someone send an order it is converted to a request and sent to the parallel port. The parallel port

converted the request to a signal transferred throw the IN/OUT to the circuit which is already connected to it. After the circuit receives the signal it forwards it to the targeting device to take the action. Automatically after the device takes action the status of it changed in the database and in the site page at the same time.

CONCLUSION

This paper presents a PC-based computer automation system that remotely controls devises using

different Medias, such as Internet, SMS and telephone line. The system consists from hardware circuit that can be attached to the PC parallel port and used to connect the remote devices to the PC. Supporting software is developed using Visual Studio .net 2005 technology. The software enables the system to receive the remote commands via the internet, SMS and telephone line and control the connected devices accordingly. The system is designed to be flexible, cheap and affordable. The system is tested by implementing e-home automation system that controls devices used in home such as appliances, camera, garden sprinklers etc. and proved to be reliable and efficient.

A considerable amount of time and effort was needed to design and develop such a system in order to achieve such a reliable, dependable and secure home automation system.

Many problems were faced the system designers in the development phase. One of them was sending SMS in class 0 from the PPC device, which was popping up in the device screen of the receiving device in the PC part without saving the information in the SIM card and that class of SMS was not supported by the PC SMS application.

The idea of this work was tested in implementing a home automation system but can be applied in other areas such as factory automation and laboratory automation where the electric devices are out of reach, or for a hazardous work place. As a result of some restrictions, especially time limitation, more than a few of improvements are still needed. One of the recommended improvements is to design a sensor circuit which feeds the system with the recent status of the devices to avoid the miss integrity with the manually controlled devices or because of power failure. Another improvement could include adding new Medias such as Bluetooth and WiFi technologies. Simple security equipments could be added to give the home some sort of security, like an alarm system with laser sensing circuit and intelligent cameras.

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