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MOBILE VIRTUAL EXPERIMENTATION UTILIZING SMS

A Y Al-Zoubi
A A Tahat
O M Hasan
Electronics Engineering Department
Princess Sumaya University for Technology
Amman
Jordan
zoubi@psut.edu.jo
tahat@psut.edu.jo
ohasan@psut.edu.jo

ABSTRACT
An interface system utilizing GSM service with low-cost hardware equipment is proposed to enable mobile access to experimental setups via short message service SMS commands in order to perform virtual remote measurements. Communication between a mobile phone client and a remote PC server is achieved through programming the server using attention commands AT and the protocol description unit PDU mode. The experimental setup can be controlled and monitored from anywhere covered by the GSM service by exchanging SMS with the server with the aid of a C++ software which manages the follow and direction of messages from the source and destination mobile numbers. The PC at the remote end can be replaced by a microcontroller server with mobile phone connectivity, and the system can be adopted in medical, industrial, environmental and other application.

KEY WORDS
Distance education, mobile and wireless communications, remote labs, virtual measurements.

1. Introduction

ELearning became the state of the art for the use of technology in education in the short space of time between 1995 and 2000. In particular, the internet offered interesting possibilities for disseminating educational material to students, both on-campus and as part of remote education. However, mobile education or Meducation is a new conceptual paradigm in the use of mobile and wireless technologies for education [1-2]. Meducation encourages distributed peer collaboration over wireless devices and desktop computers to create opportunities for education in a project-oriented approach to facilitate the learning activities of teachers, students, and peers through collaboration in a distributed environment [3].

Laboratory experiments, which are a vital part of engineering and science education, have however for long been considered impractical for Elearning and Mlearning courses or degrees. The recent advances in internet and wireless technologies and computer-controlled instrumentation have easily allowed net-based techniques to be utilized for setting up remote laboratory access [4]. The concept of providing educational laboratory experiments to students over the internet has thus been realized and adopted in many university courses [5-6]. Obvious benefits can be derived in terms of sharing expensive facilities between institutions and in terms of flexibility for the students, allowing expensive hardware resources to be utilized far more efficiently than with traditional hands-on laboratories.

The evidence is however overwhelming that Mlearning is beginning to take hold as the number of mobile devices have exceeded the 1.5 billion mark thus outnumbering PCs, with more than 1 billion wireless internet viewing being carried out on wireless platforms [7-9]. Particularly, the utilization of the short message service SMS in the control and monitoring of hardware devices by allowing mobile phones, together with PCs and laptops connected to GSM phones, to exchange text messages of up to 160 characters, may widen the scope of Mlearning to include remote virtual labs.

In this paper, the use of wireless and mobile technologies in remote virtual experimentation is explored as part of an Mlearning education laboratory scenario. A mobile learning system is developed and deployed over the GSM network based on traditional client-server architecture. The client side is implemented in the form of mobile, PDA or PCs which can communicate with the server side in the form of a mobile connected to a PC or a microcontroller that runs the experimental setup. Students can conduct the experiments by issuing predefined commands and then communicate with the server via SMS. The architecture and framework of the mobile learning system is introduced and the use of the system in the context of long distance education is demonstrated.

2. The Mobile Measurement System

The proposed mobile virtual remote measurements, control and monitoring system is shown in Fig. (1). The client is allowed access the server to perform various functions such as measuring temperature, adjusting motor position, detecting motion, capturing video signals or any other operation made available by the interface at the parallel port. The operator controls the system from the client side with the aid of predefined SMS sent to the server which only requires the addition of a SIM card to its serial port. The SMS text may be comprised of words, numbers or alphanumeric combination. A Siemens C45 mobile phone is used as the means of communication over the GSM network. A programming languages such as Visual Basic or C# may be used to implement the software with the ability to control, sense, and perform measurements. The software utilizes AT commands to enable the PC to send and receive SMS by opening the I/O RS-232 serial port.

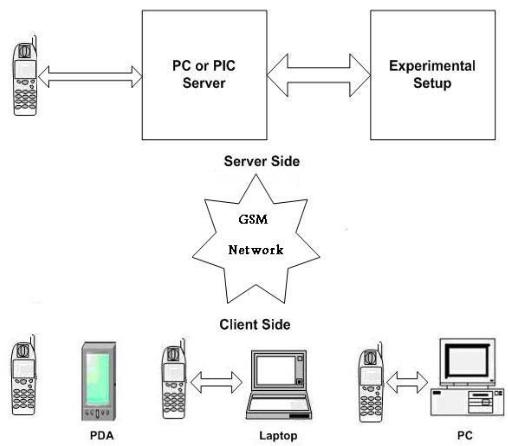

Fig. (1): Interactive Virtual Measurement System.

A hyper terminal version 1.2, working under windows environment, is used for SMS exchange after a correct registration of the serial port. Setting up the right configuration depends on the type of the modem connected to the Siemens C45 mobile.

2.1 AT commands

The AT commands are standard control tools supported by Siemens Corporation to establish communication with the mobile phone via a GSM modem. The commands set consists of strings which are capable of opening SMS, exchange serial data between the mobile and the PC according to certain syntax rules. As an example: "AT+CMGR=1", is a command for reading the first message form the mobile messages inbox, "AT" is a prefix used for all commands, "CMGR" is a description to the kind of task to be performed.

Several commands can be included in one string, and may be in upper or lower case. Command string should contain less than 40 characters, terminating command string with <ENTER>. Another command cannot be performed until a response <OK> is activated, <ERROR> in case of syntax error and <BUSY> in case mobile is under usage. AT commands set based on GSM (07.07) differ according to the manufacturer of Siemens mobile. Eight bit message (maximum 140 characters) is not viewable by Siemens C4 mobile as text messages, but they are viewed in the PDU mode. An application capable of reading incoming SMS messages can thus use text or PDU mode. If text mode is used, the application is bound to or limited by the set of preset encoding options. If PDU mode is used, any encoding can be implemented. The PDU mode that allows managing the message specifically is implemented in this work.

2.2 PDU Mode

Protocol Description Unit PDU mode is a management mode of SMS data elements. It directs the encoding process to receive SMS messages under windows environment. It is important to use the PDU mode for encoding the whole message and then display several specification like the sender phone number and the text contents to undertake the controlling process according to a comparison procedure of data base stored in the program. When a message is received by the PC according to the AT command "AT+CMGR=1", the program will be able to divide the message contents in order to execute specific content of the message and the specific text part of the message. The content of the message is contained in the user data UD part of the delivered string [10]. It is received in 8-bit octet format, and then converted into normal ASCII to be read by the software [10]. The C++ code is constructed in order to convert the 7-bit alphabet octet conversion message and thus obtaining the required information from the sent/received message. Several controlling text available in MS Access database is linked to the software modules which is compared with the received text message to perform the control task.

There are several encoding alternatives when displaying an SMS message. The most common options are "PCCP437", "PCDN", "8859-1", "IRA" and "GSM". These are all set by the AT-command AT+CSCS, when the message is read in a computer application. If the message is read by a mobile phone, proper encoding should be chosen.

2.3 System Software

A flow chart of an example prototype system software is depicted in the Fig. (2). This software can run on either the PC-based or PIC-based system. The platform used to run the software will however influence the choice of the preferred programming language used in implementing the software. The software starts with initialization and a hardware setup of the appropriate ports. Reading the

SMS message from the mobile phone is the heart to this software, where all subsequent operations are determined based on the contents of the received SMS. The command contained in the message is compared to a database of stored functions, the system is equipped and expected to perform. After each requested software task is completed, a hardware status collection is carried out and control is returned to the beginning of the program where the software will be in standby mode waiting for new messages. There are two methods to switch the system off; remotely via SMS in conjunction with a corresponding command stored in the database, or manually using a hardware button that forces the software to go to the end state.

COM port registration was set before starting the process of controlling SMS service. The software main menu will be disabled until COM port number selection is correct, and subsequently mobile connection is made. The program is then ready to start PDU format for encoding message contents after software conversion and to exchange SMS implemented in the control process which was initiated when the message received is matched with data stored in the data base.

Extra facility such as showing subscriber number and ID and displaying message contents upon using UNI code are provided. In addition, an automatic control mode responds, upon receiving the data, by acknowledgement message. Continuous cycles of sensors readings is performed to determine the load condition until the user sends an end-task message to terminate the process.

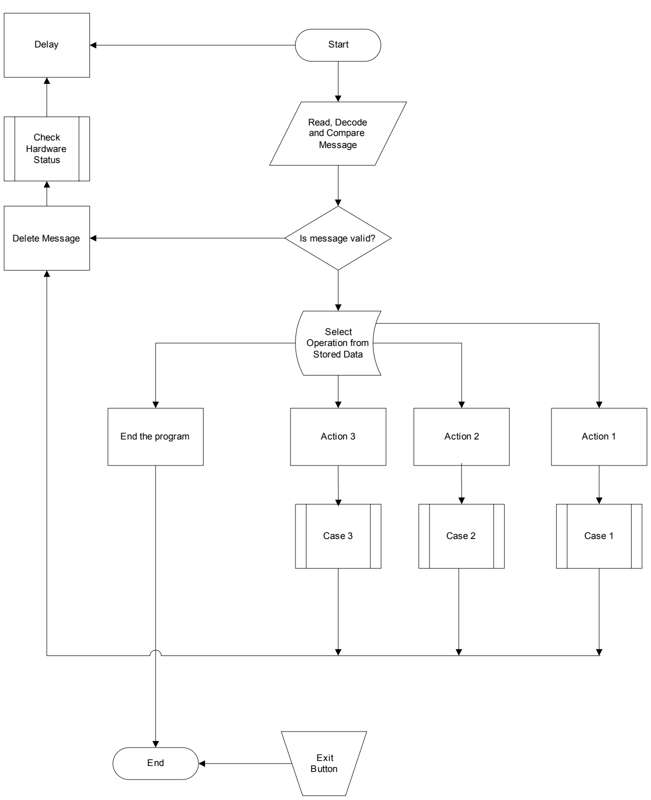

Fig. (2): System Software Flowchart.

2.4 Application

The proposed system was implemented in the control and sensing of a number of electronic devices as well as measurement of certain parameters such as the ambient temperature. When the PC acts as the server, the C++ programme simply converts the octet code into ASCII, decodes the incoming SMS by comparing it to words stored in the database and then performs the required operation. Simultaneous processing was made possible with the aid of a conventional interface and data processing circuitry consisting of A/D, multiplexers and sensors. Similar circuitry was implemented when a peripheral interface controller PIC of the type 16F877 was utilized as a server. The application as such, was confined to three cases of laboratory experimentations, namely constructing of truth tables for a number of logic gates and flip-flops, detecting sensor output values in instrumentation and measurement experiments, and performing tests in various stepper and dc motors. The performance of the experimentation system was very satisfactory in the light of the nature of SMS exchange and the limitations imposed by the GSM system itself. Such limitations include the obvious delay, small bandwidth and restrictions on message length.

Moreover, a temperature control system consisting of a thermocouple, heater and fan was also tested using the PIC server which was programmed via the digits of the keypad of the remote client mobile. The PIC-based server number is first dialed, and a series of 3 digits corresponding to the appropriate operation are pressed. Certain words were used to control the start of conversion for an A/D converter, and the selection line for the multiplexer. The software is developed to enable the PIC to act in an on/off mode. In this design the order of digits will be as follows: instruction number, desired temperature and then instruction number. The software is developed to make data transfer an easy procedure because of the difficulty in sending the sequence. It first opens the serial port, specifies baud rate, orders the modem to dial the desired number, generates the desired instructions, and then turns to the on hook state. Knowing these control words is the base for the controlling elements.

The other mode of operation is the automatic mode, which allows the user to set temperature to a certain value, for the system to maintain. Once the user sets the temperature, the system will read the actual temperature, compare it with the set temperature, and make the suitable action, weather to turn on the heater or the cooler. It will keep reading the ambient temperature until the desired temperature is obtained. The code will however drive the system into hysterises with a neutral zone of two degrees. If the temperature drops or gets higher than the set temperature by $\pm$ 2 degrees, it will stay in the neutral zone, and no control action is taken. This option was put in order to protect the actuators from turning on/off continuously.

One precaution should be taken into consideration is when the control word is sent. It will be taken as a byte, so any control word will affect all the circuitry that is connected to given address. The right control word will change the state of the desired element without affecting the others.

3. Conclusion

An interface system was designed to connect a mobile phone with a PC or a microcontroller PIC in order to perform remote control and monitoring of electronic and virtual devices via short message service SMS. The interface system is programmed with a C++ software using attention commands and the protocol description unit PDU mode. The system provides an efficient method for educational experimentation including measurements in addition to control and sensing. Many improvements can be made to this system which may enhance its performance and widen its applications including the substitution of the mobile by a GPRS card. This may lead to many applications and can be implemented as a means for exchanging virtual data between mobile and wireless devices. Expansion to suit PIC-based low-cost instruments is possible and the ultimate goal of developing an internet-PIC-mobile connectivity should be explored.

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