NEW SOFTWARE MODEL FOR DYNAMIC MOBILE MULTI FUNCTION MONITORING SYSTEM

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Abstract

This paper presents a novel algorithm implemented to works as a GSM modem. This software implementation model works in mobile/wireless control system networks. The AT commands where analyzed and processed by the application system to manage a multi-function mobile/wireless control system. To evaluate the application system a full home prototype model were built to be used in a real time control system. In this application system, a real time data can be accessed worldwide using the proposed algorithm. The proposed application system shows significant results when it was used with the proposed algorithm instead of the GSM modem (Global System for Mobile).A multi-function control system were used and tested. The system can also be configured to control an alarm or any other electrical device via a mobile phone using SMS text messaging. The proposed application system can control a home automation from the remote location, and determines the real time actions with a feedback from the system. The Cellular Shield will send the signal to the output PINs which are programmed using Java language to control the devices operation. The concerned authority can control the system through a mobile phone by sending AT Commands to the proposed software model that connected to the computer. The integrated application system works with most cell phones technologies. The application system provides access to the system security, monitoring, and controls the system operations remotely.

Keywords: Automation, GSM, SMS, Remote Monitoring &Control, AT Commands Mobile phone.

Introduction

The growth of using the digital technology, wireless and mobile networks (Ciubotaru,et al.,2006) ,and the production of services all over the world with a lowest cost for global distribution, all of these are increase the software application developments that utilize the technology. Also, much interesting in the industrial wireless communication (Catlin P.,et al.,),(K. Wieland,2004) sector in the automation system fields are increased the safety and security standards.

Recently, there has been much interest in remote monitoring and control in the field of the industrial automation. There is a great deal of benefits for industries to adopt the wireless communication to control systems. Currently, the common condition of using the wireless remote monitoring and control systems is to use the GSM SMS-based systems. The dominant mobile phone network in the world today is GSM. This network has coverage in most urban areas and offer support for the SMS (P. Gupta,) that allows users to communicate with each other by sending short text messages to each other at minimal cost.

The use of mobile phones has grown exponentially over the years (K. Wieland,2004). As the number of mobile phone users increased, the technology and infrastructure to use mobile for control system are also increased. The dominant mobile phone network in the world today is GSM.

The aim of this paper is to propose an algorithm based on the concept of development of a low-cost SMS-Based application system to control a dynamic multi-function monitoring system. This algorithm will be operates instead of the GSM modem device. All monitoring systems today are works based on GSM modem. The proposed algorithm is a novel new software model that works efficiently as GSM modem functionality. This application system works as a GSM communications module linked by a serial communications port. The proposed algorithm is used to control a home monitoring system automation relative to sort text send via SMS.

Remote monitoring, control and intelligent maintenance are one of the most important criteria for many remote monitoring control systems. This automation is maximizing production and process availability in different fields. Wireless media has been undergoing a rapid innovation process in search for a reliable, simple and business-viable technology for fast, easy and inexpensive diagnosis of faults in medical, home and industries. A new growth will come through new technology (Wireless/Mobile) (Catlin P.,et al.,2009), production at the lowest cost for global distribution, and fast real time operations.

The maximum length of the messages cannot exceed 150 alphanumeric Latin characters. This is enough to send short alert messages or commands to remote system. In the world of automation and control, several

methods have thus far been employed to attain remote monitoring and control of various processes. These attempts have met with varying levels of success.

Many fields of Remote Monitoring and Control system for Industrial Applications use the combination of an Embedded ARM Controller (ARM7 TDMI-S LPC2148) (Alkar,et al.,2005) and a GSM communications module linked by a serial communications port.

The primary aim of this paper is to propose a software model with a Low-Cost Software Application system SMS-Based to work instead of a GSM device operations.

Using the proposed application system could be efficiently to manage any monitoring system in different fields e.g. (temperature sensors, Humidity sensors, light sensors, movement sensors, and recognition fields …etc.), this actions recorded from the remote location and whenever it crosses the set limit, the ARM processor will send an SMS alert to a concerned authority(s) mobile phone. The concerned authority(s) can control the system through the mobile phone by sensing AT commands to the software model connected to PC application software that can manage the SMS commands. Also the system provides password security against operator misuse/abuse

The benefits of the proposed algorithm model are:

- Proposed a new algorithm to works as GSM modem.
- New novel algorithm works instead of GSM to control a dynamic multi-function application system based mobile networks.
- Flexibility / modularity in control by the use of the proposed algorithm via the application system.
- Global coverage through the use of the mobile networks.
- Extremely low cost software adaptation for different applications.
- Scalable, Robust and Reliable.
- Provides password security.
- Efficient and cheap means of communication by use of SMS.
- True mobility using mobile phone sets.
- Ideal for monitoring and control different monitoring fields.

2. Previous Research

The using of GSM modem and mobile networks increase the research of using SMS in remote control systems. All previous researches were done by using the GSM communication in different monitoring systems. In addition, in the most cases, they use SMS based massage to monitor and control systems or devices, many research where done, such as:

Delgado, Picking, and Grout (Delgado,et al.,2006) consider the problems with the implementation of home automation systems. Furthermore the possible solutions are devised through various network technologies.

Several issues affecting home automation systems such as lack of robustness, compatibility issue and acceptability among the old and disabled people are discussed.

Ciubotaru - Petrescu, Chiciudean, Cioarga, and Stanescu (Ciubotaru, et al., 2006) present a design and implementation of SMS based control for monitoring systems. The paper has three modules involving sensing unit for monitoring the complex applications. A processing unit that is microcontroller and a communication module that uses GPRS modem or cell phone via serial port RS-232. The SMS is used for status reporting such as power failure.

In (Conte, et al., 2003) Conte and Scaradozzi view home automation systems as multiple agent systems (MAS). In the paper home automation system has been proposed that includes home appliances and devices that are controlled and maintained for home management. The major task is to improve performance.

Mghawish (Mghawish, et al., 2012) proposed a monitoring system to control the direction of motor driving within a specified range of time, two directions where controlled in addition to activated functionality. They used a Mobile based on SM5100B Module to control the direction of motor driving.

In their paper, Alkar and Buhur (Alkar,et al.,2005) propose an Internet Based Wireless Home Automation System for Multifunctional Devices. This paper proposes a low cost and flexible web-based solution but this system has some limitations such as the range and power failure.

Murthy in (Murthy M.,2008) explores primary health-care management for the rural population. A solution proposes the use of the mobile web-technologies providing the PHC services to the rural population. The system involves the use of SMS and cell phone technology for information management, transactional exchange and personal communication.

Jawarkar, Ahmed, Ladhake, and Thakare (Jawarker,et al.,2008) propose remote monitoring through mobile phone involving the use of spoken commands. The spoken commands are generated and sent in the form of text SMS to the control system and then the microcontroller on the basis of SMS takes a decision of a particular task.

Finally, Potamitis, Georgila, Fakotakis, and Kokkinakis, G. (Potamitis,et al,2003) suggest the use of speech to interact remotely with the home appliances to perform a particular action on behalf of the user. The approach is inclined for people with disability to perform real-life operations at home by directing appliances through speech. Voice separation strategy is selected to take appropriate decision by speech recognition.

All the above researches were used the GSM communication based in remote monitoring systems they presented. The technology of mobile based on GSM modems are commonly used in this area of research as shown in (Delgado,et al.,2006),(Ciubotaru,et al.,2006),(Conte, et al., 2003),(Alkar,et al.,2005),(Jawarker,et al.,2008),(Mghawish, et al., 2012).

3. Block Diagram based on USB SIM CARD

The proposed functional block diagram for the system is shown in figure 1. It contains the process flow of the monitoring system.

As sown in the figure 1 the GSM modem did not used and it replaced by the proposed software algorithm model that works well as the GSM modem basic operations. This proposed algorithm is based on using a USB SIM CARD to be connected to the computer. The computer will contain the proposed algorithm the will compile the SMS messages into meaning full programmable hardware device operations.

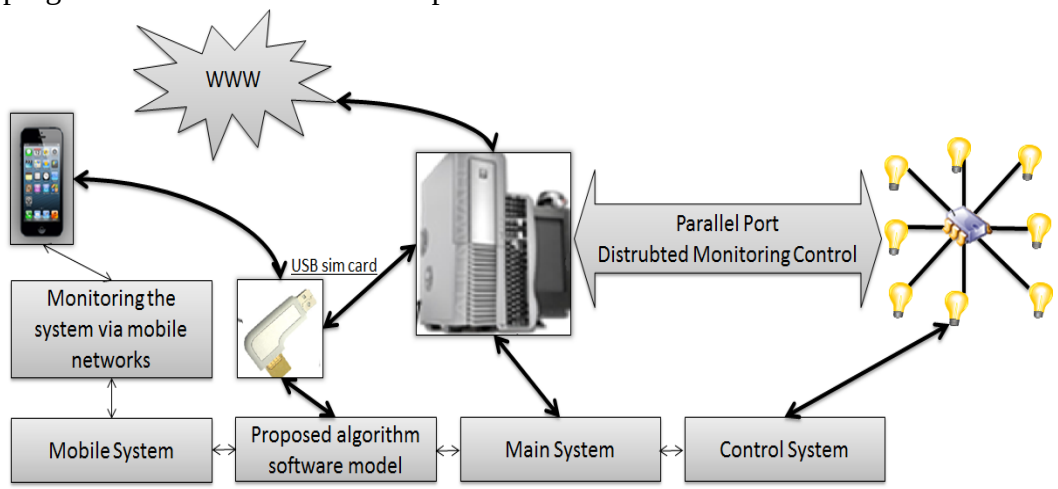

Figure 1. Functional Block Diagram

3.1. Functional Block Diagram

The Functional Block diagram of the entire system is as shown in the Figure 2. The block diagram consists of the proposed software application system to work as (GSM modem), PIC Controller, Relays, ULN2803 (to optimized for 6 to 15 volt high level CMOS or PMOS), Resistors, Diodes, Parallel Connectors, Transistor, and LEDs to indicate different electronic devices and a time duration. Figure 3 shows the main board controller that will be connected to computer where the application system software implementation processed the incoming messages.

3.2. Parallel Port Connectors

The Parallel Port Connectors shown in figure 2 are used to passes the distributed monitoring signals from the computer to the control board dynamically and then to control the different devices.

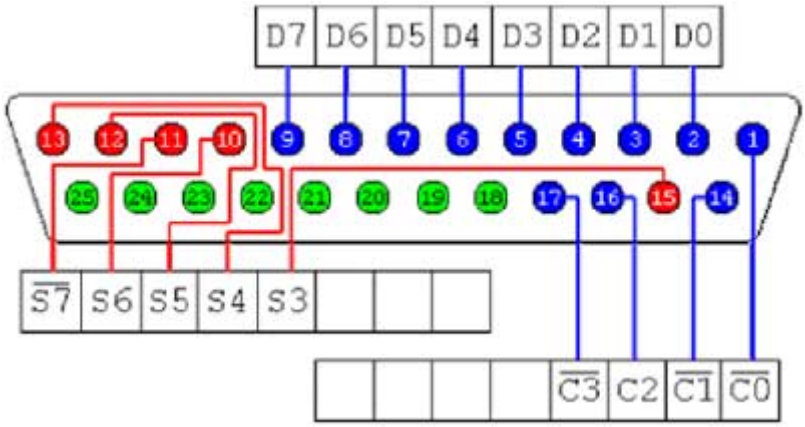

Figure 2. Parallel Port Connectors

Where the Pins 18,19,20,21,22,23,24 and 25 for ground, Pins 1, 14, 16 and 17 are for control, Pins 2,3,4,5,6,7,8 and 9 are for data, and Pins 10,11,12,13 and 15 are for status.

The control and data pins are used to execute the SMS text message that must be passes into the proposed algorithm.

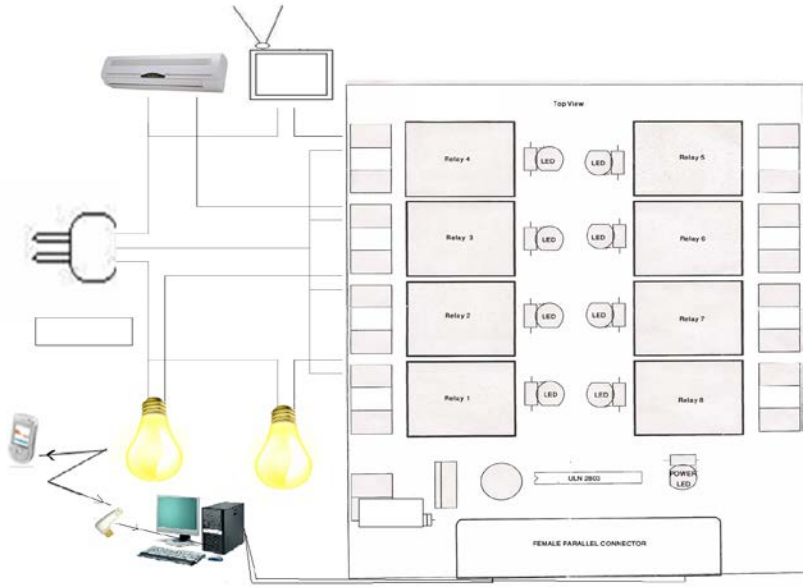

Figure 3. Main Board Controller Functions

3.2. Main Board Controller

The main board shown in figure 3 is connected to a dynamic multifunction control system based on the proposed algorithm. This circuit is used to manage and control eight electronic devices AC voltage (high voltage) by the following components as shown in figure 3.

1. Resistors multi value that increase the transistor base impedance, and protect some elements.
2. Diodes as freewheeling diode
3. Transistor is operates as electronic switch and interfaces the control signal from controller to relay element.
4. AC ports to connect several distributed devices signal from controller.
5. Relays 12V DC to reverse control to the output connected devices.
6. LED to indicate the control flow signals from the application system data to the monitoring device
7. Power led to notify the power flow in the main board, in addition to be used as a safety indicator to the electronic power.

4. The proposed Algorithm Methodology

4.1 Methodology and Software Model

The algorithm in figure 4 describes the methodology of the application system proposed in the main contribution.

The novelty of the proposed algorithm is based on the following:

1. All monitoring systems are using mobile networks are used the GSM communication based. In this research we propose a new software model that will utilize the functionality of GSM via a software model.
2. The main board controller is designed to be dynamic multi-function controller based on software programmable, on the other hand all previous systems are a hardware based.
3. All recent monitoring systems are used microcontroller for each device. This microcontroller must be programmed separately, while the proposed algorithm is dynamic multi devices with one controller that managed by the proposed software application algorithm.
4. The proposed application system and the control board, made it very efficient to monitor and manage multi devices via SMS from mobile or internet.
5. The proposed application system sends an SMS as a feedback to the user phone.

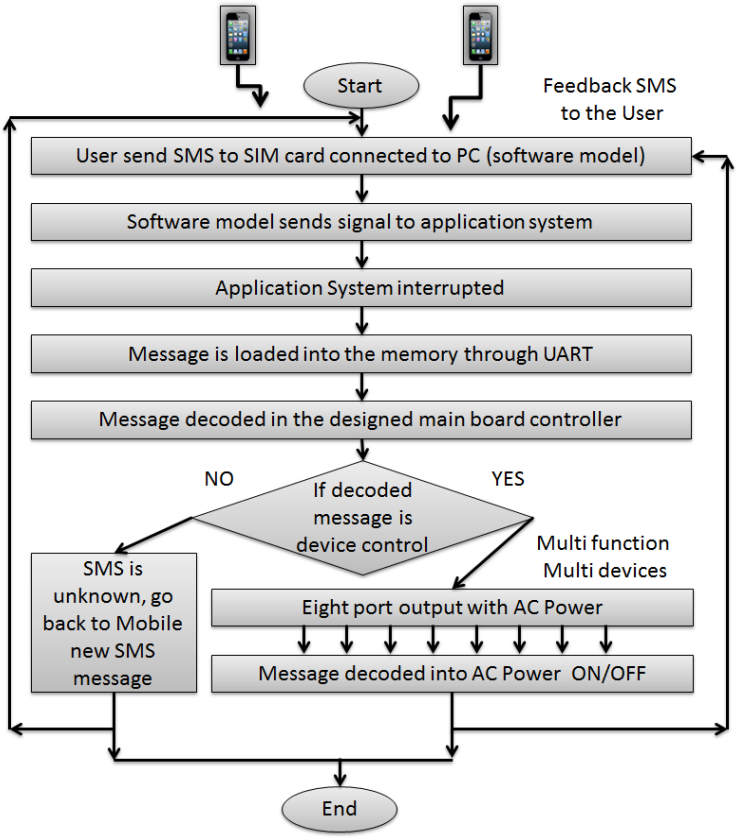

Figure 4. System methodology and application system

4.2. System Framework

The overall developed system can be configured as shown in figure 5.

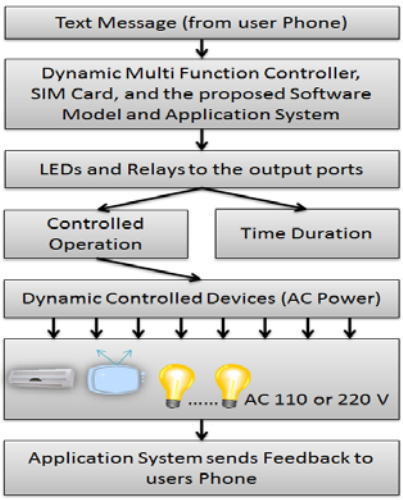

Figure 5. System Framework

4.3. Software Model Algorithm

The proposed is a new algorithm that will operates as a GSM modem based on SIM CARD and software model. The SIM CARD will be connected and configured to the computer where the proposed algorithm is installed and configured. The software model is executed and started after the SIM CARD is configured, in this cased all client phones will be notified by sending an SMS message ***"Control System is Ready"***. All SMS messages received from the client phone will be compiled and the text message is decoded by the proposed algorithm shown in figure 6.

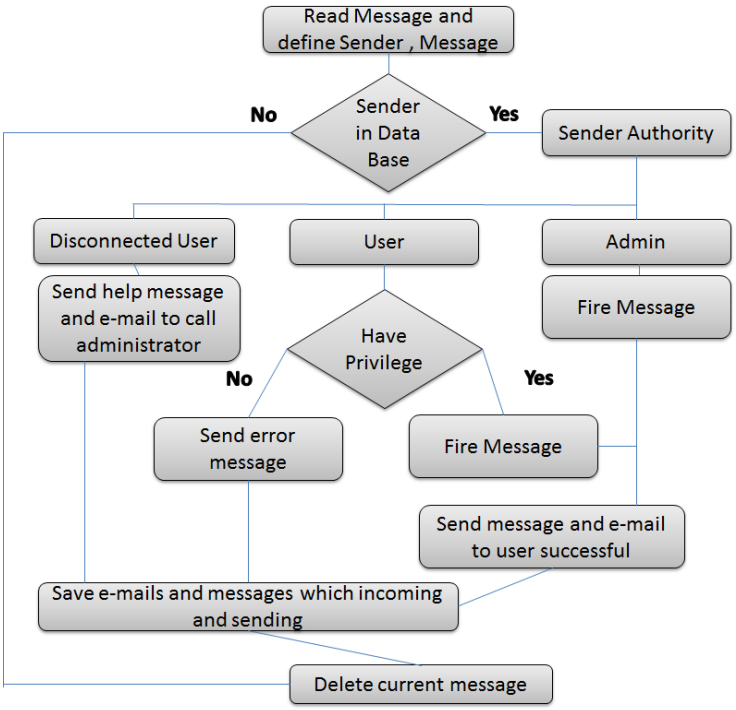

Figure 6. SMS messages received decoded by the proposed algorithm

5. System Implementation Functionality

This developed system has been designed to receive a text message from a user via a mobile phone to the proposed Software Model via a SIM card connected to the main board controller circuit, the parallel connector ports are connected to the parallel computer port, the application programs are programmed to manage their parallel ports as shown in figure1.

The Software Model algorithm is executed and started in the computer embedded with the SIM card to start receiving the ATM commands.

The following procedure shows how the process of send-receive SMS text message that is accomplished as the following steps:

1- Initialize the library with the numbers of parallel port interface PINs.

- *Decode the required eight pins for Ground (earth) for safety electricity power with high voltage.*
- *Decode the required eight pins for Data to get the distributed device.*
- *Decode the required four pins for Control.*

2- Initialize Software Model to configure the serial port for communication.

- *Set software module to send SMS mode to text and to send data to output upon receipt.*
- *Notify the clients of starting services via the software module by send SMS to client's phones.*

3- Specify the LEDs port connected to the specified device to switch ON for

- *Setup the LEDs number of columns and rows as a combination of two digits as 00, 01, 10, and 11 to switch (On/Off) the device.*

4- If the incoming character from the cellular module read the AT Command,
Send Feedback to the Phone as
"Message is received";
Otherwise;
Delete the message;

The implementation of proposed procedure above has been programmed using Java programming language.

When the system is in an "active mode" (the power supply is subjected to the controller), the SMS message will be send to distributed controlled device (multi-function operations) through the main board circuit which in turn acts to affect the device monitoring control for a given specified period or scheduled, at the same time this message is send to the user phone as SMS message.

When the system deactivated, all actions are stopped and a related status report is send to the user phone as a warning SMS message.

Every message consisting of a sequence of characters starting with an upper case letter followed by lower case letters and ending with a number (to indicate the amount of time) or with # symbol (to stop manually or by sending other message).

To demonstrate the control follow of the incoming SMS messages, we create a database table as a library of coding commands that will be used in the system.

The table 1 shows the standard format of the table attributes that will be used via the system. This table is dynamically updated by the system, in addition this table can be updated by the system administrator to manage the system updating dynamically with a simple DBMS connected to the application system built in Java language.

TABLE1. FORMAT OF SMS MESSAGE

SMS Text	Actions	Time in seconds
Upper case letter	Sequence of lower case letters	Number or # Symbol (optional)

Every received message from mobile phone consists of an AT commands followed by a sequence of characters starting. Each message must start with upper case letter followed by lower case letters and ending with a number. The last number in the message is to indicate the period of time we want to run this machine (device) then stop. Otherwise, if we need the device always running ON then, the # symbol will be used as the last character of the message. In addition, we can stop the device manually or by sending other message. Farther more, to apply a multi control device we use the "," symbol.

The following list demonstrates the different message sending by the system to control and monitor the different devices. The number of device and the time are controlled by the message as shown in table 2 below.

TABLE 2. SAMPLE OF DIFFERENT MESSAGE SENDING BY THE SYSTEM

SMS Text	*Actions*	*Time in seconds*
Room00 -1-30	Circuit is operates, and LED number 00 on the board becomes ON, and then the light of the room number 1 is become ON for a duration time of 30 seconds then stop automatically.	30
Room01 -1-20	Circuit is operates, and LED number 01 on the board becomes ON, and then the light of the room number 2 is become ON for a duration time of 20 seconds then stop automatically.	20
Room01 -1-#	Circuit is operates, and LED number 01 on the board becomes ON and then the light of the room number 2 becomes always ON.	Always ON until manually stopped or by send message
Door10-1-30, Room00 -0-	Circuit is operates, and LED number 10 on the board becomes ON and then the door motor is OPEN for 30 seconds then stopped automatically. Room00 light will be turn Off.	30 The second stopped
Off	Circuit will be shut down for all devices.	
Ledon	LED circuit is operated so it is lighting.	
Ledoff	LED circuit is turned off.	

The SIM CARD and Mobile configuration screen snapshot of the proposed algorithm is shown in figure 7.

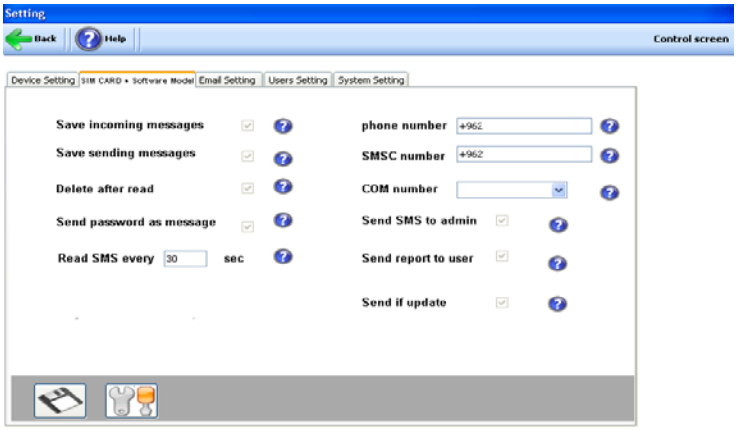

Figure 7. (SIM CARD) and Mobile configuration via software model

The figure 8 below shows the system settings, in addition to the authorization and authentication that will be manage the system security.

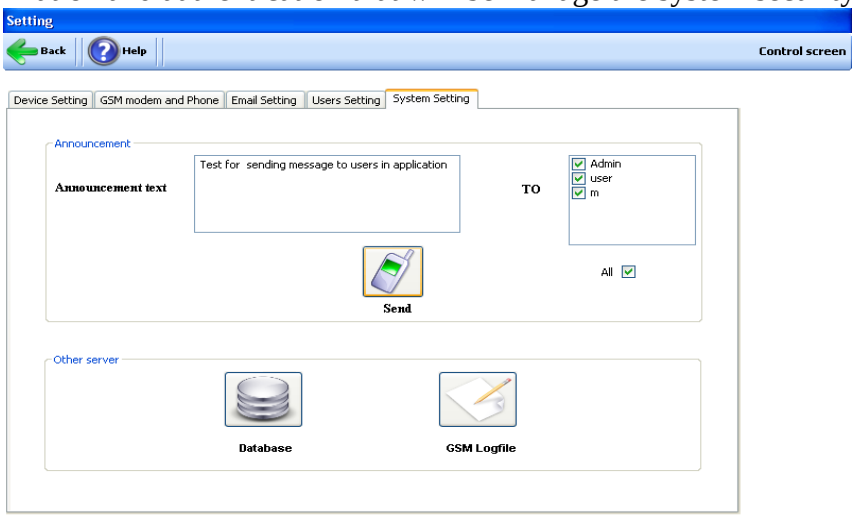

Figure 8. System Settings

The GUI of the mobile side system is shown in figure 9. The devices list menu and message diagram are shown.

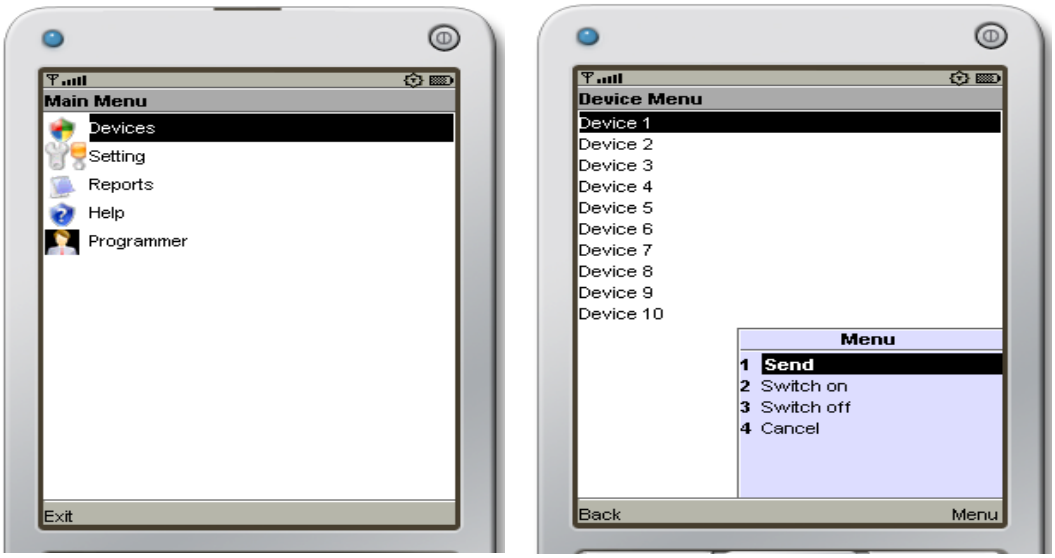

Figure 9. GUI of the Mobile Side System.

The table 3 shows the different SMS AT Commands that can be deal with the proposed system. This format is stored in a database library for the SMS message format used by the proposed system.

TABLE 3. LIBRARY DATABSE FORMAT OF SOME AT COMMANDS

AT Command	*Details*	*Description*
AT	Attention Command	Checks the communication between the phone and any accessory. Determines the presence of a phone.
AT+CGSN	Request product serial number	Causes the ME to return one or more lines of AT commands. Note: Only commands available to the user are returned.
ATD	Dial command	Initiates a phone connection, which may be data or voice (phone number terminated by semicolon). The phone number used to establish the connection consists of digits and modifiers or a stored number specification. It is also possible to initiate a phone connection with the use of the alphanumeric field for a phonebook entry location or by the use of the entry location.
AT+CLCC	List current calls	Returns the list of current calls. If command succeeds but no calls are available, no information response is sent to TE.
AT+CPIN	PIN control	The set command sends the password to the ME, which is necessary to make the ME operational (SIM PIN, SIM PUK or PH-SIM). If the PIN is entered twice, the TA will autonomously repeat the PIN. If no PIN request is pending, no action is taken towards the ME and an error message is returned to the TE.
AT+CMGR	Read message	Returns message with location value <index> from preferred message storage <mem1> to the TE. Status of

		the message and entire message data unit <PDU> is returned. If status of the message is "received unread", status in the storage changes to "received read".
AT+CMGS	Send message	Sends message from a TE to the network (SMS-SUBMIT). Message reference value <MR> is returned to the TE on successful message delivery. Optionally (when AT+CSMS <service> value is 1 and network supports it) <ACK PDU> is returned.
AT+CMGD	Delete message	Deletes message from preferred message

Conclusion

The proposed paper discussed an application system for dynamic multi-function remote control devices. More than one controlled device in parallel which uses communication networks via a mobile phone based on the designed model included a SIM CARD and software model configuration, table or library of accepted SMS messages. The system model can be used in many areas, such home automation, industrials, and many other aspects. As shown by the obtained results this remote control system is low cost, reliable, feasible, and effective. In addition this system will shows significant results while it works without using a GSM model for dynamic multi function devices.

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