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A novel SMS application with GSM control on numerator systems

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Abstract: Numerator systems are widely used in various fields, sorting, and structures to ensure regular functioning. They are used today in places such as banks and hospitals to minimize the time spent waiting in a queue, and various studies have been undertaken to achieve efficiency in the workplace. At the beginning of these studies, numerator systems, which have been integrated into the short message service (SMS) application, have been used efficiently. With this application, to supply the required information to the user in the fastest way, a numerator system is developed by utilizing radio frequency communications and the SMS message structure. The application system in this study includes hardware and software sections. The hardware section is designed using a keypad, microcontroller, and liquid crystal display as the user interface unit, and it also consists of a power supply feeding the system. The software section consists of the microcontrollers' required software to control and operate the system, software for the elements used as the user interface unit, and the menu program software that the users will notice.

Key words: SMS, GSM, GSM terminal, Numerator systems, RF communication, CHAP protocol

1. Introduction

Banks, public offices, and some private institutions are chosen as study areas for this application because the services provided are intended to be more easy and objective. Despite the widespread use of numerator systems in these organizations, a waiting-time problem remains unsolved for these operations. To resolve this waiting time problem, a communication system was developed to work in accordance with numerator systems. Time for individuals, with the implementation of this system, is intended to be used more efficiently. All of the required data are decided with the elements used in the realization and control of this system and these data are processed accurately and quickly. Communication between the user and numerator are provided through microcontroller and radio frequency (RF) terminals [1–6].

Communications between employees or clients in institutions are extremely important today. The SMS application is one of the solutions developed for the purpose of communication. SMS is an abbreviation for 'Short Message Service' [7]. SMS is a communication protocol allowing the interchange of short messages between mobile telephone devices [8–10]. The use of SMS with mobile phones has a wide application in many areas. Most people use mobile phones in order to watch or control a remote system. SMS is used for modern handsets originally defined as part of the global system for mobile communications (GSM) [11–14]. For sending

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or receiving SMS messages, GSM terminals are used outside of the mobile phone. In this study, the system is controlled by connecting to a GSM control system [the subscriber identity module (SIM) card, the GSM terminal, and the circuit photonic integrated circuit (PIC)]. The PIC in the control system, by programming in different ways of usage in systems, is provided for the desired purpose. Mobile phones can be used in many fields for remote control, such as in homes and offices for security and device control; in industry for learning machine situations and temperature, gas, and humidity control; in agriculture for learning weather forecasting, the status of silos, and to control irrigation systems; and in health for patient care [2,15]. The block diagram of the system is shown in Figure 1.

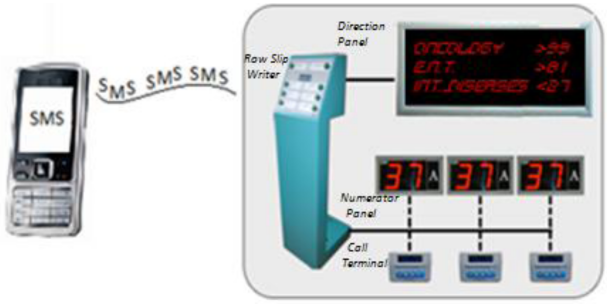

Figure 1. Block diagram of the system [16].

Today, numerator systems are widely used in places such as banks and hospitals, where the concentration of people is increasing. There are increasing numbers of people in queues and, meanwhile, people are spending too much time waiting. Along with this, all personal access to communication services becomes wireless, and nearly every citizen has a mobile communication device [13]. The GSM technology that is used in this study is performed to minimize the time spent in places that appear to be simple but take up too much time. Instruments are used effectively with the hardware and software technologies, which can be used optionally for sending sequence SMS messages via the GSM terminal [17].

Thanks to the bank numerator system, based on this study, an SMS message is sent to the user, who has a sequence number, and the user is called to the branch office. In this context, to perform more efficiently in places where people are more concentrated, an SMS message is sent to the user's mobile phone to inform the user due to the user's request by using a PIC-based study carried out in connection with the GSM terminal.

In the performed system, the first user receives a sequence number via a button. After the number is seen on the screen, the user optionally dials the GSM number via the keypad, and the dialed number is recorded in the internal memory of the electrically erasable programmable read only memory (EEPROM) contained in the microcontroller. While these operations are being performed, the people who are increasing the counter in the numerator, those maintaining normal operation, and the row numbers of their clients are displayed via the displays. In addition, the content of the menu is viewed using a 4 $\times$ 20 liquid crystal display (LCD) to direct users. Apart from this, an SMS message is sent to the user by means of the Siemens MC35i GSM terminal, which will communicate with the user's mobile phone. When the project is generating, first, the circuit elements used in hardware are determined, and then the algorithm for the software is created and the programming is realized.

2. System architecture

The application of the proposed system consists of hardware and software sections.

2.1. Hardware

The system hardware is designed using the control section, the external memory section, and communication blocks.

A microcontroller is used to perform the connection to the peripheral units and to provide the system's overall control. The PIC18F452 and PIC16F873 microcontrollers are used in the designed work. If the internal EEPROM memories of the microcontroller used in the project are insufficient, considering the development of the project at later times, the optional integrated circuit (IC) 24C256 is used as an external memory unit with 256 kB of memory. This IC is added the system and is ready to be actively used in the project. It is not immediately necessary to use this IC in the system because the internal memories of the microcontrollers are sufficient for the moment.

In this part of the project, the communication system is developed to perform the sending of the SMS through the GSM terminals to the user by the bank. To ensure this communication, a serial communication interface is used between the GSM terminal and the PIC18F452 microcontroller. The block diagram of the system's hardware section is shown in Figure 2.

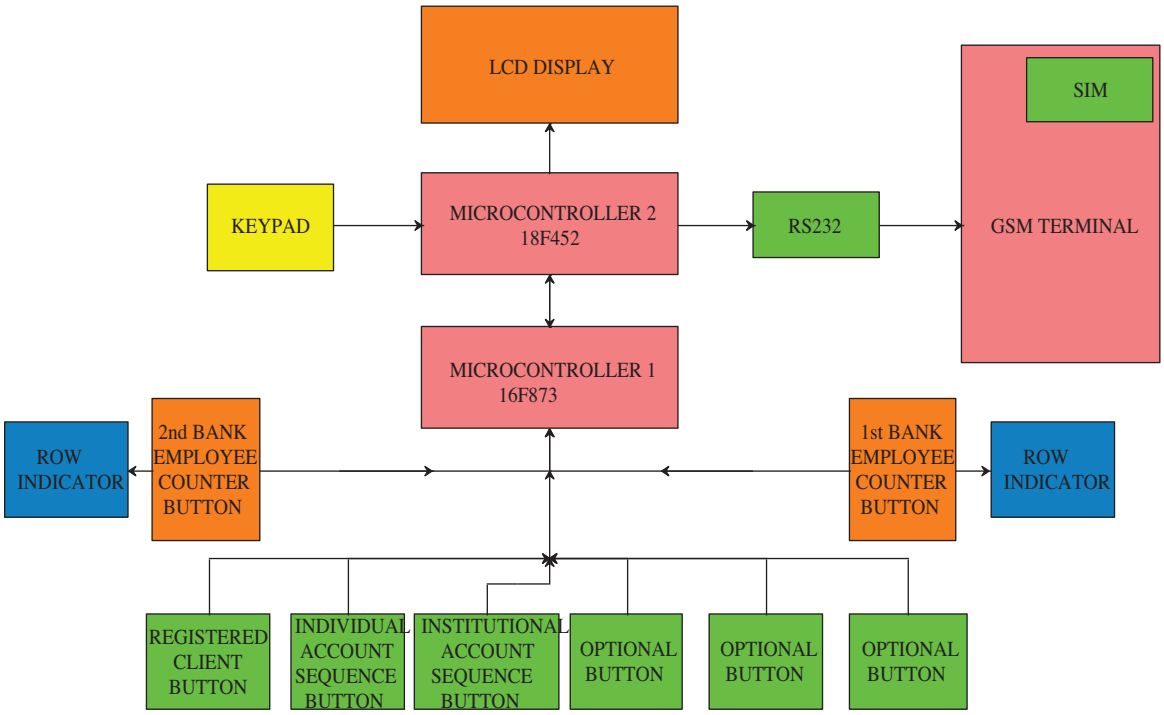

Figure 2. Block diagram of the hardware section.

In this study, a Siemens MC35i terminal is used. The MC35i GSM terminal works in a GSM 900–1800 MHz frequency band called the second generation [18,19]. The transmission power varies according to the frequency band (2 W at 900 MHz and 1 W at 1800 MHz). Communication between the microcontroller and GSM terminal cannot be directly provided. To provide this communication, an interface is required. The RS232 serial communication standard is used as the interface. The serial communication is provided by adding a MAX232 integrated circuit between the GSM terminal and the microcontroller. The GSM terminal [20,21] and the GSM module [3,22] are similar concepts, and so these concepts are confused. A GSM module is electronic

hardware in the GSM terminal. The GSM terminal consists of the RS232 connector, including the GSM module, antenna input, power input, and SIM card slot. The block diagram in Figure 3 shows the main components of a typical GSM terminal.

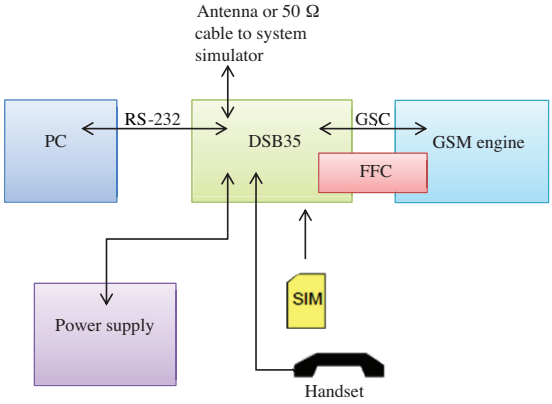

Figure 3. GSM terminal internal structure [20].

The DC supply voltage of the used GSM terminal is in the 8–30 V range, and the supply current is 200 mA at 12 V and 100 mA at 24 V.

Attention (AT) commands are used for communication between the microcontroller and the GSM terminal. There are various AT commands according to the desired operations.

The general packet radio service downlink data transmission is 85.6 kbps at maximum, and the uplink data transfer rate is 21.4 kbps. Due to this difference, the MC35i is generally used with features such as sending SMS messages and calling. The MC35i is used to send an SMS message in the system, where from the beginning of the sending process, SMS delivers the desired message to the user in as little as 10 s. This terminal supports the password authentication protocol (PAP) and challenge handshake authentication protocol (CHAP) [21,23], which are used for point-to-point connections.

The GSM terminal has a 50-Ω antenna connector and 2 analog audio interfaces. The terminal works in the range of 300–230,400 bps, within the scope of the serial interface. Thus, the autobaud system supports baud rates such as 1200, 2400, 4800, 9600, 19,200, 38,400, 57,600, 115,200, and 230,400 bps.

The used terminal's normal operating temperature range is –20 °C to 55 °C range. Except temperature values of –25 °C to –20 °C and 55 °C to 70 °C, the operating temperature range is the limit value. The terminal automatically closes itself when the temperature is lower than –25 °C or higher than 70 °C. The MC35i has 8 wire links between the user and the system and is also compatible with data communication equipment (DCE) protocol communication, a synchronous serial interface version of ITU-T V.24. Use of the terminal is designed as DCE, compatible with DCE–data terminal equipment (DTE) connections, and allows communication with DTE user applications. Port/TXD is the way that a user sends information to the terminal's TXD0 pin, i.e. the terminal end that receives the information. Port/RXD is the way that a user receives information sent from terminal's TXD0 pin, i.e. the terminal end that sends the information [5].

In addition, a 4 × 20 LCD display is used for showing the actions of the user and displaying the necessary referrals to the user during the operation of the system. Apart from this, a 4 × 4 keypad is implemented in order to ensure access of the data by interfering with the system due to the user's own request. The designed system is shown in Figure 4.

Figure 4. Numerator system application.

2.2. Software

At this stage of the study, the system software is discussed. The software algorithm of the main program is constructed as shown in Figures 5 and 6. The project's main and control subprograms are written in C programming language. The reason why the C language is preferred is that programs written in the C language are more efficient than programs written in other languages.

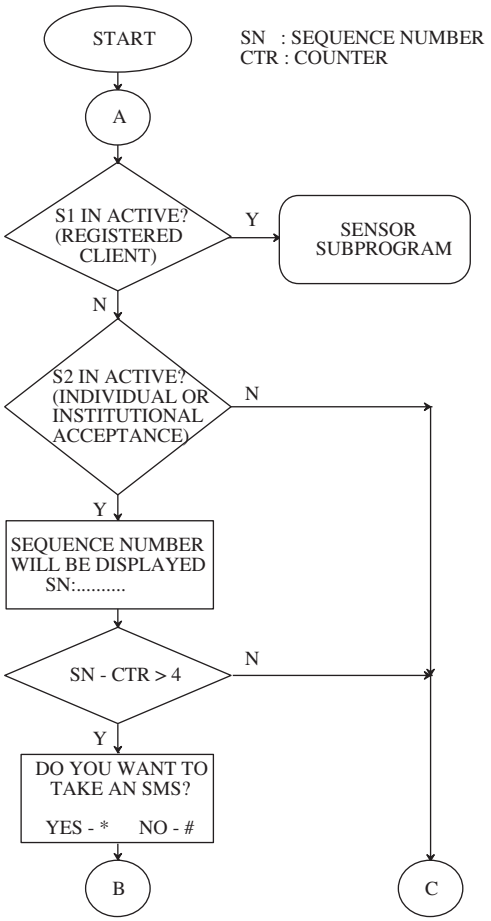

Figure 5. Flow chart of the first part of the main program.

The main program content has the necessary software to provide contact with peripheral units, such as the keypad, the LCD created in the initial setup, and the assignments made. Software is the main program of the project-based program that enables the transition as a result of the branches in the decision cycles to sense and send SMS subprograms. In this system, that may occur as a result of user intervention only and within the main program it will not have to work with each cycle. Decision mechanisms are available in the main program, enabling the transition to parts of the program to be run optionally.

While the main program is processing, the frequent realization of some operations disrupts the operation of the main program, and thus the program's completion of the cycle takes longer than usual. Subprograms are needed to minimize all of these adverse conditions and to provide more efficient operation of the system. Therefore, preventing of the operation of unneeded program parts in the main program and running of program units, required to work only where needed, within the subprogram have been done more efficiently.

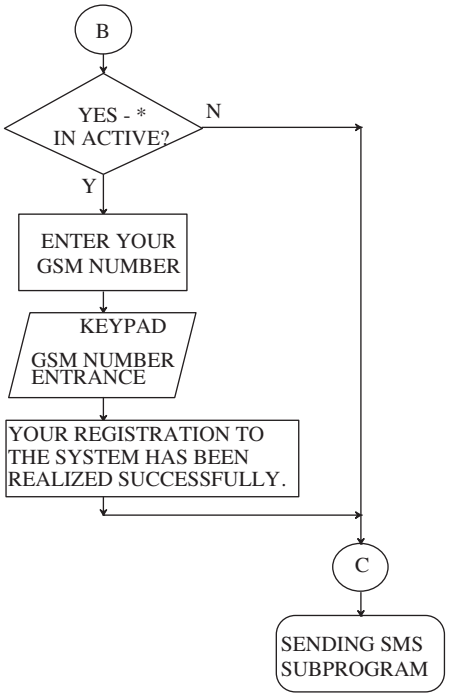

Figure 6. Flow chart of the second part of main program.

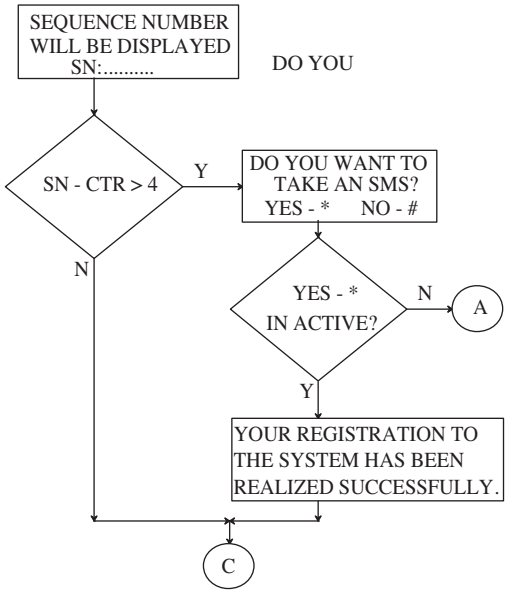

Figure 7. Algorithm for the sensor subprogram.

The software algorithm of the sensor subprogram is constructed as shown in Figure 7. In the system, a button is used as the sensor input. By pressing this button, the system acts as a sensor detector and goes to its own subprogram, and it implements the necessary operations. Within the main program, the button is used as a sensor input, being pressed at the beginning of each cycle. The routing is done by the required checking. If the button is not pressed, the main program flow continues normally, and if the sensor button is pressed, it goes to the subprogram and performs some operations. The algorithm shown in Figure 8 for sending the SMS subprogram is at the bottom of the main program and all of the subprograms are pieces of the program, which is the last step of the program flow of all of the process steps after being performed at the same time. Because of the last link in the flow of the program, in each loop, there is a GSM number that must be sent an SMS message that is checked. When the contents of this subprogram, the last link in the main program, are entered, the first state is the control of the arrival of the order of the numbers sending SMS messages to be sent. An

operation is performed in the memory of the microcontroller that temporarily stores the GSM numbers of the registered or unregistered users who want to receive SMS messages, and determination of the clients' sequence numbers is made. After the determination of the GSM number, the SMS message is sent by establishing a connection between the microcontroller and GSM terminal via the RS232 port.

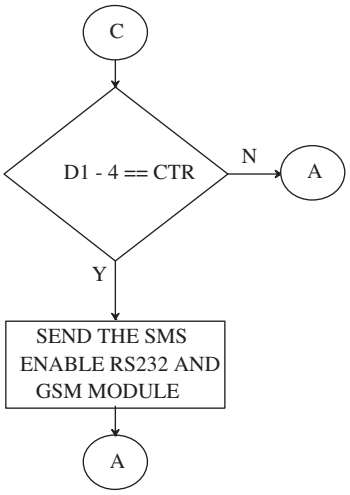

Figure 8. Algorithm for sending the SMS subprogram.

3. Evaluation and results

The GSM terminal's communication with the microcontroller is tested first, and the conclusion is reached that the communication is successful according to the data received. In the next stage, the required hardware and software are made for sending an SMS message to any GSM number using a microcontroller via the GSM terminal. Hence, an SMS message is sent to the other side and a positive result is obtained. Communications between the microcontroller and peripherals, such as the LCD display, keypad, and other buttons, made in an appropriate way, are tested and successful results are obtained.

In relation to this system, the results of 2 surveys are shown graphically below. The surveys were administered to 100 people. The object of the survey shown in Figure 9 was to observe how users evaluate the GSM application in numerator systems. The result of this survey at 90% "useful" has led to the conviction that the system will be efficient and useful. Figure 10 graphically shows the results of the other survey. This survey was a public institutional study and shows how much time people expect to wait and thus how much time is

Table.

How much time are you waiting?	
Wait time (min)	No. of people
10	2
15	5
20	7
25	10
30	14
35	16
40	20
45	26

wasted. A time period of 0–45 min is observed in this study. The results of this survey are presented below in the Table.

GSM APPLICATION IN NUMERATOR SYSTEM	
useful	not need & undecided
90%	10%

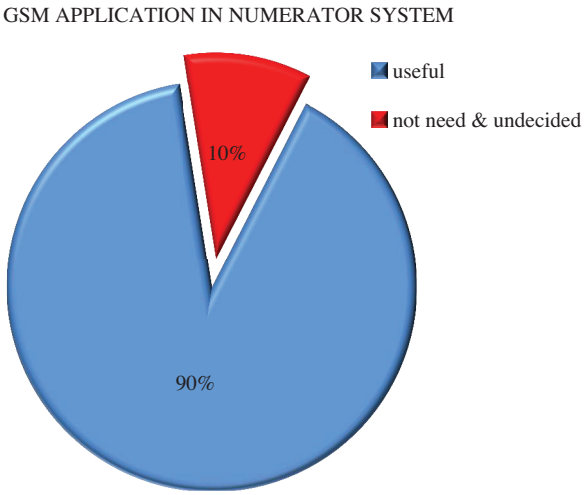

Figure 9. Availability with GSM application in the numerator system.

How much time are you waiting?	
Wait Time(min.)	People #
10	2
15	5
20	7
25	10
30	14
35	16
40	20
45	26

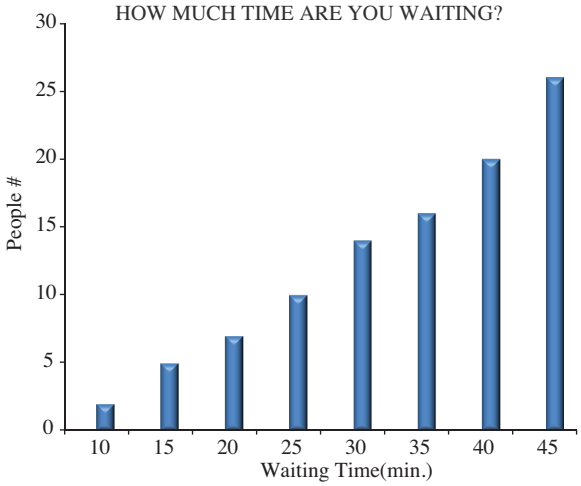

Figure 10. Waiting time for operations.

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