DESIGN AND IMPLEMENTATION OF A GSM-BASED SCROLLING MESSAGE DISPLAY BOARD

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ABSTRACT

This research work is developed with two AT89C52 microcontrollers from Atmel. The microcontrollers provide all the functionality of the display notices and wireless control. The Display is obtained on a 7X96 Light Emitting Diode (LED) dot matrix display, arranged on a Vero board. A desired text message from a mobile phone is sent via a Global System for Mobile Communication (GSM) to the GSM module located at the receiving end. The GSM modem is connected, through MAX 232 Integrated Circuit (MAX 32 IC), to the AT89C52 microcontroller. The message that is stored in the Electrically Erasable Programmable Read Only Memory (EEPROM) is then displayed on the LED dot matrix display. This hardware uses regulated 5V, 500mA power supply. A three-terminal LM7805 is employed for regulation of the voltage. A bridge type full-wave rectifier is used to rectify the AC output of the secondary of 230/12V step down transformer. The system was tested to work according to specification.

KEYWORDS

AT89C52 Microcontroller, GSM Module, EEPROM, Display Board, LED Array

1. INTRODUCTION

Prior to the invention of microcontrollers and GSM MODEMs, a scrolling message display will only display the message loaded into its memory compartment and cannot or may never be modified except by totally rebuilding the system. In more recent times (after microcontrollers and GSM MODEMs had imaged), an authentic wireless communication could easily be developed between a mobile phone and a microcontroller using a GSM MODEM. This can be utilized to change or modify the message that is being displayed at any time and from anywhere within the reach of the wireless network signal. The message display is made of an array of Light Emitting Diodes (LED) arranged in a matrix configuration with a specific number or rows and columns. The configuration allows each LED to be independently referred to and manipulated as desired.

The simple tasks involved in displaying a message on a digital notice board may be terribly cumbersome and typically needs technical skills. Vast public companies like banks, airports and cinemas use digital scrolling message board in multitude applications [1]. However, if the message that is presently being displayed has got to be modified or changed, a Personal Computer (PC) or laptop computer has to be directly connected to the display (usually Crystal

Display) and then a new message could be installed to the display board. These cumbersome processes can be totally eliminated by devising an alternative means of updating the message that would be displayed. Hence the need for a GSM based notice board. With this design, the notice board is simply updated by an SMS at any time and from anywhere with the desired message.
This work actually eliminate main problem involved in manually reprogramming the microcontroller which is responsible for displaying a new message or different style on the digital notice board. The challenge of reprogramming the microcontroller which is cumbersome, and cause endanger physical damage to the system, are therefore eliminated.

Several works have used GSM to monitor several application such as cell phone operated robot [2], SMS based voting system [3], SMS based security system [4], GSM based automatic meter reading system using ARM controller [5], SMS based teaching and learning system [6] and so on.

Also, several researches have been done on GSM based e-notice board, where SMS sent from authorized mobile phones, via a GSM network, were displayed on a digital e-notice board. These several works have proven to be efficient and fast. With greater efficiency, messages were displayed with less error and less maintenance, though there is need for few modifications for better performance [7], [8], [9], [10], [11], [12], [13].

Nivetha, Puritha, Preethi and Yashvanthini (2013) designed an SMS driven automatic display using ARM-LPC2148 to interface multiple graphical display. With this technology, a single notice could be sent to several e-notice boards via ARM-LPC2148 [14].

Rahul Kamboj and Preeti Abrol (2013) designed and developed a GSM based multiple LED display boards using AT89S52 microcontroller, GSM module, LCD and several moving LED displays. Multiple moving LED displays were connected via different GSM modules at different geographical locations such that the same SMS sent was displayed on all the moving LED displays. Though with few limitations, this work proved to be cost-effective, secured and efficient as compared to previous works [15].

Gowrishankar Kasilingam, Mritha Ramalingam and Chandra Sekar (2014) proposed development of GSM based digital notice board. The complete system would have a dual system in terms of changing message display, dual power supply switchable between solar power system and alternating current (AC) from the utility supply, and inbuilt motion detector that could automatically switch OFF the whole system after working hours and would automatically switch ON if any motion is sensed by the motion detector after the programmed working hours. This work would probably prove highly efficient in terms of ensuring better communication and continuous power supply [16].

Raj Hakani (2014) worked on GSM based alphanumeric scrolling display system using PIC 16F877A microcontroller interface with GSM modem via MAX232 level convertor. Hardware also include DS1307 real time clock, alphanumerical panel and multiple 16×2 character LCD displays and microcontroller coding was done using Embedded C and MpLab. In this research, multiple users were authorized to update notices on the digital notice board. This design can only maximum of 60 characters on the board [17]. Mayur Bhoyar, Suraj Chavhan and Vaidehi Jaiswal (2014) also worked on the same research with little modification. Here, instead of coding the microcontroller with Embedded C and MpLad, microcontroller was coded with Embedded C and Kiel and the PC was coded with Visual Basic [18].

In the current research work research work, two (2) AT89C52 microcontrollers were interconnected together to increase the speed of processing and displaying a newly received

message, i.e. to reduce the time lag between receiving a new message and displaying the message on the LED array.

The rest of the paper is organized as follows. Section 2 describes the design process. In Section 3, the construction and testing process is discussed. We present the implementation process in Section 4. Section 5 gave the results obtained from the testing. We conclude the paper in Section 6.

2. DESIGN

The main aim of this research will be to design a Short Message Service (SMS) driven automatic display notice board which can replace the currently used programmable electronic display. It is proposed to design a receiver (GSM MODEM) display board which can be programmed from an authorized mobile phone. The message that is desired to be displayed is sent through an SMS from an authorized transmitter (mobile phone). The microcontroller receives the SMS from the authorized transmitter, validates the sending Mobile Identification Number (MIN) and displays the desired information on an LED array which serves as the display board. Started off as an instantaneous News display unit, we have improved upon it and tried to take advantage of the computing capabilities of microcontroller and a larger obvious display board instead of a small Liquid Crystal Display (LCD).

The main components used includes AT89C52 microcontrollers, GSM MODEM, 7×96 characters LED display arranged in matrix configuration, max232 serial interface, electrically erasable programmable read-only memory (EEPROM), mobile phones, and voltage level conversion unit. Figure 1 shows the block diagram of the research work. The text to be displayed is sent from the mobile phone to the GSM MODEM. The GSM MODEM responds by requesting a confirmation SMS. The GSM MODEM has a different voltage level from that of the control unit. The voltage level conversion unit serves to synchronize the voltage levels.

The data collected by the GSM MODEM is stored in the external memory which is fetch bit by bit by the control unit and fed serially to the display driver (shift registers) and then finally displayed on the array of LEDs.

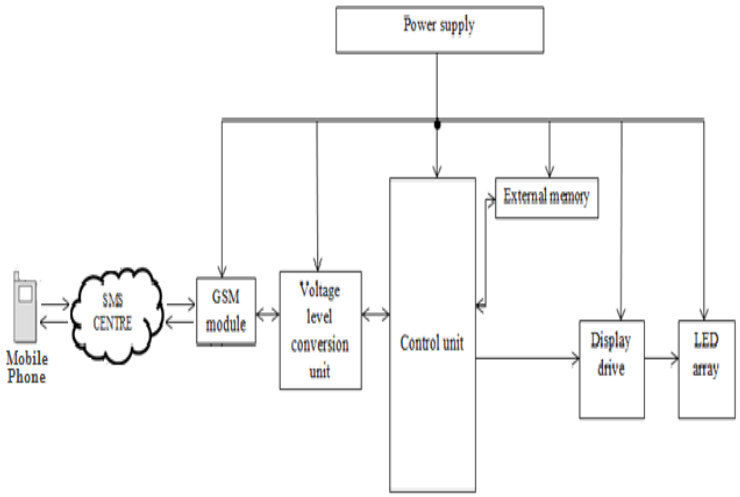

Figure 1. Block diagram of a GSM-based digital scrolling message display

For the purpose of this research, two AT89C52 microcontrollers were interconnected to increase the speed of processing and displaying a newly received message, i.e. to reduce the time lag between receiving a new message and displaying the message on the LED array. The connection is shown in Figure 2. The microcontroller at the left is connected to a memory bank where the data to be displayed is stored, but this microcontroller will perform slowly if it is responsible for both fetching and displaying messages on the LED array hence the need for the second microcontroller.

From the Figure 2, it can be observed that there are eight direct connections (pins 32 to 39 connected respectively to pins 8 to 1) between the microcontrollers which represent a byte of data sent bit by bit from the first to the second microcontroller. The connection between pin 27 and pin 15 of the microcontrollers serves as a monitor to control when data should be sent from the first to the second microcontroller.

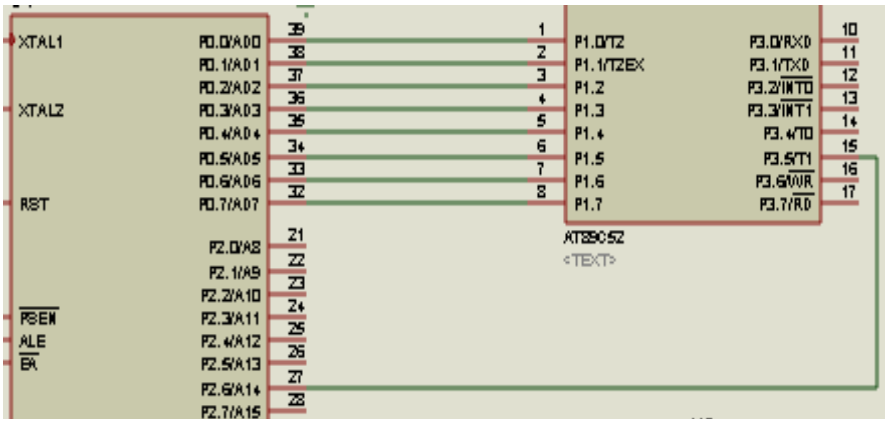

Figure 2. Connection of two AT89C52 Microcontrollers to increase speed

Also, ATMEL 24C01 EEPROM is connected to the AT89C52 microcontroller in order that, when data is received from the GSM modem to the microcontroller, it keeps it the EEPROM (electrically erasable programmable read only memory) until when it is needed. The connection between the microcontroller and the EEPROM is shown in Figure 3.

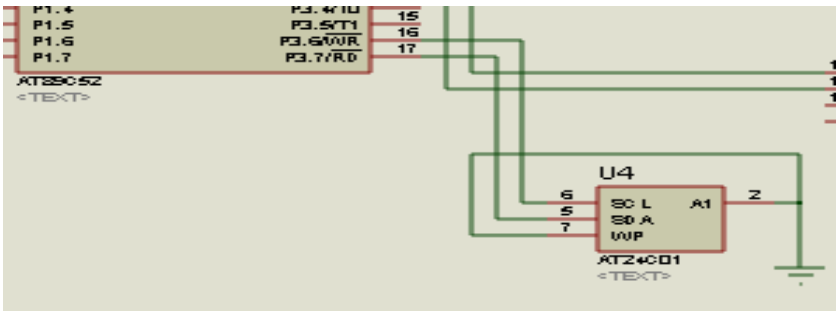

Figure 3. Connection between EEPROM and Microcontroller

A colorless LED that emits red color type was chosen for this research because it is more obvious and captivating even in the day. An array of LEDs is arranged on a Vero board to form the display board of 7 X 96 array i.e. 7 rows and 96 columns of LEDs.

MAX 232 serves to convert the signals from a DB9 serial port from a GSM MODEM to the signal suitable for an ATMEL AT89C52 microcontroller.

The alarm is used in this work such that when a message has been successfully sent to the system, which is decoded by the GSM modem, the alarm sounds audibly to indicate the reception of a new message. The message is then updated on the notice board. Also, an 11.0592 crystal oscillator is used for this project to generate the required frequency.

In this research work, twelve MM74HC595 shift registers are used to scroll the message across the display board. The display board sequentially displays 5×7 characters that move from left to right. Each shift register displays this character on 7 rows and 8 columns (7×8) and then shifts it to the next shift register making it a total of 7 rows and 96 columns.

The shift register and the LED array display board are interfaced such that when data is received from the microcontroller, it is passed to the shift register through the shift register's data input (pin 14) and then passed to the internal register of the shift register by the shift register's serial clock (pin 11). The data are then output in a parallel format through pins 1, 2, 3, 4, 5, 6, 7 and 15 (1 byte) by activating the latch clock (pin 12) of the shift register. This is demonstrated by the image shown in Figure 4.

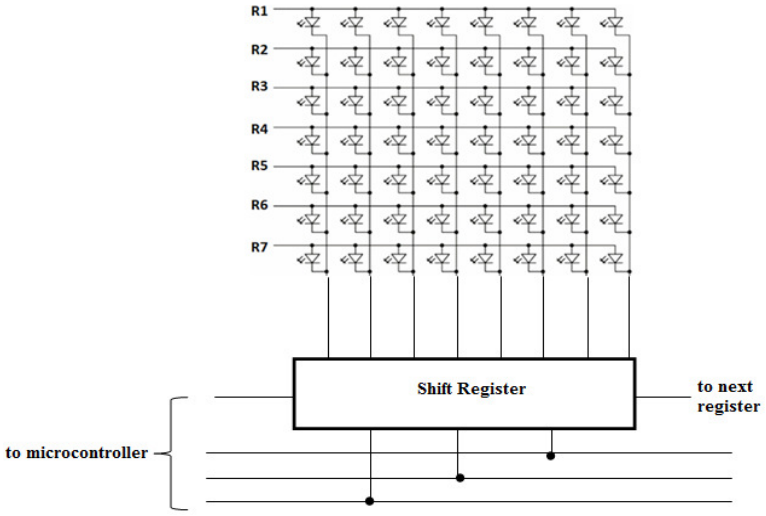

Figure 4. Shift register interface with LED array

AT (Attention) commands used in this research as stated in Table 1:

Table 1. AT commands and respective functions

AT COMMAND	FUNCTION
AT	Attention
ATEO	Echo off
AT + CMGF	Message format
AT + CMGS	Send message
AT + CMGR	Read message
AT + CMGD	Delete message

The entire system is powered by a DC supply, which it sources from an AC power adapter which serves to convert the AC supply to a suitable 12V DC that the system requires. The specification of the power adapter used in this project is as follows:

- Model number: ZH-S1224-2000M
- Input: 100-240V
- Frequency: ~50-60Hz, 0.8A
- Output: 12V, 2.0A

The major components in the power supply unit are transformer, regulator (LM7805 IC), filter capacitor, rectifier and load.

The flow-chat of the whole GSM-based scrolling message display board is shown in Figure 5.

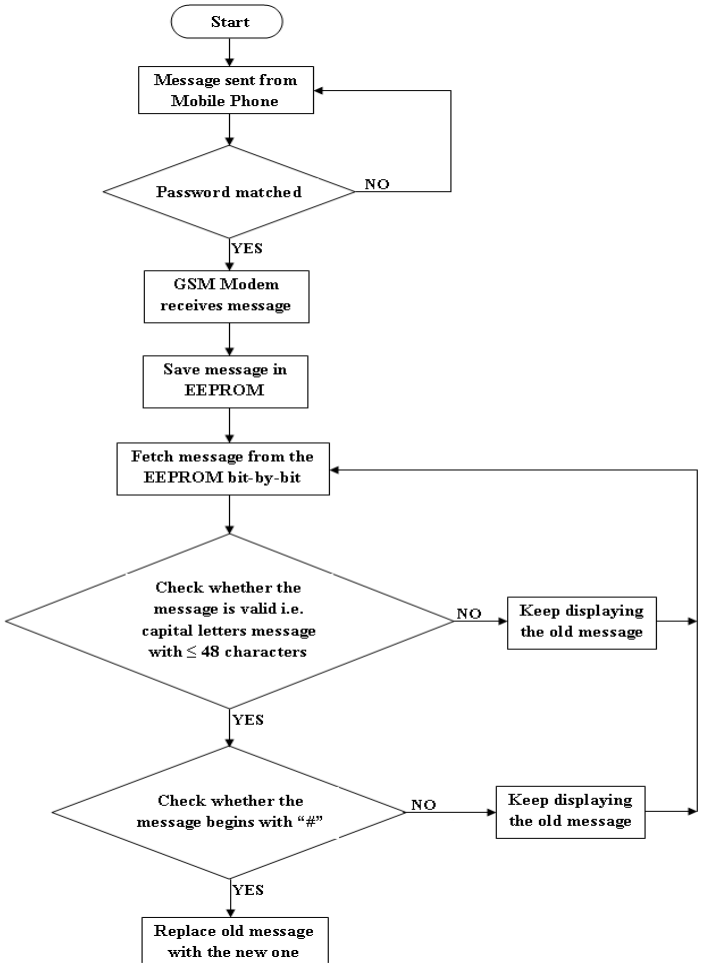

Figure 5. Flow-chat of the whole GSM-based scrolling message display board

3. CONSTRUCTION AND TESTING

The design of the GSM-based scrolling message system was followed by construction of LED array display, control unit and shift register. The array of LEDs were mounted on Vero board to from the display board of 7×96 array i.e. 7 rows and 96 columns of LED as shown in Figure 6.

Figure 6. LED array construction

The control unit, shown in Figure 7, was constructed by mounting microcontrollers, crystal oscillators, electrolytic capacitors, transistors, resistors, among others on the Vero board.

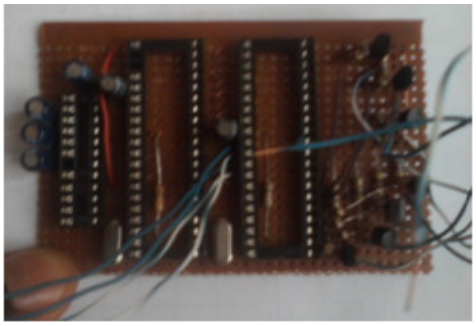

Figure 7. Control Unit

Also, the shift registers were constructed and the mounted on the LED display Vero board as shown in Figure 8. A multimeter was used to test for continuity and to ascertain that there is no bridge connection in the circuit.

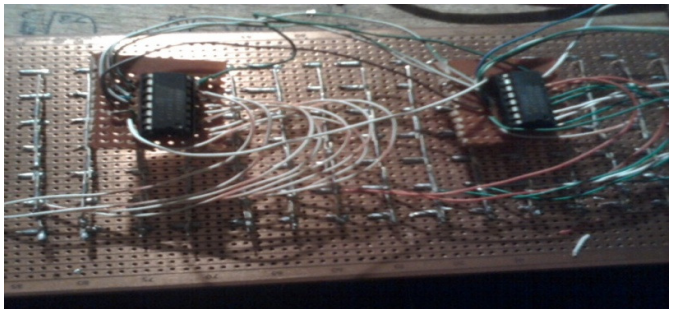

Figure 8. Shift register installed on the LED display

The complete LED display board, after the whole construction, is shown in Figure 9.

Figure 9. Display board

4. IMPLEMENTATION

After all the modules of the project (which includes the power system, the control unit, the GSM modem and the 7×96 matrix LED arrangement) has been constructed and tested independently, each module is connected appropriately to form the complete GSM based display board system as shown in Figure 10.

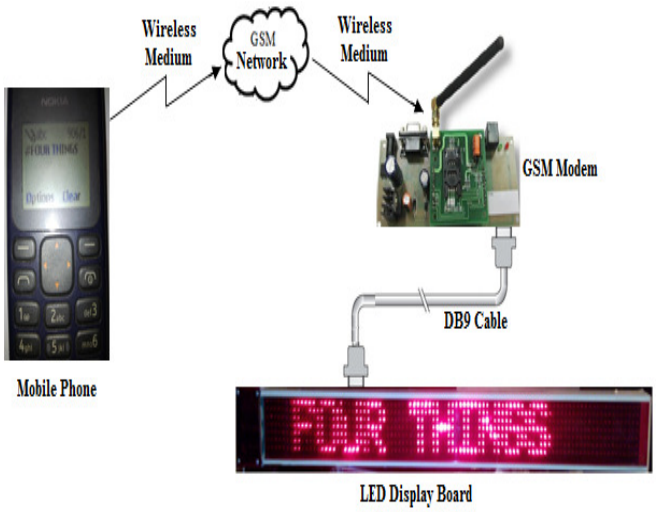

Figure 10. Implementation of a scrolling message display board

The following steps were taken in connecting the GSM MODEM to the display board:

- A functional SIM card was installed into the GSM modem through the GSM modem SIM space.
- The female data bus 9 (DB9) of the GSM MODEM was connected to the male DB9 cable outlet from the display board
- The GSM MODEM was then plugged to the power supply, and a green light came up to indicate that the GSM MODEM is powered ON.
- The GSM MODEM automatically searched for the network of the inserted SIM via its antenna. This was observed from the change in the pattern of the blinking of the light on the GSM MODEM.
- The powered GSM MODEM was connected to the display board and the display board does not yet scroll any message because it was off.
- The 12V AC power adapter was plugged to an AC power source. This passed current to the AC power adapter, but not directly to the display board.

- The display board was then switched ON and default message immediately begins to scroll from left to right on the board.

It should be noted that by default, when the display board is switched on for the very first time, a default message scroll across the board. This message continues to scroll except it is changed by sending a text message to the SIM card in the GSM MODEM which has already been connected to the display board. In order for the message to be appropriately updated on the display board, the message was started with a 'hash' ('#') character in order to distinguish it from unwanted messages and consequently, prevented unwanted messages to be displayed on the board. The message was also in capital letters for the purpose of compatibility with the program burnt in the microcontroller IC. The display board was only able to display a maximum of 48 characters due to the size of the EEPROM which was only 1024 bits or 1 Kbyte.

The following procedures were followed when updating a message on the display board:

- A 48 or less characters long text message was composed, starting with ('#') and capitalized letters. For example "#FOUR THINGS".
- The message was confirmed before being sent into the SIM card in the GSM MODEM
- The message was then sent to the SIM card in the GSM MODEM
- As the message got to the GSM MODEM, audible loud buzz from the alarm system sounds and the new message is immediately updated on the screen of the display board which contains exactly the message sent to the SIM card in the GSM MODEM. This message keeps scrolling on the display board until a new message is received by the MODEM.

5. RESULTS

The successful implementation of this work proved that the GSM based scrolling message display board system worked well as desired. The speed of processing and displaying of new message was faster than those in previous research works done, because of two the AT89C52 used. The display board was only able to display a maximum of 48 characters due to the size of the EEPROM used, which was 1024 bits or 1 Kilobyte.

It is seen that the messages were updated without physical connections (i.e. only via wireless connection) and the problem of manual programming of the Microcontrollers is totally eliminated. This work has also proven to be far more cost-effective.

6. CONCLUSIONS

GSM based notice board circuit was carefully designed and implemented in this research work proved to be efficient and cost-effective. After successful implementation, text messages sent from an authorized mobile phone, via a GSM network, were received by GSM modem and consequently, the message were instantly displayed on the LED display board. The design was implemented via a wireless network which eliminates both the unnecessary wired connections and the task of manual reprogramming of the microcontroller whenever a new message has to be displayed. The design utilized the advantage of microcontrollers to reduce the size of the design and build the entire system in a lot more compact and mobile form. Also, the use of two AT89C52 during the design and implementation has greatly increased the speed of processing and message display. Also, the design has proven to be cost-effective taking the advantages of inexpensive components such as LEDs, Vero board, microcontrollers, power supply and so on.

This research model can be used efficiently for immediate information transfer in cinemas, restaurants, schools, public transport, railways, airports, banks and so on, with less error and maintenance.

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