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Development of Feedback Mechanism for Microcontroller Based SMS Electronic Strolling Message Display Board

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ABSTRACT

Digital electronic display board is fast gaining acceptance and application in different spheres of life which include educational institutions, public utility places and in advertisement due to the problem associated with construction of signposts and manually placement of papers on walls, buildings, and edifies which makes the environment look untidy. This paper presents the design and development of a microcontroller based electronic strolling message display board, which will be used to display messages and information in real-time via SMS. This microcontroller based electronic strolling message display board offers the flexibility to a user to control the message or information displayed without recourse to geographical location of the user, provided there is GSM (Global System for Mobile Communication) mobile network. It therefore eliminates the inconveniences of physically going to the display board to manually input information using a computer system. The paper also incorporates a feedback mechanism from the remote display board to ascertain that the message sent by the user has been displayed. The circuit of the device is designed based on PIC18F4520 microcontroller and C-programming language is used to program the microcontroller.

Keywords: GSM Technology, Feedback mechanism, PIC18F4520 microcontroller, E-notice board, SMS

1. INTRODUCTION

Digital electronic display board is fast gaining acceptance and application in different spheres of life which include educational institutions, public utility places and in advertisement, due to the problem associated with construction of signposts and manual placement of papers on walls, buildings, and edifies, which makes the environment untidy. Microcontrollers which are usually embedded into devices are widely used to control many types of equipment, ranging from consumer to specialized devices, in a cheap and effective manner. Generally, there are lots of microcontrollers manufactured in order to fulfill the needs of control. One of the most popular is PIC microcontrollers. The PIC microcontroller is relatively easy to work with, yet they have most of the features essential for a complete control system.

In this work, PIC18F4520 is used as the controller. This microcontroller offers various functions that are suitable to designing of electronic strolling message display boards. It is very flexible because it can be expanded to unlimited numbers of ports. It makes design work easier.

The method used in the design of this project is modular approach in which the entire system is broken into small sub-circuits. These sub-circuits are designed separately and coupled together in the order of operational precedence.

The project circuit system is divided into eight (9) modules. The modules are:

- Mobile phone Module
- GSM Modem Module
- Serial Port Module
- Power Supply Module
- MAX232 Module
- EEPROM memory unit
- The Microcontroller Module
- LED Driver Circuit Module
- Dot Matrix Display Module

2. RELATED WORK

There are many works that have been carried out on digital electronic message display board using GSM/SMS technologies for application in different spheres of life. Nivetha et al [1] designed and implemented a SMS based wireless notice board with monitoring system. This project is designed using ARM-LPC2148 which was interfaced with graphical display. Its multiple displays are implemented with a decoder which is used to select a particular display while the corresponding message is sent through the ARM microcontroller by using GSM technology. They suggested the use of dot matrix in their future work, but the present work has no feedback mechanism to ascertain that the message has been displayed successfully.

Darshil et al [2] designed and constructed a SMS driven automatic electronic display using PIC16F874A, graphical LCD and LED. A GSM module was used in the design as the main carrier of the message to the display board. However, the extent of reliability and authenticity of the wireless communication between the controller and mobile unit via the GSM module was not considered. Furthermore Kumar et al [3] also developed a SMS based wireless E-notice board using AT98S52 microcontroller, LCD display and MAX232 in solving the challenge in [2]. However, the developed system has no feedback mechanism and good message visibility.

Ketkar et al [4] designed and implemented a GSM mobile phone based LED scrolling message display system. The system hardware consists of an AT89C51 controller which serves as the heart of the system, a wireless GSM MODEM, LED display, MAX232, buzzer and alarm system. The inclusion of the buzzer and alarm units into the design limits its area of application and makes the system unduly complex with no feedback mechanism.

In addition, Ukpa et al [5] developed a SMS Controlled Digital Display System using multiple microcontrollers namely PIC16F877 and PIC16F628 and a SAGEM MYX5-2 phone. In the design the system must be placed in region with high signal strength else the message delivery will not be achieved. Furthermore the system has shortcoming in number of characters that can be displayed on its display unit, as it accepts maximum of seven characters at once. Also, the system does not have any means of feedback mechanism to ascertain the delivery of the message.

In lieu of the above, this work presents the design and development of a microcontroller based electronic strolling message display board leveraging on GSM/SMS technology and feedback mechanism to ascertain that the message sent by the user has been displayed.

3. METHODOLOGY

The aim of this project is to design a microcontroller based electronic scrolling message display board by interfacing a microcontroller and a dot matrix display board with a GSM Modem that can send and receive text messages through the use of SMS from a mobile phone. To achieve this goal, the objectives considered are:

1. To develop and design a microcontroller based electronic scrolling display board that can be used to display messages using a mobile phone.
2. To implement objective 1 above with feedback mechanism
3. To evaluate the system based on the simulated model of objective 2.

The design considerations include:
- Power functionality
- Dual user functionality
- Cost effectiveness in choosing the components

- Packaging
- Easy testing and troubleshooting
- Security
- Size of memory
- Feedback mechanism

4. DESIGN AND IMPLEMENTATION

In the development of the system two things were taken into consideration: The hardware and software modules design.

4.1 Hardware Design
The basic operation of the system is to send information from transmitter to receiver. The system has 50Hz display refresh frequency, 12V of secondary voltage device, 220V of primary voltage source. The message to be displayed is sent through SMS from an authorized transmitter, the microcontroller receives the SMS, validates the sending Mobile Identification Number (MIN) and stores the message that has been displayed in an EEPROM before it displays the received information. The electronics displays which are being used on previous works are programmable displays which needs to be reprogrammed each time it should display new messages, which makes it inefficient for immediate information transfer, thus lose its importance.

The microcontroller based electronic message strolling display board can be used as an add-on device to these display boards and make it fully wireless. The display board would program itself with the help of the incoming SMS of proper validation, which proves to be helpful for immediate information transfer. In the microcontroller based electronic strolling message display board, mobile phone is used as transmitter which would transmit SMS through GSM Modem to LED display panel. GSM Modem, MAX232, Power Supply, LED Driver Circuits, LED Dot-matrix display are used in this work. When the user wants to display or update the notice board, the user has to send the message in his/her mobile, defining the messages and then the password of the system, to the SIM which is inserted in the display system MODEM using the SIM's number. The MODEM that is connected to the display system will receive the SMS. The microcontroller is programmed in such a way that when the modem receives any message, it will read the message from the serial port.

The nine (9) components of the hardware module are:

- Mobile phone Module
- GSM Modem Module
- Serial Port Module
- Power Supply Module
- MAX232 Module
- EEPROM memory unit
- The Microcontroller Module
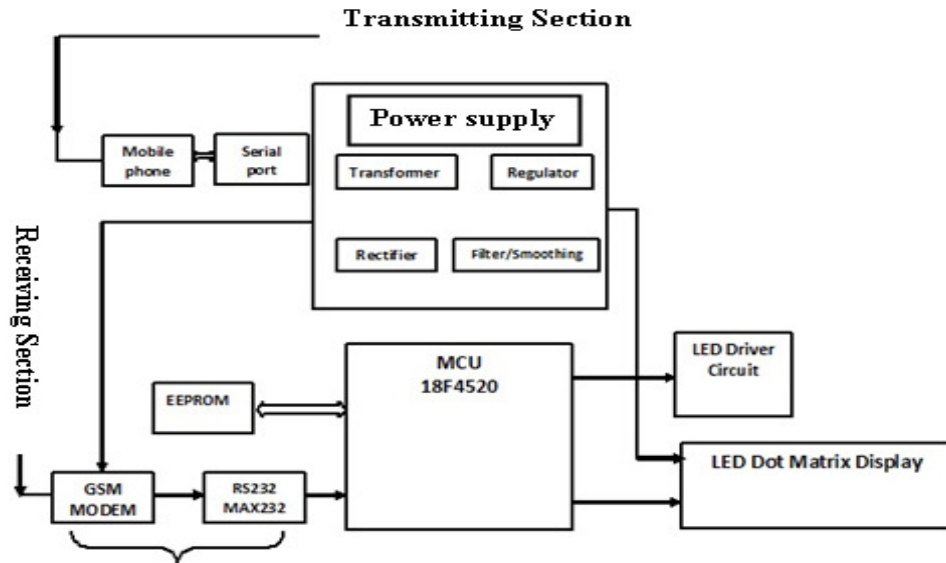- LED Driver Circuit Module
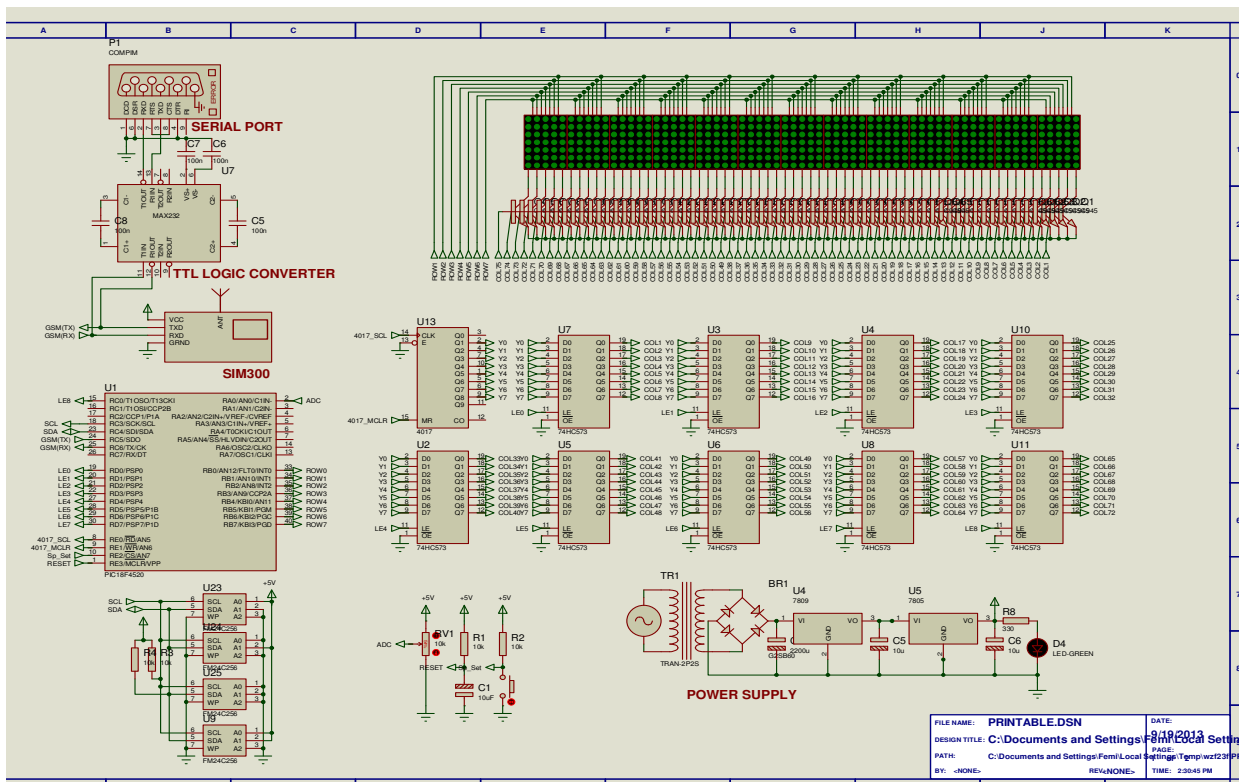- Dot Matrix Display Module

Figure 1: **Block Diagram of the Design**

Figure 2: **Circuit Diagram of the Design**

4.1.1 GSM Mobile Phone Module

The GSM mobile phone is used in this project as the source of messages that should be displayed. It sends the message to the GSM modem that is a wireless technology network that sends and receives data through radio waves, which is compatible with mobile wireless devices connectivity network using SIM Card.

4.1.2 GSM Modem Module

The GSM modem as shown in Figure 3 is a specialized device which accepts a SIM Card, and operates over a subscription to mobile operator, like a mobile phone. The functions of the GSM modem is to provide communication over the mobile network to the microcontroller, send SMS messages, monitor the signal strength, read/write and search the phone book entries.

Figure 3: GSM/GPRS SIM300 Modem

4.1.3 Serial Port Module

The serial port module consist of a female DB9 connector which is used to connect PC to microcontroller using the RS232 cable and is based on RS232 standard, that can be classified as either Data Technical Equipment (DTE) or Data Communication Equipment (DCE), which defines the devices' wire configurations as sending and receiving signal.

In general and according to the standard, terminal and computers have male connectors with DTE pin configurations while modems have female connectors with DCE pin configurations. The serial RS232 connector pin layout is shown in Figure 4.
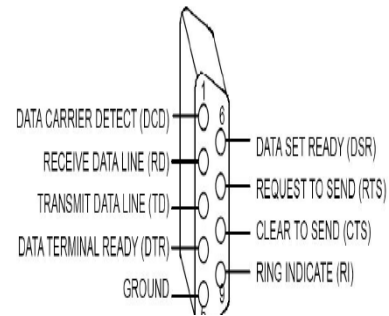

Figure 4: Serial Port RS232

4.1.4 Power Supply Module

The power supply module consists of a transformer, regulator, rectifier and filter/smoothers. The power supply is an important part of the circuit and it provides the required supply to different blocks of the circuit from 230VAC wall socket. The power supply block diagram is shown below in Figure 5.
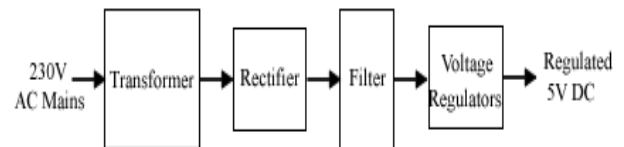

Figure 5: Block Diagram of Power Supply

4.1.5 MAX232 Module

The MAX232 is an integrated circuit, first created by Maxim integrated products, that converts signals from an RS232 serial port to signals suitable for use in Transistor Transmitter Logic (TTL) compatible digital logic circuits. The MAX232 is a dual function driver/receiver device and typically converts the RX, TX, CTS and RTS signals to TTL signals. The drivers provide RS232 voltage level outputs (approx, ±7.5v) from a single +5v supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS232 in devices that otherwise do not need any voltages outside the 0v to +5v range, as in our designed power supply module. These receivers have a typical threshold of 1.3v, and a typical hysteresis of 0.5v. The MAX232 pin configuration and its circuit diagram is shown below in Figure 6 [6].
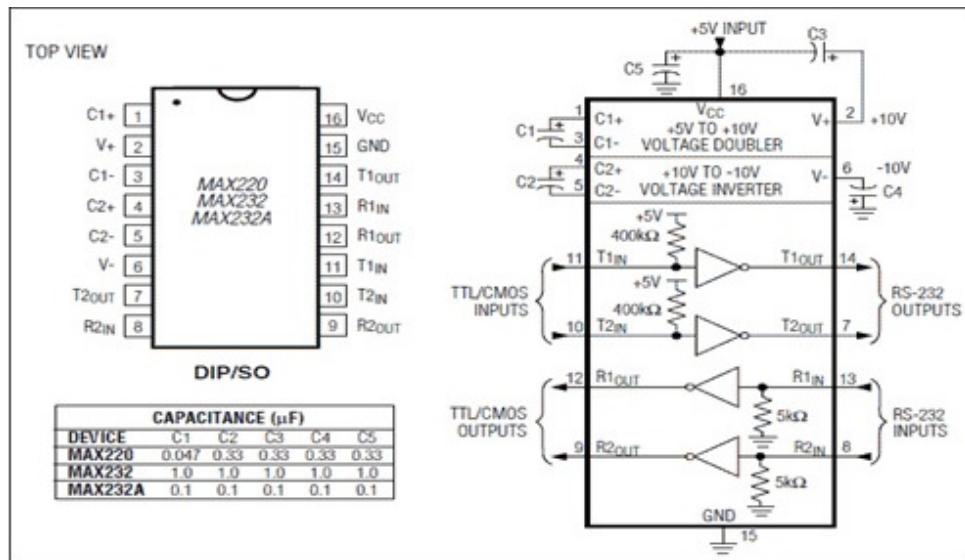
.

Figure 6: MAX232 Pin Diagram and its Circuit Schematic[6]

4.1.6 EEPROM Memory Module

These memory devices are used to store the data for off-line process. The PIC18F4520 stores and retrieves data organized as words of 8 bits from the electrically erasable and programmable read only memory (EEPROM) in serial mode.

The device is optimized for use in many industrial and commercial applications where low power and low voltage operation are essential. EEPROM communicates with the microcontroller using I^2C communication mode as shown in Figure 7; (it contains one data pin and clock pin) which are connected as slave to the microcontroller. The main application of memory in this system is to store the message being sent by user of mobile device when the microcontroller is either writing to or reading from memory.
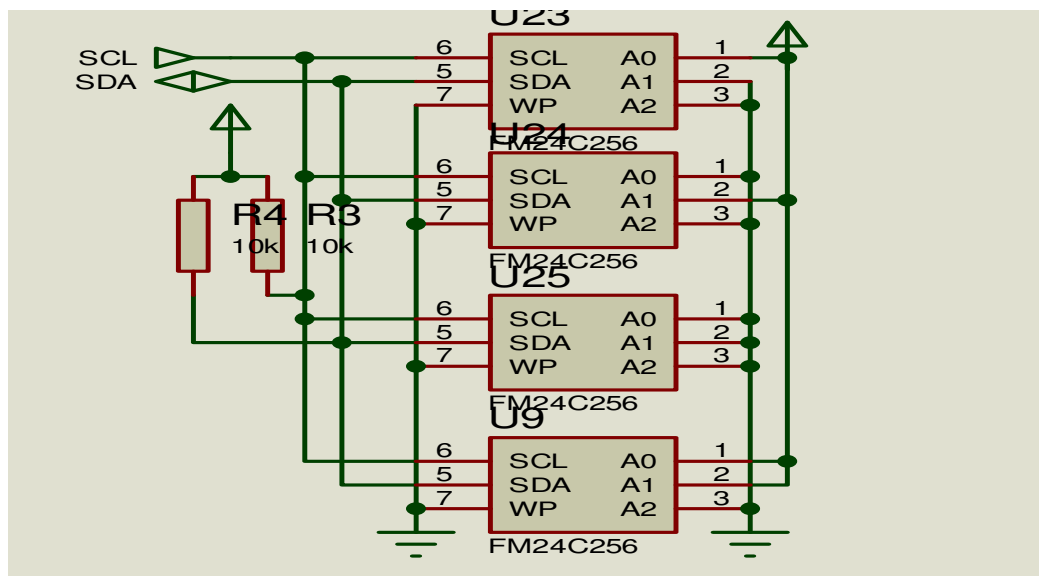

Figure 7: **EEEPROM Memory Unit Circuit Diagram**

4.1.7 Microcontroller Module

The function of the microcontroller is regarded as the most important. Its responsibilities include reading the message from the GSM Modem and displaying it on dot matrix display. Reading of message from the SIM card inserted into the modem is done by sending the appropriate AT command to the modem. PIC18F4520 is a family of Harvard architecture microcontrollers made by Microchip Technology derived from the PIC1640 originally developed by S micro electronics division. Its pin configuration is shown in Figure 8.. ICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (re-programming with flash memory) capabilities [7].

The PIC architectures have these advantages:

- Small instruction set to learn RISC architecture
- Built -in oscillator with selectable speeds
- Easy entry level, in-circuit programming plus in-circuit debugging PIC kit units
- Inexpensive microcontrollers.
- Wide range of interfaces including I^{2}C, SPI, USB, USART, A/D converter, programmable comparators, PWM, LIN, LAN, PSP, and Ethernet.
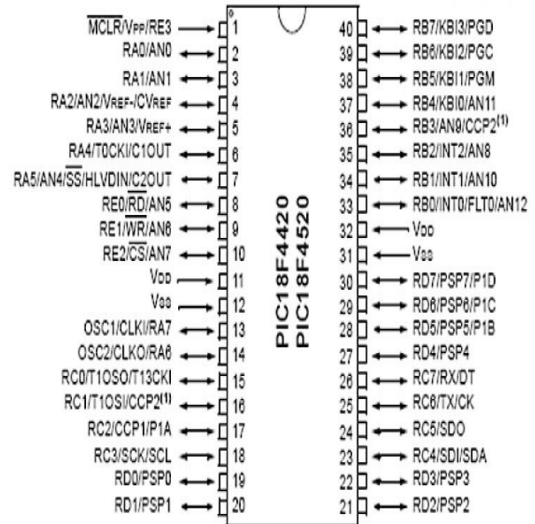

Figure 8: Pin Configuration of PIC18F4520 Microcontroller

4.1.8 LED Driver Circuit Module

The LED driver circuit module was designed using 74HCT573 octal D-type transparent 3-state latch [8], CD4017 decade counter, transistor and resistor as shown below in Figure 9.
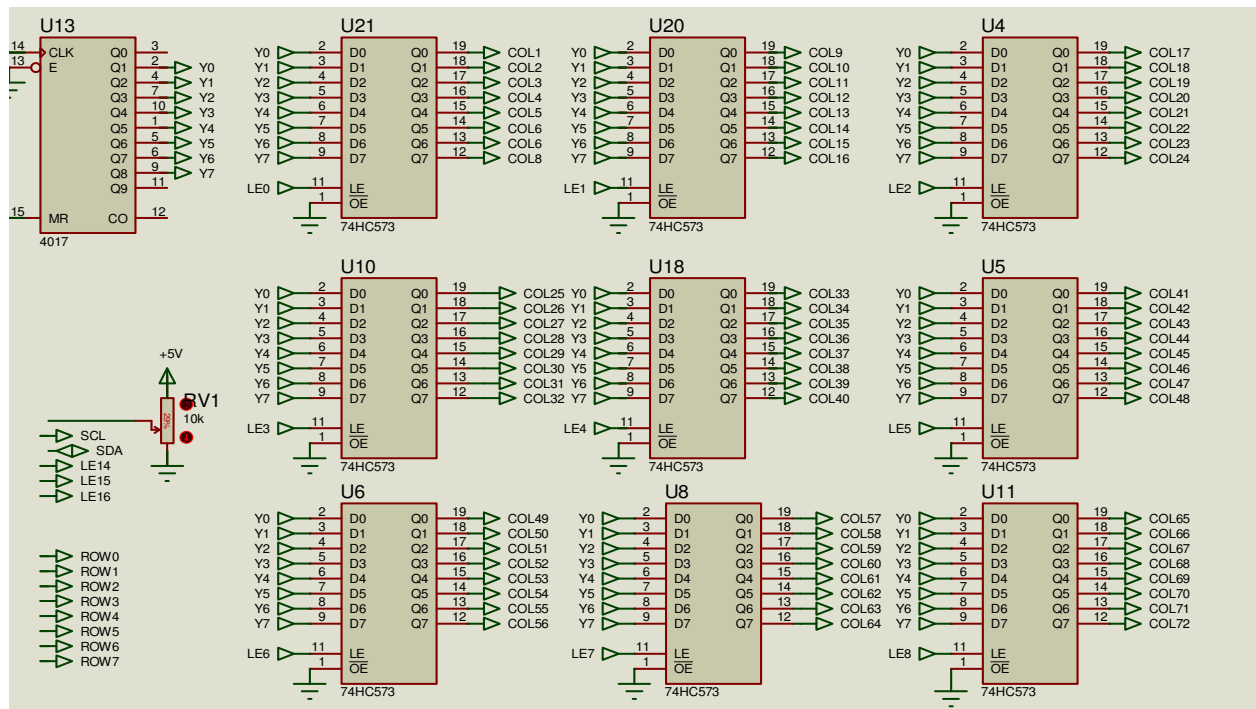

Figure 9: Diagram of the LED Driver Circuit

4.1.9 Dot Matrix Display Module

Dot matrix module was designed using LEDs (light emitting Diodes) which is widely used as output module due to its flexibilities, performance and cost. 5x7 dot matrix is chosen in this project as shown in Figure 10.

This is because there are 35 LEDs in a single dot matrix, and transistors are used to drive the dot matrix. It is consist of 10 blocks of 5x7 dot Matrix.
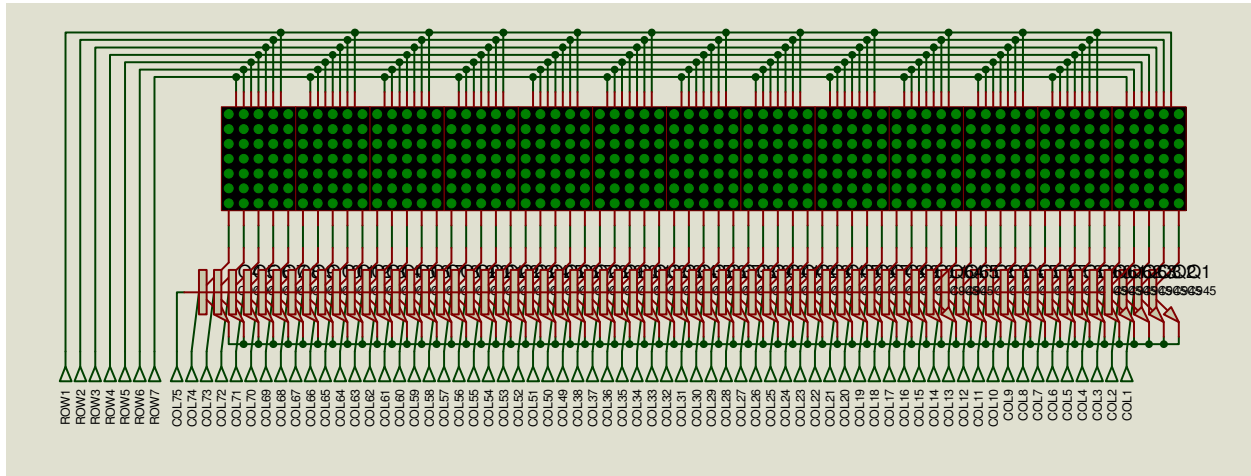

Figure 10: 5x7 LED Dot Matrix Display Unit Circuit Diagram

4.2 Software Design

The microcontroller is programmed to carry out its functional tasks as illustrated in the flow chart diagram in Figure 11, and compiled with C-programming language compiler (MikroC)

and the HEX file is generated and 'burnt' into the microcontroller. The program been written into the microcontroller and the hardware design make up the display.
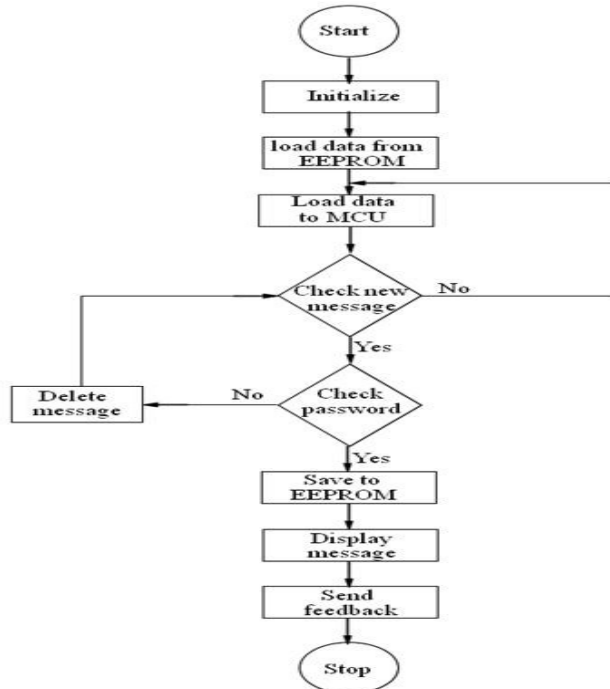

Figure 11: Flowchart Diagram

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5. Evaluation and Testing of Designed Model

The following tests were carried out and results obtained respectively in implementing the system, which resulted in the final packaged model (sub-section 5.5)

5.1 Testing of Power Supply Circuit

The power supply circuit was tested using a digital multimeter. The output voltage obtained after rectification, filtering and regulation is 4.98V as displayed on Figure 12.

Figure 12: Picture of Power Supply Value

5.2 Testing of LED Dot-Matrix Display
Testing of the LED dot-matrix display was done immediately after the voltage value of the power circuit has been tested in which 4.98V was obtained and it was used in powering the LED dot-matrix display board, as shown in Figure 13.

Figure 13: Picture of the Dot-matrix Display Board

5.3 Testing of GSM modem and the Serial Port
I.   Hercules SETUP utility, which is similar to Microsoft HyperTerminal, was used to send AT *(ATtention)* command through serial port terminal for the RS232 standard in order to query the mobile phone or GSM modem and know whether it is waiting for a PIN (Personal Identification Number, i.e. password) or not. By typing "AT" in the main window, a response "OK" would be returned from

the mobile phone or GSM modem if there was connection. By typing "AT+CPIN?" in the main window, If the response is "+CPIN: READY", it means the SIM card does not require a PIN and it is ready for use. The above response means that the mobile phone or GSM modem is working properly.
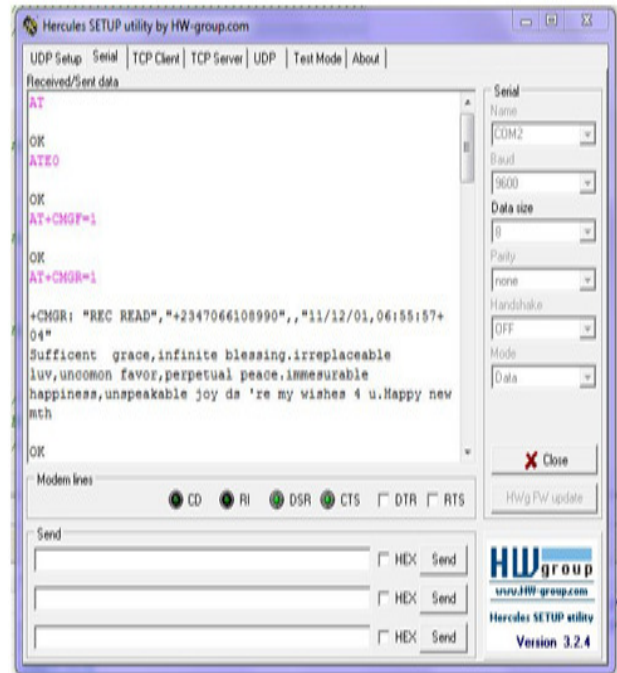
II.

Figure 14: Screen shot of the Hercules setup utility of the Serial port to query the GSM modem

5.4 Discussion of Result
An SMS was sent to the GSM modem of the microcontroller based electronic scrolling message display board using a mobile phone with the authenticated password. This SMS was received and displayed on the electronic board. The microcontroller based electronic scrolling message display board was tested with different messages from different GSM phones and was successfully received and displayed on the electronic board. Figure 16 shows the feedback SMS that was received from the GSM modem, that the information is on display on the electronic board; "HI YOUR PASSWORD WAS CORRECT: YOUR MESSAGE IS ON DISPLAY".
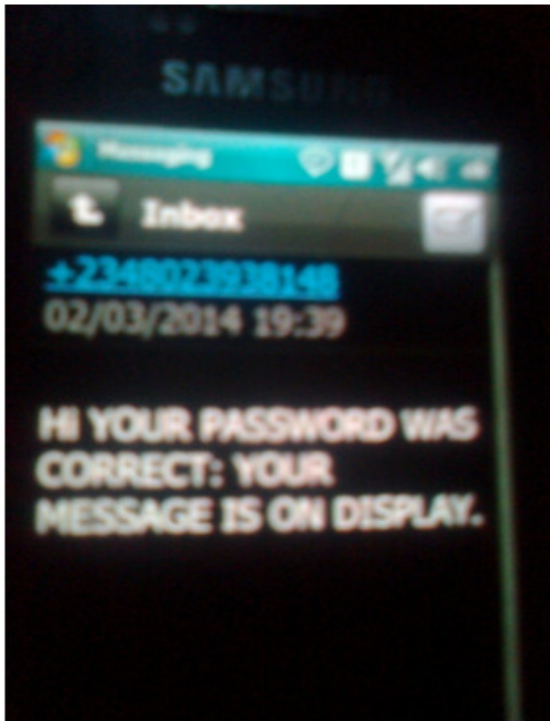
Figure 15: Feedback SMS to User's Phone Confirming Display of Message

5.5 Final Packaging

After successful testing and result, the system is coupled and put in a metal casing as shown on Figure 17.
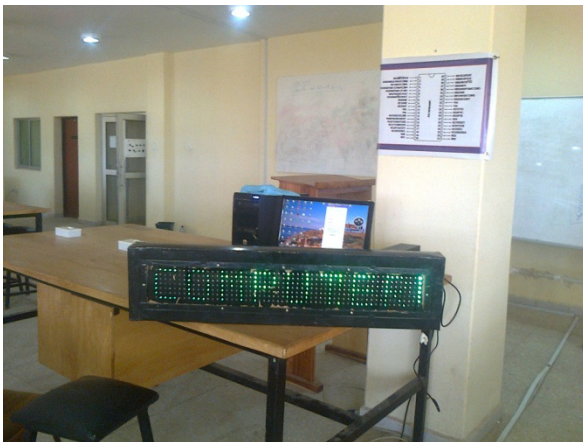

Figure 16: **Picture of Final Packaged Model**

6. CONCLUSION AND FUTURE WORK

In this paper, the design and development of a microcontroller based electronic scrolling message display board is presented. The display board accepts SMS from the GSM modem sent by the mobile phone, stores and validates it, and then displays the message on the LED with a feedback SMS sent to the user's phone confirming display of message. This work could be improved on by increasing the number of characters the Dot-matrix can display at a time. As microcontrollers gets more advanced the number of words the microcontroller can store could be increased by exploring a microcontroller with larger memory size than the PIC18F4520 used in this project. Improvement could also be made to the firmware which could result in a more reliable and stable system.

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Author's Brief

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