



## DEVELOPMENT OF MICROCONTROLLER BASED MULTIPURPOSE BILLBOARD USING GSM TECHNOLOGY

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**Abstract:** Technology has generally impinged the advertisement sector and the use of electronic medium in communication system is on geometric rise due to its flexibility, attractiveness, speed and efficiency. Various methods of information dissemination have been adopted from the use of posters, traditional billboards to electronic billboards. This research presents the development of a microcontroller based multipurpose billboard with a short message service (SMS) and an audio alert sound to enable ease and comfort of the administrator who determines the content of the billboard from any location. The input can be from a mobile phone or a web-based SMS application, provided the source is linked to a service provider. The billboard basically contains a microcontroller unit, a Subscriber Identity Module (SIM) modem and a matrix of Light Emitting Diodes (LEDs). The input to the display comprises a SIM900L Global System for Mobile communication (GSM) modem that take care of the SMS input. The text will be received by the SIM modem and will be transferred to the microcontroller which decodes the message using a set of rules. The decoded message will automatically switch ON and OFF appropriate LEDs in order to display the SMS received as a scrolling text on the screen of the billboard. Also the billboard has a sound buzzer which enables it to alert the target audience of a new message before it will be displayed as a scrolling text, the design was implemented and the GSM modem can accept as many SMS as the brain of the EEPROM.

**Keywords:** LED: Light Emitting Diodes, SMS: Short Message Service, SIM: Subscriber Identity Module, GSM: Global System for Mobile communication, EEPROM: Electrically Erasable Programmable Read Only

### 1.0 INTRODUCTION

Digital and information technology has played a vital role in the development and growth of every sector and as well immensely contributed /help to enhance the security of life and property by means of vast digital equipment in all vital places. Digital billboards have now taken the center stage in the world of advertisements and promotions of businesses, campaigns, promotions, sensitizing and educating people both in rural and urban area, [10]. Wireless communication has become more popular in the digital world today. Man wants to make virtually everything automated. This remote control of appliances is possible through an Embedded Systems. An embedded system is a combination of hardware and software to perform a specific function [19]. The value of timely information is quite enormous Notice Board is a primary device in any institution, organization or public utility places like bus stations, railway stations and parks to display any text information, [3]. Commercial advertising trend has experienced a great transformation in the past decade. From the static billboard and the mechanical advertising board, this industry has taken another step into the digital advertising [5]. These digital outdoor advertising has turned the old-fashioned outdoor advertising industry into a fast growing industry. These technologies however, are consuming a great amount of energy due to the requirement of auxiliary components such as computer, wireless, communication unit and cooling equipment. Also, proliferation of the digital advertising will incur recyclability issues. [17].

## 1.2 Statement of the Problem

Information is a key to success of every individual business, government organization, education, health sector, security of lives and many more. The cost information dissemination in the public and private enterprises today via radio and tv set today is highly exorbitant and information passes from this media houses today does not really hit the ground particularly in rural area where the network and satellite could not reach due to topographical and geographical barrier. The use of digital billboard by schools, politicians, government, health educators to advocate their message to people particularly people in rural area goes a widespread at low cost, the images and messages display, with audio sound from the board cut attention of audiences to actually listen to information passing to them. The issue of the physical challenge people to get the information been disseminated at point in time is adequately considered easy with this research work, because of its feature of displaying message and as well sound audio message simultaneously.

## 2.0 LITERATURE REVIEW

### 2.1 A Billboard

Billboards are large posters – a medium that people have used to advertise products and services since the time of the ancient Egyptians. And make no mistake: Billboards are a form of advertising – versus public relations or promotion – because you must pay for the message on display, [1]. “A billboard or bulletin is a large outdoor advertising space that is meant to target and attract the attention of pedestrians and motorists in the surrounding area,” says Digital Media. Today’s billboards attract attention via several formats: So-called “static” billboards bear the greatest resemblance to their ancient ancestors, with printed vinyl stretched over a base of wood or aluminum, [18]. *Billboard extensions add a three-dimensional element to an otherwise flattened image, with an add-on piece or cutout designed to enhance the billboard’s visibility.* Digital billboards provide even greater creative freedom. They “are essentially large computer screens that can be programmed to display messages in a range of innovative ways,” B Media Group says. “Things can be as simple as switching between images periodically so that multiple advertisers can cut costs by sharing a single billboard, or they can get more complex by utilizing animation and real-time updates [1].

### 2.2 Types of billboard

There are different kinds of billboards, below are some of them according to [16]:

1. **Poster billboards:** They are utilized for outdoor advertising. They are impressed on 8 to 30 sheets of heavy paper, according to the size. It could last for about a month, depending on weather conditions, after which it is best to remove them.
2. **Painted boards:** It is known as painted bulletins, are covered with an outdoor paint which is resistant to weather. Some outdoor paints are specially made to withstand fading.
3. **Vinyl boards:** It is one of the latest methods of billboards advertising. They have attractive color, durable life and really fine graphics and artwork. They have a brighter appearance, and look much better than conventional billboards. They are usually sprayed with an UV protective coat and can last for years.
4. **LED billboards:** are from the newer lot of outdoor advertising tools. The bright backlight and use of different colors grab instant attention of the onlookers. The adverts that are displayed are of high quality as, they are generally computer prints, with the addition of animation and other visual effects, the ads are becoming more interactive.
5. **Scrolling advert:** Is also a good way of putting the world across. If the advertiser pays for the entire board, he or she has the advantage of displaying about 10-30 ads on the same billboards [7]

### 2.3 Strengths of Billboard

Even though billboards are the most basic outdoor media used in reaching potential and actual consumers outside their homes. It has some advantages and disadvantages. Below are some of the benefits;

1. Messages on billboards can be viewed and reviewed as many times as possible. [14] Postulates that this provide high frequency of audience exposure to the message which is to make an impression on the audience.
2. The billboard is a cost effective medium. It cost less to reach a greater number of people over a period of time than it would cost in other media. Just like other outdoor media, billboards offer the lowest cost per exposure of any major advertising medium [4].
3. They are used to target consumers at odd times or during “unrelaxed” periods i.e. while they are on their way. This is different from other media which messages are consumed while the audiences are relatively relaxed.

4. Billboards are often large and intimidating, especially when placed in strategic places in middle of cities. This ensures that the message makes a quick but persuasive impression in the minds of the audience. [9]

5. It ensures customized placement: you can place your billboard advertisement wherever you feel it will have impact the most.

#### **2.4 Review of Related Works**

Advertising began outdoors. The earliest outdoor messages were probably inscriptions on Egyptians monuments. When Johannes Gutenberg invented the movable type printing in 1450, modern advertising was introduced through the handbill,[6] .In 1796 the first illustrated poster was made when the lithographic process was perfected. During the early 20th century the growing use of automobiles quickly led to companies making use of billboard advertising to publicize a wide range of products and services, [11]. The effectiveness of these advertisements led to creating an entirely new branch of advertising industry as clients demanded newer and more attractive ads that would catch the eye. Digital display were launched in the early noughties and have continue to grow rapidly ever since. In 2003, digital displays made up only two percent of the outdoor advertising market and ever since then it has taken over the advertisement sector. [13]. [3] Also developed a mobile system for information dissemination via GSM- technologies microcontroller in Technologies”, their design is energy saving and time saving, GSM takes full control of the system and it is environmental friendly. However, their research lacks security and it's text are very hard to change. [17] Works on developing a low-cost and low-power consumption flipping advertisement board, the design of the electrical circuit and the controller of the advertisement board was presented. A microcontroller, a Darlington Pair driver and a unipolar stepper motor were used to operate the electrical flipping advertisement board. The design's hardware was tested and it is capable of displaying multiple advertisements in a panel but the information stored on it cannot be changed easily and this might delay its operations a time. [2] Developed a displayed elements in an embedded system usually consume the major portion of the total power required to run the whole system. When large amount of display element are used, power dissipation issue becomes more acute. An FPGA based embedded system implementing scanning technique for low power message display is proposed in this paper. The FPGA based intelligent controller scan all the display element continuously at a certain speed to ensure only one display unit is "NO" and others are "OFF" at a given time but human eye cannot detect it due to speedy scanning of the controller. [8] Design a solar energy billboard that can stand typhoon, the display screen or display board will be rolled up automatically when the wind becomes strong. The display screen or display board is controlled by electric motor powered by solar energy, there is a three cups style wind sensor that detect wind speed in it. The detected signal is sent to single chip microcomputer MSP430 SCM made by the national semiconductor, when the detected wind speed exceeds the settings threshold, the microcontroller will send signal to motor to roll up the display screen, so there will be hardly any wind pressure on the billboard, so that it can stand firmly in whatever strong wind without being destroyed. The working power of these control system is supplied by solar energy collecting system mounted under the billboards. The billboard is both simple and elegant, it's money-saving but it affect the natural landscape of the city, [15].

### **3.0 METHODOLOGY**

#### **3.1 System Design steps**

The design steps involved in the development of the system was such that the system aimed to operate off a 12volts power supply system. The system is a digital Billboard system with at least one programmable integrated circuit, in this case, PIC microcontroller will be used which is programmed using MicroC Pro and EasyPIC6. The microcontroller is programmed to receive message from the GSM module or computer system once it receive message or instructions an activate the alarm unit inculcated in the complete system sound an audio alert and predefined messages or texts display through LCD. The program will be such that when the message is send, the system allow for 60 seconds for each line to be read and the same time activate the buzzer to sound the text displayed.

This digital billboard System consists of mechanical, electrical, and electronic components, which are integrated to complete the system design, as follows:

- |                       |                           |                             |                                |
|-----------------------|---------------------------|-----------------------------|--------------------------------|
| i. Microcontroller    | ii. GSM module            | iii. Crystal Oscillator     | iv. Comparator (LM358)         |
| v. Transistor (BC547) | vi. Light Emitting Diodes | vii. Liquid Crystal Display |                                |
| viii. Resistors       | ix. Capacitors            | x. Battery (12V)            | xi. Voltage Regulator (LM7805) |
| xii. Buzzer           | xiii. Keypad              |                             |                                |

#### **3.2 Hardware Implementation of the Design**

Hardware of the system consists of the PIC18F2455 microcontroller, GSM module, and GSM phone, Buzzer, and other components which its design was carried out on the manufactured breadboard mainly surface mounted components, in system programmer and relays to control the appliances. The input unit comprises of an integrated circuit module such as gsm module or computer system which is placed in the secured room closet to the billboard. This integrated circuit is powered using 5 volts dc power source. A message is sent to the

microcontroller each time the message or text is send, the necessary actions are taken based on the program written to the microcontroller. The PIC will be thus programmed. The power source was obtained from a 12volt battery. The microcontroller and other digital integrated circuit use 5 volts for their operation and as such, a voltage regulator will be used to regulate the 12 volts power supply to 5 volts for use by the circuit. The block diagram of the design is shown in Figure 3.1 below:

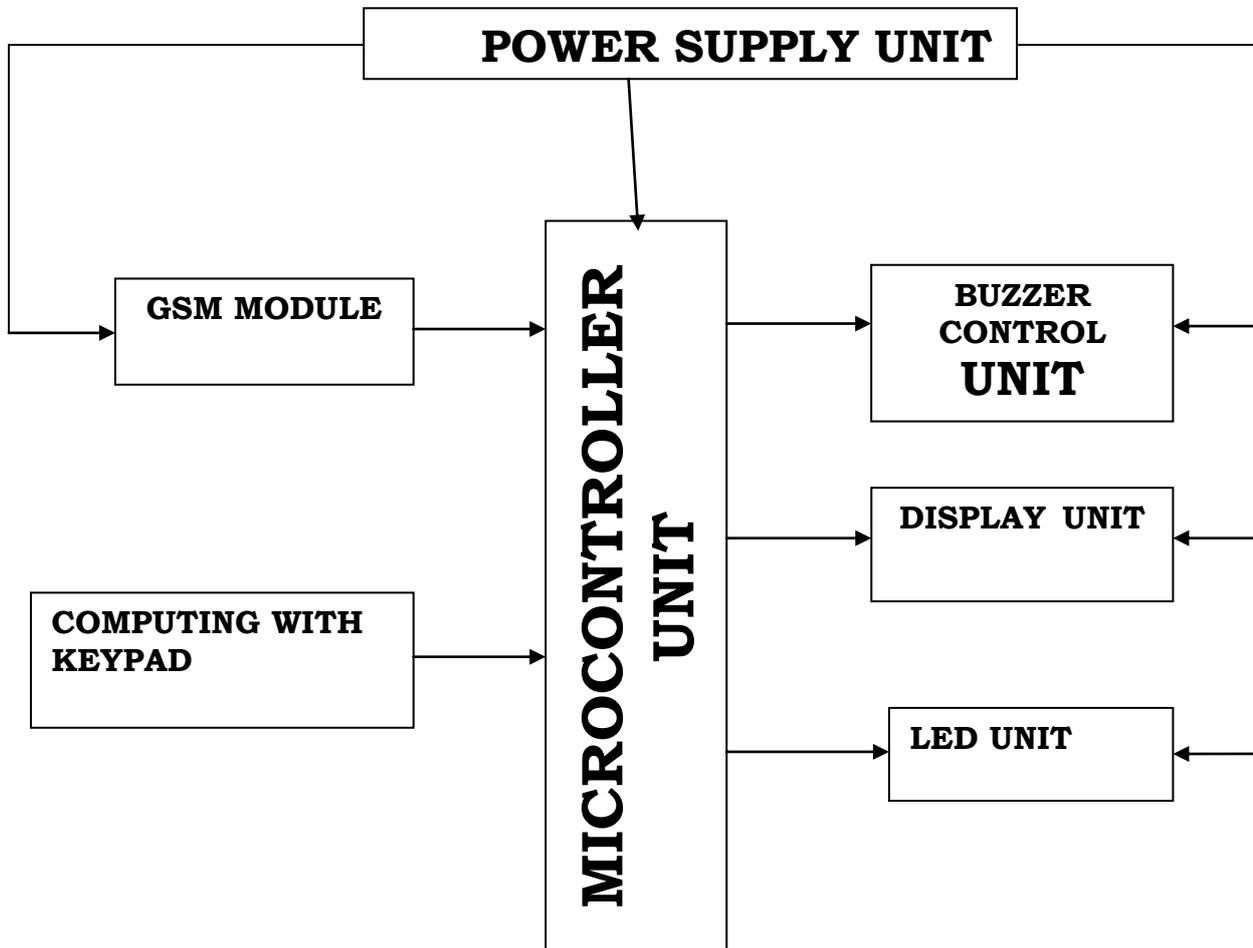


Figure 3.1: Showing the Block Diagram of the digital billboard

The block diagram shows how the following units were integrated;

- (i) GSM Module unit
- (ii) Microcontroller unit
- (iii) Alarm unit
- (iv) Display Unit

### 3.2.1 The Design of the Power Supply Unit

A stable source of voltage (between 2.0volts to 6.0volts) was used to drive the PIC18F2455 as specified by the manufacturer. This was achieved through the use of an LM7805 voltage regulator which gives an output voltage of +5volts as shown in Figure 3.2. This is made of rectifier diodes configured in a bridge arrangement as shown in below Figure3.2. This is necessary because integrated circuit as well as microcontrollers can only run on D.C voltage.

**U1 (7805)** LM78xx voltage regulator specifications from datasheet:

- Input voltage range for 7805:  $V_{in} = 7.5v \sim 20v$
- Output voltage range for 7805:  $V_{out} = 4.75v \sim 5.25v$

The 12v battery is enough to supply the minimum input voltage for the system.  $C_3$  is transient capacitor and its rating as stipulated in the 78xx voltage regulator's datasheet as 0.1uf, Nwabueze, (2009). These capacitors help

for smoothening of the output from the voltage regulators.

Current limiting resistor calculation:

$$R_4 = \frac{V_{out} - V_D}{I_D} \dots \dots \dots (3.1)$$

$V_{out}$  = Output voltage of regulator

$V_D$  = Voltage drop across diode

$I_D$  = Forward current of LED

Light emitting diode (LED) characteristics:

Forward current of LED = 10mA and voltage drop = 2v, Nwabueze, (2009). Therefore

$$R_4 = \frac{5 - 2}{10 \times 10^{-3}}$$

$$R_4 = 300\Omega$$

Therefore, resistor value used is: 330Ω.

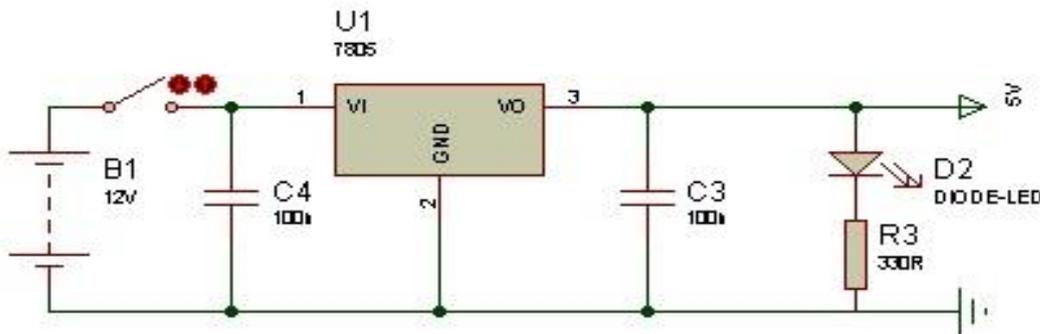


Figure 3.2: showing the interfacing Power Supply

The power supply section is very important for all electronic circuits. The system requires 5 volts dc. This voltage level will be obtained from the 12v battery. The 12v is stepped down by to deliver a secondary output of 5V, 1 A. The 12v battery output is rectified by a full-wave rectifier comprising diodes D1 through D2, filtered by capacitor C3 and C4 regulated by IC7805 (IC) Capacitor C3 bypasses the ripples present in the regulated supply. The power supply schematic is shown Figure 3.2.

### 3.2.3 PIC 18F2455 Microcontroller unit

The control module was built with the microcontroller IC. The central controller is the PIC 18F2455 MICROCONTROLLER. The PIC18F2455 microcontroller hardware circuit is usually a flexible, low power, high-speed FLASH/EEPROM using CMOS technology. PIC18F2455 Microcontroller features 128 bytes of EEPROM data memory, self-programming, reset resistor 8.2 KΩ to 15 KΩ, an ICD, 2 comparators, 5 channels of 10-bit Analog-to-Digital (A/D) converter. The 2-wire inter-integrated Circuit (I2c) bus and a Universal Asynchronous Receiver Transmitter (USART) was used, PIC microcontroller datasheet, (2012).

For the design, the following values were chosen:

- Reset resistor ( $R_1$ ): 10 KΩ
- Crystal oscillator: 12MHz
- Crystal capacitors ( $C_1$  &  $C_2$ ): 22pF

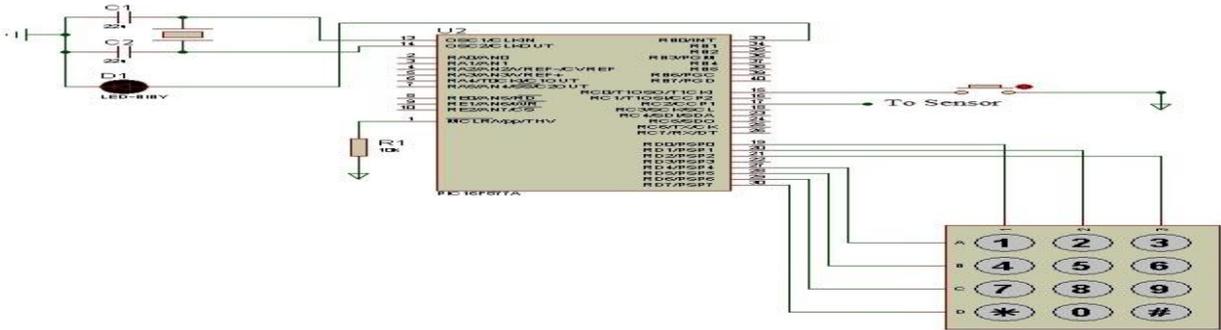


Figure 3.6: Control Circuit Design

### 3.2.4 GSM Modules Unit

The GSM modem unit is built using the SIMCOM SIM 900 modem that specialized for microcontroller and support GPRS technology for satellite navigation. This module takes care of all GSM/GPRS based communication requirements as well as provides live GPRS data.

The GSM Module SIM900A can be directly interfaced with PIC Microcontrollers, through the three lines; TX, RX, GND. The transmit signal of the serial port of the microcontroller is connected with the transmit signal (TXD) of the serial interface of GSM Modem while receive signal of the microcontroller serial port is connected with receive signal (RXD) of serial interface of GSM modem. Figure 3.4: shows how the GSM is interfaced with PIC18F2455 microcontroller.

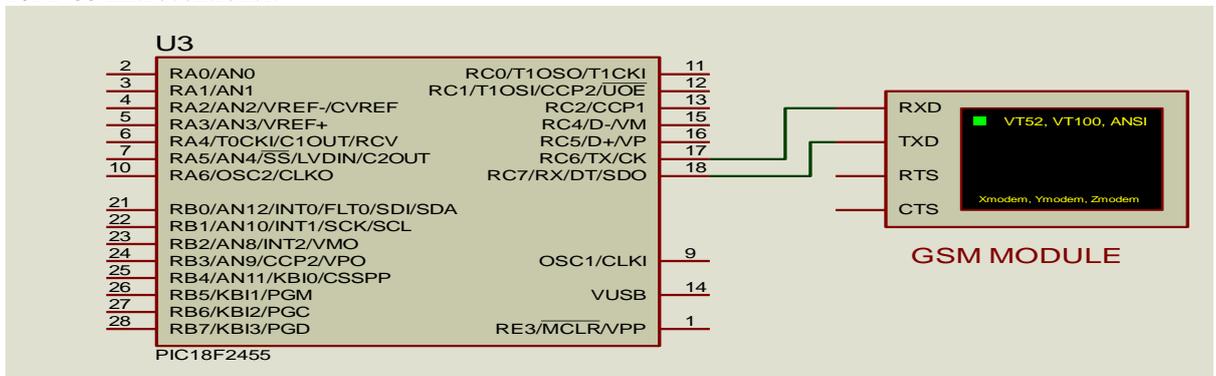


Figure 3.4: showing the Interfacing GSM module with PIC Microcontroller

### 3.2.5 The Display Unit

This display unit used for the design is Liquid Crystal Display (LCD) because of its ability to display numbers, character, graphics, ease of programming for characters and graphics and low power consumption. The 2 x16 character LCD has two rows of 16 characters each. The LCD pins and functions are given in the table 2.4. It has 16 pins with register select, read/write and enable control lines. In addition, it has a display contrast voltage line. The 4-bit interface was employed because it saves on port pins which could otherwise be used for other additional functions. Pins 15 and 16 were employed to enable visibility in the dark and for characters to be viewed with ease from a distance. The R/W (Read/Write) pin is connected to ground indicating that the LCD is receiving data only. The display receives ASCII codes for each character at D4 to D7 which is connected directly to the 4 PORTB pins of the PIC18F2455 microcontroller. To initialize the LCD, the Register Selects (RS) line must be set to logic 0. The 8-bit code for each ASCII character is sent in two halves; high nibble first, low nibble second. Although this makes the software only slightly more complex, it saves on I/O pins and allows the LCD to be driven using only six lines as shown in Figure 3.5

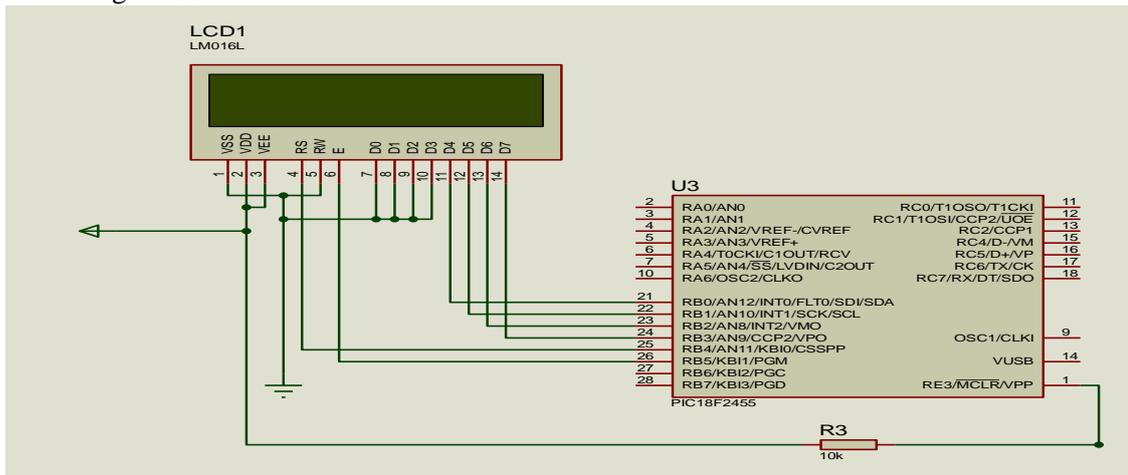


Figure3.5: Liquid Crystal Display to PIC 18F2455 microcontroller interface

### 3.2.6 The Design of the Buzzer Unit

The buzzer is connected to a 12volts supply and connected via a BC547 transistor to the ground. The base of the transistor is connected to the microcontroller through a current limiting resistor (10K), the Figure 3.6 shown the circuit diagram of buzzer unit.

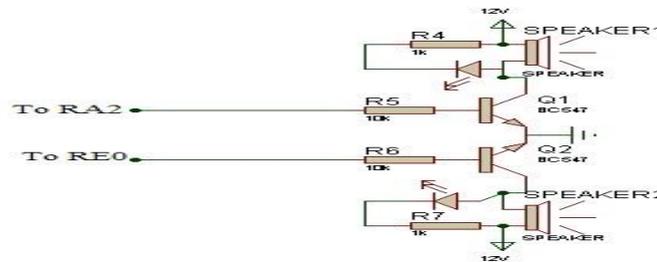


Figure 3.6: Circuit Diagram of the Buzzer Unit

### 3.3 Complete Circuit Description

The power supply was used and connected to the voltage regulator which was used to step down the voltage to the required voltage for the microcontroller that ranges from 4.5v to 5.5v. The voltage regulator has three legs, the first leg was connected to the 9V battery on positive terminal, and second leg was grounded and has to be connected to pin8 of the microcontroller. The last leg was connected to microcontroller pin7. A  $10K\Omega$  resistor was used and connected to pin1 through pin 7 of microcontroller on port A. The two capacitors of each 22pF were connected to 12MHz crystal oscillator in parallel connection with the microcontroller on pin 9 through pin10 respectively. This was to synchronize the operation of the microcontroller and other electronics on the board. In design, GSM module was used, All the LEDs on the same row are connected to have a common anode while all the LEDs on the same column are connected to be the same or common cathode. The LEDs light were arranged 56 by 8 on a dotted breadboard..

The pin 1 of Microcontroller is described as a master clear (MCLR) which is used for reset button in 60 second time delay. The LCD with 16 pins connected pin 4 (RS) pin 6 (EN) and the last 4 pins of the 8bit ASCII code: D4, D5, D6 and D7 with microcontroller at Port B pins: 26, 25, 24, 23, 22, and 21 which are data bus respectively. While pins:1 (Vss), 3 (Vee), 5 (R/W) connected in series with pin D0- D3 alongside with  $10K\Omega$  resistor were grounded, Pins 15 and 16 were for the backlight of the LCD and only pin 2 connected to the power supply, pin 8 and pin 22 on microcontroller were also grounded.

The keypad has 8 pins in which pins 0-3 were for rows and pins 4-7 were for the columns (A...D), they were interfacing with the microcontroller on port assignments. The GSM module consists of 3 pins RXD and TXD connected to microcontroller on pin 11 through pin12 respectively. Speaker or buzzer connected with the microcontroller on port B, pin 27 and through pin28 respectively. The PIC microcontroller transmits and receives data with respect to clock pulses. The physical implementation of the design was carried out on the manufactured breadboards using mainly surface mounted components. The component was then soldered into the respective component slots using a 30W soldering iron as shown in Figure 3.7

## 4.0 RRESULT AND DISCUSSIONS

### 4.1 Testing

After the integration of various sub- units of the complete prototype of the developed security system. The implementation of the circuit was tested with the help of Proteus software to ensure the proper connection of the circuit shown in figure 4.1. The simulation was performed on Proteus software which has helped to know the circuit performance and find & rectify the errors of the program. Steps followed are enumerated below:

- i. Click on the '**Debug**' menu.
- ii. Select the '**start debugging**' option. The LED starts blinking, which indicates the circuit is running.
- iii. After some time, select the '**stop debugging**' option. The LED will now stop blinking.

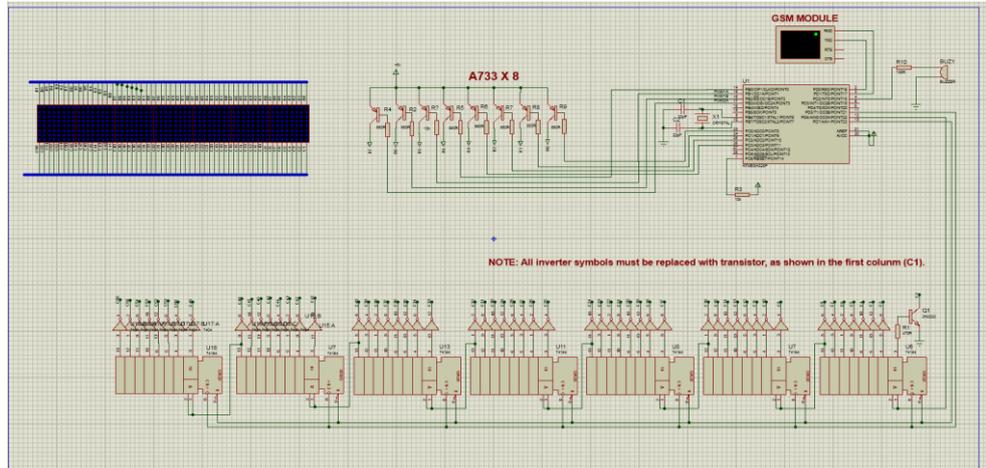


Figure 4.1 Circuit diagram of the billboard using Proteus

In preparation for the final execution of the project, a picture of the first message the billboard will display once connected to electricity is displayed in Figure. 4.2, after the billboard is plugged in and has been connected to the to a phone a text will be sent to the billboard through SMS input as shown in figure 4.3 after reading and processing it for few mins it will display it on the board as shown in figure 4.4.



Figure 4.2: first view displaying

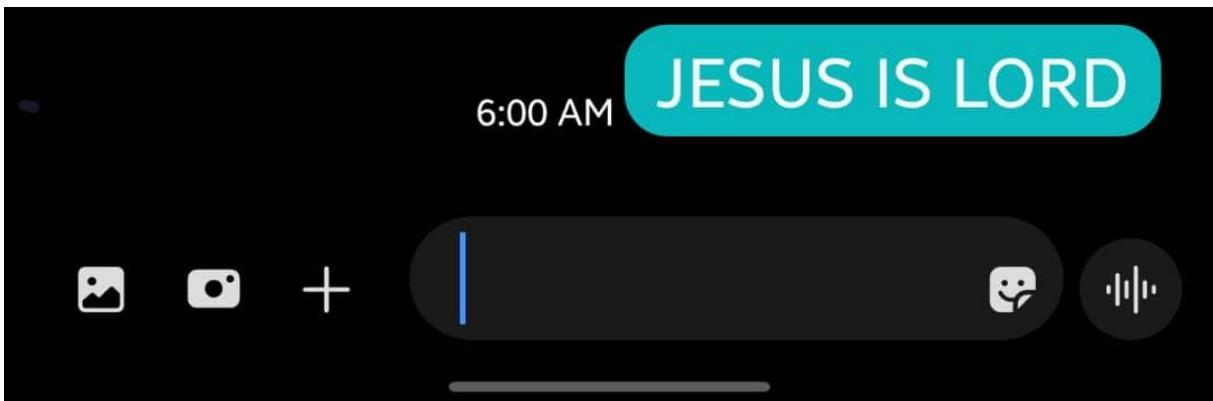


Figure 4.3: SMS input to the billboard



Figure. 4.4: SMS output on the billboard

## 4.2 Result and Discussions

The result of simulation ensures that the circuit worked properly. The practical implementation of the simulated circuit has been presented in figure 4.1. in circuit diagram microcontroller was the main component used for controlling other devices. The codes were written using C-programming, and implemented, the code was to first extract the information sent to the GSM modem, process the information and accept the information in pre-sent format and display the received SMS as a scrolling text.

While testing the working principle of the billboard, an SMS was sent to the GSM modem, the microcontroller was able to extract and process the SMS from the GSM modem notify sound buzzer of a new information and the sound buzzer immediately alert the audience of a new information before it's was displayed as a scrolling text for the audience.

## 5.0 CONCLUSION AND RECOMMENDATION

### 5.1 Conclusion

In conclusion, the billboard was able to receive SMS, notify the targeted audience of a new information with an audio sound alert in a reasonable sound level and display the message as a scrolling text for the targeted audience. The developed system is to benefit targeted audience due to it's eligibility of text and its audible audio sound alert which is capable of notify audience of a new information before the information will be display as a scrolling text for the targeted audience. The new system is also expected to benefit sender of information due to the fact that information can be entered into the billboard from any distance/location in as much as there is network in the place the billboard is placed.

### 5.3 Recommendation

For further research work to be carried out on this research, the following suggestions is recommended:

- i. Voice recognition techniques can be incorporated as a means of verifying callers since mobile service providers are fond of placing some unsolicited promotional calls through to their customers, hence, a verification mode similar to the pre-set codes used in the elimination of the network providers' messages in this work can be adopted as improvement
- ii.

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