RADIO FREQUENCY TRANSCEIVERS: A BETTER REPLACEMENT FOR DATA CABLES IN COMPUTER BASED DOT MATRIX DISPLAY SYSTEMS

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ABSTRACT

This paper highlights the disadvantages of using data cables in interfacing dot matrix display to computer and proposes a better method of doing the same. The method being used presently utilizes cables as links between the computer and the display unit. These cables have drawbacks associated with them. Among these drawbacks are signal losses or attenuation, difficulty in deployment, troubleshooting and maintenance. These contribute to the high cost of implementation especially in a situation where multiple displays are to be installed. The Radio Frequency (RF) transceiver presented in this paper has a number of features that eliminate totally the problems associated with the use of data cables. These features include in-built error checking capability, high sensitivity and long transmission range, self controlled protocol translation that is easy to use, standard UART interface that is compatible with microcontrollers among others. Multiple displays can also be controlled by a single host computer because the RF has both multiple channels and baud rates. Visual basic (VB).net is employed to develop the graphical user interface used in the implementation of the new proposed system. Communication is made through the RS232 interface protocol between the computer and RF transceiver. ATMEL microcontroller that supports serial communication, interfaced with liquid crystal display and non-volatile RAM, is used to demonstrate how the RF transceivers work.

Keywords: Data cables, Radio frequency transceivers, Signal losses, Dot-matrix display

INTRODUCTION

Dot matrix display is seriously gaining popularity in advertisements in recent time. This is because the main aim of advertisements is to influence human minds; as such visual impact has been identified as the most effective way of achieving that [4]. Display device provides this visual impact. It is used for presentation of information for visual or tactile reception, acquired, stored or transmitted in various forms. It consists of matrix of lights or mechanical indicators arranged in a rectangular configuration (other shapes are also possible, although not common) such that by switching on or off selected lights, text or graphics can be displayed [2].

Dot matrix display is used for variety of applications. Banks use it to show the current stock market values, current exchange and interest rates. It can also be used in shops to tell people the price of goods and other commercial information. Some signposts at conspicuous locations are dot matrix displays.

The current shift from the normal way of presenting information to the mind captivating display method is not only because of visual impact. Another advantage of display is that one display can be used to showcase lots of ever changing information like in banks, cinemas and shops on a daily basis. Matrix keypads were used in the past to delete old information and key in the new ones. The method was not only time consuming on the part of the user but also requires hail of programming by the programmer [8]. Using computer keyboard as input terminal to display unit was found to be more effective than keypad approach. Data cables are run from the computer terminal to the display unit. The length of the cables is dependent on the distance between the computer and the installed display unit. Data transmitted through the cables must not be corrupted in any way otherwise the aim of

installing such a display will be defeated. Besides increased cost of installation, difficulty in installation, troubleshooting and maintenance that are associated with use of cables, the major concern is the signal losses that occur along the transmission lines especially when the signal involved is as small as 5v, the microcontroller voltage [9]. A better approach is to convert the data to frequency at the computer end, transmit it and then reconvert it at the display unit. This among other things is what RF transceivers do. One good thing is that these transceivers now come as a modem with desirable features that eliminate in totality the limitations of cable technology. This paper reveals these features and also shows how to explore them. The example shown in the paper will act as a guide to designers of computer based systems that employ RF communication.

REVIEW OF THE CABLE METHOD OF INTERFACING DOT MATRIX DISPLAY TO COMPUTER

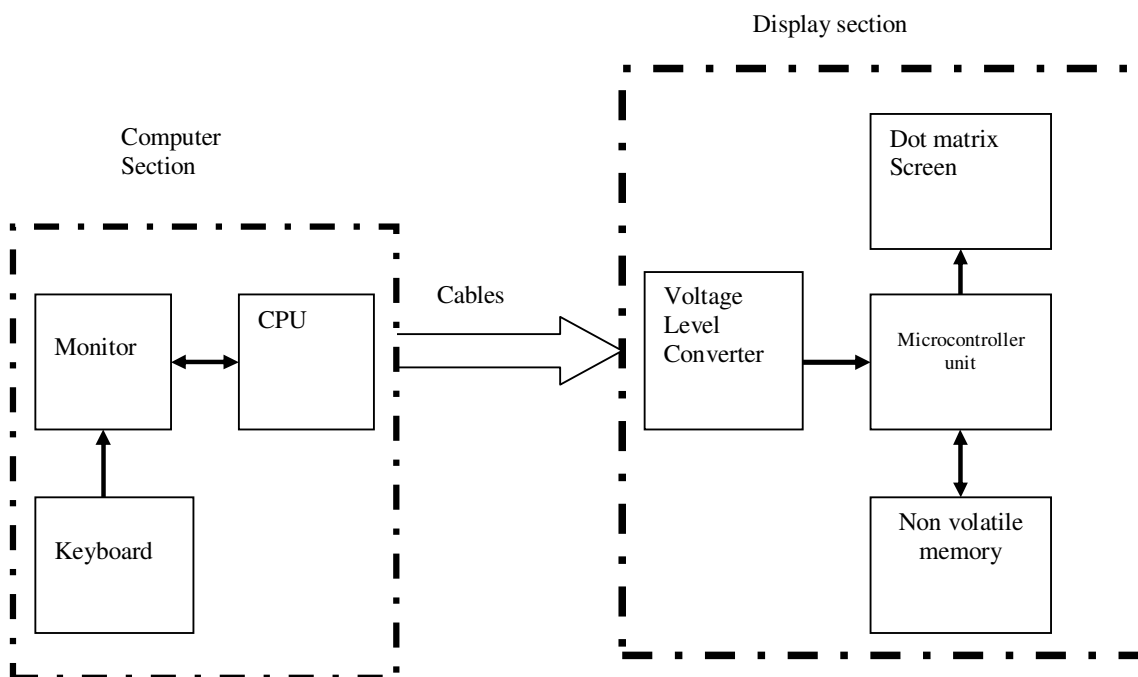

Figure1.The block diagram of interfacing dot matrix display to computer using cable

Figure 1 shows the block diagram of the existing system which is divided into two major parts: computer and display sections [9]. Data cables act as links between the two sections. The computer section is made up of the keyboard, monitor, central processing unit (CPU) that contains the application program that enables the user update the information being displayed on the dot matrix screen.

The display unit contains the microcontroller that receives the data sent by CPU, stores it in a non volatile memory from where it will retrieve the same and display it on the screen. The non volatile memory has the ability to retain the stored data when power goes off [1]. The RS232 terminal of the computer is not compatible with Transistor Transistor Logic (TTL) voltage level of the microcontroller, thus the voltage level converter serves the purpose of voltage conversion between the CPU and the microcontroller [8]. The dot matrix screen can be liquid crystal display (LCD), seven segment display or light emitting diodes (LED) arranged in dot matrix form.

The Limitations of the Cable Method

a) Using cable as channel of communication between the computer and the display unit has some drawbacks.

b) There is no form of error detection and correction for effective communication.

c) There is signal degradation along the line due to resistance of the wires.

d) Any cut in the cable will result in system malfunction and is not always easy troubleshooting such faults especially when the length of the installation cable is long.

e) Neat and ease of installation is not there especially in a place that is conduit wired.

f) The cost of installing multiple displays in different locations, say offices within the same establishment will be very high as each display will have a computer dedicated to it. Besides there will be as many operators as there are displays especially when those displays are being used simultaneously.
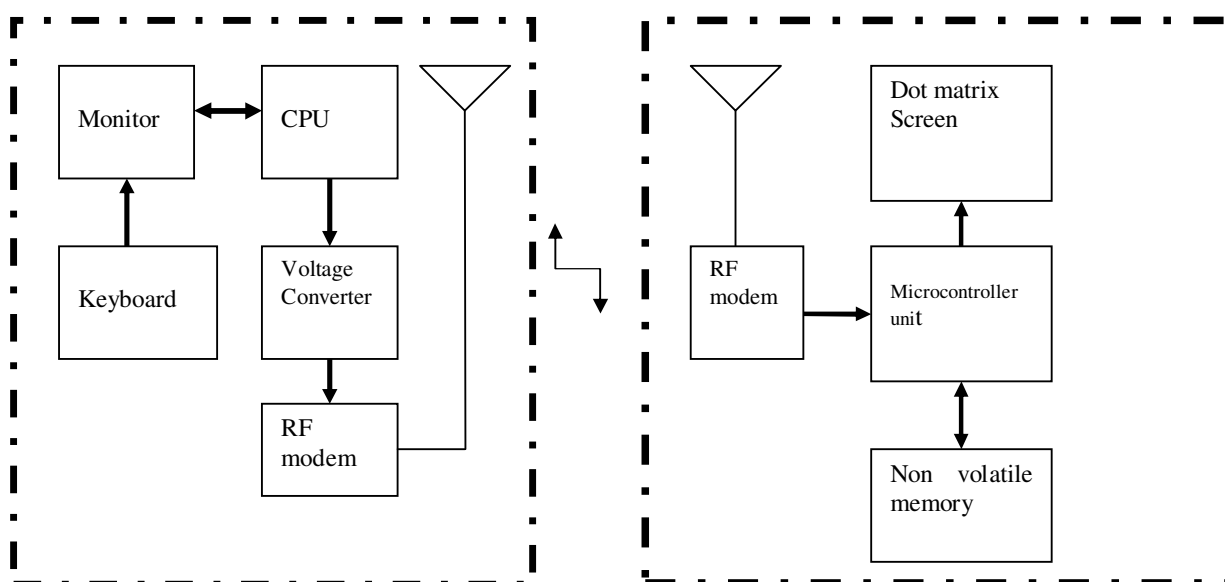
DESCRIPTION OF THE NEW PROPOSED SYSTEM

Figure2**.** The block diagram of the new system

Figure 2 is the block diagram of the new system. The data cable between the computer section and the display unit has been replaced with RF modem. A typical RF modem from sunrom [7] is shown in figure 3.

The following features make the radio frequency modem suitable for the new system:

a. It has multiple channels. Thus, a single modem can be used to communicate to multiple displays.

b. It is based on FSK technology, half duplex modem, robust to interference.

c. Its protocol translation is self controlled and easy to use.

d. It uses the IBM band, thus no need to apply for frequency usage license.

e. It has high sensitivity and long transmission range.

f. It has standard UART interface, TTL logic level

g. No tuning is required as it is self tuned.

h. Error checking of data is in-bult.
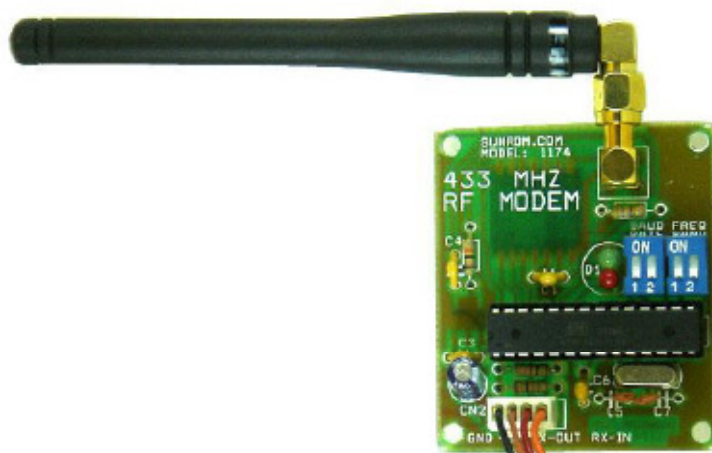
i. It is small in size and easy to mount [7]**.**

Figure 3.RF modem from sunrom

IMPLEMENTATION OF THE NEW SYSTEM

The new system is an embedded system that comprises both software and hardware components. The software components include the Graphical User Interface (GUI) developed using visual basic (vb).net, the application program running on the computer and the assembly language program running on the microcontroller. Vb.net is used to develop the GUI and application program because it has in built serial port that facilitates easy interface to microcontrollers [3]. The hardware components include the standard voltage level converter (max 232), the RF modem, non volatile memory and dot matrix screen. Although any microcontroller that is TTL compatible and has interrupt capability can be used, AT89c51 microcontroller is used because it is readily available and relatively cheap [6]. The Non Volatile RAM DS 1230YAB used in the implementation has the following features.

i.   10 years of minimum data retention in the absence of external power.

ii.   Data is automatically protected during power loss.

iii.   Unlimited write cycles.

iv.   Low power consumption

v.   Operating temperature of -40 to +85 degree centigrade.

vi.   Read and write access time as fast as 70ns.

vii.   Memory size of 256 kilobytes [5].

The choice of the screen to use is dependent on the purpose of the display. For a display that checks the current values of world currencies and displays them on the screen for customer's view as in banks, seven segments can be used. On the other hand, LED matrix screen will be a better option for menu display in a hotel. Graphic LCD will be employed in situations that involve display of animated pictures. A 4-line by 20-charater LCD is used in this paper to demonstrate how the RF modem works.

The Schematic Diagram for the Computer Section and Display Unit

Figure 4 shows the schematic diagram of the computer section for the new proposed system while figure 5 is that of the display unit. DB9 connector is used to represent the computer because it is the meeting point of the com port of the computer and MAX232. USB port can also be used.
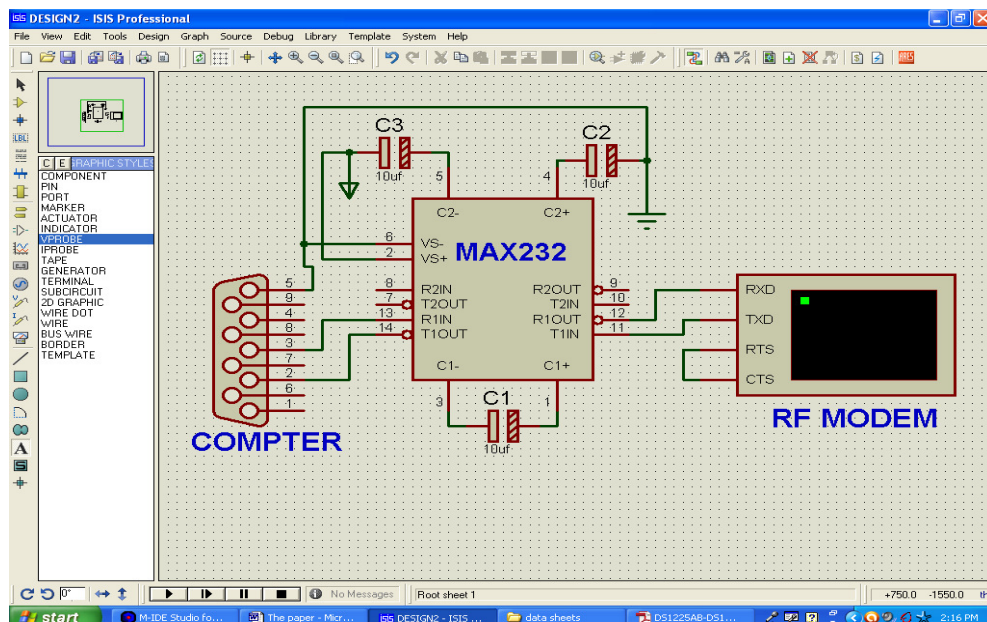
Figure 4.The schematic design of the computer section

Figure 5 shows the design of the display unit. The microcontroller, AT89C51, receives the data sent by the computer through RF modem, saves it in the non volatile RAM, DS1225AB until the last data is received. Thereafter the controller retrieves the data starting from the first and displays it on the LCD. After displaying the last data, the controller starts all over again until new data is sent to replace the old ones.
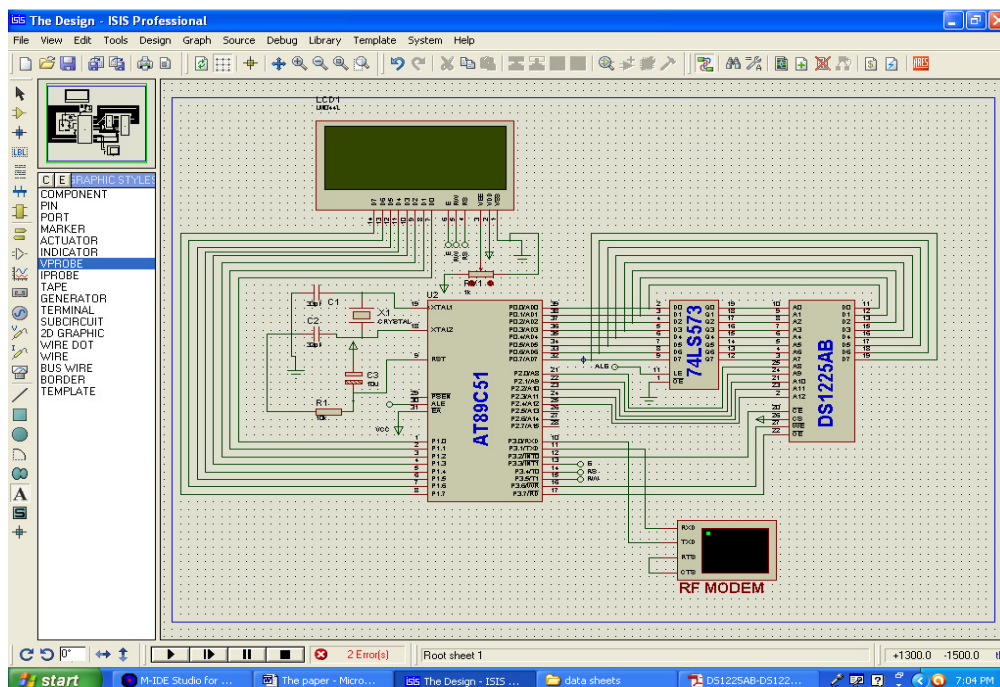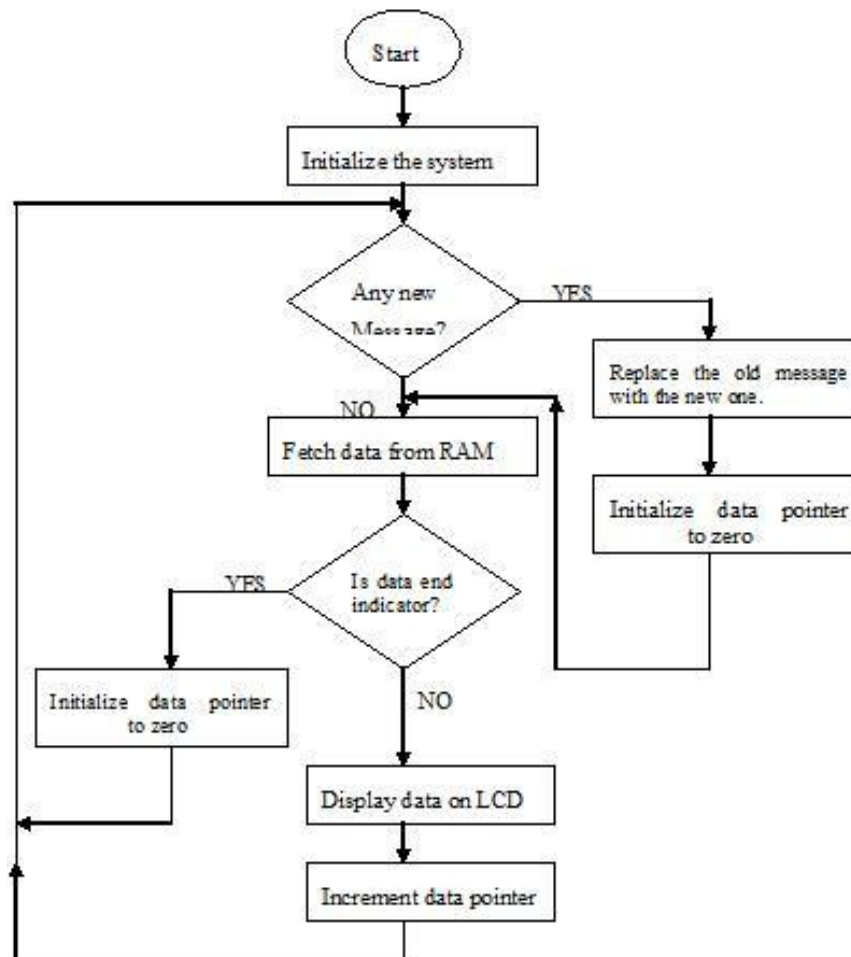

Figure 5.The Schematic design for the display unit

Flow Chart for Software Implementation of The Display Unit

Figure 6. Flow chart for the programming of the display unit.

Figure 6.1 shows the flow chart used in the implementation of the display unit of the new system. The data pointer holds the present data that is to be displayed on the LCD.

Assembly Language Program for the Display Unit

ORG 00H   ; begin the program from origin

JMP START   ; go to start

; DECLARATIONS

LCD_DATA EQU P1   ; lcd_data is assigned to port1 of the microcontroller

BASE_ADDRESS_RAM EQU 0000H ; base address of the ram is declared to be
                                    ; memory 0000h

END_OF_DATA EQU '*'   ; the ASCII character, '*', indicates the end of message

BASE_ADDRESS_LCD EQU 80H   ; base address of the lcd is declared to be 80h

EN BIT P3.3   ; enable pin of the lcd is assigned to bit p3.3 of the controller

RS BIT P3.4   ; register select pin of the lcd is assigned to bit p3.4 of the controller

RW BIT P3.5   ; read/write pin of the lcd is assigned to bit p3.5 of the controller

```
ORG 23H                    ; vector location for serial interrupt service routine
LJMP RECEIVE_SAVE_NEW_DATA ; subroutine that receives and saves data
                                         ; in the ram

ORG 30H
START: CALL INIT_LCD               ; subroutine that initializes lcd
       MOV SCON, #50h              ; configure the serial port mode
       MOV TMOD, #20h              ; setting the serial port to receive data
       MOV TH1, #-3                ; setting the baud rate to 9600
       setb TR1                    ;start timer1
; COLLECT DATA FROM RAM AND DISPLAY IT ON LCD
REPEAT: MOV A, # BASE_ADDRESS_LCD  ; mov the base address of the lcd to
                                         ; accumulator register
CALL WR_INSTR               ; tells the lcd where to display the first data
MOV DPTR, # BASE_ADDRESS_RAM         ; mov the base address of the ram to data
                                         ; pointer register
NEXT: MOVX  A, @DPTR         ; mov the data contained in the present memory
                            ; location to accumulator register
CJNE A, # END_OF_DATA, CONTINUE       ; check if the current data is the end of
                                         ; message
       JMP REPEAT                  ; start all over again from the first data
CONTINUE: CALL WR_DATA               ; subroutine that displays the data on lcd
       INC DPTR                    ; go to the next memory location of the ram
       JMP NEXT                    ; fetch next data
; RECEIVES AND SAVES DATA IN THE RAM
RECEIVE_SAVE_NEW_DATA: CLR IE.7               ; disenable interrupt for a while
       MOV DPTR, # BASE_ADDRESS_RAM
XX:    MOV A, SBUF          ; mov received data to accumulator
       CJNE a, # ' * ', SAVE   ; check if the data is the end indicator
       MOVX @DPTR, A               ; saves the end of message indicator
       SETB IE.7                   ; enable interrupt  again
       RETI                        ; return from interrupt
SAVE: MOVX @DPTR, A               ; save data in ram
       CLR RI                      ; clear the receive flag
       JNB RI, $                   ; wait for next data
       INC DPTR                    ; go to the next memory location of the ram
       JMP XX                      ; get next data
 INIT_LCD: mov a,#30h
       Call  wr_instr
       mov a,#30h
```

```
            call  wr_instr
            mov a,#30h
            call   wr_instr
            mov a,#38h
            call  wr_instr
            mov a,#0ch
            call  wr_instr
            mov a,#06h
            call  wr_instr
            mov a,#01h
            call  wr_instr
            ret
wr_instr:clr rs
             clr rw
            mov LCD_data,a
            setb en
            call delay5ms
            clr en
            ret
wr_data:setb rs
            clr rw
            mov LCD_data,a
            setb en
            call delay5ms
            clr en
            ret
delay15ms:mov r7,#20;39
            mov r6,#180;229
            jmp delay1
delay5ms:mov r7,#13
            mov r6,#34;244
            jmp delay1
delay1ms:mov r7,#3
            mov r6,#147
            jmp delay1
delays:  mov r7,#39
            mov r6,#200;229
```

delay1: djnz r6,$

djnz r7,delay1

ret

END

The Design of Flow Chart and Graphical User Interface (GUI) For the Application Software

Figure 7 shows the flow chart of application software that runs at the background of the GUI.
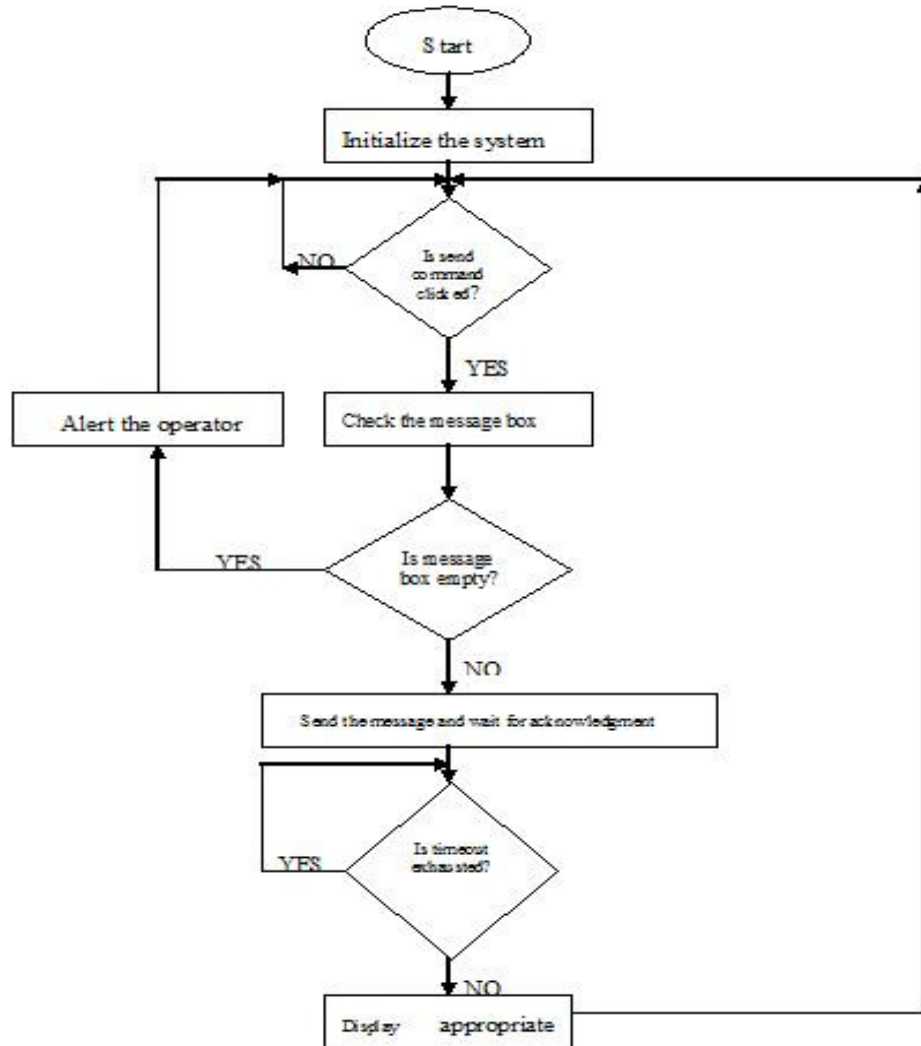

Figure 7. The flow chart for the application software

The GUI shown in figure 8 contains three icons: the message textbox, send command button and clear command button.
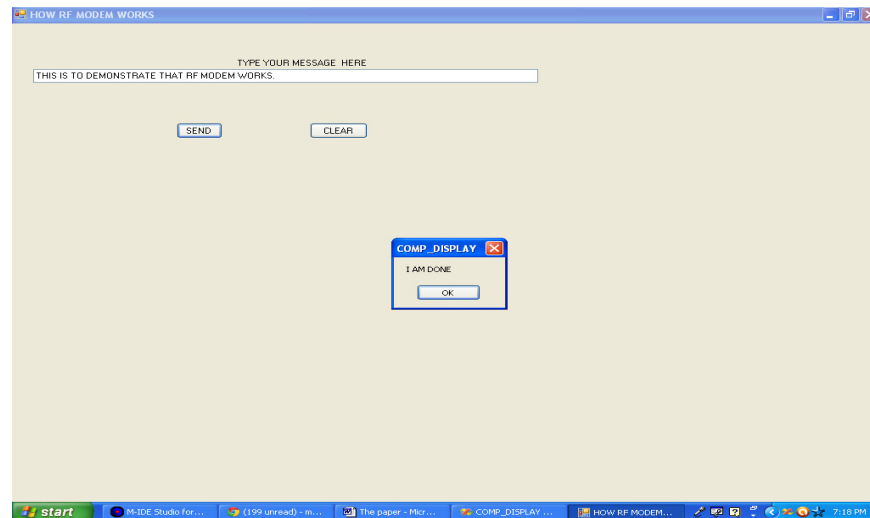
Figure 8. The GUI interface

The message to be sent is placed in the message box before clicking the send command button. If the message box is empty and the send command is clicked, the operator will be alerted by a warning message box that will pop up, see figure 10.1. A successful transmission of the message is indicated by a message box containing the text 'I AM DONE'

Vb.Net Program for the Computer Interface

Public Class Form1

'declarations

```
    Dim text1 As String

    Dim source As Integer

    Dim one As Integer

    Dim two As Integer

    Private Sub Button1_Click(ByVal sender As System.Object, ByVal e As System.EventArgs)
Handles Button1.Click

text1 = TextBox1.Text

    If text1 = "" Then

       MsgBox("the message box is empty")

    Else

       Call Send_data(text1)

       Try

       Catch ex As Exception

          MsgBox("try me", MsgBoxStyle.Critical)

       End Try

    End If

 End Sub


    Private Function Send_data(ByVal text1 As String)
```

```
      Dim serialdata As New SerialPort("com1", 9600, Parity.None, 8, StopBits.One)
scan:
      serialdata.ReceivedBytesThreshold = 2
      serialdata.ReadBufferSize = 5000
      serialdata.WriteBufferSize = 5000
      serialdata.ReadTimeout = 1000
      serialdata.DtrEnable = True
      serialdata.RtsEnable = True
      Try
        serialdata.Open()
        Do
          serialdata.Write(text1)
        Loop Until serialdata.BytesToWrite = 0
        serialdata.DiscardOutBuffer()
        serialdata.Close()
        MsgBox("I AM DONE", MsgBoxStyle.OkOnly)
      Catch ex As Exception
        MsgBox("try me", MsgBoxStyle.Critical)
      End Try
      Return (source)
    End Function
Private Sub clear_Click(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles
clear.Click
      TextBox1.Text = ""
    End Sub
End Class
```

TESTING AND RESULTS

Table 1. Summary of tests and results

Test	Expected result	Result Obtained
1. Switch on the display unit and computer unit. Send an empty message box.	The message "the message box is empty" should pop up.	The message "the message box is empty", which was clear by clicking 'OK', poped up. See figure 9.
2. Type and send the message 'welcome'.	Display unit should receive the message, and thereafter begins to display the message continuously.	The message was received as soon as it was sent and after one second, the message 'welcome' started scrolling on LCD continuously.

| 3. Off the display unit, wait for some time before switching it on again.	The message 'welcome' should continue to display on the LCD	The message started displaying one second after the power on.
4. Send another message 'RF Modem works' to the display unit.	The new message should replace the former one.	The scrolling of the former message halted. Thereafter, the new message 'RF Modem works' started scrolling on the LCD
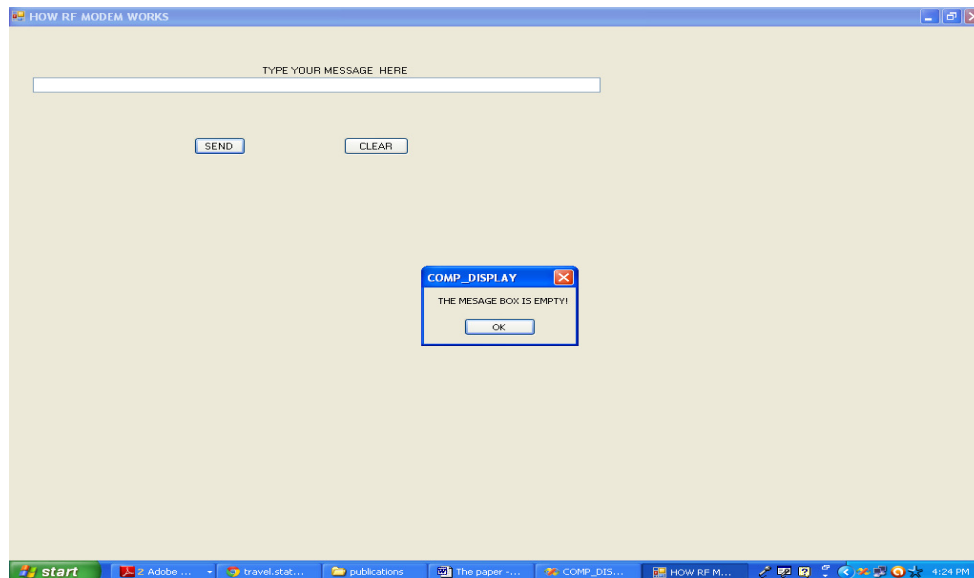
Figure 9. The result of attempting to send an empty message box to the display unit

DISCUSSION

It can be seen from the discussions so far that radio frequency modems can perfectly replace cable technology in computer based dot matrix display systems. It also has a number of advantages over cable technology. Apart from ease of installation, it is cost effective as one modem can be used to communicate to multiple display units reducing the number computers being dedicated to each display unit.

CONCLUSION

This paper has not only proposed a better method of interfacing dot matrix display unit to computers but also has implemented the same using visual basic.net programming. Thus it will also be of great help to researchers and students who have been looking for a better way of interfacing microcontrollers to computers without using visual basic 6.0 as it has number of limitations when compared to VB.net [7]. The serial communication subroutine developed in the vb.net program can be employed in various other computer based monitoring and control applications.

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