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Design of a Microcontroller based Electronics Billboard using GSM

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Abstract: The Design of a Microcontroller Based Electronic Billboard using GSM was developed with two ATMAGE328P microcontrollers from Atmel. The microcontrollers provide all the functionality of the display with wireless control. The Display is obtained on a 16X36 Light Emitting Diode (LED) module display. 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 of the system, the message is then stored in the Electrically Erasable Programmable Read Only Memory (EEPROM). The GSM module is connected through Integrated Circuit (74HC595 IC) to the ATMEGA328P microcontroller. The message that was stored in the EEPROM was then displayed on the billboard. This hardware uses regulated 5V power supply. A three-terminal LM7805 is employed for regulation of the voltage. A full wave bridge rectifier was used to rectify the AC output of the secondary of 230/12V step down transformer. The system was tested and recorded huge success.

Keywords: Microcontroller, GSM, EEPROM, SMS, LED, Regulator, Bridge rectifier.

1. INTRODUCTION

The role of information dissemination in the society cannot be over-emphasized. In addition to its vital functions of enlightening, educating, entertaining, and facilitation of commercial activities through advertisement and marketing of goods and services, its use in surveillance and monitoring (security, traffic control etc) and description of places also remain indispensable. Various means of information dissemination which include broadcasting (radio and television), the internet, newspaper, billboards, sign posts and neon displays, are employed, the choice of which depends on factors such as the targeted audience, the environment concerned, the purpose, available technology and economy (Ganiyu, 2017). Digital electronic display board is fast gaining acceptance and application because of the problem associated with construction of signposts and manual placement of paper on walls, building, which make the environment untidy (Dogo, 2014). 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 rebuilding the system. In more recent times (after microcontrollers and GMS MODEM 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 displayed 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. (Adamu, 2014). Outdoor advertising is mainly characterized by the use of paper, every bus stop and billboard has a paper advertisement inside. The reason is the paper is easy to use and extremely cheap; however it has some drawback as well. Before an image is actually placed on the streets it first has to be printed, the time from the designing and placement is quit long. Another

major disadvantage is the considerable amount of waste generated by the use of paper; finally many people just ignore paper advertisement (Joost, 2010).

In May 1968 liquid crystal display (LCD) was invented by an electrical engineer George Heilmeier and his team of scientists revealed the liquid crystal display to the public, not so surprisingly the adverting industries has been searching for years to find an alternative to replace paper kind of advertisement

2. MATERIALS AND METHODS

Proposed model for the microcontroller based electronic billboard is presented in figure 1. This gives the description of components used in the design

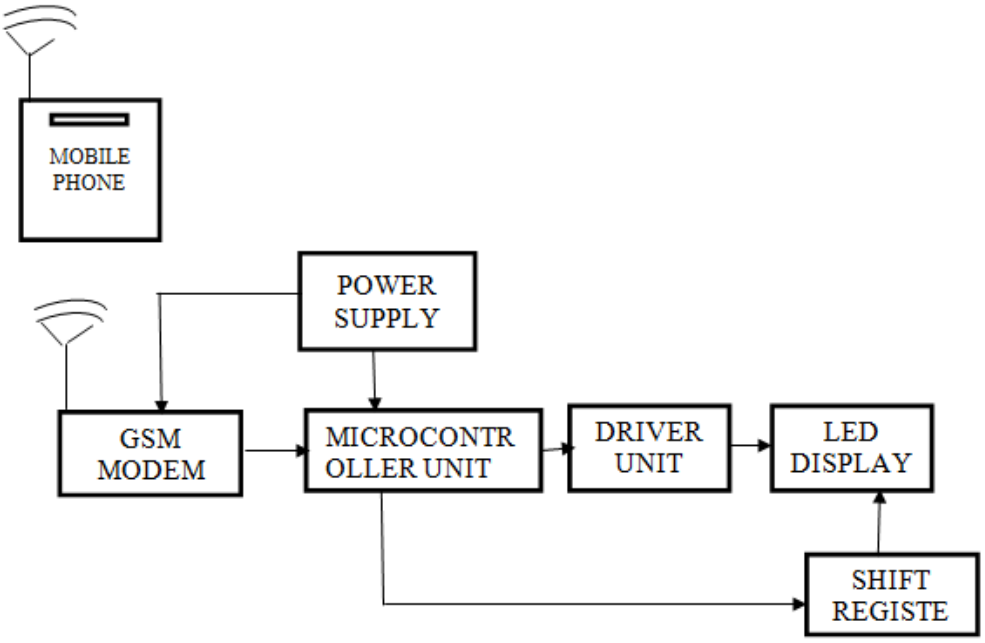

Figure1: Block Diagram of Microcontroller Based Electronic Billboard

2.1 GSM Phone

This is an electronic device used to send and receive information. In this design, GSM phone serves as a transmitter as well as an interface between intended information which could be inform of text and the GSM module which have a link with the Microcontroller. So if need be that information is to be passed across to some group of people, such message can be sent via text message (advert or an important information) anywhere and it will be displayed appropriately.

2.2 Power Supply Unit

Power Supply is an important part of a circuit. It provides 5VDC to the microcontroller and GSM modem with the help of voltage regulator (LM7805) and the GSM modem from 12VDC input rectified from the output of a 230V/12V step-down transformer filtered to 12VDC. The main blocks include, filter circuit and Voltage regulator (IC LM7805). The power section can be found in the main design circuit in figure 2.

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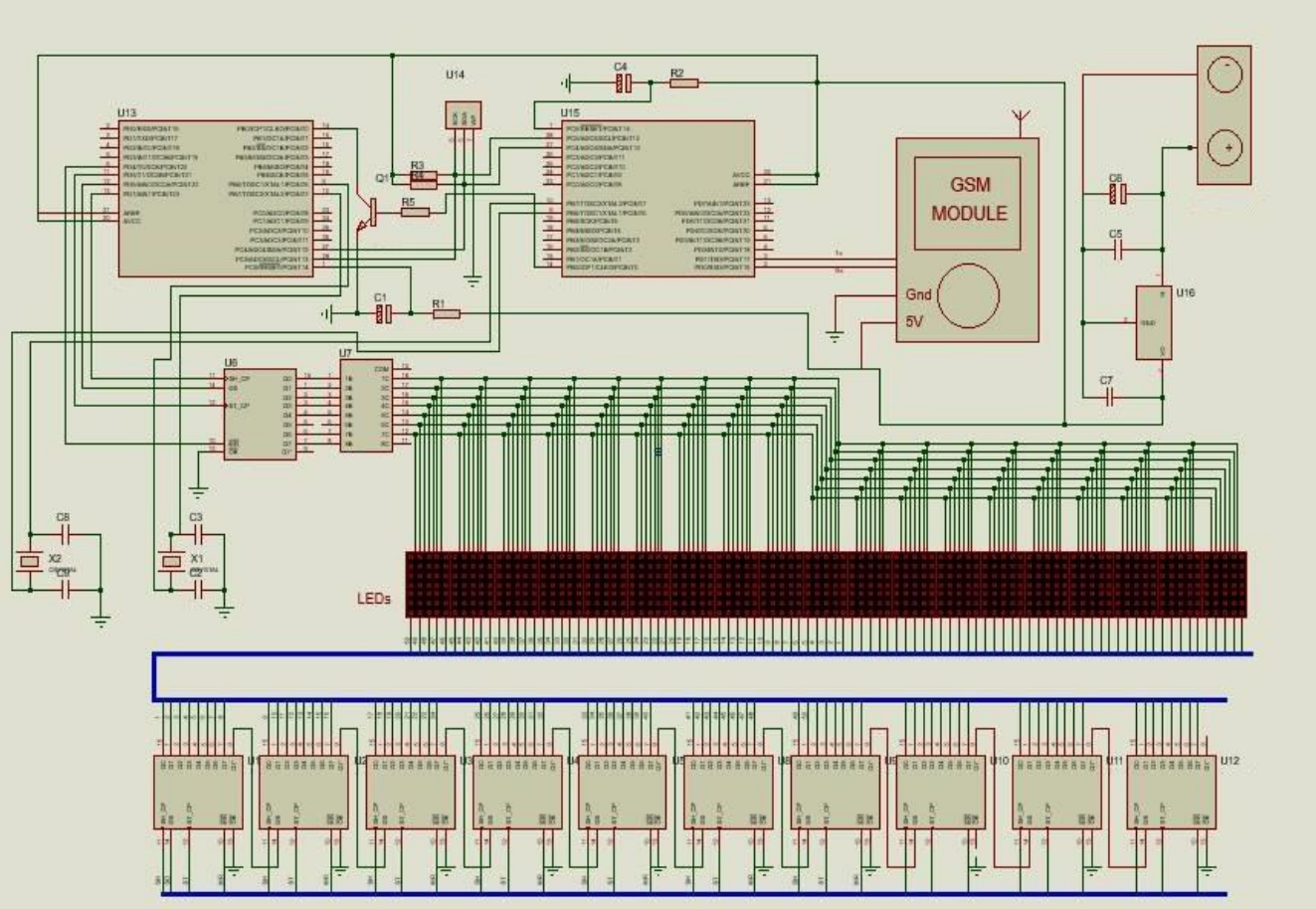

Figure 2: Circuit Diagram of Microcontroller Based Electronic Billboard

To obtain some parameters for power supply unit, the following calculations are needed as follows;

LED section

LED Load Power $P = IV$

$P = 0.02 \times 3.2 = 0.064W$

Load Voltage $= 5V$

Assuming all the LEDs are ON

The LEDs are 8 x 17 in numbers (sum of all LEDs), so

Total Load Current for LEDs $= 0.02 \times 8 \times 17 = 2.75A$

Total Load Power $P = IV$

$P = 2.75 \times 5 = 13.6W$

Total Power $= 0.064W + 13.6W$

$\approx 14W$

Filter Selection; The Capacitor which is part of the filter circuit is determined using the expression

$$C = \frac{1}{4} \times \sqrt{(3\gamma fR)}$$

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where, $F = 50Hz$

$\gamma = 1\%$

$R = 24k\Omega$

$C = \frac{1}{4} \times \sqrt{(3 \times 0.01 \times 50 \times 24000)}$

$= 0.00131 = 1 \times 10^3$

$\approx 1000\mu F$. Therefore, C6 is $1000\mu F$

2.3 Microcontroller

Microcontroller is a small computer on a single integrated circuit containing a processor core, memory and programmable I/O peripherals. We have used microcontroller ATMEGA328P. It was selected because of its high performance, low power 8-bit AVR RISC-based microcontroller which combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5 volts.

Design Calculation for Crystal Oscillator

$F = \frac{1}{2\pi\sqrt{LC}}$

Crystal oscillator frequency = 16MHz

The value of the internal inductor of the crystal oscillator = $7.496 \times 10^{-24}H$

$C = \frac{1}{L} \times \frac{1}{(2\pi f)^2}$

$C = \frac{1}{7.496 \times 10^{-24}} \times \frac{1}{(2\pi \times 16 \times 10^6)^2}$

$C = 22 \times 10^{-9} \quad = 22nF$

Therefore, Capacitor C2 and C3 are 22nF

Since the two microcontrollers are operating at the same frequency, C8 and C9 are also 22nF.

Selection of Resistance across the Microcontroller

$V = IR$

$R = \frac{Vs - V_{IC}}{I}$

Where, $R =$ resistance across the microcontroller

$Vs =$ source voltage $= 5v$

$V_{IC} =$ Operating voltage of the microcontroller $= 3V$

$I =$ current across the microcontroller $= 0.2 \times 10^{-3}$

Now, $R = \frac{5-3}{0.2 \times 10^{-3}}$

$= 10K\Omega$

2.4 Driver Unit

The drivers unit comprises of IC ULM 2003 and Shift register (U6).Shift register (U6) takes four input from the microcontroller and gives eight output to ULM amplifier. In this research, ULM2003 was used to boost the signal that goes into the LED display unit row wise

2.5 LED Display

Light Emitting Diode (LED) Display is an electronic device used to display text or graphics. The LED display is utilized as the physical notice board that displays the contents received through SMS, which is directly interfaced to a Microcontroller. In this work, 8 Rows and 136 Columns were used to build a dot matrix board for display of information.

2.6 Shift Register

Seventeen shift registers (74HC595) was used to scroll the message across the display board. The display board sequentially displays 8×8 characters that move from right to left. Each shift register displays this character on 8 rows and 8 columns (8×8) and then shifts it to the next shift register making it a total of 8 rows and 136 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).

2.7 Principle of Operation

The principle of operation of an Electronic Billboard is based on serial arrangement of different electronic sub-unit to communicate with each other (figure 3). Before a desire message can be display on an electronic billboard it has to pass through several stages, starting from the GSM module, to microcontroller, the driving unit, the shift register and finally the display unit and with the help of the power supply that power the system.

Basically when the electronic billboard display device is energized by a 12VDC output, the power supply produce a constant output 12VDC and the voltage regulator (LM7805) regulate the output voltage to the desired voltage level which is 5volts required by the microcontroller and GSM Modem.

The GSM module is in cooperated inside the electronic billboard circuit to serve as an interface between an active GSM phone and the microcontroller .The GSM module receives a text message from the mobile phone, read and processed the message then forward the output signal to the micro-controller (MIC1), the GSM module operate at 9600 bit per second (9600 bps) rate that is, it can receive 9600bits data in one second and the information

The micro controller (MIC1) received the incoming massage from the output of the GSM module, processed it, extract the vital information and store it into the electrical erasable programmable read only memory (EEPROM), whenever a new message is being stored in EEPROM the system will automatically reboot and the new message will start scrolling on the display unit. The rebooting of the system is done with the help of NPN transistor which serves as a switch and is in-cooperated between the two micro-controllers

The second micro-controller will extract the new message from EEPROM and start the scrolling message whereby putting the already programmed message on standby, the new message will be displayed on the screen with the help of the driver and the shift register, with these, the desire LED will glow, all this process is done very fast and it seems that the whole character is displayed at the same time, obviously perception of vision is experience which described how our eye works without noticeable

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Two crystal-oscillator of 16MHZ frequency each is connected to the two microcontrollers, it help the microcontroller to execute 16million instruction per seconds.

The display unit is in cooperated with 17 connected shift register in the display circuit, a shift register is a cascade of flip flops, sharing the same clock, which has the input of anyone but the last flip flop connected to the "data" input of the next one in the chain which result in a circuit that shift by one position of the data.

Finally the output result is display on the display unit which consist of a rectangular arrangement of LED in rows and column and they are interconnected together to form 8 rows and 132 columns that is scrolling massage is driven using 8 row outputs and 132 column input LED

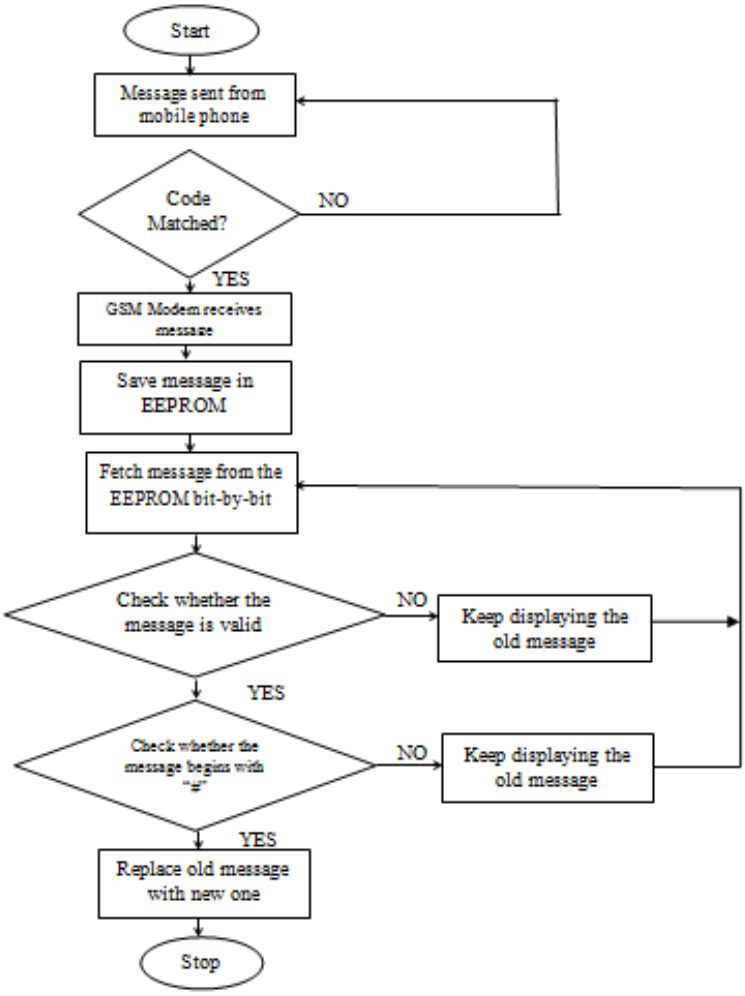

Figure 3: Flow Chart of Microcontroller Based Electronic Billboard

3. TESTING, RESULT AND DISCUSSION

3. 1 Testing

After construction, tests were carried out to ensure that the device was functioning according to the design specifications. The circuit was first simulated, thereafter all the components were properly soldered to the printed circuit board, from where other tests were carried out at various stages to ensure proper functioning of the components.

All the sub-circuits were combined together with the microcontroller to obtain the model of the design. The components were tested using a digital multi-meter.

The figure 4.1a and 4.1b below show the testing of the components as it is carried out.

Figure 4.1 : Testing the Circuit

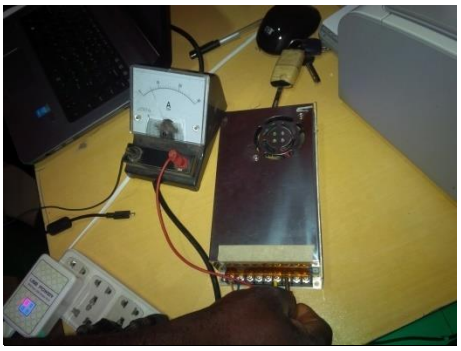

Figure 4.2: Testing the LED board

Figure 4.3: The LED display board

3.2 Result

The results of the various tests carried out on the system are shown in table 1 and 2

Table 1: Result obtained from the various test.

Type of Test	Result	Remark
Open Circuit	Nil	Ok
Short Circuit	Nil	Ok
Continuity	Yes	Ok
Polarity	Yes	Ok
Charging	Yes	Ok

Table 2: Result obtained from the brightness test of the display board.

Brightness	Result	Remark
Morning	Very Bright	Ok
Afternoon	Bright	Ok
Night	Very Bright	Ok

3.3 Discussion

After the design and construction, the results obtained from the tests carried out showed that all connections were properly done and the electronic billboard was able to accept information or message from the mobile phone as shown in the figure 4.3 with the help of the GSM modem which serves as an interface between the mobile phone and the Microcontroller. With the help of AT command (programming instruction) programmed on the microcontroller, the system was able to display the information on the LED display board.

Also, the result obtained from table 2 shows the brightness of the display board at morning, afternoon and night. From the result above it was observed that the display board is clearer and very visible in the night than afternoon, this is because the LED illuminate is brighter in the night than other time. Also the brightness of the display board is good in the morning than in the afternoon because the sun intensity is low then. The LED display board has its poorest brightness in the afternoon because of the high sun intensity in the afternoon. Hence, the electronics display board will add to the beauty of the area and its environmental friendly mostly in the night.

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