DESIGN AND CONSTRUCTION OF A LABORATORY DIGITAL TIMETABLE DISPLAY

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Abstract

The traditional method of displaying information in schools via signposts and posters is problematic because sending various notices daily is time-consuming, posted information cannot be changed automatically, and they must be constantly monitored because they can easily wear out due to weather or human intervention. Electronic message display boards are becoming more popular in most Nigerian cities due to their dependability and benefits, as well as the ease with which information is transmitted, which the general public appreciates. This paper presents the design and construction of a microcontroller-based digital time-table display system for use in laboratories. In this work, a microcontroller, Light Emitting Diode display board, smartphone and LedArt software are used to display alphanumeric characters that scroll across the screen for easy viewing. The microcontroller used in this work is the HD-W60-75 controller, it is a Wi-Fi series display controller card, which updates programs by Wi-Fi. The LED module is screwed to a wooden frame with the microcontroller. After the final coupling, a succession of texts written on the LedArt software installed on a smartphone was sent to the display board through a Wi-Fi protocol. This electronic message display helps to convey information quickly and also boosts the response to information appealingly due to the way the messages are displayed. This work will not only display a timetable but also address the issue of real-time information and assist students to know the technologists in charge at that particular period.

Keywords: Digital timetable, Microcontroller, LEDs, Laboratory, Wi-Fi

Introduction

Information dissemination is a necessary tool in any given society because it informs, educates, entertains, as well as promotes commercial activities through product and services advertisement. It is also useful in surveillance and traffic control, etc. and also a means of giving direction to places (Ogunseye et al., 2022).

The traditional African means of Information dissemination is through town carrier. The town criers go around to pass the message (Apata & Ogunrewo, 2010). One of the disadvantages of this method is that the message is lost when people were not around at that particular time. Other means of disseminating information include print, internet, broadcasting and outdoor media. The target audience will determine the choice of an information display gadget. The most important thing is that no matter the media, the objective which is information dissemination must be achieved and the material should be relevant to the intended audience and should be well presented in a clear, objective and understandable manner. Furthermore, the message display board should be attractive and inviting to capture the interest of the audience.

The extent to which the dissemination of information has developed has made it possible that the common method of information display using signposts, notice boards, etc., has to be modified by using an electronic digital display system. In today's advancing world of technology, most digital display systems are constructed without using individual logic gates and integrated circuits (ICs) which were commonly used in the past. (Aribisala et al., 2018) designed and implemented a Sequential Digital Display which is an electronic system being used to display information to the public. The components used for the construction include; a transformer, diodes, voltage regulator, resistors (fixed and variable types), capacitors, NE 555 timer, IC4017, IC7432, light-emitting diodes (LEDs) and transistors. But in recent times, microprocessors and microcontroller chips which are programmable devices which contain the necessary circuitry needed to create logic functions are being used to construct digital systems.

An electronic message display board also known as a moving message display board, is an electronic device that makes use of a matrix of light-emitting diodes (LEDs) to display alphanumeric characters, symbols and any other type of representation. The characters are scrolled and moved across the screen making the emerging information legible and engaging to the viewer. It also has an unrivalled benefit in attracting people's attention by making them reflect repeatedly on the scrolling light which displays the messages. It is widely used for outdoor purposes. Realistically, it is the most enticing, compelling and appealing mode of communication. (Ogunseye et al., 2022).

This paper is concerned with the use of a micro-controller and LED with other basic components for the design and construction of a message display to be placed at the entrance of laboratories. This design is a prototype which can be improved upon. Therefore, the purpose of this paper is to design and construct a microcontroller-based timetable display.

Review of Literature

Display of information using the analogue system has been in use indifferent forms which include signposts for pointingdirection or caution signs, billboards for price displayand scoreboards use fordisplaying scores in sports or even largeboards for advertisement purposes. But the need for ease in transmitting information is making electronic message display popular and necessary.

So many methods have been used for the construction of digital electronic message display boards for application in different spheres of life using different components with some using wired or wireless connections. (Ibrahim et al., 2014)designed a Moving Message Crawler Display System (MMCDS) also called Microcontroller Based Message Board (MBMB) via PS2 keyboard entry with serial communication using PIC16F876A microcontroller. The software design was based on the assembly language written and tested with a PIC microcontroller. Microcontroller digital electronic components combined with discrete electronic components were used with ULN 2803 driver to drive a display unit which is made up of highly efficient and low power consuming Light Emitting Diodes (LEDs) as the electronic display components. (Bakare B. I & Odeyemi F.M,2015) implemented a moving message display system using PIC16F648A to display GREAT DEPT. OF ELECT. ENGRG., with the microcontroller, programmed using an Assembly language with MPLAB software and a PIC program.

Different methods of wireless technologies have been used which include GSM-based, Bluetooth and Android-based, (Verma et al., 2016) designed a GSM Based LED Display Board using a GSM modem and LPC2148 microcontroller, (Smart et al., 2018) also designed a GSM Based Wireless Electronic Notice Board using PIC18F2550 Microcontroller. In each of these designs, a message is sent from a phone user to the modem and the message received is sent to the microcontroller which helps to display the message on the board. (Jagtap et al., 2019) designed a GSM-based wireless electronic notice board system using different microcontrollers with a GSM modem which also displays temperature, time and date. A message from an authorized mobile phone is sent to the GSM modem and the microcontroller extracts the message from the GSM modem and then displays it on the display board. Similar work to this has been carried out by (Hussaini et al., 2019) using GSM 300 module and AT-mega 32 microcontroller.

(Gayathri et al., 2015),developed a wireless notice board with in-built power using a solar panel. The display side of the system uses a GSM modem to receive SMS and a microcontroller (IC AT89c51) as a controller to drive the LED display board.(Nivetha et al., 2013) designed and implemented an SMS-based wireless notice board with a monitoring system. The project was designed using an integrated circuit ARM-LPC2148 which is interfaced with a graphical display. Messages are sent through an ARM controller using GSM technology. The monitoring system makes use of an image sensor which captures the images for a specified amount of time and these images can be transferred to a PC using a USB port for storage

(Chinedu & Regina, 2017) made use of Embedded C language MikroC IDE and AT Command to send messages through a mobile phone from any location to a SIM card inserted in a GSM Modem where the Modem receives the message sent and sends it serially to the USART module of the microcontroller through a DB9 serial cable and the message is then displayed on an LCD screen

(Kabika & Jian-min, 2014) designed and implemented a PC Based Moving Message Display Board System with RF link which makes use of wireless technology consisting of the hardware and software with AT89S51 microcontroller,

RF module, and 8x32 matrix moving LED display. This system also consists of a graphical user interface (GUI). The GUI is linked to a database (Ms Access 2007) where the system can only be accessed by the authorized user. The message is entered into the computer by the use of a keyboard and it is displayed by the RF transmitter (SZ05) connected to the computer and then received by the RF receiver (SZ05) which is connected directly to the AT89S52RC microcontroller. The microcontroller decodes the received data packet, and transfers the decoded information (message) to the display board with the help of the programmed AT89S52RC microcontroller,

(Obianuju et al., 2020) proposed an Automated Real-Time Light Emitting Diode (LED) Display Board for the University of Jos, Nigeria. The Architecture of the system consists of Arduino mega 2560 microcontroller which is used for processing and validation, and an onboard micro-SD card which is used to store files for serving over the network. An Ethernet shield and the Arduino mega are used to create a web server which enables remote configuration of the message and the microcontroller forwards the message to the LED dot matrix to display.

Also, Mahdi et al. (2021) designed a wireless scrolling message display board using Bluetooth technology, where the message display is interfaced with an android application which is used to display information from an android phone to a LED screen using the Bluetooth interface. This design makes use of an ATMEGA328p microcontroller, a Bluetooth module (HC-06) and a LED screen. This work is therefore aimed at improving upon previous works in the design and implementation of message displays.

Methodology

This paper describes the design and construction of a laboratory digital timetable display. The led display system mainly consists of the HD-W60-75 microcontroller, display module, and LedArt software which is used to send messages from an authorized mobile phone. The microcontroller and Light Emitting Diode display board are powered from the power source as shown in the system block diagram in Figure. 2. The system operates based on the instruction saved in the LedArt editor, the HD-W60-75 microcontroller used in this system receives and transmits the data. The message sent through the LedArt software on an Android phone is processed by the microcontroller and from there to the display module for display. It is possible to change the text on the LED display board easily by using the LedArt editor. The materials used in the construction of this work were carefully selected to suit every part of the design as well as the performance at the required operational standards and a few factors were taken into consideration which are; power consumption, portability, durability, cost-efficiency, size, and heat dissipation.The digital display frame was constructed using plywood. The numbers and dimension of the P10 LED display module to be used was taken into consideration. The wooden frame was secured together using TOP BOND glue and nails and it was carefully covered with a layer of vinyl sticker to cover the wood. Figure 1 shows the construction of the frame.The idea described in this paper is to construct a system which is cost-effective and also easier to operate.

Figure.1Construction of the digital display frame

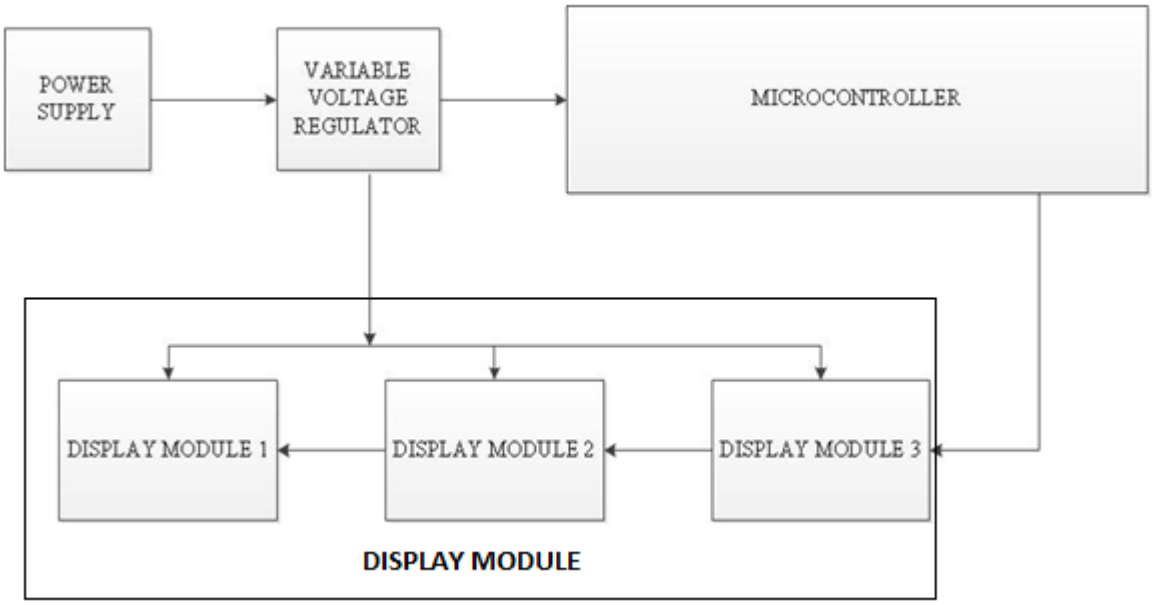

Figure. 2: Block diagram of digital display time-table

Selection of Materials

This work is broken down into two categories; Hardware Module and Software.

Hardware Module

The constituent parts involved with this module are:

- LED Display module
- LED Controller module.
- Power supply

LED Display Module

A led display is a flat panel display that makes use of an array of Light Emitting Diodes (LEDs) as a pixel to display texts, images and videos. Three modules were used in this work, each having a length and width of 12 inches and 6 inches respectively. The three modules were placed side by side due to the type of text to be displayed. The total length of the modules was 36 inches therefore; the dimension of the wooden frame was approximately 37inches by 7inches. Figure 3a and 3b show the interior and exterior view of the LED display module after putting it on the wooden frame.

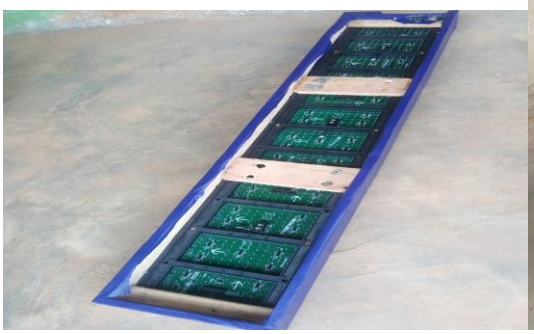

Figure 3a (Interior view)

Figure 3b (Exterior view)

Features of a P10 LED display module

- Brightness: 3500-4500nits
- Max Power Consumption: 20W
- Voltage Input: DC 5V
- 1W Pixel Configuration
- High Viewing Angle
- High Contrast Ratio

LED Controller Module

An HD-W60-75 controller module is used in this work. It is a Wi-Fi series display controller card, which updates programs by Wi-Fi and also through USB Port. The controller has a rated voltage of 3 to 5V and a communication distance of 10 to 30 metres. This controller consists of various terminals used for various connections. The wiring connection is shown in Figure 4 below.

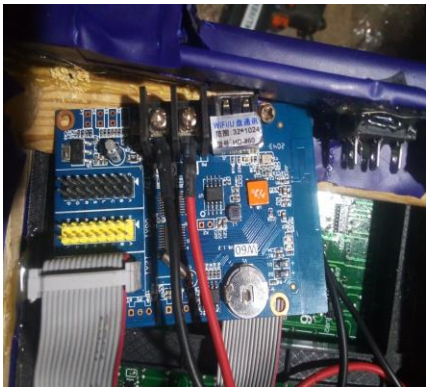

Figure 4. Wiring connections of the HD-W60-75 LED controller

Power Supply Unit

The power supply unit makes use of the following components; a 12V adapter, wires**,** 10kΩ variable resistor**,** a 330Ω resistoranda variable voltage regulator (LM317). The 12-volt adapter is powered using a 220V AC mains supply and it is connected to the variable circuit consisting of the 330 Ω, 10kΩ variable resistor and LM317.The LM317 is an adjustable 3-terminal (adjustment, input and output) voltage regulator which has an output current of 1.5A and an output voltage within the range of 1.25V to over 30V. It is ideal for any low voltage power supply because it has an in-built current limiting and thermal shutdown capabilities. By using the ratio of the two resistors;330Ω and the 10kΩ

variable resistor which was varied to 1.32 kΩ,the desired output of 5V was achieved which is the voltage needed to power the system with a corresponding input voltage of 12V from the adapter. The circuit connection is shown below in Figure.5.

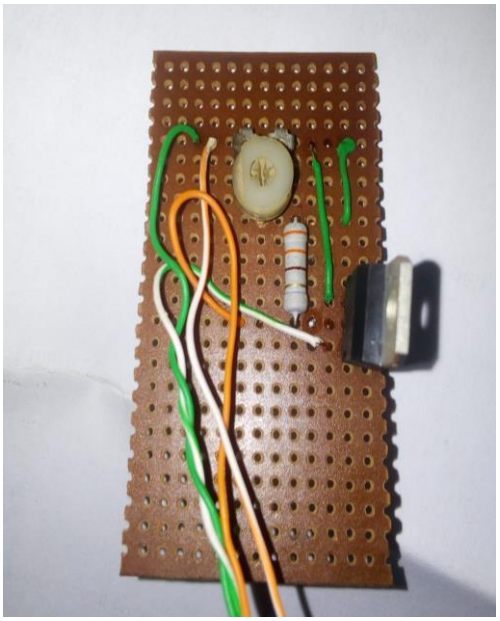

Figure 5:Variable Voltage Supply Circuit

The required value of R2 needed to give an output of 5V was calculated using the equation below ;
Vout= 1.25(1 + R2/R1)
R1= 330Ω, Vout=5V, R2=? 1.25V= constant reference voltage of feedback resistor
R2= 330 .((5/1.25) -1) = 1320 Ω

Software

An android software known as LedArt application which can be downloaded from the Google play store is used to input characters to be displayed on the message display board and it has the following features;

- Mobile phone system support - Android 4.0 and above; iOS 7.0 and above.
- Communication mode - Communication through Wi-Fi.
- Mobile phone remote settings control card, send remote instructions.
- Cluster send program.
- Support multi-program.
- Support multi-language.
- Support the Internet remote control screen

Wi-Fi Connection

For the Wi-Fi connection, open the phone settings, then go to wireless settings (or WLAN/Wi-Fi), and check for the wireless signal of the control card (A60-15-A2316) click and enter thepassword, with the default password as 88888888. This password can later be changed by the user. The process is shown in Figure 6 below. To establish communication between the Digital Time Table display and the smartphone, "Find device" is clicked on the software menu for a corresponding control for wireless Wi-Fi signal connection.

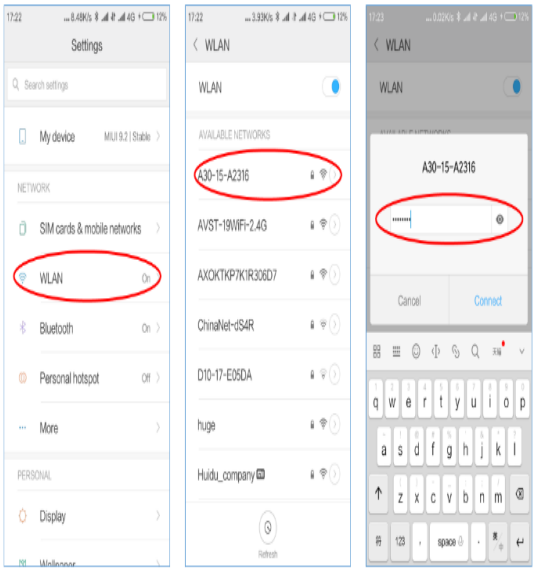

Figure 6. The smartphone wireless connection setting interface

Main interface

The device list and the function settingarea make up the software interface. Under the function settings, the switching machine setting, thebrightness setting, the time correction, the remote control, shake etc can be seen as shown in Figure 7.

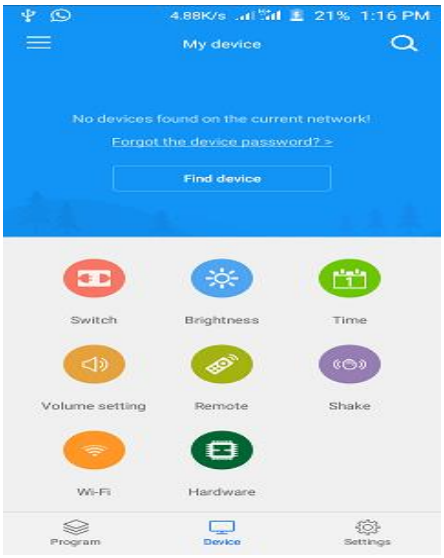

Figure 7. The LedArt software main interface.

Program editor

The LedArt application's program editor is used to display the timetable on the display board. As soon as the application is opened, a list of editable programs is displayed. When any of these programs is selected, a window displaying a program and text at the bottom left of the screen appears. When the program option is chosen, the display time can be entered and when the text option is chosen, the desired message can also be typed in. Finally, the send button in the top right corner of the window is clicked, and the message is sent to the message display board via the W60-75 LED Display Controller Board.

3. Result

The performance of the system (hardware and software) was tested after the construction. The system voltage was measured using a multimeter and the voltage was 5.03V as seen in Figure 8 below. A wireless connection between the hardware(display) and the software(LedArt) was also tested to ensure the connectivity and functionality of the display.

Figure 8:Testing and adjustment of input voltage

4. Discussion

The design and construction of the laboratory digital timetable display was achieved using discrete components. The result of the initial display shows that the system cannot perform effectively with a voltage below 3V. Anything below this voltage will result in a poor display of the desired message as seen in Figure 9a adjustment was done on the power supply circuitto achieve the required voltage needed to power the system and the display in Figure 9b shows the final test result while Fig.9c shows the installed system. The system is easy to construct as it makes use of a few components. This system is also easy to use as programming is not required by the user. The user will simply use an android application (LedArt), free of charge to interface with an HD-W60-75 controller which allows messages to be sent wirelessly to the LED display.

Figure 8a. Initial test result

Figure 8b. Final test result

Figure 8c. Installed Laboratory digital timetable display

5. Conclusion

This paper is based on the use of wireless technology. The main objective is to replace the display of timetables with sheets of paper with a faster, efficient and convenient system. This objective has been achieved by this system which is cost-efficient system and also easy to handle. Modifications can still be made to this construction to develop larger scales and more costly prototypes. Certain factors such as portability, efficiency, durability and availability of components were duly considered. The performance of the system was tested after coupling and was seen that the desired specification was met. This project will not only provide the display of time table for practical hours but also solve the problem of instant information transfer.

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