

DESIGN OF AN LED MATRIX DIGITAL DISPLAY SYSTEM

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ABSTRACT

The digital display system is used for disseminating information to a crowd or a larger audience within a particular location. In today's world of technological innovation, digital media is playing an important role in information dissemination as well as in the Educational sector in enhancing or keeping students abreast of academic work and the latest news around the campus. This paper, is a detailed analysis of the design and implementation of a microcontroller-based digital display system, using wireless communication to send and receive information displayed on the display board. It has three sections; power, control and display. The designed system is made up of two parts, the hardware and the software. The hardware part is made up of many p10 modules (LED matrix), power supply modules, Esp32 microcontrollers, jumper cables and the aluminium casing. The software consists of the Microcontroller unit (MCU) code and the mobile application code. The MCU code controls the MCU functions, receives custom messages from mobile devices and displays them in a readable form by illuminating the corresponding LED. The mobile application provides an interface for the users to write and send custom messages to the MCU using WiFi communication.

INTRODUCTION

Information delivery and dissemination are as old as man. The need to show or deliver information, and advertise products has led to increasing research and technological advancement in the area of information display and signage which has revolutionized the method of displaying information from traditional methods such as signposts, placards, fliers, notice boards, etc. Advancement in information delivery using electronic display systems has been gaining ground in recent times, making static methods of information or sign display such as banners, and flyers look unattractive and monotonous (Jagtap *et al.* 2016).

The need to pass information to others or to constantly communicate an idea, event, or update to one another is of great importance and cannot be overemphasized. The primary aim is to provide individuals with necessary or germane information that is essential to improving lives. In institutions of learning especially in Universities, colleges, and polytechnics the need for real-time information dissemination is of utmost importance, as it enables students to be aware of their schedule, the timing of exams, classes, notices, events and other necessary information they need to improve learning, planning as well as life in school Arijaje *et al.* (2020). Technological advancement has provided alternative means of disseminating information, disrupting traditional methods that have been used in the past. These ingenious innovations have birthed new technology in Wireless communication such as WiFi, Bluetooth, and cellular networks.

This has greatly impacted our daily lives, making it easier for people to communicate, sell their products, or socialize.

The use of programmable and reprogrammable electronics display information has provided a real-time and adaptable method of delivery information at a much cheaper cost, and wider reach. The development of an electronic based information delivery system has covered numerous technologies since its beginnings Adetoye *et al.* (2018). Display technologies have undergone significant development over the years. During the late 20th century, the market was primarily ruled by cathode ray tubes (CRTs) and analogue systems. Nevertheless, emerging trends in display technology are laying importance on features such as picture quality, size, and energy consumption.

The need to transfer information from one person to the other is of great importance. Also, the method chosen to deliver or share an information will determine if it will get to the recipient. In most institution today, they still rely on traditional or static mode of information delivery, such as sign board, banners, flyers etc. Kalu *et al* (2024). These methods are rather boring, easily worn out due to climate, and unattractive. Information displayed on flyers, boards, and banners are static, and cannot be changed or customized when the need arises especially for real time information such as weather report, news headlines, or bus schedules which constantly needs to be changed or updated always. It makes the entire process redundant, slow, and expensive and requires a number of human effort to design and print new banners or fliers. Also most of the existing LED matrix display system are monotonous such that the messages are not customizable or do not have medium to communicate with the controller, hence it is rather difficult to change or update information displayed with ease. The aim of this research is to develop a digital display system using p10 LED matrix module and ESP 32 microcontroller (MCU). The developed system is a programmable information display system using LED matrix.

It employs the use of an ESP32 Microcontroller with inbuilt WiFi and Bluetooth module. For the LED matrix, a P10 module was used, and to get the desired frame size of 4feet by 2 feet, a total 16 pieces of p10 module was used. They were connected in series using a wired jumper cable. To communicate with the microcontroller wirelessly, an android application was developed to interact with the system so as to send personalized messages to the microcontroller (MCU). This processes the messages received, therefore illuminating the LEDs to represent the information in a readable format.

This project is of great importance to Business owners, event organizers or promoters, organizations, and institution of learning as it provides them with tools and device to display their information, advertise their goods, and promote their events. It provides the platform to reach a wider audience with ability to regularly change the messages or information with ease, and at cheaper cost. This project is also beneficial to students and enthusiast especially those in electronics and computer engineering as it provides them with reference materials to build embedded, customizable or automated systems.

MATERIALS AND METHODS

The developed system consists of two different part, which are the hardware and the software. The hardware are the physical components that was connected to display the messages on the LED, while the software is the program code. The program is also divided into two (2) parts, which are the microcontroller code, written in C++ programming language, and the programming code for the developing the mobile application written in Java.

The system hardware is made up of a number of individual components, each performing a specific function. They include ESP32 Microcontroller, this acts as the brain of the system and controls the other individual parts of the system, to ensure information are displayed through the LED. WiFi and Bluetooth module are incorporated in the MCU, and hence comes as a single component. Other components are P10 LED matrix module, power pack, voltage regulator, temperature sensor, and the outer casing.

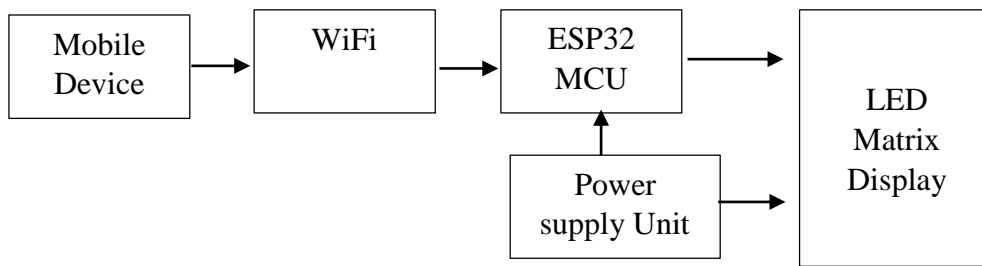


Fig 1: Block diagram of the designed digital display system. Source: (Author)

Microcontroller unit (MCU)

The microcontroller unit (MCU) acts as the brain of the system, it holds the program to receive messages from mobile device through WiFi network, process and execute the instructions. For this project, ESP32 Microcontroller was used for the development.

The Esp32 MCU is outstanding for the development of this project, due to modules embedded into it such as Radio Frequency (RF) components integrated into it like Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun. It has a Single or Dual-Core 32-bit LX6 Microprocessor with a clock frequency of up to 240 MHz. Making designing LED digital display around ESP32 rather easy.

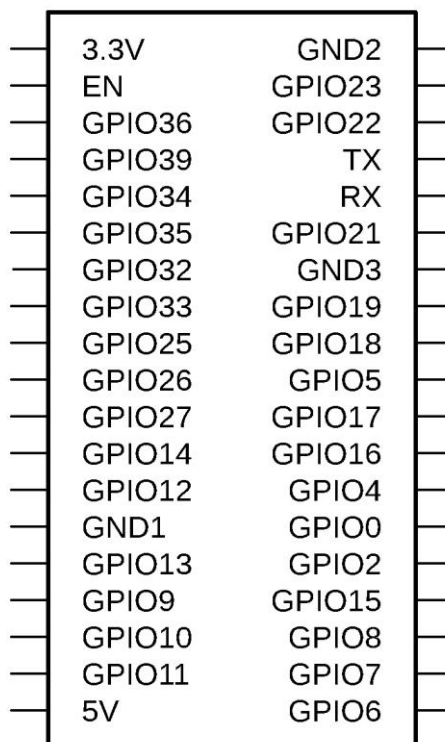


Fig 2: Esp32 Microcontroller unit (MCU) with its GPIO pins. Source: (<https://www.electronicclinic.com/wp-content/uploads/2020/01/esp32-led-circuit-diagram.png>)

P10 LED module: P10 LED module is a type of LED module in matrix that is commonly used for information displays, and for visual communications. As the name implies, the P10 refers to the pixel pitch, or the distance between the center of one pixel to the center of the next pixel. A P10 has a distance

of 10 millimeters from one point to the other. P10 LED displays are composed of many small LED modules, each containing red, green, and blue LED chips. These modules are assembled together to form a larger display panel, which can range in size from a few square feet to several hundred square feet. To display content on a P10 LED display, a control system sends signals to each LED module, which illuminates the appropriate LEDs to create the desired image or message.

Temperature sensor: The temperature sensor module measures the ambient temperature of the LED display system. It was attached to the LED board, and measures the temperature by converting the input data into electrical signal, so as to regulate the cooling fan, as the temperature changes.

Mobile application: The mobile application is installed on a mobile device with either an android or IOS operating system. The application has an interactive user interface that enables users to compose and edit messages that are sent to MCU via WiFi.

RESULTS

The designed digital display system was tested in the department of Electrical, School of Secondary Education (Technical), College of Education (Technical), Ekiadolor Edo state. The system was connected to a supply main of 220V. It was stepped down by a 220V to a 15V DC transformer. To obtain a constant 5V, an LM805 Voltage regulator integrated circuit (IC) was connected to the supply, to provide a constant voltage of 5V to the LED module. This is to ensure the LED luminous intensity does not fluctuate under increased load current.



Fig 2. The result P10 module lit up and displayed “WELCOME TO Department of Electrical”.



Fig 3. Digital display system with all the P10 module connected in series.

CONCLUSION

This paper presents the development of a digital display system using WiFi to communicate between a mobile application and the MCU. This will enable a robust medium for updating the digital display with information at real time. The designed system provides a robust and innovative medium for dissemination of information to the public, and also ensure a wider audience is reached. This project is a cutting edge technology, with a friendly and interactive user interface for clear information display.

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