

WI-FI CONTROLLED SCROLLING DISPLAY SYSTEM

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Abstract- In the era of digitization and IoT (Internet of Things), display systems have evolved from static signage to programmable and remotely accessible solutions. This paper presents the development and implementation of a Wi-Fi-controlled scrolling display system using an ESP8266 microcontroller and an LED matrix display. The proposed system enables real-time, wireless communication through a web-based interface for seamless content updates. Applications range from educational institutions and public transport to commercial advertisements. The system offers cost-effective, scalable, and energy-efficient digital signage.

Keywords: Scrolling Display, Wi-Fi Communication, IoT, ESP8266, LED Matrix, Wireless Display, Real-Time Messaging.

1. INTRODUCTION

In today's digital age, dynamic communication systems are playing an increasingly vital role in disseminating information quickly and effectively. Display boards, in particular, are essential tools for visual communication and are extensively used in a variety of environments such as public transportation systems, educational institutions, commercial complexes, government offices, hospitals, and industrial premises. These boards are used to share announcements, instructions, advertisements, and alerts in real time.

However, conventional display systems are often limited by manual data entry, local hardware control, or the need for physical connectivity through serial or USB interfaces. This traditional approach leads to inefficiencies such as delayed message updates, restricted access, and increased maintenance effort. These limitations become more significant in scenarios that require frequent content updates or remote access.

With the rapid evolution of the Internet of Things (IoT), wireless communication has emerged as a promising solution to enhance the flexibility and responsiveness of display systems. Wi-Fi-enabled microcontrollers now offer seamless integration with web-based interfaces, enabling users to remotely update and manage displayed content in real-time, from any location with network access.

This research presents the design and implementation of a **Wi-Fi-controlled scrolling display system** using the **NodeMCU ESP8266** microcontroller and an **LED matrix display**. The system allows users to input and modify scrolling text messages wirelessly through a simple and intuitive web interface hosted directly on the microcontroller. The integration of wireless technology not only reduces the cost of hardware infrastructure but also enhances system scalability and ease of use.

The proposed system is ideal for real-time message broadcasting, emergency alerts, public information dissemination, and advertising. It offers a low-cost, energy-efficient, and user-friendly solution for modern smart display applications. The paper further elaborates on the hardware setup, software implementation, communication mechanism, and potential applications, along with experimental results that validate the effectiveness of the system.

2. SYSTEM ARCHITECTURE

The proposed **Wi-Fi-controlled scrolling display system** is designed to enable real-time, wireless message updates on an LED matrix display. It integrates embedded hardware, wireless communication, and a simple web-based user interface to form a seamless and user-friendly digital signage solution. The architecture is composed of three primary components:

2.1 Wi-Fi Module (NodeMCU ESP8266)

The NodeMCU ESP8266 is a low-cost microcontroller with built-in Wi-Fi capabilities. It acts as the central processing unit of the system, responsible for establishing a wireless connection, hosting the web interface, receiving input from users, and transmitting display commands to the LED matrix.

2.2 LED Matrix Display

This is the visual output device where the scrolling text is displayed. The matrix is controlled by the ESP8266 and is capable of displaying alphanumeric characters in a continuous scrolling fashion. The display size can be adjusted based on application needs (e.g., 8x32, 16x64 modules).

2.3 Web Interface

Developed using HTML and JavaScript, the web interface is hosted on the ESP8266 itself. Users can access it via any device (laptop, smartphone, tablet) connected to the same network. The interface includes a text input field that allows users to submit custom messages for display.

3. SYSTEM FLOW

3.1 User Access

The user connects to the NodeMCU via Wi-Fi. This can be done either through a local Wi-Fi network (Station Mode) or directly to the device's hotspot (Access Point Mode), depending on configuration.

3.2 Message Entry

Once connected, the user opens a web browser and accesses the HTML-based interface. A text box is provided where the desired message can be typed.

3.3 Message Submission

Upon clicking the submit button, the message is sent to the ESP8266 microcontroller through an HTTP GET or POST request.

3.4 Message Display

The microcontroller processes the message, formats it for the LED matrix, and sends display instructions. The LED matrix then scrolls the message across the screen at a defined speed and brightness.

This modular approach ensures that the system is flexible, easy to maintain, and scalable for future enhancements such as multilingual support, message queuing, or integration with online APIs (e.g., weather, news, alerts). The use of wireless technology significantly improves accessibility and user control, making it suitable for various real-time display applications in both public and private sectors.

4. COMPONENTS USED

Component	Description
ESP8266 (NodeMCU)	Microcontroller with built-in Wi-Fi
8x32/16x32 LED Matrix	For scrolling text output
Power Supply (5V 2A)	For LED matrix and NodeMCU
HTML/CSS	Webpage design
Arduino IDE	Code development and uploading

5. SOFTWARE AND PROGRAMMING

The code is developed using Arduino IDE with the following libraries:

- ESP8266WiFi.h: To manage Wi-Fi connections
- ESPAsyncWebServer.h: For handling the web server
- Adafruit_GFX.h and Max72xxPanel.h: For controlling the LED matrix

5.1 Snippet of code for web server setup

```

cpp
CopyEdit
#include <ESP8266WiFi.h>
#include <ESPAsyncWebServer.h>

const char* ssid = "YOUR_SSID";
const char* password = "YOUR_PASSWORD";
AsyncWebServer server(80);

// HTML page hosted on the microcontroller
const char index_html[] PROGMEM = R"rawliteral(

```

```

<!DOCTYPE html>
<html>
<head><title>Scrolling Display</title></head>
<body>
  <form action="/get">
    <input type="text" name="message">
    <input type="submit" value="Send Message">
  </form>
</body>
</html>rawliteral";

```

6. RESULTS AND DISCUSSION

The proposed Wi-Fi-controlled scrolling display system was developed and tested in a controlled laboratory environment to validate its performance and functionality. The primary objective was to assess the effectiveness of the wireless communication interface, responsiveness of the system, and accuracy of message display. The testing process involved multiple users connecting to the system through Wi-Fi using different devices, including laptops and smartphones. The following observations were recorded:

6.1 Wi-Fi Connectivity

Users were able to successfully connect to the ESP8266 module using the hosted Wi-Fi network. The connection was stable and consistent within a defined range.

6.2 User Interface Interaction

Upon accessing the web-based interface through a standard web browser, users were able to input custom text messages. The interface responded well to user input, and no compatibility issues were observed across different devices and browsers.

6.3 Display Response

Once the message was submitted through the interface, the scrolling text appeared on the LED matrix display almost instantaneously. The system demonstrated smooth and continuous scrolling, maintaining text readability and formatting.

6.4 Performance Metrics

The following performance parameters were measured during testing:

6.4.1 Latency

The time taken from message submission to display update was consistently below **1 second**, indicating a high degree of responsiveness suitable for real-time applications.

6.4.2 Operational Range

The system maintained stable Wi-Fi communication within a range of approximately **20–30 meters** in an open environment. Performance in enclosed spaces may vary depending on physical obstructions and interference.

6.4.3 Message Capacity

The system was able to handle text messages of up to **255 characters** efficiently. Longer messages were automatically scrolled across the LED matrix without any truncation or delay.

These results confirm the practical viability of the system for real-time wireless message broadcasting. The low latency and user-friendly web interface make it ideal for applications such as digital notice boards, public alerts, and dynamic advertising displays. Further improvements such as mobile app integration, support for multiple users, or cloud-based message storage can enhance its functionality and scalability.

7. APPLICATIONS

- Real-time announcement boards in schools/colleges
- Bus stand/train station updates
- Retail and mall advertisements
- Office/building entrance notifications

CONCLUSION

The development of the Wi-Fi-controlled scrolling display system demonstrates an efficient, low-cost, and scalable solution for wireless content dissemination. By integrating the ESP8266 microcontroller with an LED matrix and a web-based user interface, the system enables real-time message updates without the need for physical connections or complex infrastructure. The user-friendly design and responsive performance make it highly suitable for a wide range of applications, including educational institutions, public transport hubs, retail spaces, and industrial environments.

The successful implementation and testing validate the system's functionality, offering key advantages such as ease of use, rapid deployment, and flexibility in message control. Its adaptability makes it a strong candidate for deployment in both urban and rural settings where real-time digital communication is essential.

Future enhancements could focus on:

- **Integration with voice assistants** for hands-free operation,
- **Cloud-based messaging systems** for remote content management,
- **Multilingual display support** to cater to diverse user bases,
- **Mobile app development** for enhanced accessibility and control.

These additions will further enhance the system's versatility and usability, paving the way for more intelligent and connected public display systems.

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