International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 03 | March - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Remote ESP32 Holographic Display System

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Abstract - This paper presents the design and implementation of a remote-update holographic display system utilizing the ESP32 microcontroller. The system facilitates dynamic image projection through a combination of hardware and software components. A web server acts as an intermediary for image storage and distribution, while a mobile application offers a user-friendly interface for image selection and system control. The ESP32, upon network connection and IP address acquisition, communicates with the web server to retrieve updated image data, enabling real-time content modification. This configuration allows for versatile and interactive holographic presentations.

Key Words: ESP32, holographic display, remote update, web server, mobile application, IP address, dynamic projection.

1. INTRODUCTION

Holographic display technology has the potential to revolutionize visual communication and information display. Traditional holographic methods often involve static images or complex optical setups, limiting their dynamic capabilities. This project aims to overcome these limitations by developing a system that allows for remote and real-time updates of holographic content.

The core of the system is the ESP32, a cost-effective microcontroller with integrated Wi-Fi connectivity. A web server is employed to host and manage image data, enabling seamless distribution to the display unit. A mobile application provides users with an intuitive interface to select, upload, and control the displayed holographic content. The ESP32 acts as the bridge between these components, fetching updated images and driving the holographic projection hardware.

2. SYSTEM ARCHITECTURE

A. System Overview: The remote-update holographic display system comprises the following key components:

- ESP32-based holographic display unit
- Web server for image hosting and management
- Mobile application for user interaction and control
- The ESP32 microcontroller serves as the central processing unit, responsible for network connectivity, data retrieval from the web server, and control of the holographic display hardware. The web server functions as a repository for image data and provides the necessary API for communication with the ESP32 and the mobile application. The mobile application offers a user-friendly interface for users to interact with the system, enabling image selection, uploading, and display control.

B. ESP32 Implementation: The ESP32 microcontroller is programmed to establish a connection with the local Wi-Fi network and dynamically obtain its IP address. This IP address is crucial for network communication and allows the mobile application to target the correct display unit. The ESP32 periodically communicates with the web server, querying for image updates. Upon detection of a new image or update request, the ESP32 downloads the corresponding image data and processes it for display on the holographic projection hardware.

C. Web Server Implementation: The web server acts as a central hub for image storage, management, and distribution. It provides API endpoints for the ESP32 and the mobile application to facilitate seamless communication and data transfer. The server handles image uploads from the mobile application, storing them securely for subsequent retrieval by the ESP32. Additionally, the web server maintains a record of the currently displayed image, enabling synchronization and status tracking across the system.

D. Mobile Application Implementation: The mobile application provides users with a graphical interface to browse, select, and upload images for display on the holographic projection unit. It communicates with the web server via API calls to upload new images, trigger update requests, and receive feedback on the current display status. The application also incorporates network discovery functionality to identify and connect to ESP32-based display units within the local network.

3. HOLOGRAPHIC DISPLAY MECHANISM

The holographic display unit is designed to project 2D images in a manner that creates the illusion of a 3D object. This is typically achieved through a combination of optical principles

and rapid image sequencing. Common implementations involve the use of a transparent pyramidal structure or a rotating display surface. The specific design of the holographic display can be adapted based on the desired visual effect and application requirements.

3. SOFTWARE IMPLEMENTATION

A. ESP32 Firmware Development

The ESP32 firmware is developed using the Arduino IDE and the ESP32 SDK, leveraging libraries for Wi-Fi connectivity, HTTP communication, and display control. The firmware encompasses the following key functionalities:

- Wi-Fi network connection and IP address acquisition.
- Communication with the web server via HTTP requests.
- Image data download and processing.
- Control of the holographic display hardware, including image sequencing and synchronization.

B. Web Server Development

The web server is implemented using standard web technologies such as HTML, CSS, JavaScript, and a server-side language like Python (with Flask or Django) or Node.js. It provides a RESTful API for communication with the ESP32 and the mobile application, handling image uploads, data retrieval requests, and server-side logic.

C. Mobile Application Development

The mobile application is developed for the Android platform using Java or Kotlin. It incorporates features for image browsing, selection, uploading, and display control. The application also includes network discovery mechanisms to identify and connect to ESP32-based display units within the local network.

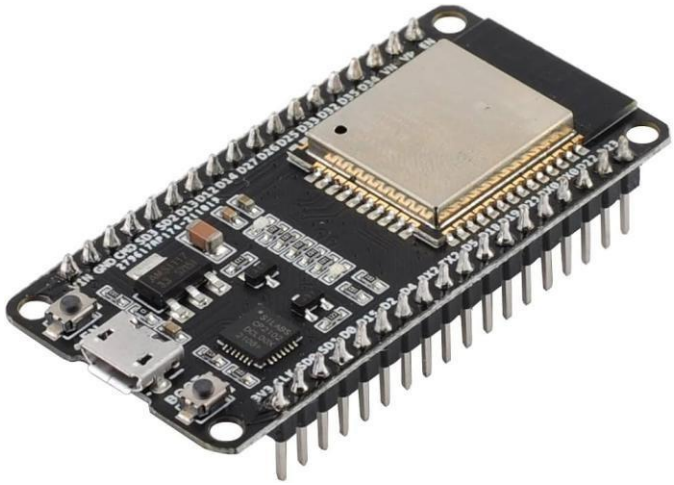

Fig -1: ESP32

3. CONCLUSIONS

This paper presents a cost-effective and versatile solution for creating dynamic holographic displays with remote update capabilities. The integration of the ESP32 microcontroller, a web-based platform, and a mobile application provides a flexible framework for interactive holographic applications. Future research directions may include:

- Enhancing the display resolution and image quality.
- Exploring advanced holographic projection techniques for improved 3D effects.
- Integrating interactive features such as gesture control or voice commands.
- Developing multi-display synchronization for larger holographic installations.

ACKNOWLEDGEMENT

The authors would like to acknowledge the support and resources that made this research possible. We are grateful for the opportunity to explore the potential of real-time, remotely updatable holographic displays using the ESP32 platform.

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