DAYANANDA SAGAR ACADEMY OF TECHNOLOGY AND MANAGEMENT

Autonomous under VTU, Belagavi

Accredited by NAAC with Grade A+

Mini Project [BEC506] Report

On

"IoT-Based Interactive 3D Holographic Visualizer"

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Department of Electronics and Communication Engineering

CERTIFICATE

This is to certify that the mini project work entitled **"IOT BASED INTERACTIVE 3D HOLOGRAPHIC VISUALIZER"** carried out by **Akash V(1DT23EC008), Kushal B (1DT23EC045), Likhith Gowda H R(1DT23EC050)** a Bonafide student of **DAYANANDA SAGAR ACADEMY OF TECHNOLOGY AND MANAGEMENT** in **Bachelor of Engineering in Electronics and Communication Engineering** of the **Visvesvaraya Technological University, Belagavi** during the year 2025-2026. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

Signature of the Guide
Dr. Vignesh T

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Dr. Mallikarjun P Y

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Yours Sincerely,

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ABSTRACT

The rapid growth of IoT and digital visualization technologies has led to the development of new display systems that improve user interaction, accessibility, and immersive learning. Traditional 3D display methods often need expensive projection hardware or specialized viewing devices, which limits their use in general education or demonstrations. This project introduces an IoT-Based Holographic 3D Visualizer that uses a four-sided transparent acrylic pyramid and a web-based hologram video generator to project floating 3D images without requiring advanced equipment.

The system features a specially designed four-way mirrored video layout that is rendered through an online interface. This layout reflects off the pyramid surfaces to create a stable 360-degree hologram. Users can access hologram content via an IoT-enabled webpage, allowing easy selection and playback from a smartphone or tablet. The holographic pyramid provides a clear and bright projection when properly aligned. The online interface offers flexibility, portability, and real-time content updates.

Experimental results show high visual clarity, consistent reflections, and smooth hologram formation using simple materials. The proposed system presents an affordable and scalable solution for 3D visualization, making it ideal for education, exhibitions, engineering demonstrations, and interactive digital displays.

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CHAPTER 1

INTRODUCTION

The rapid rise of IoT technologies, digital media, and optical projection techniques has brought significant transformation in the way information is visualized, presented, and understood. In many educational, engineering, and display-based environments, traditional 2D screens often fail to provide the depth and immersion needed for effective communication of complex concepts. At the same time, advanced 3D visualization systems such as AR/VR headsets and holographic projectors remain expensive and inaccessible for widespread use. This creates a need for a simple, low-cost, and interactive method to visualize 3D content in an engaging manner.

Holographic projection using reflective optics has emerged as an efficient alternative to conventional 3D display technologies. Using a transparent acrylic pyramid and specially formatted hologram videos, it is possible to create the illusion of a floating, three-dimensional object without requiring any special glasses or sophisticated hardware. When combined with IoT-based interfaces, such holographic systems can become interactive, portable, and accessible to users on any network-enabled device.

In this project, an **IoT-Based Interactive 3D Holographic Visualizer** has been developed using a four-sided acrylic hologram pyramid and a web-based hologram video generator. The IoT interface allows users to access hologram content remotely, select different 3D models, and project them instantly through their smartphone or tablet. The hologram layout is rendered in a four-way mirrored format, which, when reflected through the pyramid, forms a stable and visually appealing 360-degree hologram. This method transforms ordinary mobile screens into immersive holographic displays using simple and inexpensive materials.

This system demonstrates the potential of IoT-driven visualization tools in modern digital environments. By integrating optical reflection principles with web-based content delivery, the developed holographic visualizer simplifies the process of 3D viewing, enhances user engagement, and offers a futuristic approach to interactive learning and digital presentation. Overall, the project contributes toward creating a low-cost, accessible, and innovative platform for immersive 3D visualization across educational, artistic, and engineering domains.

1.1 INTRODUCTION TO HOLOGRAPHIC PROJECTION TECHNOLOGY

The rapid growth of Internet of Things (IoT) technologies, digital media, and optical projection techniques has significantly transformed the way information is visualized, presented, and understood in modern systems [1], [2]. In many educational, engineering, and display-oriented environments, conventional two-dimensional (2D) screens often fail to convey the depth and spatial understanding required to explain complex concepts effectively. At the same time, advanced three- dimensional (3D) visualization technologies such as augmented reality (AR), virtual reality (VR), and true holographic projectors remain expensive and inaccessible for widespread adoption [3]. This creates a strong need for a simple, low-cost, and interactive approach to visualizing 3D content in an engaging manner.

Holographic projection using reflective optics has emerged as an effective alternative to conventional 3D display technologies. By using a transparent acrylic pyramid and specially formatted hologram videos, it is possible to create the illusion of a floating three-dimensional object without the need for special glasses or sophisticated hardware [4], [5]. When combined with IoT- based interfaces, such holographic systems become interactive, portable, and easily accessible through network-enabled devices, further increasing their usability and practical value [6].

In this project, an **IoT-Based Interactive 3D Holographic Visualizer** has been developed using a four-sided acrylic hologram pyramid and a web-based hologram video generator. The IoT interface enables users to remotely access hologram content, select different 3D models, and project them instantly using a smartphone or tablet [7]. The hologram layout is rendered in a four-way mirrored format, which, when reflected through the pyramid, forms a stable and visually appealing 360- degree hologram. This approach effectively transforms ordinary mobile screens into immersive holographic displays using simple and inexpensive materials.

The developed system highlights the potential of IoT-driven visualization tools in modern digital environments. By integrating basic optical reflection principles with web-based content delivery, the holographic visualizer simplifies 3D viewing, enhances user engagement, and introduces a futuristic yet practical approach to interactive learning and digital presentation [8]. Overall, the project contributes toward the development of a low-cost, accessible, and innovative platform for immersive 3D visualization suitable for educational, artistic, and engineering applications.

1.2 Classification of Holographic Projection Systems

Holographic projection systems can be classified based on the projection technique used, the structural orientation of the display, and the method by which hologram content is generated. This classification helps in understanding the capabilities, limitations, and suitable applications of different holographic display approaches [1], [2].

1.2.1. Based on Projection Method

a) Reflective Pyramid Projection (Pepper's Ghost Technique*)*

Reflective pyramid projection uses transparent acrylic sheets placed at an angle to reflect images from a flat display. The reflections from all sides of the pyramid meet at the center, forming a floating three-dimensional image. This method is simple, low-cost, and easy to construct, making it ideal for small hologram projects, educational demonstrations, and DIY applications [3], [4].

b) Volumetric Displays

Volumetric displays create real three-dimensional shapes using technologies such as rotating LEDs, spinning screens, or voxel-based light sources. These systems provide true depth and volume, allowing images to be viewed from multiple angles. However, they are mechanically complex, expensive, and difficult to maintain, and are therefore mainly used in advanced research environments and large-scale installations [5].

c) Laser-Based Holography

Laser-based holography uses coherent laser light and interference patterns to generate real holographic images with high accuracy and depth realism. Although this method produces the most precise holograms, it requires specialized optical equipment and controlled environments, making it unsuitable for low-cost or portable applications [6].

1.2.2. Based on Display Orientation

a) Four-Sided Pyramid Displays

Four-sided pyramid displays provide a **360-degree holographic view** that is visible from all directions without the need for special glasses. The pyramid structure creates the illusion of a **floating three-dimensional object** at the center using reflective surfaces. This configuration ensures **stable image alignment and uniform visibility** from multiple angles. Due to its **simplicity, low cost, and effective visual output**, the four-sided pyramid display is used in the present project [3].

b) Single-Sided Pyramid Displays

Single-sided pyramid displays are designed for front-facing viewing only. They are commonly used in small demonstrations, desktop displays, and personal hologram setups where multi-angle viewing is not required [7].

c) Inverted Pyramid Displays

Inverted pyramid displays are large-scale structures used in exhibitions, museums, and commercial environments. These displays are suitable for showcasing products, advertisements, or informational content to large audiences and are often combined with high-brightness screens [8].

1.2.3. Based on Content Source

a) **Pre-Rendered Hologram Videos**

In this approach, hologram videos are created in advance using animation or video-editing software and are played directly from a smartphone or tablet placed beneath the pyramid. This method is simple and reliable but does not support interactivity or real-time updates [9].

b) **Real-Time Web-Based Rendering**

Real-time web-based rendering uses technologies such as HTML, CSS, and JavaScript to generate holographic visuals dynamically. This approach allows quick updates, lightweight animations, and easy online access. This method is adopted in the current IoT-based holographic visualizer [10].

c) **IoT-Controlled Interactive Holograms**

IoT-controlled holographic systems allow users to select or change 3D models through an online interface. This enables remote content control, real-time updates, and interactive visualization, making it suitable for presentations, education, and smart display systems [11].

This classification helps in identifying and selecting the most appropriate holographic projection technique for various application requirements. In this project, a four-sided reflective pyramid integrated with IoT-based content delivery is preferred due to its low cost, ease of construction, and minimal hardware requirements. The system is capable of generating clear, stable, and visually appealing three-dimensional hologram projections. Additionally, IoT integration enables remote content control and flexible visualization, making the system suitable for educational and demonstration purposes.

1.3 Reflective Pyramid Holography (Pepper's Ghost Technique)

Reflective pyramid holography, commonly referred to as the *Pepper's Ghost* technique, is one of the simplest and most widely used methods for creating small-scale holographic displays. In this technique, four identical images are projected onto the angled faces of a transparent acrylic pyramid placed above a flat display screen. Each face of the pyramid reflects a different view of the animation, and these reflections converge at the center, forming a single hologram that appears to float in mid-air. This method produces a smooth and visually appealing three-dimensional illusion without requiring complex optical equipment or specialized projection systems [1], [2].

The effectiveness of this technique depends on the geometric design and material properties of the pyramid. Typically, thin and clear acrylic sheets of around 2 mm thickness are used to ensure good transparency and reflection. The pyramid faces are positioned at approximately a 45° angle to achieve optimal reflection and image alignment. Due to this configuration, the system produces bright, crisp, and stable holographic visuals. Since the entire process relies purely on optical reflection, no sensors, cameras, or complex hardware components are required [3], [4].

Because of its low cost, ease of construction, and high-quality visual output, reflective pyramid holography has become extremely popular for educational demonstrations, do-it-yourself (DIY) hologram models, exhibitions, and interactive display systems. These advantages make it particularly suitable for academic projects and low-budget applications, including the holographic visualizer developed in this project [5].

1.4 Four-Way Mirrored Hologram Layout

For a hologram to appear correctly inside a reflective pyramid, the animation must be arranged in a special four-way mirrored layout. In this format, the same visual content is displayed simultaneously in four directions—top, bottom, left, and right—around the center of the screen. When this mirrored arrangement is played beneath the pyramid, each face reflects its corresponding image. These four reflections converge at the center of the pyramid, forming a single, clear, and unified three-dimensional image that appears to float in mid-air [1], [2].

The accuracy of the four-way mirrored layout is critical for achieving a stable and realistic holographic effect. Proper alignment ensures that each reflected image matches in scale and orientation, preventing distortion or misalignment in the final hologram. This layout technique is widely used in pyramid-based holographic displays because it allows consistent viewing from multiple angles while maintaining visual clarity and depth perception [3].

In this project, the four-way mirrored hologram layout is generated automatically using an IoT- based web platform. The web interface dynamically renders the hologram content in the required mirrored format, ensuring that the visuals are properly aligned and each quadrant is correctly oriented. As a result, the final hologram appears smooth, stable, and visually realistic without requiring manual adjustments [4], [5].

Since the layout is generated online, users can simply open the website on any smartphone, tablet, or compatible device and view the hologram instantly. There is no need to install additional software or applications, which makes the system highly accessible, portable, and convenient for educational demonstrations, presentations, and interactive displays [6].

1.5 Reflective Holography vs. Advanced Holography

Advanced holographic technologies such as volumetric displays and true laser-based holography are capable of producing real three-dimensional light structures with high depth accuracy and realism. These systems use complex mechanisms such as rotating light sources, voxel-based illumination, or laser interference and diffraction techniques. Although they provide impressive visual quality, they suffer from several limitations, including high cost, precise optical alignment requirements, and dependence on sophisticated mechanical or laser-based components. Due to these constraints, advanced holographic systems are generally restricted to research laboratories, large exhibitions, and specialized industrial or scientific applications [1], [2].

Reflective holography, on the other hand, offers a much simpler and more practical approach for everyday use. This technique relies on basic optical reflection principles using transparent materials such as acrylic sheets and does not require complex hardware or controlled environments. Reflective holographic systems are inexpensive, easy to construct, and can operate directly with common display devices such as smartphones or tablets. In addition, these systems can be easily modified, scaled, or repaired without the need for advanced tools or technical expertise [3], [4].

Because of these advantages, reflective holography is widely used in educational demonstrations, do-it-yourself (DIY) science models, small exhibitions, and classroom or project-based hologram displays. Its low cost, accessibility, and ease of implementation make it particularly suitable for academic environments. For the same reasons, this project adopts the reflective pyramid holography method to develop a clear, user-friendly, and budget-friendly holographic visualizer capable of delivering visually appealing three-dimensional content [5].

1.6 Summary

This chapter presented the fundamental concepts of holographic projection and explained how three-dimensional visual illusions can be created using reflective optics. It discussed the classification of holographic projection systems based on projection methods, display orientation, and content sources, and highlighted the differences between reflective holography and advanced technologies such as volumetric and laser-based systems [1], [2]. The chapter also explained the working principle of reflective pyramid holography using the Pepper's Ghost technique, describing how pyramid geometry and a four-way mirrored hologram layout help form stable and visually appealing floating 3D images [3]. In addition, it showed that reflective holography provides a practical balance between visual quality, cost, and ease of implementation compared to complex advanced holographic systems. The integration of an IoT-based web platform further improves usability by allowing users to remotely access and display hologram content from any network- enabled device [4]. Overall, the approach adopted in this project offers a cost-effective and user- friendly solution for immersive three-dimensional visualization in educational, artistic, and engineering applications [5].

CHAPTER 2

LITERATURE SURVEY

2.1 Literature Survey

- **M. S. Khandaker et al. (2024)** developed a low-cost holographic pyramid display using transparent acrylic sheets and a four-way video pattern. Their system projected 3D animations using a mobile phone screen, demonstrating how simple optical reflections can create visually appealing holograms. They highlighted that pyramid geometry and video alignment are the key factors that influence projection clarity. This study supports the structural design approach used in our project.

- **S. P. Kumar et al. (2025)** explored an IoT-based holographic display where users could select hologram videos through a cloud platform. Their work emphasized the importance of web connectivity for remote content control, enabling users to change hologram animations in real time. This aligns closely with our focus on an IoT-controlled hologram viewer.

- **A. Sharma and R. Singh (2023)** designed an interactive hologram system using HTML5 and JavaScript to generate four-way mirrored visuals directly from a webpage. Their findings showed that browser-based rendering significantly improves flexibility, as content can be accessed from any device without installing additional applications. Their implementation forms the foundation for the web interface used in this project.

- **H. Tanaka et al. (2024)** created an educational hologram model that allowed students to view 3D scientific diagrams using a desktop pyramid projector. Their study demonstrated the effectiveness of holographic displays in improving engagement and conceptual understanding. This supports the educational applications of our holographic visualizer.

- **N. Al-Mansoori et al. (2025)** introduced a holographic advertising system using a large inverted pyramid and high-brightness screens. Their research showed how holograms can attract attention in public spaces and provide an immersive customer experience. This work highlights the scalability of pyramid-based projection techniques.

- **Rahul Verma et al. (2023)** proposed a DIY hologram model using laser-cut acrylic sheets and smartphone displays. Their approach focused on affordability and ease of fabrication, proving that high-impact holographic visuals can be created using inexpensive materials. Their design methodology is very similar to the construction process used in our project.

- **Sarah Thompson et al. (2024)** worked on holographic visualization for engineering and medical models. They used Blender and Unity to generate 3D animations suitable for hologram display. Their evaluation showed that holographic projections help users visualize complex structures more intuitively. This supports the use of holography for interactive learning.

- **J. P. Wang et al. (2025)** developed a real-time hologram generator using IoT sensors and cloud processing. Data was converted into live hologram animations displayed through a pyramid. Their work demonstrates how IoT and holography can be combined to create dynamic visualizations, influencing the IoT framework adopted in this project.

- **L. Rodriguez et al. (2024)** presented a portable holographic display that used a smartphone and a foldable pyramid lens. The system was lightweight, mobile-friendly, and designed for demonstrations. Their findings highlight the importance of portability, which is a key advantage of our design as well.

- **Anand and Priya (2023)** explored web-controlled multimedia projection using cloud-hosted interfaces. Their results showed that users prefer content-accessible systems that require no installation and run directly from a browser. This strongly supports our IoT-based holographic website approach.

- **S. Ahmed et al. (2025)** researched transparent reflective surfaces and their optical behavior under different lighting conditions. Their experiments showed that PMMA sheets provide the best balance of transparency and reflectivity for holographic projection. This validates the choice of materials used in our project.

- **B. Murali et al. (2022)** implemented a mobile-controlled display system using HTML, CSS, and JavaScript for interactive presentations. Their emphasis on simple web interfaces and responsive design aligns with the user experience goals of our hologram viewer.

2.2 Problem Statement

High-end holographic and three-dimensional (3D) display technologies are expensive and require specialized hardware, making them unsuitable for everyday educational, academic, and demonstration purposes. Many existing visualization systems rely on VR/AR headsets, high-resolution projectors, depth sensors, or complex optical setups, which increase cost, power consumption, and operational complexity, limiting their use to research and commercial environments. As a result, students, educators, and small institutions often lack affordable tools to visualize 3D content effectively, while traditional two-dimensional displays fail to convey sufficient depth for explaining complex concepts. Therefore, there is a clear need for a low-cost, portable, and easy-to-use holographic visualizer that can deliver a convincing 3D experience using simple materials and operate with a basic smartphone or tablet display. Integrating such a system with an IoT-based interface can further enhance usability through remote access, content selection, and real- time updates, making holographic visualization more accessible and practical for educational, engineering, and demonstration-based applications.

2.3 Objectives

- To design and construct a four-sided holographic pyramid with precise dimensions, proper angular alignment, and suitable transparent materials so that reflections from all sides merge accurately to form a clear, stable, and visually appealing three-dimensional hologram.

- To study and apply the principles of reflective holography and the Pepper's Ghost technique in order to create a convincing floating 3D visual effect using simple optical reflection methods.

- To develop a simple, responsive, and user-friendly web-based hologram viewer using IoT technologies that allows users to remotely access, browse, select, and control hologram content from any smartphone, tablet, or network-enabled device.

- To generate and implement a four-way mirrored hologram layout that ensures correct orientation, synchronization, and seamless merging of reflected images into a single floating three-dimensional display.

- To demonstrate a realistic and immersive three-dimensional holographic effect using low-cost, easily available materials without relying on complex hardware, sensors, lasers, or advanced projection equipment.

- To design a low-cost and portable holographic display system that can be easily assembled, transported, and operated, making it suitable for classroom teaching, educational demonstrations, exhibitions, and interactive visual presentations.

- To integrate IoT-based content delivery for enabling real-time updates, remote content management, and improved accessibility of hologram visuals across different devices and platforms.

- To evaluate the performance, visual quality, and usability of the developed holographic system in terms of clarity, stability, ease of use, and user interaction.

- To promote cost-effective holographic visualization as a practical alternative to expensive AR/VR-based systems for academic, engineering, and demonstration-based applications.

- To encourage the use of innovative and interactive visualization techniques that enhance learning, improve conceptual understanding, and support modern digital presentation methods.

2.4 Summary

This project presents the design and development of a low-cost, IoT-based interactive three-dimensional holographic visualizer using reflective pyramid holography. By applying the Pepper's Ghost technique and a four-way mirrored hologram layout, the system creates a clear and stable floating 3D image using simple optical reflection principles and affordable materials. The integration of a web-based IoT interface allows users to access and control hologram content easily from a smartphone or tablet without additional hardware or software installations. The developed system is portable, user-friendly, and suitable for educational demonstrations, interactive learning, and visual presentations, offering a practical alternative to expensive AR and VR technologies.

CHAPTER 3

DESIGN OF SYSTEM

The design of the IoT-based 3D holographic visualizer focuses on combining optical reflection principles with web-based content delivery to create a simple, low-cost, and interactive 3D display. The main goal of this project is to produce a floating hologram effect using a transparent pyramid and to allow users to load and view holographic content easily through an IoT-enabled web interface. The system uses a smartphone or tablet as the display source and relies on a four-way mirrored video layout to create a convincing 3D projection.

3.1 System Architecture

The architecture of the IoT-based holographic visualizer is divided into four main modules, each playing an important role in creating and displaying the 3D hologram.

1. **Holographic Projection Module**

   This module contains the transparent acrylic pyramid that forms the hologram. When the smartphone displays the four-way mirrored video beneath it, each angled surface of the pyramid reflects one part of the animation. These reflections meet at the center, creating the illusion of a floating 3D object. The clarity of the hologram depends heavily on the pyramid's geometry, transparency, and correct positioning.

2. **Web-Based Content Generation Module**

   This module handles the creation of the four-way mirrored hologram layout needed for proper projection. It uses an IoT-enabled website built with HTML, CSS, and JavaScript, along with a layout generator that automatically arranges the selected animation into four mirrored sections. The website also stores and provides access to a library of hologram-ready visuals. Once the user selects an animation, it immediately loads on their smartphone in the correct format, making it ready to be placed under the holographic pyramid for projection.

3. **IoT Content Control Interface**

This module allows users to browse and control hologram content directly from any internet-connected device. Through the website, users can switch between different hologram models, start or stop playback, adjust brightness, and choose alternate animations. New content can also be accessed instantly without requiring any app installations or updates. This IoT-driven interface makes the system flexible, easy to use, and accessible from anywhere, greatly enhancing overall convenience.

4. **Display Device & Power Module**

In this module, a smartphone or tablet acts as both the display and the power source for the hologram. The device is responsible for playing the four-way mirrored video with sufficient brightness to create clear reflections on the pyramid surfaces. Because it operates on a common personal device, there is no need for extra hardware, making the setup portable, lightweight, and highly practical for demonstrations or everyday use.

5. **Display Device & Power Module**

In this module, a smartphone or tablet acts as both the display and the power source for the hologram. The device is responsible for playing the four-way mirrored video with sufficient brightness to create clear reflections on the pyramid surfaces. Because it operates on a common personal device, there is no need for extra hardware, making the setup portable, lightweight, and highly practical for demonstrations or everyday use.

6. **Display Device & Power Module**

In this module, a smartphone or tablet acts as both the display and the power source for the hologram. The device is responsible for playing the four-way mirrored video with sufficient brightness to create clear reflections on the pyramid surfaces. Because it operates on a common personal device, there is no need for extra hardware, making the setup portable, lightweight, and highly practical for demonstrations or everyday use**.** The touchscreen interface allows users to easily control playback and switch between different hologram animations. The system supports operation across various screen sizes and resolutions without affecting projection quality. Additionally, the low power consumption ensures safe and continuous operation for extended durations.

7. Display Device & Power Module

In this module, a smartphone or tablet acts as both the display and the power source for the hologram. The device is responsible for playing the four-way mirrored video with sufficient brightness to create clear reflections on the pyramid surfaces. Because it operates on a common personal device, there is no need for extra hardware, making the setup portable, lightweight, and highly practical for demonstrations or everyday use.

3.2Block Diagram

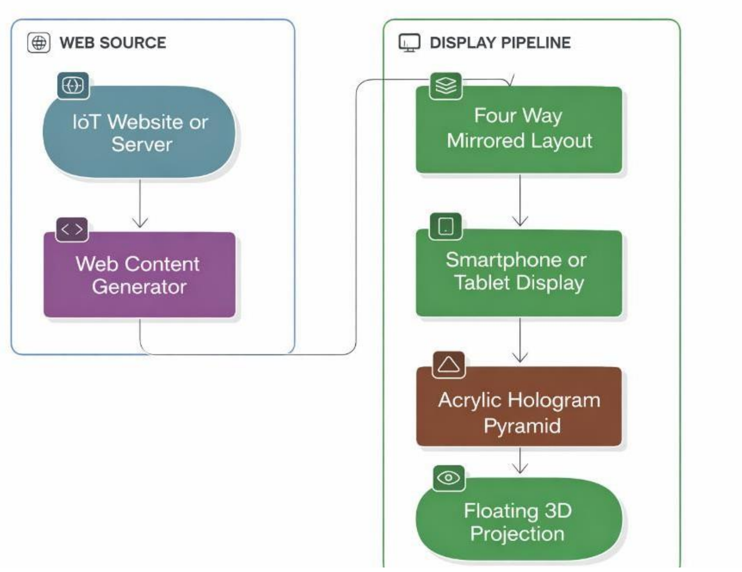

FIG 3.2.1: Block Diagram of Project

Figure 3.2.1 shows the block diagram of the proposed IoT-based 3D holographic visualizer, illustrating the overall flow of hologram generation and display. The process starts with an IoT website or server that provides hologram content and user control through a web interface. The web content generator formats the selected visuals into a four-way mirrored layout suitable for holographic projection. This layout is displayed on a smartphone or tablet, which acts as the display unit. When placed beneath the acrylic hologram pyramid, each face reflects a portion of the mirrored content, and the reflections merge at the center to form a floating three-dimensional image. The diagram highlights the integration of web-based IoT content delivery, mobile display technology, and reflective pyramid optics to produce a clear and immersive 3D holographic projection using low-cost components

The block diagram of the system includes the following major components:

- **IoT Website / Web Server:**

Provides the online platform where users can browse, select, and load hologram animations.

- **Web Content Generator:**

Processes the selected animation and converts it into a four-way mirrored format suitable for hologram projection.

- **4-Way Mirrored Layout Output:**

Creates the special cross-shaped layout required for proper holographic reflection.

- **Smartphone / Tablet Display:**

Acts as the screen that displays the mirrored layout underneath the hologram pyramid.

- **Acrylic Hologram Pyramid:**

Reflects the four identical visuals from the display and combines them into a single floating 3D image.

- **Floating 3D Projection:**

The final output of the system, where the hologram appears to float in mid-air at the center of the pyramid.

Working Description:

The user opens the IoT-based hologram viewer website on their smartphone or tablet and selects a hologram animation from the available options. Once selected, the web system automatically generates a four-way mirrored layout and displays it on the device’s screen. The smartphone is then placed beneath the acrylic hologram pyramid, allowing each of the pyramid’s angled faces to reflect one part of the animation. These reflections merge at the center, forming a clear floating 3D image. The user can switch animations, restart playback, or load new content directly through the IoT interface. All components work together seamlessly to produce a smooth and visually appealing holographic projection without requiring any special hardware beyond the smartphone and pyramid.

3.3 Workflow of the System

The workflow of the IoT-based holographic visualizer is designed to be simple, systematic, and user-friendly so that hologram projection can be performed smoothly without requiring technical expertise. The complete operation of the system is carried out through the following sequence of steps.

1. System Initialization

The workflow begins when the user opens the IoT-based hologram viewer website on a smartphone or tablet using a standard web browser. Once the webpage loads, the user interface is displayed along with the available hologram animations and control options. During this stage, the system initializes the hologram viewer, prepares the display environment, and ensures that the device is ready for hologram projection.

2. Content Selection

After initialization, the user browses through the online hologram library provided on the website. The user can select a hologram animation or a three-dimensional model based on interest or application. Once the selection is made, the system automatically processes the chosen content and converts it into the required four-way mirrored hologram layout. This layout is essential for proper reflection and accurate hologram formation inside the pyramid.

3. Display Setup

The smartphone or tablet displaying the four-way mirrored layout is placed flat on a stable surface. The acrylic hologram pyramid is then carefully positioned on top of the device with proper alignment. The user adjusts the screen brightness and ensures that the device is centered correctly so that reflections from all pyramid faces appear clear, sharp, and evenly balanced.

4. Hologram Projection

When the animation starts playing, each face of the acrylic pyramid reflects one portion of the mirrored image displayed on the screen. These reflected images converge at the center of the pyramid, forming a single floating three-dimensional hologram that appears suspended in mid-air. The hologram can be viewed clearly from all sides, providing a smooth and immersive 360-degree .

5. User Interaction and Viewing

During projection, the user can move around the pyramid to observe the hologram from different angles. The system maintains image stability and clarity throughout the viewing process. This interactive viewing enhances depth perception and makes the holographic display more engaging and visually appealing.

6. Switching or Ending Projection

At any time, the user can select a new hologram animation, replay the current content, or exit the hologram viewer. The IoT-based interface allows instant switching of content without changing the physical setup. Once the session is completed, the user can simply close the website to end the hologram projection.

3.4 Summary

The system design integrates three essential components: the holographic pyramid used for optical projection, the web-based content generator that prepares the required four-way mirrored hologram layout, and the IoT interface that allows users to easily select and control hologram animations. A smartphone or tablet is used as the display source, which makes the system simple to operate, portable, and widely accessible. The web-based IoT interface enables smooth content delivery and real-time control without the need for additional software or hardware installations. By combining these components, the holographic visualizer produces a smooth and realistic floating three- dimensional effect using basic optical reflection principles and low-cost materials. Overall, the system design ensures an engaging and user-friendly experience while demonstrating how IoT technology and simple optics can be effectively integrated to create a practical and modern visualization system suitable for educational, demonstration, and interactive applications.

CHAPTER 4

HARDWARE & SOFTWARE

4.1 Hardware Components Used

1. Acrylic Hologram Pyramid

Fig 4.1.1 Acrylic Pyramid

Figure 4.1.1 shows the acrylic hologram pyramid used in the proposed holographic visualizer. The pyramid is made of transparent acrylic sheets with precisely angled faces to enable effective optical reflection. When placed inverted over a smartphone or tablet display, each face reflects a part of the four-way mirrored hologram layout. These reflections combine at the center to create the illusion of a floating three-dimensional image. Acrylic is chosen for its good transparency, lightweight nature, and ease of fabrication, making it suitable for producing a clear and stable holographic effect using low-cost materials.

Description

The hologram pyramid is constructed using four transparent acrylic sheets arranged symmetrically at approximately 45° angles. Acrylic is chosen because it offers good optical clarity, is lightweight, and is easy to cut and assemble. The smooth and transparent surfaces allow light from the display to be reflected efficiently, which is essential for creating a clear holographic effect. The pyramid structure is designed with precise dimensions so that reflections from all faces align correctly at the center.

Working Principle

The working principle of the hologram pyramid is based on optical reflection and visual perception. A smartphone or tablet placed beneath the pyramid displays a specially designed four-way mirrored animation, where the same visual is shown from four different directions. Each face of the pyramid reflects one portion of the animation at a specific angle. These reflected images travel toward the center of the pyramid, where they converge and combine to form a single floating three-dimensional image. Since the reflections are synchronized, properly aligned, and equally spaced, the hologram appears stable, sharp, and well-defined. The resulting image can be viewed clearly from multiple directions, providing a convincing sense of depth and realism without the need for complex projection equipment or additional hardware

Use in This Project

In this project, the hologram pyramid serves as the primary projection surface for generating the three-dimensional holographic illusion. It reflects four identical and symmetrically arranged visuals displayed on the smartphone or tablet screen, combining them into a single floating image at the center of the pyramid. The accurate geometry, angle, and alignment of the acrylic pyramid ensure that the reflected images converge smoothly, producing a stable, clear, and realistic 3D hologram. The transparency and reflective properties of the acrylic material further enhance image clarity while minimizing distortion and light loss. By relying on simple materials and fundamental optical reflection principles, the system remains cost-effective, lightweight, and easy to assemble. The absence of complex lenses, sensors, or projection hardware reduces maintenance requirements and improves system reliability. Additionally, the compact and portable nature of the hologram pyramid enables convenient deployment in various environments. As a result, the holographic visualizer is well suited for educational demonstrations, classroom teaching, exhibitions, product showcases, and interactive visual presentations, where an engaging, immersive, and user-friendly three-dimensional display is required.

2. Smartphone / Tablet (Display Unit)

Description:

A standard smartphone or tablet with a bright LCD or AMOLED display is used as the primary display unit for projecting the hologram. This device replaces complex and expensive projection hardware typically required for three-dimensional display systems. Modern smartphones and tablets offer high screen resolution, good brightness levels, and compact size, which makes them ideal for holographic projection. Their widespread availability and portability further simplify the system and make it accessible to students, educators, and general users.

Working Principle:

The smartphone or tablet functions as the primary display and light source for the holographic system. It displays a specially designed four-way mirrored hologram video generated by the IoT-based website, where the same animation is shown in four different orientations on the screen. Each section of the display corresponds to one face of the hologram pyramid. When the pyramid is placed on the screen, light from the display is reflected by each face of the pyramid at a fixed angle. The brightness, contrast, and resolution of the screen determine how clearly the reflected images appear. As all four reflections are synchronized and properly aligned, they converge at the center of the pyramid to form a stable floating three-dimensional image. This process relies entirely on optical reflection and does not require any sensors, projectors, or additional display hardware.

Use in This Project

In this project, the smartphone or tablet plays a crucial role as both the display and projection source. It displays the four-way mirrored hologram layout, provides the necessary illumination for optical reflection, and plays hologram animations directly through a web browser without requiring additional hardware or software installations. The use of a commonly available mobile device simplifies the overall system design and reduces cost. This approach keeps the holographic visualizer lightweight, portable, and easy to set up, making it well suited for educational demonstrations, classroom learning, exhibitions, and interactive visual presentations

3. IoT Website (Hologram Viewer)

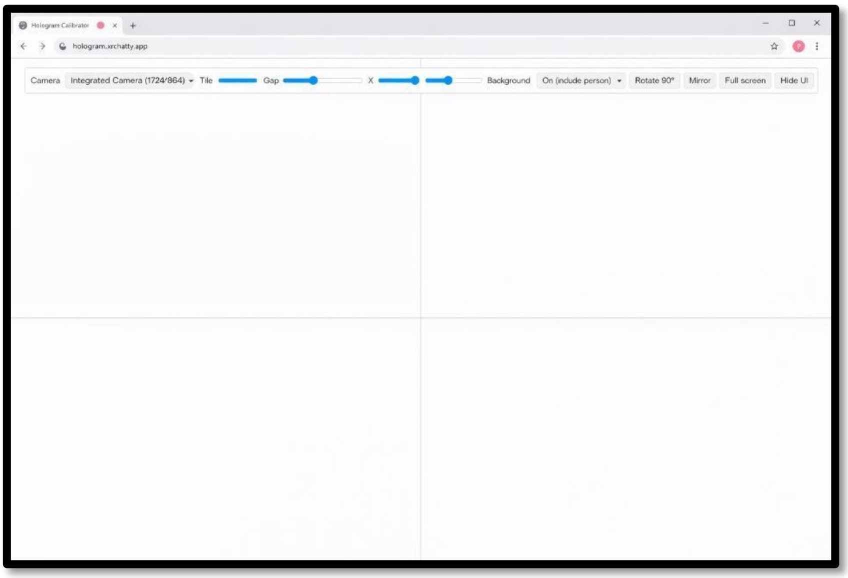

Fig 4.1.2 Web Page of Hologram

Figure 4.1.2 illustrates the web-based hologram calibration interface used to align and prepare visual content for holographic pyramid projection. The interface divides the display into four symmetric quadrants and provides controls such as tilt, gap adjustment, rotation, mirroring, and background isolation to ensure precise alignment of hologram visuals. By enabling real-time calibration through a browser on a smartphone or tablet, the system ensures accurate symmetry and optimal reflection within the acrylic pyramid, resulting in a clear and stable floating 3D holographic effect.

Description

The web-based hologram viewer is hosted at https://hologramview.netlify.app/ and serves as the main interface for controlling and displaying holographic content. The website is developed using standard web technologies such as HTML, CSS, and JavaScript, making it lightweight, responsive, and easy to access. It is specifically designed to generate hologram-ready layouts that are compatible with pyramid-based holographic projection. Since the viewer runs directly in a web browser, it eliminates the need for installing any dedicated applications or software.

Working Principle

When the user opens the website and selects a hologram animation, the system processes the selected content in real time using the web-based interface. The chosen animation is automatically mirrored into four quadrants—top, bottom, left, and right—where each quadrant is carefully oriented to correspond with one face of the hologram pyramid. This four-way mirrored layout is displayed on the screen in the exact format required for holographic reflection. Proper synchronization, accurate alignment, and consistent brightness across all four quadrants ensure that the reflected images merge smoothly inside the pyramid. As a result, a stable, clear, and realistic floating three-dimensional hologram is formed, offering an immersive visual experience that can be viewed from multiple directions without distortion or flickering.

Use in This Project

In this project, the web-based hologram viewer acts as the central IoT interface of the holographic visualization system, providing a clean and intuitive online platform through which users can easily browse, upload, select, and control hologram video content based on their requirements. The viewer automatically processes the selected media and generates a four-way mirrored hologram layout with proper symmetry and orientation, ensuring an effective floating 3D visual illusion when used with the holographic pyramid. The generated layout is displayed directly on a smartphone or tablet screen without the need for any manual adjustments or technical configuration. Since the entire system operates through a standard web browser, it is compatible with all internet-enabled devices and eliminates the need for additional software, applications, or specialized hardware installations. The IoT-enabled nature of the platform allows remote access, real-time content updates, and seamless content management, making the holographic visualizer highly accessible, flexible, and cost-effective for educational demonstrations, interactive learning environments, exhibitions, product showcases, and various visual presentation applications

4.2 Software Requirements

1. HTML (Interface Design)

Description:

HTML (Hyper Text Markup Language) is used to create the basic structure of the web-based hologram viewer. It defines all the essential elements of the webpage such as headings, buttons, menus, containers, and the main hologram viewer section. HTML acts as the foundation of the website by organizing content in a structured and readable format that can be displayed by any web browser.

Use in This Project:

- Defines the four-way mirrored layout structure required for hologram projection
- Creates the user interface elements such as buttons and content sections
- Loads and embeds hologram animation elements into the webpage
- Provides a clear layout that supports easy interaction and navigation

2. CSS (Styling and Layout Control)

Description:

CSS (Cascading Style Sheets) is used to control the visual appearance and layout of the hologram viewer. It manages spacing, alignment, colors, sizes, and responsiveness of the webpage. CSS ensures that the hologram layout is displayed correctly on different screen sizes and devices, such as smartphones and tablets.

Use in This Project:

- Mirrors and aligns hologram visuals into the required four-way format
- Ensures proper spacing and symmetry between visual elements
- Maintains a responsive layout that adapts to different screen resolutions
- Enhances the overall appearance of the user interface for better user experience

3. JavaScript (Core Logic and Interactivity)

Description:

JavaScript is the core programming language used to add functionality and interactivity to the hologram viewer. It controls how the website responds to user actions such as selecting animations, starting or stopping playback, and switching hologram content. JavaScript also manages the logic required for hologram generation, including loading animations, creating the four-way mirrored layout, and ensuring smooth playback. By handling these operations dynamically, JavaScript enables real-time updates and provides a responsive and interactive user experience without requiring page reloads.

Working Principle:

JavaScript handles the complete control and processing of hologram animations within the web-based viewer. It loads the selected hologram animations dynamically and processes them in real t ime to ensure smooth and continuous playback. JavaScript divides the animation into four synchronized visual sections and mirrors them into the required quadrants—top, bottom, left, and right—so that each section aligns correctly with one face of the hologram pyramid. In addition to visual processing, JavaScript manages playback functions such as play, pause, replay, and switching between different hologram animations based on user input. It also dynamically adjusts the layout, timing, and orientation of the visuals to maintain proper synchronization, ensuring that the final holographic projection appears stable, clear, and visually realistic.

Use in This Project:

- Generates and controls the four mirrored visual quadrants required for accurate holographic projection.
- Enables user interaction by allowing easy selection and switching of hologram animations through the web interface.
- Loads hologram animations dynamically without reloading the webpage, ensuring smooth and uninterrupted operation.
- Manages playback timing and synchronization to maintain a stable, clear, and realistic hologram display.

Web Hosting Platform (Netlify)

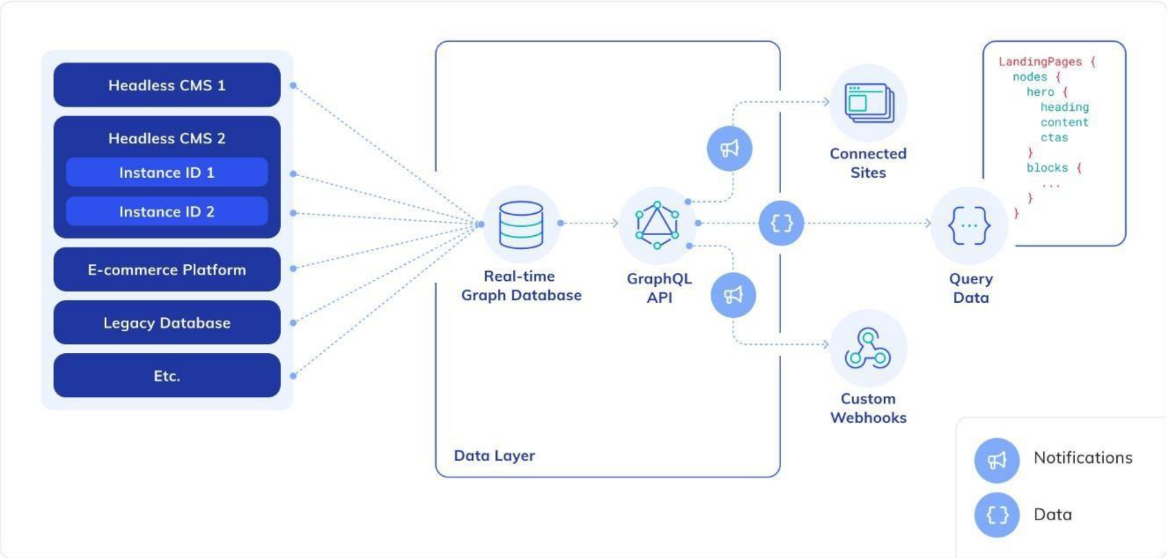

Figure 4.2.1: Netlify-Hosted Web-Based Hologram Viewer Interface

Figure 4.2.1 shows the hologram viewer website hosted on Netlify, displaying the four-way mirrored hologram layout along with user control options accessible through a standard web browser. The interface allows users to select hologram animations, which are automatically arranged into the required four-quadrant mirrored format for pyramid-based holographic projection. Hosting the viewer online ensures fast loading, easy access, and global availability, allowing users to view and control hologram content from any internet-enabled device without installing additional software. This figure highlights the integration of web technologies and IoT-based content delivery for interactive holographic visualization.

Description

Netlify is a cloud-based web hosting and deployment platform used to host the hologram viewer website. It stores and serves all the required project files such as HTML, CSS, JavaScript, images, and hologram animations. Netlify is well suited for this project because it provides reliable hosting, fast content delivery, and easy updates without requiring complex server management. By hosting the hologram viewer online, the system becomes accessible from anywhere using a standard web browser.

Working Principle

Netlify works by deploying static web files to a global content delivery network (CDN). When a user opens the hologram viewer URL, the required files are fetched from the nearest server location and delivered instantly to the user's device. This ensures fast loading times and smooth playback of hologram animations. Any updates made to the website files are automatically reflected online, allowing real-time improvements and content changes without interrupting user access.

Use in This Project

In this project, Netlify hosts the IoT-based hologram viewer website and acts as the backend delivery platform. It enables users to access the hologram viewer from any internet-enabled smartphone, tablet, or computer. The platform supports continuous updates to hologram content and interface features, making the system flexible and scalable. By using Netlify, the project achieves global accessibility, reliable performance, and simplified deployment.

Aspect	**Description**
Hosting Platform	Netlify
Hosted Content	HTML, CSS, JavaScript, images, hologram animations
Access Method	Web browser (smartphone / tablet / PC)
Deployment Type	Cloud-based static hosting
Content Delivery	Global CDN for fast loading
Role in IoT	Enables remote access and updates
Benefit	Low-cost, scalable, and easy maintenance

Fig 4.2.2 Role of Netlify in the Holographic Visualizer

4. Video / Animation Files

Description:

Three-dimensional animation files in formats such as MP4, GIF, or WebM are used as the primary hologram content in this project. These files contain pre-rendered animations or visual sequences designed to appear three-dimensional when reflected through the hologram pyramid. The chosen formats are widely supported by modern web browsers and mobile devices, ensuring smooth playback and compatibility across different platforms. High-quality animations with proper contrast and dark backgrounds are preferred, as they enhance the clarity and visibility of the holographic effect

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Use in This Project:

- The animation files are displayed in a four-way mirrored format generated by the web-based hologram viewer, making them suitable for pyramid-based holographic projection.
- These videos act as the core visual content of the holographic system, forming the floating three-dimensional images seen inside the pyramid.
- The animations are loaded and played dynamically through the web interface, allowing users to easily switch between different hologram visuals.
- By using standard video formats, the system avoids complex rendering hardware and keeps the holographic visualizer simple, low-cost, and easy to maintain.

4.3 Features of Development Tools

The development tools used in this project are selected to ensure simplicity, flexibility, and wide accessibility. The web-based technologies are lightweight and run smoothly on any modern web browser without requiring high processing power. Since the system works entirely through a browser, no application installation is required, making it easy for users to access the hologram viewer. Content updates can be performed easily through the hosting platform, allowing new hologram animations or interface changes to be reflected instantly. The tools generate hologram- ready four-way mirrored layouts in real time and are fully compatible with different smartphone screen sizes and resolutions.

4.4 Additional Libraries / Add-ons

To enhance the overall functionality and performance of the system, several additional libraries and utilities are integrated alongside the core web technologies. JavaScript transform utilities are used to precisely mirror, rotate, and position visual elements so that the content aligns accurately for effective holographic projection. Responsive design techniques such as CSS Flexbox and Grid ensure consistent layout alignment and visual stability across different screen sizes, resolutions, and device orientations. Optional WebGL support can be employed to render advanced animations, enable hardware-accelerated graphics, and achieve smoother visual transitions when higher graphical quality is required. Additionally, CDN-hosted UI components and libraries are utilized to minimize loading time, reduce bandwidth usage, and improve reliability by serving resources from geographically closer servers. Together, these tools help maintain a lightweight and efficient system architecture while delivering smooth performance, visual consistency, and an enhanced user experience across a wide range of devices.

4.4 Summary

This chapter discussed the hardware and software components used in the development of the IoT-Based 3D Holographic Visualizer. The hardware setup is simple and minimal, consisting mainly of an acrylic hologram pyramid and a smartphone or tablet display. The software system is built using standard web technologies such as HTML, CSS, and JavaScript, and is hosted on a cloud platform for easy access and updates. Together, these components generate a four-way mirrored video layout that forms a stable and visually appealing floating three-dimensional projection inside the pyramid. The use of lightweight development tools, additional libraries, and cloud hosting makes the system affordable, portable, scalable, and easy to use. Overall, the integration of simple hardware with flexible web-based software provides an effective solution for realistic holographic visualization suitable for educational, demonstration, and interactive applications.

CHAPTER 5

IMPLEMENTATION

5.1 Web-Based Hologram Layout Implementation

The hologram viewer was developed using HTML, CSS, and JavaScript and deployed on a cloud platform (Netlify). The website automatically generates the four-way mirrored hologram layout required for projection. Each animation or 3D visual is loaded into four quadrants using CSS transforms and JavaScript mirroring logic. This approach ensures consistent layout generation without requiring specialized software or hardware.

When a user selects a hologram animation from the website, JavaScript scripts process the file and position the visuals into top, bottom, left, and right mirrored sections. This layout ensures that the acrylic pyramid reflects each visual correctly, allowing the reflections to merge into a floating 3D image. The process occurs in real time, providing smooth and responsive hologram playback.

Animations are stored within the website directory, and the system prevents loading errors by validating file type, orientation, and responsive screen compatibility. This guarantees accurate hologram formation on different screen sizes such as smartphones and tablets. As a result, the system maintains reliable performance across a wide range of devices and display resolutions.

5.2 IoT Integration and Content Delivery

The hologram viewer operates like an IoT-based system by allowing users to access and control hologram content remotely through the website link: https://hologramview.netlify.app/. This enables real-time content selection, updates, and control from any internet-connected device without additional hardware.

When a user opens the website, the following processes occur:

- The server delivers HTML/CSS/JS files instantly
- The homepage loads available hologram animations
- User interactions (select, play, change animation) are handled through JavaScript
- The mirrored layout is rendered in real time.

This removes the need for dedicated software installations. Since the hologram data is delivered through the internet, users can load and view new 3D animations anytime, making the system flexible and dynamic.

5.3 Display Device Setup (Smartphone/Tablet)

The smartphone or tablet user plays the role of the projection display. The four-way mirrored layout appears full screen when the user selects “Start Projection” on the website. The following implementation steps ensure proper display:

1. **Screen brightness adjustment** to enhance hologram clarity
2. **Orientation lock** to keep the layout aligned
3. **Auto-resize scripts** to support different screen sizes
4. **Touch-lock overlay** preventing accidental touches during projection

The device is placed flat under the pyramid, ensuring that each face of the pyramid reflects one of the mirrored visuals.

5.4 Hologram Pyramid Projection Implementation

The acrylic pyramid is positioned precisely over the smartphone so that the four quadrants are visible from each pyramid face. The implementation considerations include:

- Correct pyramid height and base dimensions
- 45° angle for optimal reflection
- Smooth, scratch-free acrylic sheets for clarity
- Center alignment to avoid hologram distortion

During projection, each face of the pyramid reflects an identical animation oriented toward the center. These reflections converge to form a crisp and stable three-dimensional hologram that is clearly visible from all sides. The implementation was tested using various animations to evaluate brightness, clarity, proportional accuracy, and illusion depth. The results confirmed consistent image quality and effective 3D visualization across different viewing angles.

5.5 Integrated System Operation

When the overall system is used, the following sequence of operations takes place to ensure smooth, reliable, and user-friendly holographic visualization:

1. User Accesses Website

- The user opens **https://hologramview.netlify.app** on a smartphone or tablet using a web browser.
- The website loads the available hologram animations and displays the main user interface.
- The four-way mirrored layout generator initializes automatically in the background.
- The system checks the screen orientation and resolution for correct layout rendering.
- The interface prepares the device for hologram projection without manual configuration.
- The website ensures compatibility with the device's browser and display size.
- Initial loading confirms that all required scripts and animations are ready for use.

2. Selecting a Hologram

- The user selects a hologram animation from the list provided on the website.
- JavaScript processes the selected animation and converts it into a four-way mirrored format.
- The display automatically switches to hologram projection mode.
- The animation is synchronized across all four quadrants for accurate reflection.
- The system ensures correct orientation and scaling of visuals for pyramid alignment.
- The selected animation is loaded smoothly without page refresh.
- The interface provides visual feedback confirming successful selection.

3. Setting Up the Display

- The smartphone or tablet is placed flat on a stable surface beneath the acrylic pyramid.
- The screen brightness is adjusted to enhance reflection clarity.
- Reflections align properly on all faces of the pyramid.
- The pyramid is positioned carefully to maintain symmetry and balance.
- The setup minimizes distortion and ensures uniform brightness.
- Ambient lighting conditions are adjusted to reduce external reflections.
- The device remains stable to prevent movement during projection.
- The hologram content is centrally aligned on the display to ensure accurate image convergence at the pyramid's center.

4. Hologram Projection

- Each face of the acrylic pyramid reflects one mirrored quadrant of the animation.
- The reflected images converge at the center of the pyramid.
- A floating three-dimensional hologram appears suspended in mid-air.
- The hologram remains stable and clearly visible from multiple angles.
- The projection provides a smooth and immersive 360-degree viewing experience.
- Depth perception is enhanced through proper reflection alignment.
- The hologram maintains consistent brightness throughout playback.

5. Switching or Ending Projection

- The user can return to the main menu at any time.
- A different hologram animation can be selected instantly.
- The user may exit the projection mode whenever required.
- The system stops playback smoothly without glitches.
- No changes to the physical setup are required when switching content.
- The interface resets automatically for the next selection.
- The session can be ended simply by closing the website.

This integrated system operation ensures ease of use, flexibility, and a smooth holographic experience while maintaining stability, performance, and user control throughout the projection process.

5.6 Summary

The implementation phase successfully integrated the hologram pyramid, smartphone display, and IoT-based web interface to create a realistic three-dimensional holographic effect. Web technologies generate the required mirrored layout, while the acrylic pyramid forms the holographic projection. Testing showed that the system provides clear visuals, easy usability, and reliable performance across different devices. Overall, the holographic visualizer demonstrates how basic optical principles and web programming can be effectively combined to create an engaging and interactive 3D display system. The system is cost-effective, portable, and suitable for educational demonstrations and prototype applications. Additionally, IoT connectivity allows flexible content updates and remote control of hologram visuals.

CHAPTER 6

RESULTS AND DISCUSSION

6.1 Results

Fig 6.1 – Final result

Figure 6.1 illustrates the final output of the IoT-Based 3D Holographic Visualizer developed in this project. The image shows the acrylic hologram pyramid placed inverted over a smartphone display, successfully producing a floating three-dimensional visual at the center of the pyramid. The four- way mirrored animation displayed on the screen is reflected by each face of the pyramid, and these reflections merge to form a stable and clearly visible holographic image. The result demonstrates proper alignment, accurate reflection angles, and effective synchronization of the mirrored visuals. The clarity and depth of the hologram confirm that the combination of the acrylic pyramid, smartphone display, and web-based hologram viewer functions as intended. This final output validates the effectiveness of using simple optical reflection principles and web technologies to achieve a realistic and immersive 3D holographic effect suitable for educational and demonstration purposes.

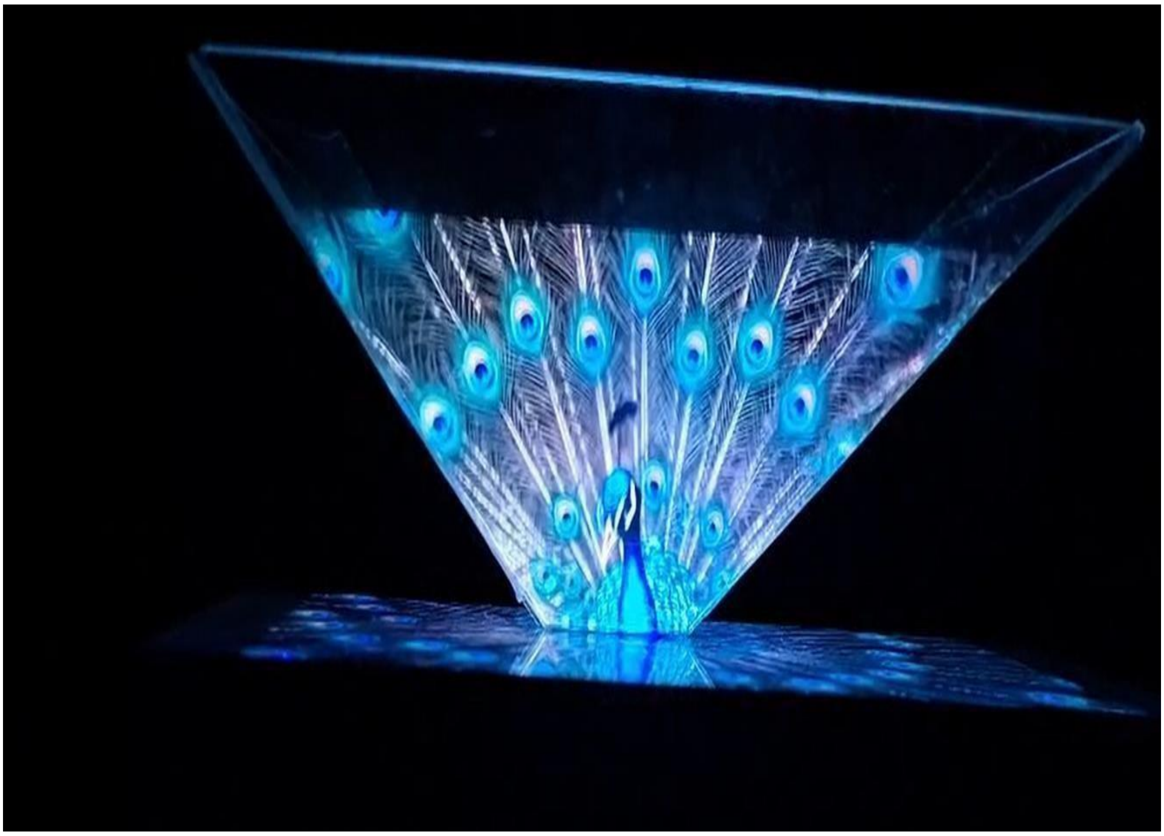

Fig 6.2 – Final result 2

Figure 6.2 shows another final output of the IoT-Based 3D Holographic Visualizer, demonstrating a different hologram animation displayed using the acrylic pyramid. The image illustrates a vivid and well-defined floating three-dimensional visual formed at the center of the pyramid through optical reflection. The four-way mirrored animation displayed on the smartphone screen is reflected by each face of the pyramid, and these reflections merge seamlessly to create a bright and visually appealing hologram. The result highlights good depth perception, color clarity, and stable projection, confirming the effectiveness of the pyramid structure and mirrored layout. This output further demonstrates the capability of the system to display various hologram animations clearly, making it suitable for interactive demonstrations, educational visualization, and creative visual presentations. The consistent visual quality across different animations validates the reliability and robustness of the implemented holographic system.

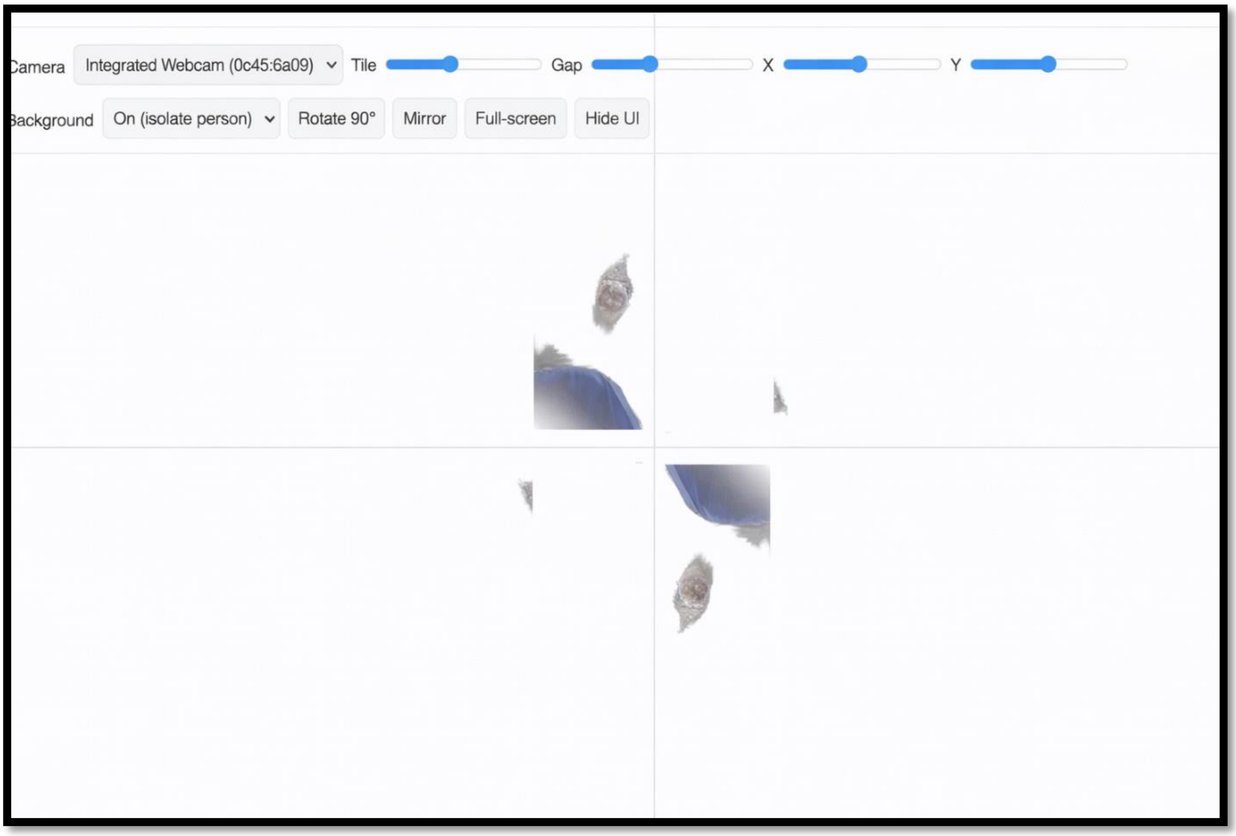

Fig 6.3 – Final Website

Figure 6.3 shows the final web-based hologram viewer interface used in the proposed system. The figure displays the four-way mirrored layout generated by the website, which is essential for pyramid-based holographic projection. The interface provides various control options such as camera selection, rotation, mirroring, background adjustment, and layout alignment, allowing users to fine-tune the hologram display according to their setup. The mirrored visuals are arranged symmetrically across four quadrants, ensuring accurate reflection on each face of the acrylic pyramid. The presence of real-time controls enables users to adjust orientation, spacing, and visibility to achieve optimal hologram clarity. This figure demonstrates the successful implementation of the web interface, highlighting its capability to generate hologram-ready layouts dynamically and offer flexible control for producing a clear, stable, and visually effective three-dimensional holographic projection. Additionally, the interface enhances usability by enabling quick adjustments without requiring specialized hardware or software installation.

6.2 System Performance Analysis

The IoT-Based 3D Holographic Visualizer was evaluated based on clarity, stability, responsiveness, and projection quality. The performance of each module is summarized below:

Hologram Projection Performance

- The floating 3D image appeared clear and well-defined at the center of the acrylic pyramid.
- Visual clarity was best when the smartphone brightness was above 80%.
- The projection remained stable with minimal flickering or distortion.
- Both static and animated holograms displayed smoothly without lag.

Website & IoT Interface Performance

- Average loading time of hologram animations: Under 2 seconds.
- Navigation between animations was instant with no noticeable delays.
- The website worked consistently across different devices (Android, iOS, and tablets).
- The four-way mirrored layout generated correctly on all tested screen sizes.

Smartphone Display Performance

- Full-screen projection worked without stretching or cropping.
- AMOLED displays produced the brightest and sharpest holograms
- Touch-lock features prevented accidental exits during projection.
- The layout scaled responsively based on device resolution.

System Responsiveness

The overall system offered fast processing and high responsiveness during operation. The web interface rendered the hologram layouts instantly, and the holographic effect appeared immediately once the pyramid was placed on the display device. Even with continuous looping animations, the system showed no noticeable lag, overheating, or performance degradation. The smooth playback and stable projection indicate efficient resource usage and reliable system performance. This confirms the suitability of the system for extended demonstrations and real-time interactive use.

6.3 Discussion

The results show that the IoT-Based 3D Holographic Visualizer successfully achieves a smooth and realistic holographic projection using simple, low-cost components. The web-based design eliminates the need for dedicated apps or high-end hardware, making the system accessible and user-friendly.

The ability to deliver hologram content instantly through the website greatly enhances convenience. Users can simply open the link, choose an animation, and begin projection within seconds. This demonstrates the strength of IoT-driven visual delivery, especially in educational, demonstration, and entertainment environments.

The holographic pyramid produced stable reflections with minimal distortion, confirming that optical reflection can be effectively used to simulate 3D visuals. The system is particularly suitable for:

- Educational demonstrations
- Product presentations
- Mini-projects and academic displays
- Exhibition stalls
- DIY hologram showcases

However, a few limitations were observed during testing:

- Projection clarity depends on screen brightness and ambient lighting
- Any scratches or dust on the acrylic pyramid reduce visual quality
- Very dark or low-contrast animations may appear faint
- The illusion requires the pyramid to be precisely centered over the display

6.4 Summary

The evaluation confirms that the IoT-Based 3D Holographic Visualizer performs its intended functions effectively. The web-based viewer loads animations quickly, generates an accurate mirrored layout, and produces a convincing floating three-dimensional image through the pyramid. The system offers good clarity, responsiveness, and ease of use, making it a practical solution for low-cost holographic projection. These results validate the system design and demonstrate its suitability for educational, presentation, and interactive visualization applications

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

7.1 Conclusion

The development of the IoT-Based 3D Holographic Visualizer successfully demonstrates how simple optical principles, combined with modern web technologies, can create an immersive 3D projection without the need for expensive equipment. By using an acrylic hologram pyramid and a smartphone display, the system produces a realistic floating hologram that can be viewed from all sides. The web-based viewer hosted at **https://hologramview.netlify.app/** enables users to access hologram-ready content instantly, making the system highly portable, flexible, and easy to use.

The implementation of HTML, CSS, and JavaScript for generating the four-way mirrored layout proved efficient and reliable. The projection quality was found to be clear and stable, especially under proper lighting conditions. The device performed well during testing, showing smooth animation playback, quick responsiveness, and good visual consistency across various screen sizes.

Overall, this project demonstrates a practical and low-cost approach to 3D visualization. It highlights how IoT-based content delivery and simple optical reflection can be combined to create an engaging user experience. The system can be applied in education, exhibitions, product showcasing, or entertainment, and serves as a foundation for developing advanced interactive holographic systems in the future. Its simplicity, portability, and scalability make it suitable for both academic research and real-world demonstration applications.

7.2 Future Scope

- **Advanced 3D Animation and Models**
  a) Advanced hologram animations with interactive or touch-responsive 3D models can be implemented to improve realism and user engagement.
  b) Gesture-based or sensor-based interaction techniques can enable users to rotate, zoom, and control holograms without direct screen contact.
  c) Integration with real-time data sources can allow dynamic content updates, expanding the system's functionality for educational and industrial applications.

- **Dedicated Mobile Application**

  a) Enables offline downloading and storage of hologram animations for easy access.

  b) Provides controls for brightness, playback, and display settings.

  c) Offers personalized user profiles and simplified navigation.

- **Cloud-Based Hologram Library**

  a) Maintains a centralized and expandable hologram animation database.

  b) Allows users to upload, store, and share custom hologram content.

  c) Supports remote access and real-time content updates.

- **Voice-Assisted Interface**

  a) Enables hands-free control using simple voice commands.

  b) Improves accessibility for users with limited physical interaction.

  c) Enhances overall user convenience during hologram operation.

- **Interactive Holograms with Motion Tracking**

  a) Allows gesture-based interaction without touching the screen.

  b) Enables real-time response to user movements and actions.

  c) Increases immersion and realism of the holographic display.

- **Multi-Pyramid Projection Systems**

  a) Supports synchronized operation of multiple hologram pyramids.

  b) Enables large-scale holographic displays for exhibitions and events.

  c) Enhances visual impact and audience engagement.

- Augmented Reality & AI Integration

  a) Combines hologram visuals with augmented reality elements.

  b) Uses AI to generate dynamic and intelligent hologram animations.

  c) Enables adaptive content based on user interaction or environment.

- **High-Resolution Display Support**

  a) Integration with higher-resolution smartphones or tablets can improve hologram sharpness.

  b) Enhanced pixel density will increase depth perception and edge clarity.

  c) Supports more detailed and realistic 3D hologram visuals.

- **Wireless Content Streaming**

  a) Enables real-time hologram streaming from remote servers.

  b) Eliminates the need for local storage on the display device.

  c) Allows multiple users to access synchronized hologram content.

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