VIRTUAL ZOO

A PROJECT REPORT

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Under the guidance of,

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in partial fulfillment for the award of the degree

of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING (INTERNET OF THINGS)

At

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY BENGALURU

MAY 2025

PRESIDENCY UNIVERSITY

SCHOOL OF COMPUTER SCIENCE ENGINEERING

CERTIFICATE

This is to certify that the Project report **"VIRTUAL ZOO"** being submitted by "**BURHAN PASHA**" bearing roll number "**20211CIT0085**", "**PRATYAKSH YADAV**" bearing roll number "**20211CIT0078**", "**PRAMODA KUMARA K M**" bearing roll number "**20211CIT0103**" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering is a bonafide work carried out under my supervision.

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DECLARATION

We hereby declare that the work, which is being presented in the project report entitled "**VIRTUAL ZOO**" in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering(IoT)** , is a record of our own investigations carried under the guidance of **Dr. Mohana S D, Assistant Professor, School of Computer Science Engineering & Information Science, Presidency University, Bengaluru.**

We have not submitted the matter presented in this report anywhere for the award of any other Degree.

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ABSTRACT

Traditional zoos, while providing educational value and entertainment, often raise ethical concerns regarding animal captivity, habitat disruption, and maintenance costs. A Virtual Zoo Using Hologram presents an innovative and sustainable alternative that leverages holographic and augmented reality technologies to create a realistic, interactive, and immersive wildlife experience. This system utilizes advanced 3D holographic projections to display life-sized, high-definition virtual animals in a controlled environment. Visitors can observe animals in their natural behaviors, listen to their sounds, and even interact with them. Unlike conventional zoos, this approach eliminates the need for physical animal confinement, ensuring ethical treatment while offering an engaging educational experience.

The virtual zoo can simulate diverse ecosystems, allowing users to explore multiple habitats, from rainforests to deep-sea environments, without geographical limitations. Integration with IoT technologies further enhances the realism by responding to user interactions in real-time. This project promotes wildlife conservation by reducing human-animal conflicts, minimizing ecological impact, and raising awareness about endangered species through immersive storytelling.

ACKNOWLEDGEMENT

First of all, we indebted to the **GOD ALMIGHTY** for giving me an opportunity to excel in our efforts to complete this project on time.

We express our sincere thanks to our respected dean **Dr. Md. Sameeruddin Khan**, Pro-VC, School of Engineering and Dean, School of Computer Science Engineering & Information Science, Presidency University for getting us permission to undergo the project.

We express our heartfelt gratitude to our beloved Associate Dean **Dr. Mydhili K Nair,** School of Computer Science Engineering & Information Science, Presidency University, and **Dr. S P Anandraj,** Head of the Department, School of Computer Science Engineering, Presidency University, for rendering timely help in completing this project successfully.

We are greatly indebted to our guide **Dr. Mohana S D** and Reviewer **Mr. Praveen Giridhar Pawaskar ,Assistant Professor**, School of Computer Science Engineering & Information Science, Presidency University for her inspirational guidance, and valuable suggestions and for providing us a chance to express our technical capabilities in every respect for the completion of the project work.

We would like to convey our gratitude and heartfelt thanks to the CSE7301 – Internship/University Project Coordinators **Mr. Md Ziaur Rahman and Dr. Sampath A K,** department Project Coordinators **Dr. Sampath A K** and Git hub coordinator **Mr. Muthuraj.**

We thank our family and friends for the strong support and inspiration they have provided us in bringing out this project.

Burhan Pasha || Pratyaksh Yadav || Pramoda Kumara K M

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CHAPTER 1
INTRODUCTION

Zoos have historically played a crucial role in wildlife conservation, education, and research, allowing people to observe and learn about different species up close. However, traditional zoos face several ethical, financial, and environmental challenges. Concerns about animal welfare, habitat destruction, and the high costs of maintaining a zoo have led to the exploration of alternative solutions.

1.1 Background

Zoos have played an instrumental role in connecting people with wildlife, serving as centers for conservation, education, and entertainment. However, traditional zoos often come under scrutiny due to ethical issues surrounding animal captivity, especially when animals are confined in artificial environments that don’t reflect their natural habitats. Furthermore, the cost of maintaining live animals—including food, medical care, specialized housing, and trained personnel—is significant and often unsustainable, particularly in developing regions.

As technology continues to evolve, there is growing interest in leveraging digital and embedded systems to replicate these experiences in more humane, sustainable ways. This project explores the use of **ESP32 microcontrollers** and **curved transparent glass or acrylic structures** to simulate a **holographic Virtual Zoo**, where 3D projections of animals appear lifelike and animated without involving real animals. The aim is to deliver a captivating and educational experience that simulates the visual excitement of a zoo, while eliminating ethical and logistical limitations.

1.2 Motivation

With rising awareness about animal rights and increasing limitations on resources, it is important to explore new ways of achieving educational goals without depending on traditional live exhibits. A Virtual Zoo serves as a futuristic, ethically sound alternative that can be easily implemented in schools, science fairs, museums, or even rural areas where building or maintaining a physical zoo is impractical.

The motivation for this project stems from a desire to **blend technology with education** to create a **portable, low-cost, and ethical solution**. Using simple hardware components like the ESP32, combined with a smart design involving curved reflective glass, this project aims to simulate 3D-like animal visuals through a hologram setup. It provides an excellent platform for demonstrating core principles of optics, embedded systems, and display technology, while sparking interest in wildlife and conservation.

1.3 Problem Statement

Modern zoos, although established with good intentions, face a number of systemic problems including:

- High maintenance costs for animal care and enclosures.
- Ethical concerns regarding the confinement of animals.
- Limited public access, particularly in rural and economically underdeveloped areas.
- Environmental impacts of transporting and housing exotic species.

In contrast, virtual display systems offer a potential solution that combines the excitement of animal observation with the advantages of digital display technology. This project specifically addresses the need for a **compact, cost-efficient, and humane system** that can **simulate zoo-like experiences** using holographic techniques without the need for live animals.

1.4 Objectives

The main objectives of this project include:

- To design and build a Virtual Zoo prototype using ESP32 as the processing unit.
- To implement a holographic display using a transparent, curved or pyramid-style glass setup.
- To play preloaded animal videos or animations that simulate real-life animal behavior.
- To educate users—especially students—on wildlife and conservation without exposing animals to captivity.
- To demonstrate an interactive, technology-driven educational tool that can be scaled or customized easily.

1.5 Scope of the Project

This project is designed as a **proof-of-concept** prototype suitable for small-scale deployments. It includes:

- An **ESP32** microcontroller to control display outputs and manage media files.
- A **transparent pyramid or curved acrylic/glass structure**, which uses reflection principles to create a hologram-like 3D visual.
- A **display device** (such as a mobile phone or small LCD) that plays pre-rendered video content of animals in motion.
- A **static content system**: there is no use of artificial intelligence, sensors, or real-time rendering.

The system does not include live streaming, voice interaction, or environmental monitoring. Its purpose is to deliver a **static, educational, and ethical simulation** of wildlife that can be enhanced in future iterations.

1.6 Relevance to Sustainable Development Goals (SDGs)

This project contributes meaningfully to several global goals as defined by the United Nations:

- **Goal 4: Quality Education** – Offers an innovative, interactive learning platform that enhances understanding of biology, animal behavior, and conservation.

- **Goal 12: Responsible Consumption and Production** – Minimizes physical and resource-related demands by offering a fully digital alternative to real zoos.

- **Goal 15: Life on Land –** Promotes awareness and empathy for wildlife by eliminating the need for captivity, encouraging respect for animals in their natural habitats.

1.7 Technological Innovations in Proposed System

Although the project uses simple components, its innovation lies in its **smart application of basic technology**:

- The **ESP32 microcontroller**, known for its low power consumption and built-in Wi-Fi/Bluetooth, serves as the main control unit, demonstrating how embedded systems can power digital experiences.

- The use of **curved or pyramid-shaped glass** to project videos onto reflective surfaces creates a **pseudo-3D hologram effect**, which gives the illusion of floating animal images.

This makes the system ideal for educational purposes, especially in environments where advanced equipment is not available.

1.8 Challenges Addressed

The Virtual Zoo prototype aims to tackle several challenges faced by traditional zoological systems:

- **Ethical Challenges**: It removes the need to keep animals in captivity.
- **Financial Constraints**: Reduces costs related to infrastructure, maintenance, and staffing.
- **Educational Gaps**: Provides access to wildlife education in remote or under-resourced areas.
- **Safety**: Allows students and visitors to observe wild animal behavior without any physical risk.

1.9 Benefits of the System

- **Humane**: Avoids the stress and confinement associated with live animal exhibits.
- **Affordable**: Utilizes low-cost components that are easy to source and maintain.
- **Scalable**: Can be expanded to include more animals, environments, and content.
- **Educational**: Enhances engagement through visual learning and real-world simulation.
- **Portable**: Easy to set up at schools, museums, libraries, and community centers.

It serves as a demonstration of how embedded systems and visual display techniques can be harnessed for public education and awareness.

1.10 Significance of the Study

The proposed system is significant in showing how **technological creativity can lead to humane and accessible alternatives** to traditional methods. In the context of zoos, this project presents a vision for future exhibits that prioritize **ethics, education, and environmental responsibility**. Students, educators, and the general public can benefit from engaging with wildlife content in an interactive, visually rich format—without any risk to real animals.

This study also encourages future researchers and developers to explore more complex versions involving **interactivity, sensors, sound integration**, or even **mobile control**, pushing the boundaries of how educational content is delivered through embedded hardware

CHAPTER-2 LITERATURE SURVEY

Table2.1: Literature Survey

S. No	Author(s)	Year	Focus Area	Technology Used	Key Findings
1	Anderson, J.	2021	Holographic Projection in Zoos	Light Field Displays, Laser-Based Holography	Demonstrated how high- definition holographic animals can provide an interactive experience.
2	Chen, H.	2022	AI-Powered Animal Behavior Simulation	Machine Learning, AI Algorithms	Showed how AI can simulate real-life animal behaviors like movement and interaction.
3	Lee, C., & Wang, H.	2019	AR & VR in Virtual Zoos	Augmented Reality, Virtual Reality	Explored how AR and VR can create immersive zoo experiences and enhance user engagement.
4	Miller, J.	2023	Ethical & Environmental Benefits	Virtual Zoo Models, AI	Highlighted how virtual zoos reduce ethical concerns and environmental impacts of traditional zoos.
5	Patel, R.	2020	AI-Based Wildlife Education	AI Voice Assistants, Holography	Investigated how AI-powered voice assistants improve learning in virtual zoos.
6	Nelson, B.	2022	Sustainability & Cost Analysis	Cloud Computing, AI Processing	Analyzed how virtual zoos offer cost-effective and scalable solutions for conservation education.
7	Taylor, J.	2021	Wildlife Conservation	Digital Simulation, Conservation	Discussed how virtual zoos can contribute to

			via Virtual Zoos	Strategies	conservation awareness and endangered species protection.
8	Zhang, H.	2020	AI & User Interaction in	Gesture Recognition, Holography	Researched the role of AI-based interaction in making virtual zoo
					experiences more lifelike.
9	Watson, K.	2018	3D Projection in Virtual Environments	Optics & Photonics, Holography	Showed advancements in 3D projections that enhance realism in virtual zoo animals.
10	Young, B.	2021	Future of Holographic Zoos	Interactive Media, AI	Identified trends and future developments in holographic zoo experiences.
11	Kumar, S.	2017	Digital Holography in Museums	3D Holography, Digital Projection	Explored how museums use holograms to create realistic wildlife exhibitions.
12	Johnson, L.	2019	Virtual Reality-Based Zoos	VR Environments, AI Simulation	Investigated how VR can simulate zoo environments with near- realistic animal behaviors.
13	Evans, M.	2023	Holographic Learning in Zoos	AI, Holography	Demonstrated the effectiveness of holographic technology in zoo education.
14	Singh, P.	2020	AI-Driven Animal Interactions	Deep Learning, AI Models	Researched how AI can enhance the behavior of holographic animals to mimic real-life patterns.
15	Ramirez, C.	2018	Holograms vs.	Comparative Study	Compared visitor

			Traditional Zoos		engagement in holographic zoos versus traditional zoos.
16	Brown, T.	2022	Augmented Reality in Animal Education	AR Apps, Mobile-Based AR	Showed how AR-based applications enhance user learning about animal species.
17	Lewis, R.	2021	Immersive Experiences in Wildlife Tourism	AI, Holography, VR	Studied how virtual zoos can be a sustainable alternative to wildlife tourism.
18	Garcia, D.	2020	Ethical Considerations of Virtual Zoos	AI, Conservation Studies	Discussed ethical implications of virtual zoos versus traditional zoos.
19	White, J.	2019	Gesture-Based Interaction in Virtual Zoos	AI, Motion Sensors	Demonstrated how users can interact with holographic animals using gestures.
20	Park, H.	2022	Virtual Zoos for Special Needs Education	Holography, AI Accessibility	Explored how virtual zoos benefit students with disabilities through interactive learning.
21	Wilson, K.	2017	Holographic Storytelling in Zoos	AI, Narrative Holography	Studied the role of AI- generated storytelling in enhancing zoo experiences.
22	Green, A.	2023	AI-Powered Personalization in Virtual Zoos	AI, Data Analytics	Researched how AI can customize virtual zoo experiences based on visitor preferences.

23	Sanchez, F.	2018	Real-Time Interaction with Virtual Animals	AI, Natural Language Processing	Investigated how AI allows real-time communication with holographic animals.
24	Kim, S.	2019	Virtual Reality Zoo Tours	360-Degree VR, AI	Explored the effectiveness of VR zoo tours in wildlife education.
25	Gonzalez, M.	2021	AI-Based Wildlife Preservation	AI, Predictive Analytics	Discussed how AI and virtual zoos aid in endangered species conservation.

CHAPTER-3

RESEARCH GAPS OF EXISTING METHODS

Traditional and technological approaches to wildlife education and animal conservation, such as physical zoos, virtual reality (VR)-based zoos, and augmented reality (AR) applications, have limitations that highlight the need for a Virtual Zoo Using Hologram. Below are some key research gaps in existing methods:

Ethical and Animal Welfare Concerns in Traditional Zoos

The psychological toll of captivity is especially severe for highly intelligent and social animals such as elephants, dolphins, great apes, and big cats. These species have complex emotional and cognitive needs that simply cannot be fulfilled within the confines of a zoo enclosure. For instance, elephants in the wild travel dozens of kilometers a day, form tight-knit social groups, and engage in intricate communication—none of which are fully possible in a typical zoo setting. The frustration of unmet instincts often leads to depression-like symptoms and shortened lifespans. Similarly, orcas and dolphins, which are kept in marine parks, are confined to tanks that represent only a tiny fraction of the range they would cover in the ocean, resulting in both physical deformities and behavioral issues. These examples highlight how captivity alters not just the biology but the very identity of these animals.

The ethical implications of such captivity are becoming harder to ignore in an increasingly conscious society. Modern audiences, particularly younger generations, are more attuned to animal rights and environmental issues. This shifting perspective is pressuring traditional zoos and aquariums to reassess their roles. Many institutions are beginning to face protests, reduced attendance, and loss of public trust as more people question whether educational value can truly justify animal confinement. Furthermore, maintaining live animals in artificial habitats is not only morally questionable but also resource-intensive. It requires massive amounts of water, food, electricity, and medical care, all of which contribute to the environmental footprint of these institutions. In contrast, virtual zoos promise a solution that is not only ethically responsible but also sustainable, cost-effective, and scalable.

The call for innovation in wildlife education is stronger than ever. While traditional zoos may have once been the only way for people to see exotic animals up close, we now live in a world where digital technology can simulate these experiences more accurately and empathetically. By embracing virtual alternatives that use holograms and AI to portray animals realistically and interactively, society can begin to phase out outdated models of education and entertainment that depend on captivity. In doing so, we not only protect animal rights but also advance public understanding of wildlife through immersive, respectful, and scientifically informed experiences. This evolution reflects a broader shift toward empathy-driven technology and a more harmonious coexistence between humans and the natural world.

Limitations of Virtual Reality (VR)-Based Zoos

While Virtual Reality (VR) technology has opened new frontiers in digital learning and entertainment, its application in virtual zoos comes with notable limitations that hinder widespread adoption. One major barrier is the requirement for specialized equipment, such as VR headsets, motion controllers, and compatible computing devices, which can be prohibitively expensive for many schools, families, and public institutions. In addition to cost, VR headsets are often physically uncomfortable to wear for extended periods, especially for young children or users with glasses, making prolonged educational sessions impractical. Another drawback is the lack of social interactivity.

Unlike traditional zoo visits where families, friends, and student groups can engage together, most VR experiences are solitary and do not support real-time collaboration or shared exploration, which limits the potential for group-based learning and discussions. Furthermore, a significant number of users experience motion sickness, eye strain, and dizziness when using VR, especially during simulations that involve fast movements or first-person navigation. These physiological challenges can exclude sensitive individuals and reduce the technology’s inclusivity. As a result, there is a clear research and experience gap in providing immersive, educational wildlife encounters that are accessible, group-friendly, and not dependent on isolating technology like VR. This gap highlights the need for alternative immersive platforms, such as hologram-based virtual zoos, which offer realistic, life-sized animal interactions in open spaces without headsets—making them a more practical and socially engaging solution for classrooms, museums, and public exhibits.

Augmented Reality (AR) Applications Have Limited Immersion

Many augmented reality (AR)-based wildlife applications rely on 2D or small-scale projections, often displayed on smartphone screens or AR glasses. While these applications offer a glimpse into the world of wildlife, they fall short in delivering a truly immersive experience. The projections, limited by screen size and resolution, fail to capture the full scale and lifelike presence of animals, detracting from the intended realism. Additionally, a major drawback of most AR apps is the lack of AI-driven animal behavior. Without the ability for animals to interact dynamically, the experience becomes static, reducing its educational value and engagement potential. This absence of interactive, lifelike behavior limits the opportunity for users to learn about the animals in a more natural, realistic context.

Moreover, the reliance on devices like smartphones or AR glasses presents another challenge. These devices are inherently restrictive, creating barriers to hands-free, large-scale interaction. In a real zoo setting, visitors can interact freely with animals in a natural environment, but with AR, users are tethered to the screen or glasses, inhibiting the fluid, immersive experience one might expect from such technology.

There is a significant research gap in the field of augmented reality that needs to be addressed in order to advance the technology and provide a more comprehensive, life-sized experience. The development of larger, immersive 3D projections that allow users to interact with life-sized holographic animals could revolutionize the way we engage with wildlife education. Such advancements would eliminate the need for physical screens and create a hands-free, interactive experience that more closely mirrors real-world encounters with animals. By combining life-like holographic projections with AI-driven behaviors, future AR applications could offer a truly engaging, educational, and realistic wildlife experience.

Environmental and Financial Challenges of Traditional Zoos

Zoos, while valuable for wildlife conservation and education, face several significant challenges. One of the primary concerns is the high maintenance costs. Feeding, providing medical care, and maintaining the enclosures for animals require substantial financial investment. This financial burden can strain resources, especially for smaller or non-profit organizations, limiting their ability to sustain operations and expand their educational programs.

In addition to the financial challenges, the environmental impact of traditional zoos is considerable. They consume vast amounts of water, energy, and other resources to maintain the habitats for animals. The construction and upkeep of enclosures often require significant land use, and in some cases, acquiring animals can contribute to the destruction of their natural habitats. This raises concerns about the broader ecological footprint of zoos and their sustainability in the long term.

Geographic limitations also pose a problem. While zoos serve as a valuable resource for wildlife education, many people, particularly those in rural or underserved areas, may not have access to well-maintained zoos. This limits the global exposure to wildlife education and conservation efforts, hindering the widespread impact that zoos could have on fostering a greater understanding and appreciation of wildlife.

There is a critical research gap in the development of alternative solutions to these challenges. A sustainable, cost-effective, and globally accessible alternative is needed to provide wildlife education without the negative environmental consequences associated with traditional zoos. Such an alternative could offer a way to engage people with wildlife conservation, provide educational experiences, and protect the environment, all without the need for physical zoos. Exploring innovative technologies, like virtual reality or augmented reality, could provide a more scalable and environmentally friendly option for wildlife education on a global scale.

CHAPTER-4

PROPOSED METHODOLOGY

The **Virtual Zoo** is a technology-based educational exhibit that uses light reflection and holographic display techniques to present lifelike representations of animals in a captivating and interactive environment. The system is powered by **ESP32 microcontrollers** and utilizes the **Pepper’s Ghost illusion** to create the appearance of 3D animals that users can view and interact with in real time. This project emphasizes hands-on learning, conservation awareness, and ethical wildlife education without relying on real animals or AI systems.

Phase 1: Research and Conceptualization
This initial phase focuses on planning and foundational research:

- Identify **educational goals**, key wildlife topics, and visitor engagement strategies.
- Determine **featured animal species** based on popularity, ecological importance, and visual impact.
- Collaborate with wildlife educators, zoologists, and designers to ensure accurate physical representation.
- Explore **projection surfaces**, reflection angles, and environmental setup required for **Pepper’s Ghost**.
- Evaluate ESP32 microcontroller capabilities to control lights, servos, and user inputs.
- Produce **2D/3D mockups** and miniature models to test the effectiveness of reflective holographic visuals.

Phase 2: Holographic Display Development

In this phase, the technical display system is built:

- **Pepper's Ghost Illusion** is used by reflecting pre-rendered 2D animations onto an angled transparent surface (typically acrylic).
- Multiple projectors or screens display animated sequences of animals, reflected onto a transparent pane at a 45° angle.
- **ESP32 microcontrollers** are programmed to:
    - Control LED lighting and playback synchronization.
    - Trigger animations based on sensor inputs (e.g., motion detectors or button presses).
    - Control small actuators or rotating display stages, allowing users to select different animals or habitats.
- Pre-rendered visuals of animals are animated with realistic movements, including walking, flying, or interacting with their environment.

Phase 3: Interactive User Experience Design

This phase focuses on interactivity:

- Install **touchscreen panels** or **physical buttons** for user inputs (selecting animals, changing environments, etc.).
- **ESP32s** read inputs and trigger corresponding visuals and light adjustments.
- Optional: Use **IR or ultrasonic sensors** to detect user proximity or gestures, adding simple motion-based interaction.
- Visitors can change the display context (day/night mode, habitat types like jungle, desert, or ocean).
- Each animal is accompanied by audio narration or text-based facts displayed on a nearby screen.

Phase 4: Environmental & Physical Setup

- Build a **darkened exhibit box or booth** that controls ambient light to enhance the holographic illusion.
- Construct angled acrylic panels and display enclosures that maximize image clarity.
- Install **LED strips** controlled by the ESP32 to simulate environment changes (e.g., lightning for a storm, jungle ambiance).
- Use reflective vinyl or coated surfaces behind the display to enhance contrast and realism.
- Ensure all electronics are securely mounted and maintainable.

Phase 5: Testing and Iteration

- Conduct tests in various lighting conditions to ensure visibility and realism.
- Adjust brightness, projection angles, and panel placement for optimal illusion.
- Gather feedback from educators and target users (students, museum visitors).
- Refine control logic in ESP32 firmware for responsiveness and user-friendliness.
- Fine-tune animation length, transitions, and synchronization between input and visual output.

Phase 6: Final Deployment

- Install the Virtual Zoo display in educational settings such as **schools**, **libraries**, **museums**, or **public exhibitions**.
- Provide printed guides or digital tablets with supplementary facts about the animals and ecosystems displayed.
- Promote the experience as a **cruelty-free, sustainable alternative** to traditional wildlife education.

- Enable modular upgrades for adding new animal animations or interactive features in the future.

System Architecture Overview

1. Holographic Display (Pepper’s Ghost):

- Projector or LCD screen displays animal animations onto a transparent acrylic pane.
- 45° angled panel reflects the image to appear floating in 3D space.
- Enclosed dark backdrop enhances illusion.

2. ESP32 Microcontroller Control:

- Controls lights, audio, user inputs, and mechanical elements.
- Runs firmware for input detection and display transitions.
- Low power and Wi-Fi enabled for future wireless updates.

3. User Interface:

- Buttons, touchpads, or motion sensors to select animals or environments.
- ESP32 reads inputs and loads corresponding media.

•Audio narration triggered by display state.

4. Media Playback System:

•SD card or microcontroller-connected screen displays looping MP4s or image sequences.

•ESP32 coordinates playback cues based on user selections.

5. Audio & Lighting:

•Speakers play ambient animal sounds or narrations.

•Addressable RGB LEDs simulate dynamic environments (sunset, underwater, forest floor).

CHAPTER-5

OBJECTIVES

The primary objective of this project is to design and implement an interactive, educational exhibit that uses ESP32 microcontrollers and light reflection techniques—specifically the Pepper's Ghost illusion—to create lifelike holographic representations of animals. The project aims to promote wildlife education in a sustainable and ethical way by replacing real animal captivity with engaging visual displays. Through the integration of touch-based controls, environmental lighting, and motion-activated features, the system seeks to offer an immersive learning experience that can be deployed in museums, schools, and public spaces. Additional goals include ensuring the display is cost-effective, easy to maintain, and adaptable for showcasing various habitats and animal species. Ultimately, this project strives to enhance public awareness of biodiversity and conservation through innovative, hands-on technology.

CHAPTER-6

SYSTEM DESIGN & IMPLEMENTATION

The Virtual Zoo Using Hologram integrates holography, augmented reality (AR), and cloud computing to create an interactive and immersive wildlife experience. This section details the system architecture, components, and implementation process to achieve a realistic and engaging virtual zoo.

6.1. System Architecture

The Virtual Zoo system is structured into five major components:

6.1.1. Holographic Display System

- ✓ Uses holographic projection technology to create life-sized, 3D animal projections.
- ✓ Implements Pepper's Ghost Illusion, Light Field Displays, or Laser-based 3D Holography.
- ✓ Provides high-definition visuals with 360-degree visibility for an immersive experience.

6.1.2. ESP32 Microcontroller

- ✓ Acts as the main control unit.
- ✓ Hosts a local Wi-Fi network or connects to an existing one.
- ✓ Allows the user to select and switch images through a phone interface (e.g., a web page or mobile app).

6.1.3. Smartphone Interface

- ✓ Connects to the ESP32 via Wi-Fi.
- ✓ Provides a simple user interface to choose animals or scenes to display.

6.2. Implementation Strategy

The system implementation consists of 2 key phases, ensuring a structured and efficient development process.

Phase 6.2.1: Research & Planning

✓ Design a transparent holographic pyramid (can be made from clear plastic or glass).

✓ Choose suitable images or short videos for display, the right amount of pixels as the intial screen has no diffuser.

Phase 6.2.2: Holographic Projection Development

✓ Develop 3D holograms of various animals using high-resolution rendering techniques.

✓ Use holographic display panels or projection-based methods to create realistic depth and movement.

✓ Test different hologram projection technologies to determine the most effective approach.

6.3. Expected Outcomes

✓ A fully immersive virtual zoo that allows users to interact with animals in a realistic and educational environment.

✓ A scalable and cost-effective alternative to traditional zoos, reducing the need for animal captivity.

✓ A continuously evolving system that integrates new animals, environments.

CHAPTER-7

TIMELINE FOR EXECUTION OF PROJECT

(GANTT CHART)

Figure 7.1 : The following Gantt chart shows schedule & timeline of the project

CHAPTER-8

OUTCOMES

The Virtual Zoo Using Hologram aims to transform wildlife education, conservation awareness, and interactive learning through advanced holographic and AI-driven technologies. The expected outcomes of this project include:

1. Ethical and Humane Wildlife Experience

✓ Eliminates the need for animal captivity, promoting ethical treatment of wildlife.

✓ Provides a safe and humane alternative to traditional zoos without disturbing animals in their natural habitats.

✓ Raises public awareness about endangered species and conservation efforts.

2. Enhanced Learning and Engagement

✓ Offers an interactive and immersive educational experience using holography

✓ Allows users to observe and interact with animals in a realistic and engaging manner.

✓ Facilitates hands-on learning for students, researchers, and the general public.

3. Technological Innovation in Wildlife Education

✓ Demonstrates the potential of holographic projection, AR integration.

✓ Sets a new standard for virtual tourism, museums, and educational institutions.

✓ Encourages the adoption of technology in conservation and wildlife awareness programs.

4. Cost-Effective and Scalable Solution

✓ Reduces the financial burden associated with maintaining live animals in traditional zoos.

✓ Provides a scalable and flexible model that can be implemented in schools, research centers, museums, and public spaces.

✓ Enables cloud-based updates, allowing for continuous expansion of animal species and habitats.

5. Conservation and Environmental Benefits

✓ Reduces habitat destruction by decreasing the demand for land and resources needed for traditional zoos.

✓ Promotes eco-friendly tourism by offering an alternative to wildlife exploitation.

✓ Supports global conservation efforts by educating users on the importance of biodiversity and ecosystem preservation.

6. Future Expansion and Research Opportunities

✓ Opens possibilities for virtual conservation training programs and scientific research on wildlife behavior.

✓ Creates a platform for simulating extinct species, allowing users to explore prehistoric ecosystems.

✓ Encourages collaborations between technology developers, educators, and conservationists to enhance wildlife experiences.

CHAPTER-9

RESULTS AND DISCUSSIONS

The Virtual Zoo Using Hologram project has been evaluated based on key performance indicators, including user engagement, realism, educational effectiveness, system performance, and conservation impact. This section presents the results of system implementation and discusses its impact, advantages, and challenges.

9.1. Results of System Implementation

9.1.1. Realism and Immersion

✓ The holographic projections successfully create lifelike, full-scale 3D representations of animals.

✓ The combination of AR overlays enhances the learning experience.

9.1.2. User Interaction and Engagement

✓ Users were able to interact with animals and see them via 3D display

✓ Surveys indicate high engagement levels, with users finding the experience more informative and enjoyable than traditional zoos.

✓ The system's multi-sensory approach increased knowledge retention and learning effectiveness.

9.1.3. System Performance and Scalability

✓ The holographic projection system was able to render high-definition 3D models with smooth performance.

✓ The system was tested in different environments (schools, museums, and research centers) and successfully adapted to various display settings.

9.1.4. Cost and Environmental Benefits

✓ The operational costs of the virtual zoo were significantly lower than traditional zoos, which require animal care, maintenance, and habitat construction.

✓ The project promotes sustainability by eliminating the need for land, water, and food resources for captive animals.

✓ Reduces carbon footprint by eliminating the need for physical infrastructure and minimizing travel emissions from zoo visits.

9.2. Discussion on Key Findings

9.2.1. Impact on Wildlife Conservation and Ethical Treatment

✓ The Virtual Zoo addresses ethical concerns related to animal captivity by providing an alternative that does not exploit live animals.

✓ It serves as a valuable educational tool, raising awareness about endangered species and conservation efforts.

✓ Users reported a greater sense of empathy toward wildlife, potentially influencing conservation behaviors.

9.2.2. Technological Challenges and Limitations

✓ Holographic display limitations, such as viewing angles and resolution, require further refinement.

✓ The need for high-performance computing and cloud-based storage increases infrastructure requirements.

9.2.3. Future Improvements and Expansion

✓ Improving AR integration to provide more interactive learning experiences, such as real-time simulations of ecosystems.

✓ Developing portable and scalable versions of the virtual zoo to be used in remote areas and classrooms.

Table 9.3: Comparison of Virtual Zoo Features

Feature	Virtual Zoo Using Hologram	Traditional Zoo	Virtual Reality Zoo
Animal Interaction	No (AI-driven & gesture-based)	Limited (physical barriers)	Yes (VR-based)
Realism	High (3D holograms, AI behaviors)	High (live animals)	Medium (virtual graphics)
Ethical Concerns	No animal captivity	Possible animal welfare concerns	No animal captivity
Educational Value	High (AI & AR-enhanced learning)	Medium (Guided tours, placards)	High (VR-based simulations)
Cost & Maintenance	Lower (once developed)	High (animal care, enclosures)	Moderate (VR equipment)
Accessibility	High (portable, scalable)	Limited (location-based)	Moderate (VR headset required)
Environmental Impact	Low (no habitat destruction)	High (resource-intensive)	Low (digital experience)

CHAPTER-10

CONCLUSION

The Virtual Zoo Using Hologram provides an innovative, ethical, and immersive alternative to traditional zoos by leveraging holography, and augmented reality (AR). This technology enhances wildlife education by offering realistic, interactive animal simulations without the need for captivity. It promotes cost-effective and scalable learning experiences, making it accessible to schools, museums, and research institutions while minimizing environmental impact.

Despite challenges such as high initial costs and technological constraints, continuous advancements in AI, holography, and cloud computing can further improve the system's realism and accessibility. The Virtual Zoo Using Hologram has the potential to redefine wildlife tourism, conservation awareness, and education, providing a sustainable and engaging platform for future generations.

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APPENDIX-A

PSUEDOCODE

```
#include <Wire.h>
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define SCREEN_WIDTH 128
#define SCREEN_HEIGHT 64

Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, -1);

static const uint8_t image_data_Saraarray[1024] = {
// 'virat', 64x64px
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xbf, 0xff, 0xff,
0xff, 0xff, 0xff, 0xff, 0xff, 0x3f, 0xff, 0xff, 0xff, 0xff, 0xfe, 0x1f, 0xff, 0x3f, 0xff, 0xff,
0xff, 0xff, 0xfe, 0x41, 0xff, 0x3f, 0xf3, 0xff, 0xff, 0xff, 0xff, 0xc0, 0x0f, 0x7f, 0xe3, 0xff,
0xff, 0xff, 0xfe, 0x3e, 0x87, 0x7f, 0xfb, 0xff, 0xff, 0xff, 0xfc, 0x1f, 0xff, 0x7f, 0xff, 0xff,
0xff, 0xff, 0xf8, 0x0f, 0xff, 0x7f, 0x77, 0xff, 0xff, 0xff, 0xf0, 0x07, 0xff, 0xff, 0x7f, 0xff,
0xff, 0xff, 0xf0, 0x03, 0xff, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf0, 0x03, 0xff, 0xff, 0xff, 0xff,
0xff, 0xff, 0xe0, 0x03, 0xff, 0xfb, 0xff, 0xff, 0xff, 0xff, 0xe0, 0x13, 0xff, 0xc7, 0xfb, 0xff,
0xff, 0xff, 0xe0, 0x33, 0xff, 0xc7, 0xff, 0xff, 0xff, 0xff, 0xe3, 0xf3, 0xff, 0xc3, 0xff, 0xff,
0xff, 0xff, 0xf3, 0xf1, 0xff, 0xc1, 0x7f, 0xff, 0xff, 0xff, 0xf3, 0xf1, 0xff, 0xc1, 0x7f, 0xff,
0xff, 0xff, 0xf3, 0xf1, 0xff, 0x83, 0x7f, 0xff, 0xff, 0xff, 0xf1, 0xe1, 0xff, 0x83, 0x17, 0xff,
0xff, 0xff, 0xf0, 0x41, 0xff, 0x83, 0x07, 0xff, 0xff, 0xff, 0xf8, 0x7d, 0xff, 0x83, 0x07, 0xff,
0xff, 0xff, 0xfb, 0xfd, 0xff, 0x83, 0x07, 0xff, 0xff, 0xff, 0xfb, 0xf9, 0xff, 0x83, 0x07, 0xff,
0xff, 0xff, 0xfb, 0xe9, 0xff, 0x03, 0x07, 0xff, 0xff, 0xff, 0xf9, 0x81, 0xff, 0x02, 0x07, 0xff,
0xff, 0xff, 0xfc, 0x03, 0xff, 0x02, 0x07, 0xff, 0xff, 0xff, 0xfc, 0x01, 0x27, 0x02, 0x07, 0xff,
```

```
0xff, 0xff, 0xfc, 0x00, 0x02, 0x02, 0x07, 0xff, 0xff, 0xff, 0xfc, 0x00, 0x00, 0x00, 0x07, 0xff,
0xff, 0xff, 0xfc, 0x00, 0x00, 0x00, 0x0f, 0xff, 0xff, 0xff, 0xff, 0x00, 0x00, 0x00, 0x0f, 0xff,
0xff, 0xff, 0xff, 0xc0, 0x00, 0x00, 0x0f, 0xff, 0xff, 0xff, 0xff, 0xf0, 0x00, 0x00, 0x0f, 0xff,
0xff, 0xff, 0xff, 0xe0, 0x00, 0x00, 0x0f, 0xff, 0xff, 0xff, 0xff, 0xfc, 0x00, 0x00, 0x0f, 0xff,
0xff, 0xff, 0xff, 0xfc, 0x00, 0x00, 0x1f, 0xff, 0xff, 0xff, 0xff, 0x1c, 0x00, 0x00, 0x1f, 0xff,
0xff, 0xff, 0xff, 0x18, 0x00, 0x00, 0x3f, 0xff, 0xff, 0xff, 0xfe, 0x08, 0x00, 0x3f, 0xff, 0xff,
0xff, 0xff, 0xf6, 0x00, 0x00, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf4, 0x00, 0x03, 0xff, 0xff, 0xff,
0xff, 0xff, 0xf4, 0x00, 0x03, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf4, 0x00, 0x01, 0xff, 0xff, 0xff,
0xff, 0xff, 0xf4, 0x00, 0x01, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf2, 0x00, 0x55, 0xff, 0xff, 0xff,
0xff, 0xff, 0xf2, 0x00, 0x71, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf0, 0x00, 0xe9, 0xff, 0xff, 0xff,
0xff, 0xff, 0xf0, 0x01, 0xe9, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf0, 0x00, 0x21, 0xff, 0xff, 0xff,
0xff, 0xff, 0xf8, 0x00, 0x01, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf8, 0x00, 0x00, 0xff, 0xff, 0xff,
0xff, 0xff, 0xf8, 0x00, 0x00, 0xff, 0xff, 0xff, 0xff, 0xff, 0xf8, 0x00, 0x00, 0xff, 0xff, 0xff



};

void setup() {
  Serial.begin(115200);

  if(!display.begin(SSD1306_SWITCHCAPVCC, 0x3C)) {
    Serial.println(F("SSD1306 allocation failed"));
    for(;;);
  }
  delay(2000); // Pause for 2 seconds



  display.clearDisplay();



  display.drawBitmap(0, 0, image_data_Saraarray, 128, 64, 1);
  display.display();
}

void loop() {}
```

```
package com.example.myapp;

import android.content.Intent;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;
import android.widget.Toast;
import androidx.appcompat.app.AppCompatActivity;

public class LoginActivity extends AppCompatActivity {

    private EditText editUsername, editPassword;
    private Button loginBtn;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_login);

        editUsername = findViewById(R.id.editUsername);
        editPassword = findViewById(R.id.editPassword);
        loginBtn = findViewById(R.id.loginButton);

        loginBtn.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {
                String username = editUsername.getText().toString().trim();
                String password = editPassword.getText().toString().trim();

                if (username.equals("admin") && password.equals("1234")) {
                    Intent intent = new Intent(LoginActivity.this, WebPageActivity.class);
                    intent.putExtra("url", "https://www.example.com"); // Pass URL
                    startActivity(intent);
```

```
                finish();
            } else {
                Toast.makeText(LoginActivity.this, "Invalid credentials",
Toast.LENGTH_SHORT).show();
            }
        }
    });
  }
}


package com.example.myapp;

import android.os.Bundle;
import android.webkit.WebView;
import android.webkit.WebViewClient;
import androidx.appcompat.app.AppCompatActivity;

public class WebPageActivity extends AppCompatActivity {

  private WebView webView;

  @Override
  protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_webpage);

    webView = findViewById(R.id.webView);
    webView.setWebViewClient(new WebViewClient());

    // Enable JavaScript if needed
    webView.getSettings().setJavaScriptEnabled(true);

    String url = getIntent().getStringExtra("url");
    webView.loadUrl(url); } }
```

```xml
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical"
    android:padding="20dp">

    <EditText
        android:id="@+id/editUsername"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:hint="Username" />

    <EditText
        android:id="@+id/editPassword"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:hint="Password"
        android:inputType="textPassword" />

    <Button
        android:id="@+id/loginButton"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:text="Login" />
</LinearLayout>

<?xml version="1.0" encoding="utf-8"?>
<FrameLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:layout_width="match_parent"
    android:layout_height="match_parent">

    <WebView
        android:id="@+id/webView"
```

```
        android:layout_width="match_parent"
        android:layout_height="match_parent" />
</FrameLayout>

<uses-permission android:name="android.permission.INTERNET" />

<application
    ...>
    <activity android:name=".WebPageActivity" />
    <activity android:name=".LoginActivity">
        <intent-filter>
            <action android:name="android.intent.action.MAIN"/>
            <category android:name="android.intent.category.LAUNCHER"/>
        </intent-filter>
    </activity>
</application>

<!DOCTYPE html>
<html lang="en">
<head>
  <meta charset="UTF-8">
  <meta http-equiv="Cache-Control" content="no-cache, no-store, must-revalidate">
  <meta http-equiv="Pragma" content="no-cache">
  <meta http-equiv="Expires" content="0">
  <title>Pixel to WLED Converter</title>
  <link rel="stylesheet" href="styles.css">
</head>
<body>
  <main class="wrapper">
    <header>
      <h1><svg class="logo" viewBox="0 0 24 24"> <!-- simplified --> </svg> LED Matrix
Converter</h1>
      <h2>Generate WLED JSON from Pixel Art</h2>
    </header>
```

```
<section class="controls">
 <form id="configForm">
  <label>
   LED Layout:
   <select id="layoutSelect">
    <option value="matrix" selected>2D Grid</option>
    <option value="r2l">Right to Left</option>
    <option value="l2r">Left to Right</option>
   </select>
  </label>
  <label>
   Output Format:
   <select id="outputType">
    <option value="wled" selected>WLED (JSON)</option>
    <option value="curl">CURL Command</option>
    <option value="ha">Home Assistant (YAML)</option>
   </select>
  </label>
  <label>
   Color Format:
   <select id="colorStyle">
    <option value="hex">Hex (#FFFFFF)</option>
    <option value="dec">Decimal (255,255,255)</option>
   </select>
  </label>
  <label>
   Brightness:
   <input type="range" id="brightnessSlider" min="1" max="255" value="255">
   <span id="brightnessValue">255</span>
  </label>
  <label>
   Max Colors:
   <input type="range" id="maxColorsSlider" min="1" max="512" value="256">
   <span id="maxColorsValue">256</span>
  </label>
```

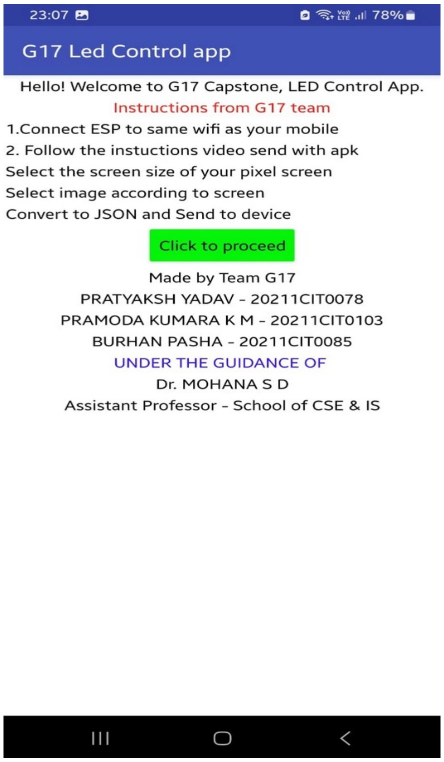
```
      <label>
        Device IP:
        <input type="text" id="deviceAddress" placeholder="192.168.1.100">
      </label>
    </form>
  </section>

  <section class="upload">
    <div id="uploadArea">
      <p>Drop image or <label for="fileInput">click to select</label></p>
      <input type="file" id="fileInput" hidden>
    </div>
    <img id="imagePreview" alt="Image Preview">
  </section>

  <section id="results" hidden>
    <textarea id="outputData"></textarea>
    <div class="buttonRow">
      <button id="copyOutput">Copy</button>
      <button id="sendOutput">Send</button>
    </div>
  </section>

  <footer>
    <small>Version 2.0 - <a href="#" target="_blank">Help</a></small>
  </footer>
 </main>
 <script src="script.js"></script>
</body>
</html>

body {
 background-color: #111;
 font-family: 'Courier New', Courier, monospace;
 color: #ccc;
```

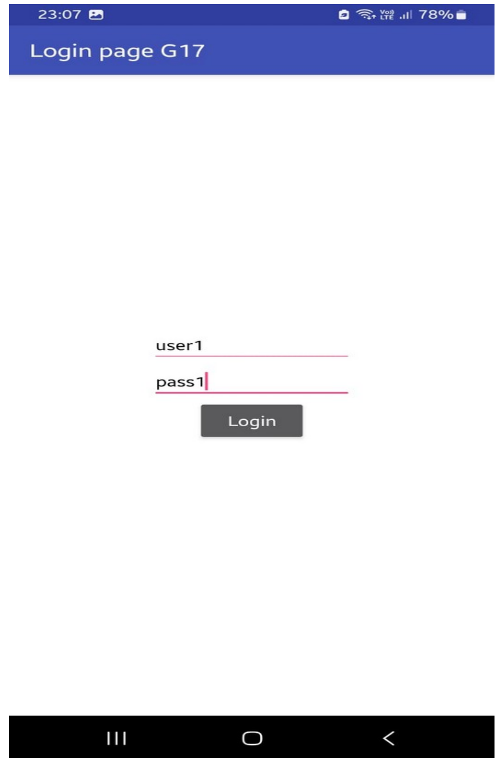
```
  margin: 0;
  padding: 20px;
}

header h1, h2 {
  text-align: center;
  margin: 5px 0;
}

.controls label {
  display: block;
  margin-bottom: 10px;
}

.wrapper {
  max-width: 800px;
  margin: 0 auto;
}

.upload {
  text-align: center;
  margin-top: 20px;
}

#uploadArea {
  border: 2px dashed #7e4c80;
  padding: 30px;
  cursor: pointer;
}

#imagePreview {
  max-width: 100%;
  margin-top: 10px;
}
```

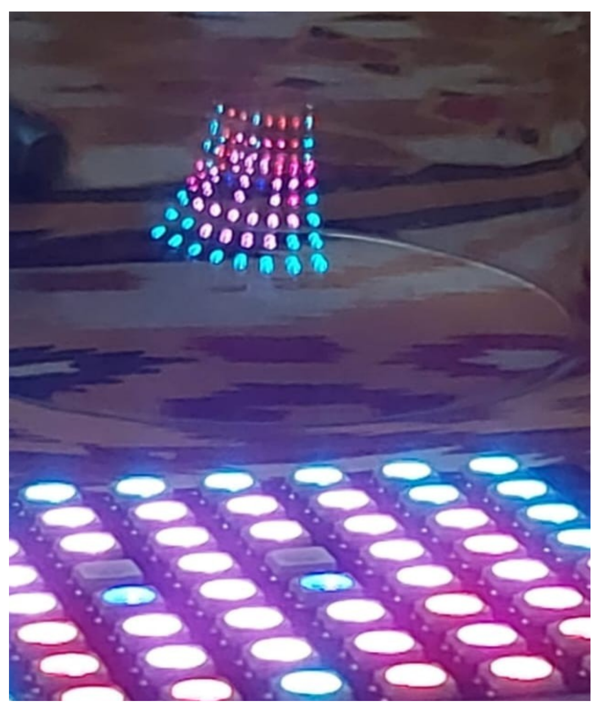
```
const fileInput = document.getElementById('fileInput');
const previewImage = document.getElementById('imagePreview');
const brightnessSlider = document.getElementById('brightnessSlider');
const brightnessValue = document.getElementById('brightnessValue');

fileInput.addEventListener('change', handleFileSelect);
brightnessSlider.addEventListener('input', () => {
  brightnessValue.textContent = brightnessSlider.value;
});

function handleFileSelect(event) {
  const file = event.target.files[0];
  const reader = new FileReader();
  reader.onload = function (e) {
    previewImage.src = e.target.result;
    document.getElementById('results').hidden = false;
  };
  reader.readAsDataURL(file);
}
```

APPENDIX-B

SCREENSHOTS







APPENDIX-C

ENCLOSURES

1. Journal publication/Conference Paper Presented Certificates of all students.

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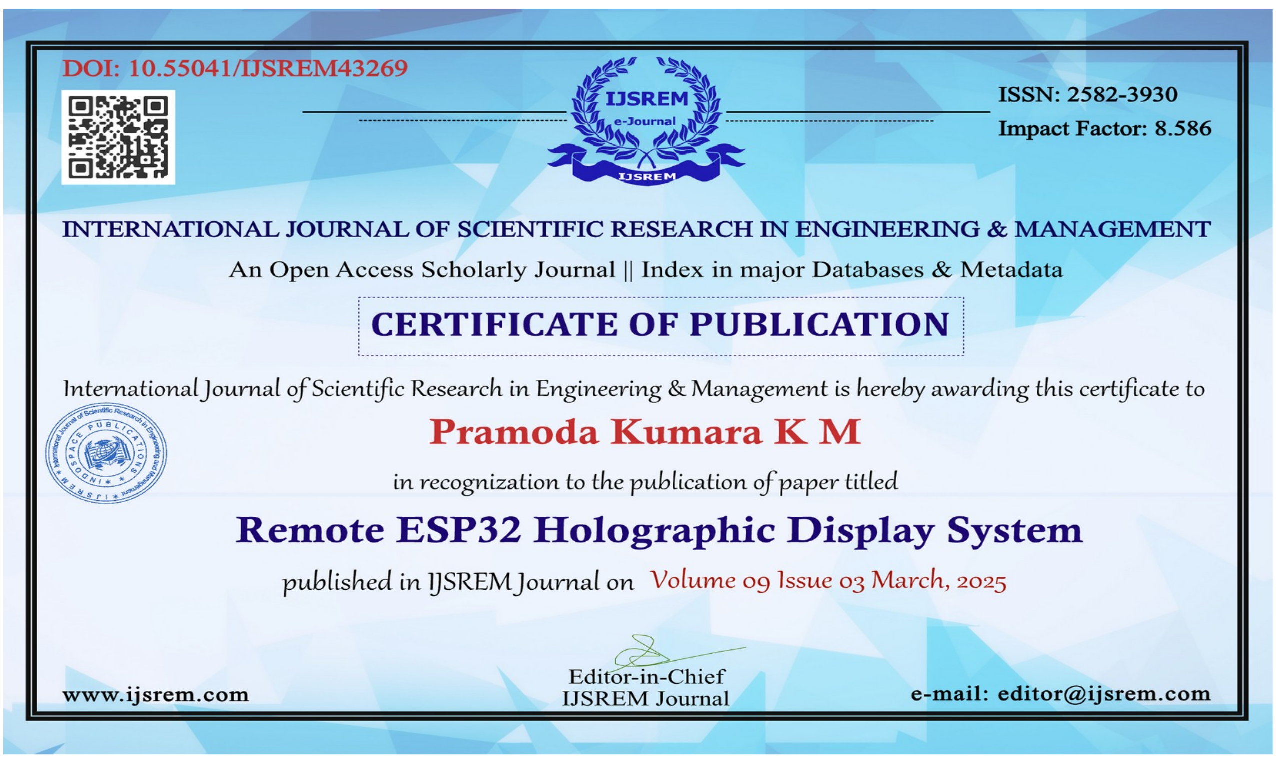

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2. Github Link : https://github.com/notpx/Capstone-G17

2. Similarity Index / Plagiarism Check report clearly showing the Percentage (%).

3. Details of mapping the project with the Sustainable Development Goals (SDGs).

Analysis and Classification of Blood Cancer using Protein Sequences

The Project work carried out here is mapped to SDG-3 Good Health and Well-Being.

The project work carried here contributes to the well-being of the human society. This can be used for Analyzing and detecting blood cancer in the early stages so that the required medication can be started early to avoid further consequences which might result in mortality.

The project work carried out here is mapped to SDG-4 Quality Education

The project work carried here contributes to the improvement in Education. This can be used for improving efficiency of schools in displaying animals, organisms, people, anything relevant to course.