Comprehensive Review of 3D Interactive Holographic Display

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Abstract -- **The era we are living in is completely digital providing different helpful realistic things which we witness in day-to-day life. People desire each day a new advancement in technology, touching new heights. 3 D is the term where each item can be represented in realistic way. The experience of viewing the things completely changes with this technology. It can be applied in various fields like medical, engineering, marketing and others where hologram display is required. In this technology, interference design is created by refraction which is displayed by holographic projectors. In this paper author proposes the design and fabrication of holographic display using technology of refraction by minimum loss of light.**

I. INTRODUCTION

A controlled display of light involves required number of pixels which is displayed with different colour combinations and unique light intensity. It is all mannered in respective way and represented by hologram. Sometime it contains pictures spatial information. A holographic display is a technology that creates holograms, without the need for special glasses or wearable devices. It uses a combination of optics, projection systems, and sometimes lasers to generate the illusion of a three-dimensional object floating in space.Unlike traditional displays that project images onto a 2D surface, holographic displays use reflection, light diffraction, and interference principles to create the perception of depth, allowing viewers to see objects from different angles. The holographic display creates the illusion by encoding and reconstructing light waves that mimic the way light interacts with objects in the real world.

There are several types of holographic displays, including:

Pepper's Ghost: This technique uses angled reflective surfaces or transparent screens to reflect an image onto a clear surface, giving the impression that the object is floating in space.

Holographic projection: This method projects light onto a screen or a diffuser, creating the illusion of a three-dimensional image in mid-air. It can use techniques such as interference patterns or laser-based projections.

Holographic volumetric displays: These displays use a combination of lasers, optical systems, and rotating mirrors or rapidly moving screens to create three-dimensional images with full 360-degree visibility. They allow viewers to walk around and view the holograms from various angles. The 3D interactive holographic display project is a critical endeavour with significant implications across various domains. Let's explore in detail why this project is needed.

The primary objective of the project is to provide users with an unparalleled level of immersion and interactivity. Holographic displays offer the potential for users to engage with content in a three-dimensional space, providing a more realistic and captivating experience compared to traditional two-dimensional displays. By creating a sense of depth and spatial presence, holographic displays enable users to perceive content in a more intuitive and engaging manner. This immersive experience has wide-ranging applications in entertainment, where it can revolutionize gaming, virtual reality experiences, and live performances. Moreover, in fields such as design, healthcare, education, and advertising, holographic displays can offer novel and captivating ways to visualize and communicate ideas, concepts, and data.

The project seeks to advance the capabilities of visualization. By presenting content in three dimensions, holographic displays allow for a more comprehensive and intuitive representation of complex information. This is particularly valuable in scientific research, engineering, architecture, and data analysis, where visualizing intricate structures, simulations, or datasets can enhance understanding and facilitate insights. The ability to manipulate and interact with holographic objects enables more effective communication of ideas, enabling clearer explanations and more engaging presentations. Holographic displays can facilitate collaboration, improve decision-making processes, and enable more effective knowledge transfer.

The project serves as a catalyst for innovation and creativity in the field of display technologies. By addressing the challenges associated with holographic displays, researchers and engineers are pushed to develop novel solutions, techniques, and materials. This drive for innovation leads to advancements not only in holographic display technology but also in related fields such as optics, materials science, computer graphics, and human-computer interaction. The project encourages exploration of new display methodologies, optical designs, and projection techniques to overcome technical limitations and enhance the visual quality, resolution, and interactivity of holographic displays. These advancements fuel technological progress and have the potential to revolutionize the way we interact with digital content.The project has significant implications for education and training. Holographic displays offer unique opportunities to enhance learning experiences. By visualizing complex concepts and data in three dimensions, holographic displays provide students with a more intuitive and immersive way to grasp abstract or challenging subjects. The ability to interact with holographic objects can foster active learning and enable students to explore and manipulate virtual content, deepening their understanding. Holographic displays also hold promise in remote training scenarios, allowing individuals to practice skills and procedures in virtual environments, reducing the need for physical equipment and providing cost-effective training solutions.

In entertainment, holographic displays can revolutionize live performances, gaming experiences, and virtual reality applications by providing more immersive and realistic interactions. Additionally, holographic displays hold promises in advertising and marketing, enabling innovative and attention-grabbing campaigns. The widespread adoption of holographic displays can spur the growth of a new industry sector, creating job opportunities and driving economic development.

II. METHODOLOGY AND PROGRAMMING

The working principle behind 3D interactive holographic displays involves the projection of light onto a specialized medium and creates the illusion of a three-dimensional object mid-air. These displays utilize techniques such as interference, reflection, diffraction, and polarization to generate holographic images.The project contributes to advancements in display technologies, materials, and systems. By addressing the challenges related to resolution, viewing angles, portability, and integration with other technologies, engineers can push the boundaries of what is achievable in holographic displays. Research and development efforts can lead to breakthroughs in display panel technologies, optical design, holographic projection techniques, and real-time rendering algorithms. These advancements not only benefit holographic displays but can also have broader implications for other display technologies, potentially revolutionizing the way we perceive and interact with visual information across various domains.

We have programmed the raspberry pi microprocessor to take inputs from the keyboard and the mouse to interact with the object. The successful implementation of holographic displays can have substantial implications for various industries, leading to new opportunities and economic growth. Design and architecture industries can benefit from holographic displays for

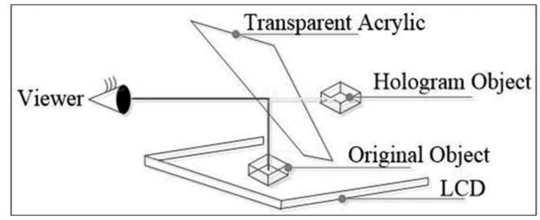

Figure 1. Working principle.

visualizing and presenting concepts to clients, facilitating better communication and collaboration. In healthcare, holographic displays can assist in medical imaging, surgical planning, and patient education.

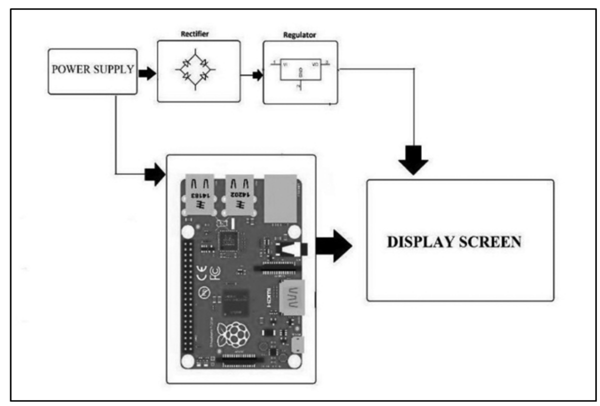

Figure 2. Working diagram.

Acrylic Sheet: Acrylic sheets, also known as acrylic glass or polymethyl methacrylate (PMMA), are transparent or translucent thermoplastic materials. Acrylic sheets are derived from acrylic acid, a substance obtained from petroleum. Acrylic sheets offer a compelling choice for 3D interactive holographic displays due to their optical clarity, lightweight nature, ease of fabrication, UV stability, scratch resistance, cost-effectiveness, and versatility. By leveraging these properties, acrylic sheets can contribute to the creation of captivating and visually stunning holographic experiences for users.

Monitor: For our model we used a 15-inch Lapcare 38.36 CM monitor.

Metal frame: Once the dimensions of the acrylic sheets and the monitor are decided, we can work on the dimensions of the frame.

For the metal frame, length of the sides is 27.5 centimetres, width of the frame is 41.5 centimetres and height for the frame is 20 centimetres.

Raspberry Pi 3 B+: The Raspberry Pi 3 B+ is a single-board computer developed by the Raspberry Pi Foundation. It is an upgraded version of the previous Raspberry Pi 3 Model B. It consists of the following components on board:

Processor: The Raspberry Pi 3 B+ is powered by a Broadcom BCM2837B0 system-on-a-chip (SoC) with a 64-bit quad-core ARM Cortex-A53 CPU running at 1.4 GHz. This provides improved performance compared to its predecessor.

Memory: It has 1GB LPDDR2 RAM, allowing for smooth multitasking and running various applications.

Connectivity: The board offers built-in Wi-Fi (802.11n) and Bluetooth 4.2, providing wireless connectivity options for internet access, IoT projects, and peripheral device connectivity.

Ethernet: It includes a Gigabit Ethernet port, allowing for fast and reliable wired network connections.

USB Ports: The Raspberry Pi 3 B+ has four USB 2.0 ports, enabling the connection of peripherals such as keyboards, mice, external storage devices, and other USB accessories.

Video Output: It features a full-size HDMI port that supports up to 1080p resolution, allowing you to connect it to a monitor or TV. Additionally, it has a MIPI DSI display port and a MIPI CSI camera port for connecting compatible displays and cameras.

Storage: The board utilizes microSD card storage for the operating system and data storage. It also has a microSD card slot for easy expansion.

GPIO: The Raspberry Pi 3 B+ has a 40-pin GPIO header, providing access to various general-purpose input/output pins for connecting to sensors, actuators, and other external devices.

Power: It requires a 5V micro-USB power supply for operation.

Operating System: The Raspberry Pi 3 B+ supports various operating systems, including Raspbian (a Linux-based OS optimized for the Raspberry Pi), Ubuntu, and other Linux distributions.

III. PYTHON LANGUAGE

Python is a high-level, interpreted programming language known for its simplicity and readability. Python emphasizes code readability and provides a clear and concise syntax that makes it easy to understand and write, even for beginners.In this project python is used to generate a GUI for displaying the three-dimensional object, and to interact with it, using keyboard and mouse as its GPIO.Easy to learn and use: Python has a straightforward syntax that focuses on simplicity and readability. Its indentation-based block structure enhances code readability, making it easier to understand and maintain. Python is an interpreted language, meaning that code can be executed directly without the need for compilation. This enables rapid development and testing as developers can experiment and interact with code in an interactive shell.Python is a cross-platform language, which means that Python code written on one operating system can run on multiple platforms without any or with minimal modifications. This versatility makes it suitable for a wide range of applications and environments. This library saves time and effort by offering ready-to-use solutions for common programming challenges.Python has a vibrant and active community of developers who contribute to its growth and development. This community provides support, resources, and a vast ecosystem of third-party libraries and frameworks. It provides classes, objects, and inheritance, enabling the implementation of complex software architectures and design patterns.

Python finds applications in various domains, including web development, scientific computing, data analysis, artificial intelligence, machine learning, automation, and scripting. It is widely used by individuals, small-scale projects, as well as large organizations, thanks to its versatility, ease of use, and strong community support.

Geany IDE: Geany is a lightweight integrated development environment (IDE) that is popular among developers for its simplicity and efficiency. It is designed to provide a straightforward and fast environment for coding in various programming languages. Geany is available for multiple platforms, including Windows, macOS, Linux, and Raspberry Pi OS. This cross-platform support allows developers to use Geany on their preferred operating system without any major differences in functionality.

Pi3D LIBRARY

Pi3D is a python module that is used to render 3D and 2D designs in python. It simplifies writing 3D codes and enables commands to edit the 3D graphics, textured and animated models, landscape, shaders, lights, camera angles etc.Pi3D includes following features:

Display: The display class is responsible for managing the graphical display for rendering 3D graphics on the Raspberry Pi.

Shape: It includes all the objects to be drawn by pi3d. It holds all the information about the object, its position, rotation, and scale, etc.

Buffer: Buffer includes array of values representing the object like vertices, faces, texture coordinates, etc.

Shader: To run the program it is used in ver fast pace**.**

Camera: The camera class provides a way to define and control the camera used to view a 3D scene.

Light: The light class of the pi3d library has the properties of defining the colour, ambient and direction of light.

The 3D interactive holographic display project has various applications, including engineering, medical imaging, design, education, and more. They offer unique and immersive visual experiences, enabling viewers to interact with virtual objects as if they were real and enhance user experiences, advance visualization and communication capabilities, foster innovation and creativity, facilitate education and training, drive industry applications, contribute to economic growth, and push technological advancements. By creating immersive and interactive holographic displays, the project opens new possibilities for visual content representation and interaction, promising to reshape the way we perceive and engage with digital information in a wide range of fields.

IV. CONCLUSION

The development of 3D interactive holographic displays has brought about a revolution in the field of visual communication and human-computer interaction. These advanced displays have the potential to reshape numerous industries, including entertainment, education, healthcare, and advertising. Through the projection of virtual objects into physical space, they offer an immersive and interactive experience that was previously limited to science fiction.Over the years, significant progress has been made in the field of holographic displays, resulting in more realistic and vibrant visual representations. This technology utilizes various techniques such as light field displays, volumetric displays, and holographic projections to create the illusion of three-dimensional objects floating in mid-air. The combination of these techniques with interactive capabilities has opened a wide range of possibilities for users to engage with virtual content in a natural and intuitive way.

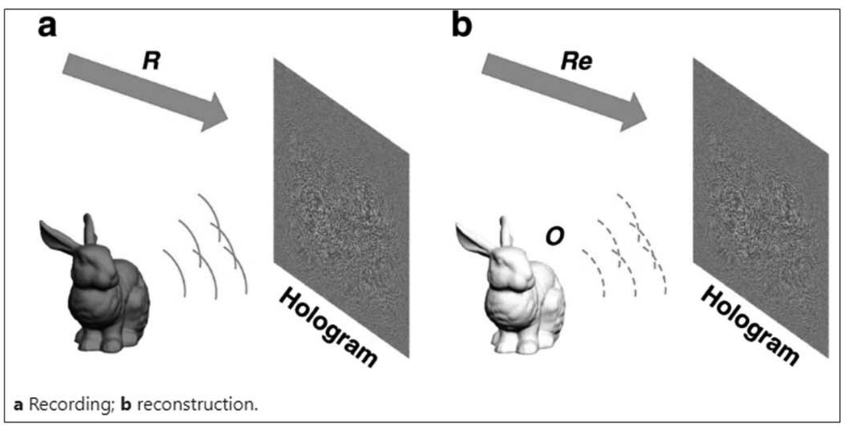

Figure 3. Recording and Reconstruction process [2].

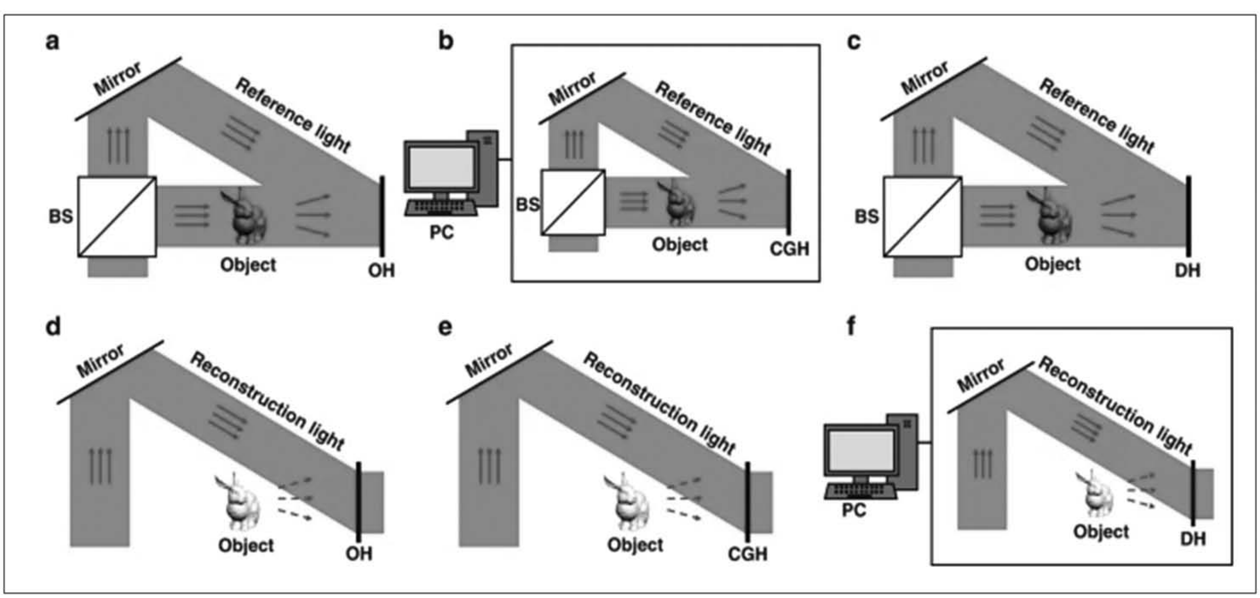

Figure 4. Optical, Digital and Display Holography [2].

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