INTERNATIONAL JOURNAL OF COMPUTER ENGINEERING AND APPLICATIONS
VOLUME XVI, ISSUE IV, APRIL 22, WWW.IJCEA.COM, ISSN 2321-3469

INTERACTIVE HOLOGRAM USING FINGER GESTURES

Yadnesh Chowkekar[1], Athava Deshmukh[2], Sakshi Polekar[3], Yogita chavan[4]

Department of Computer Engineering, New Horizons institute of technology and Management Thane, India

ABSTRACT:

In this work, we show how to use the quadrangular pyramid hologram and parabolic system (for 3D holographic object reconstruction) and the flick gesture module (as a finger action) to make a 3D holographic projection. Not only can this device reconstruct and project a 3D hologram item in mid-air, but it also allows users to interact with it by providing certain finger gestures. The three basic processes are the reconstruction of a 3D object, projection of a 3D hologram object in mid-air, and interactive manipulation of a 3D hologram object. A quadrangular pyramid hologram with an LCD display is used for the first step, whereas the other hardware components help in processing the gestures and applying the changes in the hologram.

Keywords: hologram, gestures, quadrangular pyramid, 3D projection, LCD display.

[1] INTRODUCTION

Three-dimensional (3D) data capture and visualization has always been a popular issue. Researchers recently predicted that they would be able to construct a true 3D display that can be viewed from multiple angles. As a one-of-a-kind approach, the holographic display can record and recreate the wavefront information of a light wave. As a result, the genuine 3D object may be recreated, and there is no conflict between human eyes convergence and accommodation. As a result, holographic displays are expected to be the best way to convey 3D content. Three-dimensional holographic communication technology, which exploits the idea of three-dimensional computer images to project a remote person or

item in three dimensions in the air, is commonly seen in science fiction movies. With the development of science, all the equipment is miniaturized and precision, while the display device cannot match. People want a new display technology to fix the problem, and they're willing to spend money on it. This is why the 3D holographic projection was created. As the frontier of science and technology, holographic museums have appeared in the world in recent years. While displaying cultural relics, they can also interact with visitors, which not only ensures the safety of cultural relics, but also enhances visitors' experience. Interactive holographic projection technology has become a hot spot of international scientific and technological research, and also an inevitable trend of the future development of the times, with tremendous vitality and market prospects.

[2] LITERATURE SURVEY

This section introduces related efforts on the display of 3D objects in space and the manipulation of 3D objects.

[2.1] HOLOGRAPHIC TECHNIQUE

The holographic technique is a method of recording and reproducing genuine three-dimensional images of objects using interference and diffraction principles. The holographic projection uses a laser as its illumination source and divides the light it emits into two beams: one that is directly directed to the photosensitive film and the other that is reflected by the object and then directed to the photosensitive film. Interference is created when these beams of light collide on the photographic plate. Finally, the hologram reconstructed using the digital image basic principle is further processed to remove digital interference and produce a clear hologram. The sci-fi picture Iron Man has a large following, and holographic projection technology has played a significant role in its success. In the French language, holographic projection first appeared. While one Jean-Luc Mélenchon discussed politics openly in Lyon, another Jean-Luc Mélenchon appeared 450 kilometers away in the Paris Concert Hall. This "separation" matches Jean-Luc Mélenchon's actions in Lyon with the use of 3D holographic projection, and the supporters listened to his "separation" speech. Furthermore, the use of this technology in live theater is getting increasingly dazzling and stunning. Figure 1 demonstrates the holographic approach.

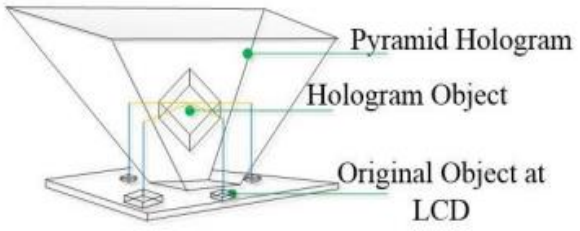

Figure1. Holographic technique

[2.2] INTEGRAL PHOTOGRAPHY

Integral photography holographic projection is one of the easiest methods for creating a 3D hologram from a 2D surface. A quadrangular pyramid and a sophisticated display system are employed in this strategy. When a quadrangular pyramid made of clear plastic board is piled on a flat-panel display, the flat-panel display's picture is mirrored on the quadrangular pyramid's surface and seen by the observer.

This scenario is feasible because, depending on the incidence angle, transparent synthetic resin generally reflects a significant amount of photons. As a result, an observer sees a floating item in the quadrangular pyramid.

[2.3] NATURAL INTERACTION TECHNOLOGY

At this time, the natural interaction interface represented by touch has rapidly supplanted the keyboard and mouse as the primary means of accessing the digital world. Academia and business are still seeking natural interaction, which is expressed by movements and voice, and can help users convey their interaction intents more easily and efficiently. Table I shows comparative tables of the properties of several interaction styles.

Table I. Comparison of different interaction modes

Interaction mode	Simplicity	Learning Cost	Accuracy
Key mouse	middle	middle	high
Touch	high	low	middle
somatosensation	low	middle	middle
Voice	low	high	high
Gestures	high	low	middle

In recent years, a variety of natural interaction technologies with low learning costs continue to be the focus of academic attention.

[2.4] SOMATOSENSORY INTERACTION

The technology of somatosensory natural interaction is to calculate and process the position of the key parts obtained by the action capture system, analyze the user's action behavior and convert it into input instructions, so as to realize the interaction between the user and the computer. Microsoft's Kinect uses a depth camera to capture the user's motion information, thus operating virtual objects on the interactive interface. Magic Leap One of Magic Leap also allows users to interact with gestures. This kind of interaction not only reduces the cost of human-computer interaction, but also conforms to the natural habits of human beings. It is more natural and intuitive than the traditional way of interaction. It is a hot topic in the field of human-computer interaction.

[2.5] VOICE INTERACTION

Language is the most direct way of human communication. Language interaction has a large amount of information and high efficiency. Therefore, speech recognition has become one of the most important ways of human-computer interaction. In recent years, with the development of artificial intelligence and the enhancement of computer processing power, speech recognition technology is becoming increasingly

mature and widely used in intelligent terminals. The most representative of these technologies is Siri launched by Apple and Cortana launched by Microsoft. They both support natural language input and acquire instructions through speech recognition. Returning the most matched results according to the user's needs and realizing the natural human-computer interaction.

[2.6] FINGER GESTURES

A gesture is a sort of nonverbal or nonvocal communication in which observable physical motions are used instead of or in addition to words to transmit certain meanings. Gestures can be made using hands, faces, and other body parts. Individuals can use gestures to express a wide range of emotions and thoughts, from contempt and hostility to approval and tenderness, and they often use body language along with words when they speak.

[3] SYSTEM DESIGN

This section explains the design concept of 3D Holographic and Interactive systems. The system design has three main parts: 1) pyramidal trunk 2) luminaire and 3) ambient light suppression.

[3.1] PYRAMIDAL TRUNK

The type of material utilized for reflection and the spatial precision of the pyramid frustum are both critical factors in the production of a 3D Hologram object Various reflective materials can be used, such as glass, acrylic sheets etc, can be employed. To make the pyramidal frustum, however, we used black reflective glass.Since black glass cancels out reflected black light, it is easier to project objects onto a black background on a display panel. The dimensions of a pyramidal frustum are determined by the display screen's dimensions and the angle of inclination between the frustum and the display screen. The angle of inclination must be 45º for a flawless reflection of a 3D object. If the inclination angle is greater than 45º, the object appears to be further away from the center of the image. Table II provides the formula for calculating dimensions of faces of the frustum. Let us assume the screen size as: Length = α cm , Width = β cm.

Table II. Dimensions calculation formula

Sr No	Name	Height(in cm)	Slant height(in cm)
1.	Front Face	(α – 2)*tan45º	(α-2) / cos45º
2.	Side Face	(β – 2) * 0.5 * tan45º	(β – 2) * 0.5 / cos45º

Figure3. shows the dimensions of the pyramidal glass trunk for the television (TV) screen having α = 27 cm and β = 48 cm, which is used to build the prototype.

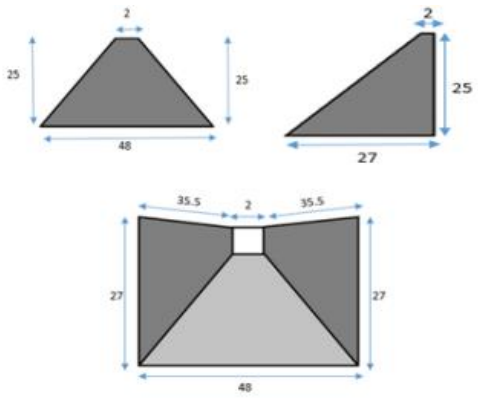

Figure3. Dimensions of pyramid

[3.2] WOODEN LUMINAIRE

To support the TV screen and the pyramidal trunk, the proposed system consists of a wooden frame.The dimensions of the device depend on the dimensions of the display device (TV screen) and of the pyramidal trunk. The angle of inclination is also an important factor that must be taken into account when designing luminaires. Figure5. shows the design of our device. It consists of two separate rectangular support frames and two rear support panels. The upper rectangular support is used to position the TV screen. The lower support provides support to the pyramidal trunk. Two wooden planks at the back maintain the height between the log and the TV, so that the tilt angle is not changed.

Figure4. Wooden Fixture

[3.3] AMBIENT LIGHT SUPPRESSION

Although reflective glass cancels out most ambient light, a significant amount of ambient light obscures the output. To diffuse the ambient light, we used pieces of black painted cardboard attached to all sides of the fixture. Figure6. shows the wooden fixture covered with cardboard pieces.

Figure5. Removal of ambient light

In order to get a perfect view of the 3D hologram, the cardboard pieces mounted onto the side of this fixture can be removed but since removal of the ambient light is necessary, we preferred keeping the side pieces as it is. These cardboard pieces are easily removable and can be adjusted according to the user's preference. The fixture without the side pieces provides better output whereas the fixture with the cardboard pieces removes the extra lighting and the output seems to have more contrast.

[4] SOFTWARE IMPLEMENTATION

This section explains the software requirements of 3D Holographic and Interactive systems. There are three main software requirements of the system: 1) Gesture control module and 2) Integration of the whole system using python programming language.

[4.1] GESTURE RECOGNITION

Gesture Recognition is a topic in computer science and language technology with the objective of using mathematical algorithms to comprehend human gestures. It's a computer vision subdiscipline. Gestures can come from any physical move or state, although they are most typically made with the hands or the face.Identifying emotions from the face and recognizing hand gestures are two of the current hot topics in the field. Simple motions can be used to control or interact with gadgets without having to physically touch them. Cameras and computer vision algorithms have been used in a variety of ways to read sign language. Gesture recognition techniques, on the other hand, are used to identify and recognise posture, gait, proxemics, and human behaviors.**Gesture recognition module** is compatible with Arduino Raspberry Pi Micro:bit and Jetson Nano, strong expandability meets a variety of programming learning needs. Integrated “PAJ7620” gesture recognition sensor can detect the approach and departure of objects to improve the recognition accuracy. The sensor module integrates gesture recognition interactive sensors, which can be controlled by 9 gesture actions. Note: The gestures are fixed and cannot be modified by programming.

[4.3] INTEGRATION OF SYSTEM USING PYTHON

For this proposed system we used python programming language for integrating the hardware components together. The raspberry pi 4 is connected to the monitor that is used to display the

images/video that will be used for projection of 3D holograms. Python programming language is also used for integrating the gesture recognition module with raspberry pi 4. With the help of python our proposed system will recognise the gestures from the user as input. These gestures will be comprehended by the raspberry pi module.
According to these gestures provided by the user, the 3D hologram projected on the pyramid is changed.

[5] WORKFLOW

In this section we will consider the workflow of this proposed system. The workflow is shown below in figure8.

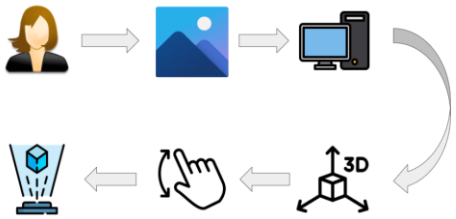

Figure6. Workflow

The workflow can be understood from the following steps:

1. Initially the system accepts an image/video from the user that is meant to be displayed on the monitor.
2. This image which is displayed on the monitor is henceforth casted onto the quadrangular pyramid forming a 3D hologram.
3. Now the user can provide certain gestures in order to interact with the 3D hologram.
4. Once the system accepts the gestures from the user, the final output is revealed.

[6] APPLICATIONS

1. **Medical Science:**
   In this field, the interactive hologram can be used for professors as well as students. The professors can use this technology to showcase certain holograms of the human anatomy and the students can use it for understanding concepts in an interesting way that has never been done before.
2. **Education:**
   Not only medical science but this system can be considered useful in the entire world of education especially for children who prefer and enjoy learning from videos, pictures etc instead of books and blackboards. It will make teaching and learning a lot easier and overall a better experience for both.
3. **Advertisement:**
   The primary application of this project is into advertisement, it's often observed that companies advertise their products by launching ad campaigns, hoardings etc. But this system will become an eye-catching prototype in the upcoming years because its unique and any product displayed

using this system will certainly attract more people and the success rate of converting these curious people to customers will increase.

4. **Architecture:**
   Architecture is the most important field when it comes to 3D structures and buildings. Viewing these structures on a small scale is possible using projectors and computers but with an advanced version of our system it can be scaled up to a bigger size with a better view of the buildings, cities, roads.

[7] CONCLUSION

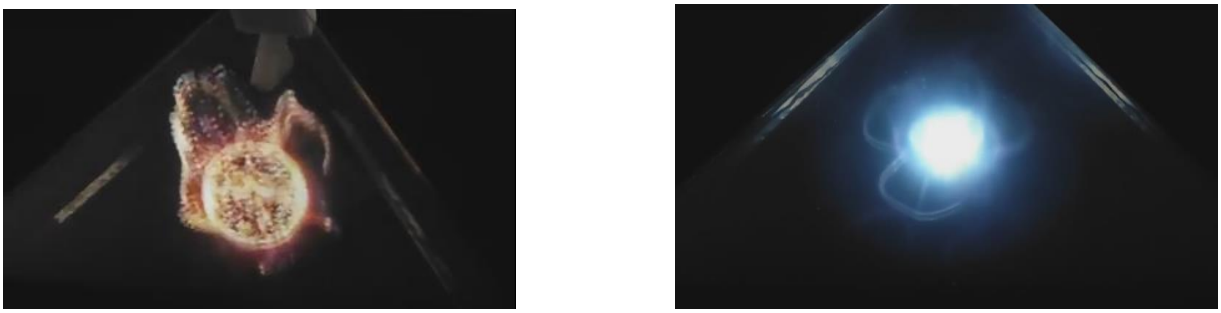

Figure7. Output Holograms

This proposed system is a prototype that consists of a balanced hardware and software combination that in return provides an immersive experience of a 3D hologram from 2D images or videos. It is not only about converting 2D to 3D but to add a futuristic as well as enthusiastic environment to the world of technology, Science, Education, Architecture and much more. This project supports education, innovation as well as the vast fields of media and entertainment. This system is able to use any image or video in a particular format as mentioned in the above sections and convert it into a 3D hologram(3D equivalent of the image/video floating in air). It is achieved by a quadrangular pyramid and a black background to help reduce the ambient lighting inside the glass pyramid. This system also supports gestures in order to allow the user to interact with the 3D hologram. Gestures such as swiping towards right and left are supported in order to scroll through the collection of holograms.

REFERENCES

[1] J. Mahfud and T. Matsumaru, "Interactive aerial projection of 3D hologram object," 2016 IEEE International Conference on Robotics and Biomimetics (ROBIO), 2016, pp. 1930-1935, doi: 10.1109/ROBIO.2016.7866611.

[2] James Ardie Arcao, Vince Carl Cadag, Vduani Martinez, Evita Roxas, Keenmer Jon Serrano, Roselito Tolentino, “Holographic projection of 3D realistic avatar that mimics human body motion ”, January 2018.

[3] Dhyey Patel, Parth Bhalodiya, “3D Holographic and interactive artificial intelligence system”, Second International Conference on Smart Systems and Inventive Technology (ICCSIT 2019).

[4] Shota Yamada, Takashi Kakue, Tomoyoshi Shimobaba & Tomoyoshi Ito, “Interactive Holographic Display Based on Finger Gestures”, January 31, 2018.

[5] Li Weiying, “The 3D Holographic Projection Technology Based on Three-dimensional Computer Graphics”, Department of Digital Media Arts，Shanghai JianQiao College，Shanghai China, March 4. 2019.