

3D HOLOGRAM : THE FUTURE OF MEDICINE

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Abstract - Long-term preparation and experiences are needed to read 2D slices from medical scanners on a flat screen and analyse them into a complete 3D structure in one's own mind. As a result, outside of doctors and specialists, it is extremely difficult for patients to pursue their own state of disease based solely on a physician's explanation and a collection of 2D slices projected on flat screens. Pyramid holograms have only been used for advertisements and entertainment up to now, but not in the medical field due to their inability to communicate. As a result, our project is to add interactive capabilities to this framework. The first step is to create a hologram from multi-layer images captured by CT or MRI scanners in the form of DICOM via pyramid hologram, using the MATLAB programming language and a variety of image processing functions. This project's entire process consists of 6 main steps. The first 4 steps include: reconstructing 3D images from a folder of CT or MRI multi-layer images, capturing 4 orthogonal projections of the 3D image, arranging these four side views into one appropriate PNG image, and saving the final image. Step 5 is to make a pyramid hologram with the use of transparent acrylic sheet. The final step is to interact with the 3D hologram object by moving a user's finger with the use of Leap Motion Gesture Control or a Raspberry Pi. A pyramid hologram can be used to display a 3D hologram image from a CT or MRI scanner. A 3D pyramid hologram is modelled and implemented in this paper, and it can be rotated around, zoomed in on, and manipulated in 3D space. By way of a prototype demonstration, this proposed hologram traces the design principle for the coding function of producing a hologram image from the original medical devices. The project's future work will involve developing a hardware device that can be used in conjunction with the pyramid hologram to enable users to interact with the model.

Key Words: Pyramid Hologram, CT, MRI, DICOM, MATLAB, 3D Hologram, Leap Motion Gesture Control, Raspberry Pi, 3D Image Reconstruction

1. INTRODUCTION

Holography is a technique developed by Hungarian scientist Dr. Dennis Gabor in the 1940s that has proven to be very useful in a variety of fields, including commerce, scientific science, finance, education, entertainment, art, manufacturing, medicine, and healthcare. Many medical

systems today use advanced imaging technology to produce complex data, such as magnetic resonance imaging (MRI), computed tomography (CT) scans, positron emission tomography (PET) scans, or ultrasound scans. Typically, the electronic data from these forms of technology is used to view flat images on a computer screen, which many doctors and specialists may understand but can be difficult for patients and students to follow. Although the hologram produced in this paper is still in the virtual image stage, it could be transformed into a real and interactive image in the near future. The coding for the pyramid hologram in this paper is just the first step in using real-interactive 3D (Three Dimensional) holographic images to teach and educate students and patients how to read data from medical scanner devices using a simple and inexpensive technique [1].

2. AIM AND OBJECTIVE

2.1 Aim: To bring 3D Hologram more towards the Medical Field.

3D Hologram will help us to move the organs around, zoomed in on, or manipulated in actual 3D space.

2.2 Objective: To design a system that can stimulate or aid in capturing 3D holographic images from the medical scanners, display them on screen with the major help of MATLAB (Matrix Laboratory) programming language for image processing.

The final product is in the form of software that allows people to convert images from medical scanners into holograms that can be displayed on screens with dimensions that can accommodate any demand for any pyramid scale. We hope that this project will not only be user-friendly and cost-effective, but also a great and useful tool for visualising patient data and educating patients and students [1].

3. PROBLEM STATEMENT

- While biomedical imaging technology has advanced to the point that it can now display us 3D images of our internal organs, there are still technical issues with the current technology [3].
- Current 3D viewing technology is incapable of producing a fully accurate 3D rendition: To produce a

rough 3D image, 2D images from MRI, CT scanner, ultrasound, and other devices are stitched together [3].

- The outcome isn't perfect; holes can appear in these pictures, making diagnosis and care difficult for doctors [3].

4. PROPOSED SYSTEM

Our group's holographic design focuses on the 3D pyramid hologram, which includes the requisite hardware design and software creation.

This is a simple device created by cutting a transparent acrylic sheet into the shape of a hollow pyramid, with all four panes forming a fitting angle with the horizontal surface. The further view sides from various angles of the 3D structures that must be computed, the more panes or faces of the pyramid hologram device that must be computed, resulting in more complex calculations, coding, and time waste. The four-main-angle hologram, on the other hand, is simpler but still provides ample detail about the 3D image's outward structure. The method is not only simple and straightforward to use, but it can also be scaled up or down depending on the needs of the users [1].

The Pyramid hologram was created using the Pepper's ghost illusion, which was named after John Henry Pepper, who invented a working version of the device in 1862 and used the idea of reflection to create an illusion for the observer. Since the pyramid hologram generator is so simple to build, anyone can make one for themselves in any size they want [1].

4.1 Methodology

- By giving doctors a hologram of organs that can be passed around, zoomed in on, and manipulated in real-time 3D space. It has the potential to improve the efficiency of diagnosis and treatment procedures [3].
- The 3D holography may help diagnose problems in complex organs like the heart or the brain without requiring painful physical procedures [3].
- A pyramid hologram platform was to project the results of the hologram picture displays [1].
- The system is a straightforward device that was created by cutting a transparent acrylic sheet into the shape of a hollow pyramid, with all four faces forming a fitting angle with the horizontal surface [1].
- Several parameters may be used for pyramid holograms, but after some basic calculations, the pyramid hologram specifications chosen for this project were shown in Table 1.

Table -1: Pyramid Hologram Specifications

Material	Thin Transparent Acrylic Sheet
Length	Upper Side 13.5 cm Bottom Side 2.2 cm
Height	14 cm
Angle	70°

4.2 Process Model used for the Project

There were 6 main steps. The first 4 steps in the Flow Chart (Fig -10) demonstrate how images taken from CT/MRI scanners were processed and displayed by the MATLAB programming language and the process is shown below:

Step -1: Reconstructing 3D Images from a folder of CT or MRI multi-layer Images

A total of 142 CT slices of a brain (patient Doe Pierre [54879843]—1 January 2006) with Post-Concussive Syndrome (PCCS) were downloaded as Digital Imaging and Communications in Medicine (DICOM) files (*.dcm) from the Patient Contributed Image Repository (PCIR) website [8]. These files were kept in the same folder so that they could be accessed using the MATLAB programming language's Graphical User Interface (GUI) (Fig -1). These DICOM files are usually automatically arranged in an appropriate sequence after a CT/MRI scan for easy detection. As a result, no manual naming was needed when organizing these files [1].

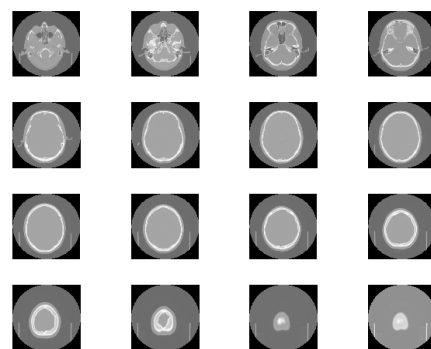


Fig -1: 142 CT Slices of a Brain

Step -2: Capturing 4 Orthogonal Projections of the 3D Image

The algorithm modified its location at 6 views of the 3D figure (top, bottom, front, rear, left, and right views), representing the 6 orthogonal projections, using the MATLAB programming language and many of its available functions. The camera took an image from each location and saved all six as Portable Network Graphic (*.png) files when the code was run on MATLAB (Fig -2). However, based on

the pyramid hologram theory, only 4 out of 6 views were needed, namely the front, back, and two side views (Fig -3) [1].

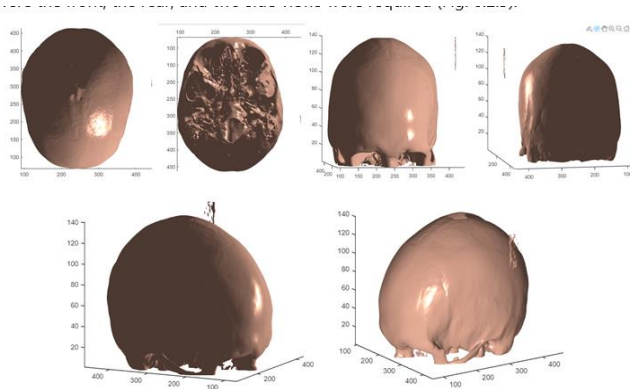


Fig -2: Using MATLAB to construct 3D Image: From Left to Right, Top to Bottom are the view of Top, Bottom, Front, Rear, Right, and Left

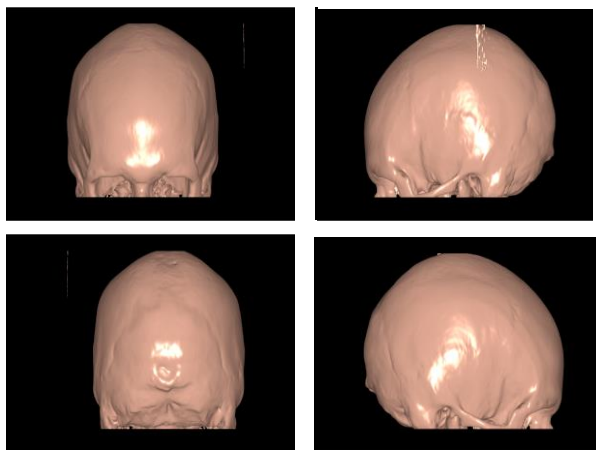


Fig -3: From Left to Right, Top to Bottom are the view of Front, Left, Rear and Right viewed Projections of the 3D Volume

Step -3: Arranging these 4 Side Views into one appropriate PNG Image

A square-shaped frame was created on a flat 2D image and divided into 9 equal invisible segments by a grid. All of the saved png images from the series of 4 3D image projections were replicated and scaled to the same ratio so that they could all fit into one small square. Figure 4 depicted the layout of 4 side views [1].

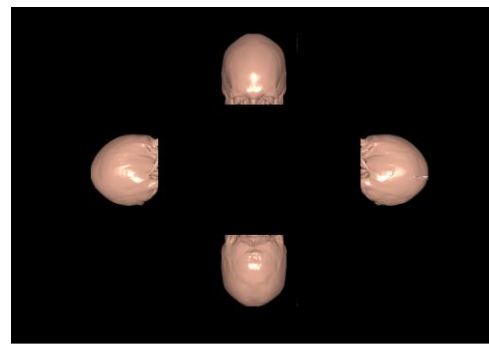


Fig -4: Arrangement of 4-Sided Projections of the 3D Image

Step -4: Saving the Final Image

The final image was saved as a png file that could be viewed on a variety of devices and projected using a pyramid projector [1].

Step -5: Making a Pyramid Hologram with the use of Transparent Acrylic Sheet

1. Ruler
2. Transparent Acrylic Sheet
3. Cardboard
4. Tape
5. Pencil, Eraser and Sharpener
6. Scissors
7. Glass Cutter



Fig -5: Requirements for Making a Pyramid Hologram

- Step 1
Using a pencil and a piece of cardboard, make the following rhombus shape and cut it out with scissors. The dimensions should be 2.2 x 14 x 13.5 cm.
- Step 2
Trace the rhombus shape on the transparent acrylic sheet and carefully cut out the rhombus shape, using a glass cutter.
- Step 3
Connect the four pieces together with tape. Just make sure to use clear tape so it doesn't distort the effect.

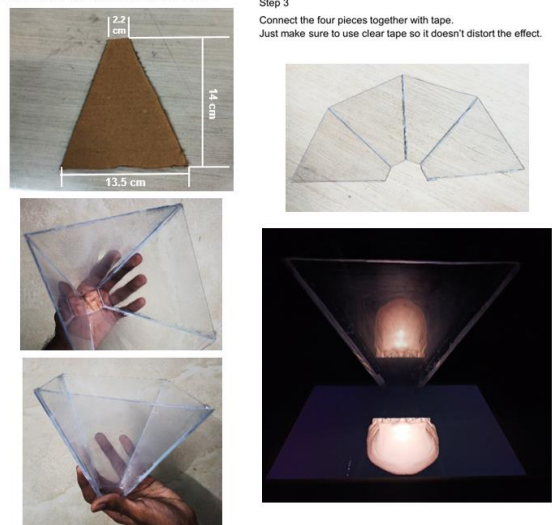


Fig -6: Steps for Making a Pyramid Hologram

Step -6: Interacting with the 3D Hologram Object by moving a User's Finger with the use of Leap Motion Gesture Control or Raspberry Pi



Fig -7: Leap Motion Gesture Control



Fig -8: Raspberry Pi

5. DESIGN

5.1 Block Diagram

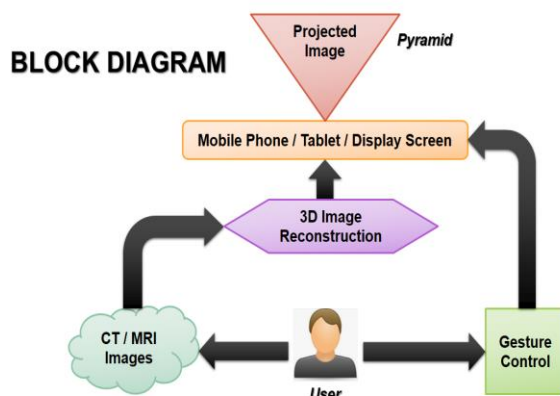


Fig -9: Block Diagram of 3D Hologram

5.2 Flow Chart

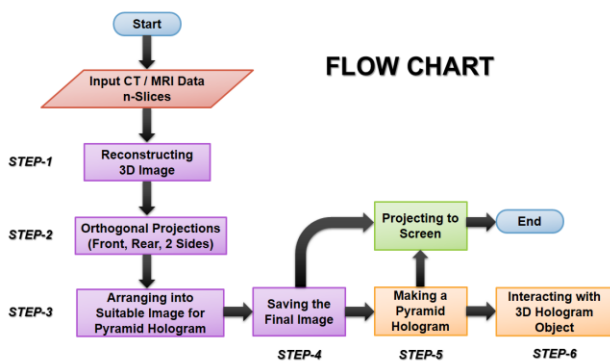


Fig -10: Flow Chart of 3D Hologram

5.3 3D Image Reconstruction

- 1) Changing the Data Format from 4-D to 3-D
- 2) Displaying Images of CT/MRI Data

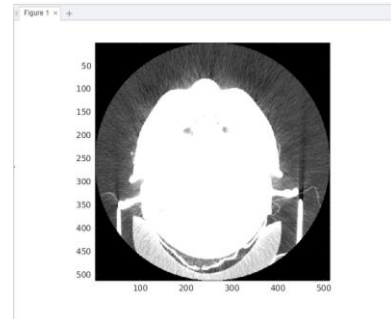


Fig -11: Displaying Images of CT/MRI Data

- 3) Displaying a 2-D Contour Slice

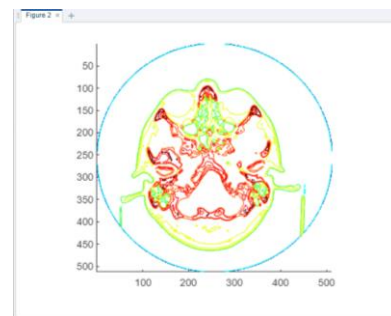


Fig -12: Displaying a 2-D Contour Slice

- 4) Displaying 3-D Contour Slices

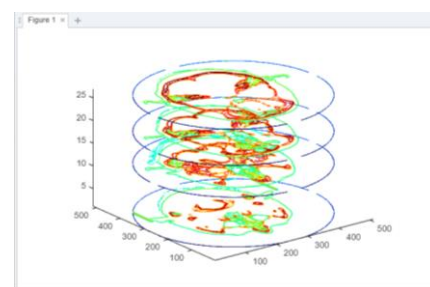


Fig -13: Displaying 3-D Contour Slices

- 5) Applying an Isosurface to the CT/MRI Data

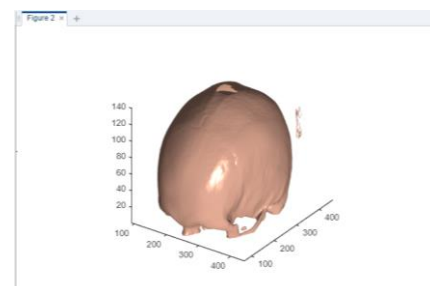


Fig -14: Applying an Isosurface to the CT/MRI Data

- 6) *Defining the View and Setting the Aspect Ratio*
- 7) *Add Lighting*

5.4 Final 3D Hologram Image

- 1) *Changing the Data Format from 4-D to 3-D*
- 2) *Displaying 3-D Contour Slices*
- 3) *Creating Axes in Tiled Positions*

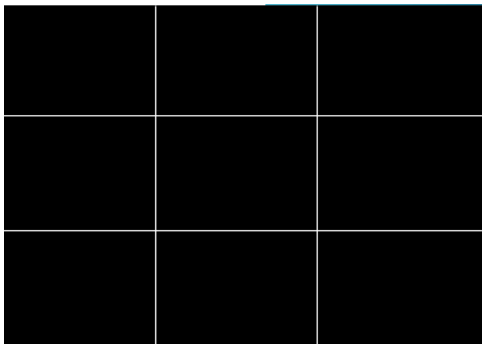


Fig -15: Creating Axes in Tiled Positions

- 4) *Applying an Isosurface to the CT/MRI Data*
- 5) *Defining the View and Setting the Aspect Ratio*
- 6) *Add Lighting*
- 7) *Changing Background Color to Black and Hide Axis Visibility*

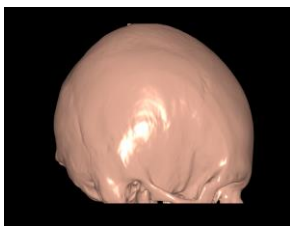


Fig -16: Changing Background Color to Black and Hide Axis Visibility

- 8) *Rotating Camera about View Axis*

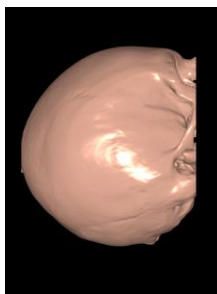


Fig -17: Rotating Camera about View Axis

6. HARDWARE AND SOFTWARE REQUIREMENTS

6.1 Hardware Components

- 1) *Pyramid (Transparent Acrylic Sheet)*
- 2) *iPad*

6.2 Software Apps and Online Services

- 1) *MATLAB*
- 2) *DICOM*

7. SCOPE

Holographic technology, with its infinite applications as far as the human mind can imagine, will become an increasingly important part of human societies and culture in the future.

In future, holographic displays will replace all current displays in all sizes from small phone screens to large projectors. To study body metabolisms, doctors use a holographic projection of the human body.

In the future, holography will aid doctors in the study, diagnosis, and prediction of orthopaedic disorders. Using the reviewed data and better user information, the patient-specific surgical procedure can be done quickly and easily. In upcoming years, it will become an efficient technology for decision-making, solving a complex problem, and innovating in orthopaedics [4].

8. CONCLUSION AND FUTURE WORK

The goal of this study is to create a final product in the form of software that will allow people to easily convert images from medical scanners into holograms via holographic pyramid system.

Despite the fact that the hologram was successfully designed, viewed, and projected using the pyramid hologram device, there is still a lot of future works to be done. Further research into this methodology could lead to the creation of a device that not only displays 3D images but also allows users to interact with them by developing a hardware framework (Leap Motion Gesture Control or Raspberry Pi) that can be used in conjunction with the pyramid hologram.

This is a brand-new approach for creating live, interactive images from a simple pyramid holographic projector—a low-cost, easy-to-assemble device—and hence, very suitable for individual student studies and training content for low-income patients.

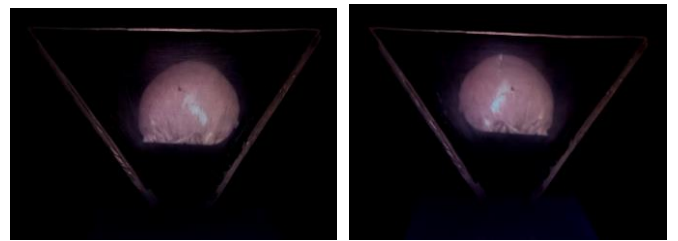
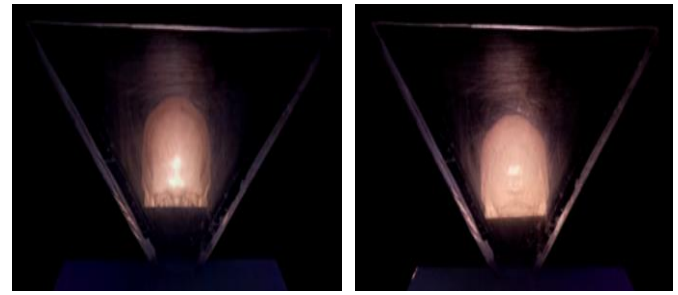
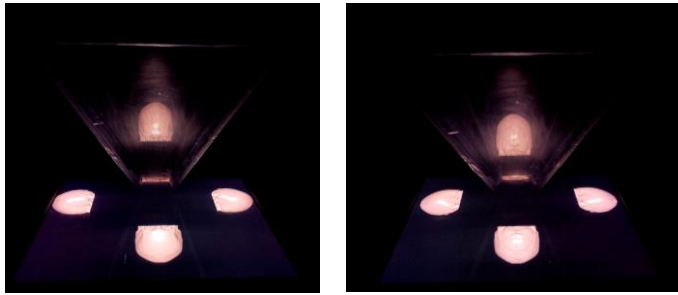


Fig -18: Image displaying the Pyramid Hologram Prototype via iPad Screen

Fig -19: Zoomed View of Image displaying the Pyramid Hologram Prototype via iPad Screen

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