

## THE USE OF 3D HOLOGRAPHIC PYRAMID FOR THE VISUALIZATION OF SINO-PORTUGUESE ARCHITECTURE

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**Accepted date:** 2 May 2017

**Published date:** 12 October 2017

### To cite this document:

Kalarat, K. (2017). The Use Of 3d Holographic Pyramid for the Visualization of Sino-Portuguese Architecture. *Journal of Information System and Technology Management*, 2(5), 18-24.

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**Abstract:** *This paper presents information about archaeological building through Hologram technology and interacts with hand gesture. 4 buildings of Sino Portuguese Architecture are the unique construction in Phuket, Thailand, combined with East and West architecture styles around A.D.1890-1920. The constructions are displayed as virtual building in pyramid hologram which the observer can view around the virtual building and receive their information by visual and audio narrative. Moreover, the user is able to control the point of view with Free-Hand interaction using Leap Motion Controller device. The system uses game engine, Unity3D, to be able to perform real-time rendering for synchronizing gesture command and point of view of the archaeological building. The strengths and weaknesses of 3D holographic technology will be identified as an educational tool to evaluate its effectiveness for providing the information. For the evaluation, a survey has been carried out on 30 participants and the questionnaire has been utilized as a data gathering technique. Findings show that, 82% of respondents confirmed the importance of 3D Holographic technology as an effective information providing tool for the future. However, 18% of participants mentioned that the main barriers to view the detail of the building as the small hologram.*

**Keywords:** *Hologram Technology; Pyramid Hologram; Free-Hand Interaction; 3D Holographic*

### Introduction

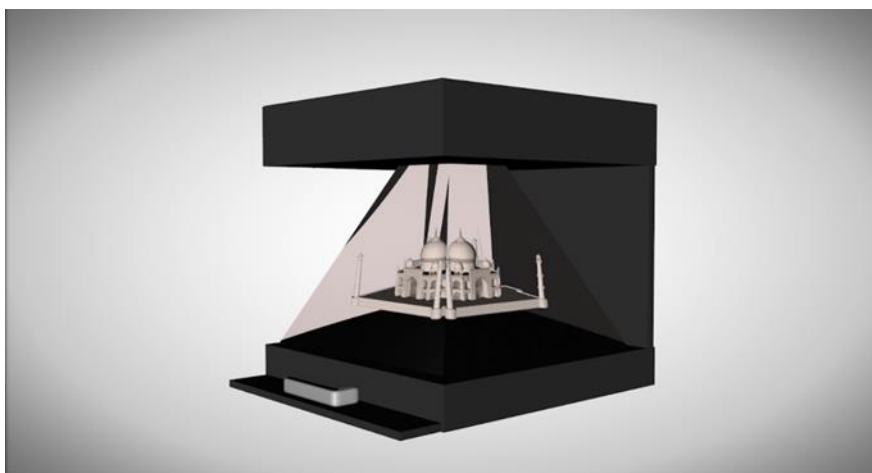
Sino Portuguese Architecture is built around A.D.1890-1920 in Phuket province, Thailand. The architecture combines Chinese and European culture with uniqueness such as the decoration on the wall, façade, balcony and pediment, etc. Sino Portuguese Architecture, which is in Phuket province, in southern Thailand, is such unique architecture heritages. The architecture is really interesting which is influenced by many styles of building as Siamese, Chinese, Malaysian and European [7]. Sino Portuguese architecture is influenced the decorative facade from European with were in form of plant emphasizing interflow and spiral vines, leaves and flower [8]. However, doors and windows are Chinese style. This research creates 4 buildings to represent 4 different styles of Sino Portuguese Architecture which are

Shop-house along Thalang Road, Phuket Philatelic Museum, Phuket Thai Hua Museum and Old Phuket Police Station with Clock Tower. Each building has its own history and there are the landmarks of Phuket.

However, there is certainly merit in the structure and history of the architecture, it still lack of attraction to the new generation people. Conventional media that always used to describe the structure and history are text and picture. Therefore, researcher would like to create new media which increase more perception to the audience by augmenting sound, 3D animation and interaction to the conventional media. This research uses 3D holographic projection to display the buildings and interact with hand gesture via Leap Motion. There is narrative voice to describe history of each building.

The holographic projection is a kind of 3D technology of without wearing glasses, and viewers can see the virtual object in three-dimensional. This technology uses the projection equipment projected 360 degree of the recording virtual object image in different angle and import the image through holographic projection membrane of the hologram film. The 360 degree phantom images show as three-dimensional screen that suspend the projection image in mid-air that seem like creating magic of floating object and providing sense of depth.

This research applies 270 degree hologram to display the buildings because of using wide-screen monitor to project the light source through the 3 sides of hologram films. The 3 sides hologram also represent depth to audiences, however, the visitors cannot see around the object by changing their perspective angle. However, this hologram equipment provides Leap Motion Controller to apply hand gesture control to turn the object around compensated the blind side. The visitors can interact with holographic display glass, and perceive a mysterious and magical fantasy feeling and provided the modern, stylish, interactive tools for the query of the display. The 270 degree of pyramid hologram 3D design is shown Figure 1 including 3 sides display which are 1 front view and 2 side views using Leap Motion Controller interacted by hand gesture. The 3D object seems to be floating in mid-air of the hologram and there is Leap Motion device in front of the hologram for controlling.



**Figure 1: shows overview design of the pyramid hologram and the interactive device.**

### ***Related technologies***

#### ***3D Pyramid Hologram***

3D Holographic Pyramid is the new wave of display technology that is able to show an autostereoscopic for visualizing 3D objects as holographic images. It is applied to many fields to change how we view things such as education, science, art, business, healthcare and advertisement. Holographic is the method for recording interference pattern of light and reproduced the pattern as three-dimensional image called a hologram. The hologram was invented by Hungarian physicist Dennis Gabor in 1947. One of the most common techniques generated hologram is based on an illusionary technique called Peppers Ghost, and was first used in Victorian theatres across London in the 1860s popularized effect by John Henry Pepper. The Pepper's Ghost is an illusion technique used in some magic tricks and in theatre. Basically, the Pepper's Ghost make by a large piece of glass at a 45 degrees angle to the audience and special lighting techniques are used, to show the audience a combination of light passing through from behind the glass and light reflecting off the glass at a 90 degree angle from the line of sight. For the Pyramid Hologram, it is a type of hologram which is built base on the Pepper's Ghost technique; however; it is built in pyramid form and use monitor, computer or TV, to be a light source. The pyramid is a square pyramid, which square base and four triangular outer surfaces called "360 degree of pyramid hologram". The pyramid slope should have 45 degrees angle to the base for non-deformation shape reflected images of the object. A better effect is achieved by using dark backgrounds.

For this research, we use 270 degree of pyramid hologram which still include square base, but use just three triangular as outer surfaces. It is because there is a limitation from size for the monitor and monitor shape as wide screen. We use 29 inch monitor to make a light source of hologram. Therefore, the hologram is limited with the size of front is 43cm, side is 29.5cm, x high is 20cm to maintain 45 degree of its base.



Figure 2: shows prototype hologram and final hologram hardware

Figure 2. shows hologram that has been built from the specification. Figure 2 (a) represent the testing of virtual building which is the Shop-house displayed on prototype of hologram and Figure 2 (b) shows the final hologram hardware built after prototype tested.

### **3D Modeling**

3D virtual constructions of this research are built by using software to create computer graphics from scratch which is Autodesk Maya. We have started by collecting the

information of 4 building from official document of Phuket municipality for the houses' structure and old pictures from Thai Hua museum to be evidences to create accommodations' properties.

### ***Game engine***

In this research, we use game engine, Unity3D, which is a software framework designed for video games development. Because of many functionalities of game engine, they provide utilities that we need to apply for this project such as real-time rendering, input devices manipulation, collision detection, sound, scene management.

### ***Leap motion***

Leap Motion is a computer hardware sensor device that uses to track hand and finger motions as input, but not requires hand contact or touching. The Leap Motion Controller is actually quite simple from a hardware perspective. The device consists of two cameras and three infrared LEDs. This project will use this device to capture the hand gesture which is the input for interacting to control virtual building perspective of hologram.

### **Research Approach**

There are 3 environments that involve with developing this research which Autodesk Maya environment, Unity3D environment and Hologram environment. For Autodesk Maya environment, we use software, Autodesk Maya, to create 4 buildings providing construction information of official document from Phuket municipality.

For Unity3D environment, after receiving the models created from last step, the models are imported to game engine, Unity3D, to record each perspective view of the building by virtual cameras in the game engine. Three of virtual cameras are used to capture 3 sides of view from the building that is in front of each camera which is set perpendicular from the others as shown in the Virtual Camera Recording image for Unity3D environment. Then the sequence of images, which are captured from the 3 cameras, will be assembled for displaying to computer monitor screen as shown in Reconstruction image of Unity3D environment.

For the last environment, it begins with mapping each image on the computer monitor screen to three triangular outer surfaces for each side of hologram. The each image have to be tuned their position for reconstruction the virtual construction in 3D. For the final step, we use Leap Motion Controller to control the gesture commands for interacting Sino-Portuguese architecture exploration.

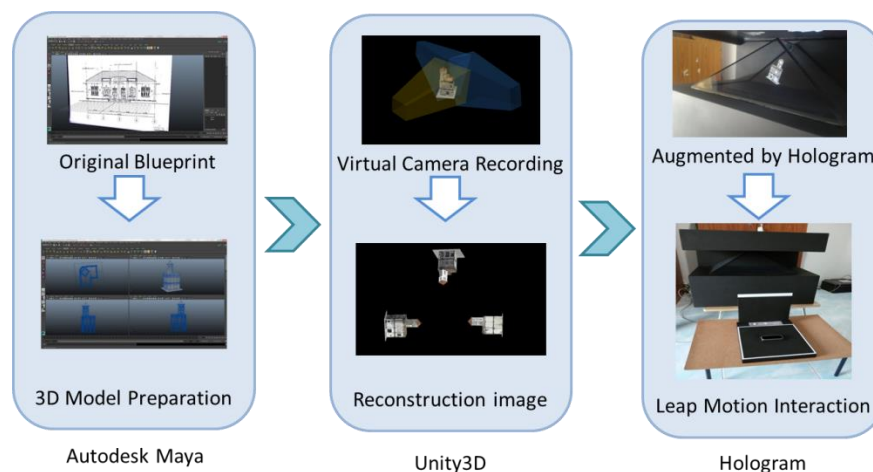


Figure 3: shows developing process of this research.

Figure 3. shows 3D holographic pyramid for the visualization of Sino-Portuguese architecture process which is separated into 3 developing environments. The first process is built in 3D model creation environment by using Autodesk Maya software. The second process creates the reconstruction image in Unity3D which is a game engine. And the last process is to install the program to display in the hologram environment using Leap Motion Controller for interaction.



Figure 4: shows the assembled buildings image preparing to display on monitor screen

Figure 4. shows the sequence of images, which are captured from the 3 cameras and assembled for preparing to display on computer monitor screen.

## Results and Discussion

After the hologram system has been finished developing, we invite 30 participants randomly to test our system by interacting through the virtual building via Leap Motion. Then, this research identified the 3D holographic technology as an educational tool to evaluate its effectiveness for providing the information by making a survey process which has been carried out on all of participant and the questionnaire has been utilized as a data gathering technique. The data shows that, 82% of respondents confirmed the importance of 3D Holographic technology as an effective information providing tool for the future. However, 18% of participants mentioned that the main barriers to view the detail of the building as the small hologram.



Figure 5: shows the final image in hologram.

Figure 5. shows 4 buildings of Sino-Portuguese architecture that create 4 building represent 4 different styles of Sino Portuguese Architecture which are Phuket Thai Hua Museum, Old Phuket Police Station with Clock Tower, Phuket Philatelic Museum and Shop-house along Thalang Road respectively.

### **Conclusion and Future Work**

In this paper we introduce the new way to represent the structure and detail of archaeological buildings via hologram technology which is a new wave of technology that will change how we view things in the new era.

Using 3D holographic projection on pyramid hologram to show Sino-Portuguese architecture is able to be outstanding interest from the audiences as the buildings seem to be floating in mid-air magically. Visitors are able to select and explore each building by hand gesture in real-time via Leap Motion Controller. They can see around the outside of the constructions. They are able to omit the roof from the building to watch inside of the building and zoom in/out the buildings to view for more detail. However, it still has limitation of view on the hologram film as the limitation of hologram size. To illustrate the building which has large scale or lot of detail, hologram should have to cover all displayed detail of the building.

In the future we pretend to investigate the hand gesture for each motion whether it could interact in the nature way or not and try to apply other antique objects for displaying in pyramid hologram.

### **Acknowledgements**

This work was partly supported by Multimedia Technology and Animation, School of Informatics, Walailak university. We would like to thank Phuket municipality for providing

information of Sino-Portuguese architecture and Sino-Holo team, A. Aumtong for 270 degree pyramid hologram hardware creation, S. Pakpoom and Y. Katreeya for supporting 3D modeling of the buildings.

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