Using Hologram Technology in Constructing Virtual Scenes in Archaeological Sites to Support Tourism in Egypt

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Abstract:

There is no doubt that each nation has its own rich heritage from which its nationality and belonging are derived, Egypt is considered one of the first countries that has a rich history, civilization and a high cultural heritage as most of its provinces which have several rich archeological sites of unique cultural characters. However, Egypt has not taken its earned position of cultural tourism around the world yet. Perhaps the main reason for this is the change in the passion of many tourists for that kind of tourism due to the technological developments and the great possibilities of transferring media via the internet which leads to the relative stagnation of this type of tourism that is considered one of the most important sources of national income. That leads to research problem which is represented in lack of using modern technological methods in ancient archaeological sites in Egypt that makes them not interactive, attractive and thrilling to form elements of attraction for visitors and tourists. The importance of this research is to shed light on the importance of employing hologram technology in restoration of archeological sites in Egypt through the construction of dramatic, historical and virtual scenes so that the archaeological site serves as a true expressionist decor. Research goals are to highlight the role of technology in the restoration of archaeological sites in Egypt and Show the effect of merging between the modern technology and the Egyptian cultural heritage. Research hypothesis that Hologram technology can be adapted to build historical hypothetical scenes in archaeological sites. Research Methodology is inductive approach to the hologram technology, and then the deductive approach to reach a methodology to integrate the technological methods with the urban heritage of Egypt. The study has shown the possibility of digital and optical processing of the outer spreads of archaeological sites.

Key words : Hologram - Development of archeological sites - Augmented reality - Revival of urban heritage.

ملخص البحث:

مما لا شك فيه أن لكل أمه تراثها الزاخر الذي تفخر به وتستمد منه قوميتها وانتمائها، ولعل مصر من أولى الدول التى تمتلك تاريخاً عريقاً وحضارة زاخرة وموروث ثقافى رفيع، فجميع محافظاتها تقريبا تضم بين جنباتها العديد من المواقع الأثرية الغنية ذات الطابع الحضارى الفريد. وبالرغم من كل ذلك فلم تحظ مصر بعد بنصيبها الذى تستحقه من نسبة السياحة الثقافية حول العالم، ولعل أبرز أسباب ذلك هو تغير شغف العديد من السائحين وعزوفهم عن ذلك النوع من السياحة ، نظراً للتطور التكنولوجي الحادث والامكانيات الجبارة لنقل الوسائط عبر الإنترنت، مما ترتب عليه ركود نسبي

لهذا النوع من السياحة التى تعد أحد أهم مصادر الدخل القومى المصري، وفى ضوء ما سبق أصبح من الضرورى أن نجد أسلوباً متطوراً يعيد لهذا النوع من السياحة رونقها وجاذبيتها بأسلوب عصري يستخدم التكنولوجيا العالية ويوظفها لإضفاء المزيد من الجاذبية والإبهار لمواقعنا الأثرية العريقة مما يعيد لها زوارها و يزيد من الإقبال عليها، من هذا المنطلق جاءت مشكلة البحث التى تتمثل فى افتقار المواقع الأثرية العريقة فى مصر إلى الوسائل التكنولجية المستحدثة التى تمنحها التفاعلية والجاذبية و التشويق لتشكل عناصر جذب للزوار والسائحين ، وتكمن أهمية البحث في إلقاء الضوء على أهمية توظيف تكنولوجيا الهولوجرام فى إعادة احياء المواقع الأثرية فى مصر من خلال بناء مشاهد تاريخية دراماتيكية افتراضية يكون الموقع الأثري بمثابة ديكور تعبيري حقيقي لها . ويهدف البحث إلى تسليط الضوء على دور تكنولوجيا الهولوجرام فى اعادة احياء المواقع الاثرية فى مصر وابراز أثر الدمج بين التكنولوجيا المستحدثة والتراث الحضارى المصري. ويفترض البحث أنه يمكن تطويع تكنولوجيا الهولوجرام فى بناء مشاهد تاريخية افترضية فى المواقع الأثرية. ويتبع البحث المنهج الاستقرائي لتكنولوجية الهولوجرام وامكانيات تشغيلها، وكيفية توظيفها لدعم إنعاش حركة السياحة فى مصر، ومن ثم المنهج الاستنباطي للوصول إلى منهجية للدمج بين الوسائل التكنولوجية والتراث الحضرى المصري، وقد أظهرت الدراسة إمكانية المعالجة التكنولوجة الرقمية والضوئية للحيزات الخارجية للمواقع الأثرية.

الكلمات المفتاحية: الهولوجرام - تطوير المواقع الأثرية - الواقع المعزز- احياء التراث الحضري.

Introduction:

Egypt is a country with the largest open museums that tell the history of human civilization of all its diversity. Alexandria has a variety of museums that tell a part of the history of the Greek and Roman civilization, and Luxor alone owns one third of the world's monuments, and it is considered as an open museum to visitors and tourists from all over the world. Museums are considered the most important narrator of the history of our Egyptian identity. Therefore, it has become necessary to develop the techniques of exhibitions in Egyptian museums and temples, and take advantage of modern techniques in artistic and cultural performances as a result of the rapid technological development in that field. There are many techniques that can be used in museum exhibitions such as virtual reality, augmented reality and Hologram technique which is used in the display of the tomb of Tutankhamun in the Great Museum. The use of advanced technology in the decoration of museum exhibitions helps to attract more visitors and creates astonishment in the spectators that are accustomed to the traditional techniques used in museums such as sound and light in the pyramids and the Temple of Karnak in Luxor. We should not miss that the spectator today has a very high absorptive capacity to all of the modern techniques, especially in the field of decoration, considering that modern technologies play an important role in the design of the decoration of museum displays, and the possibility of implementation in the natural display of the temples. That is because decoration is an essential element of the scene, which has become easier to implement in three-dimensional Hologram to give accompanying and interactive with the elements of time and space (3).

Virtual reality (VR):

Virtual reality is known as artificial reality, and is defined as a 3D dimensional interactive environment designed by computer programs. Virtual reality surrounds the user and takes him into an imaginary world so that this world seems to be realistic. Interaction with this reality as a result of the interactions between the virtual environment and the user's senses and responses. This technology is based on the combination of imagination and reality by creating artificial environments that are able to represent the reality and provide the ability to interact with. This technology is used in various fields such as medicine, engineering, architecture and arts. Actually, it is useful in all fields, especially in entertainment and museum shows (12).

3D plays a main role in virtual reality technology. It gives virtual reality models and makes users integrate as if they are immersed in the environment of reality. Virtual reality enables individuals to see the program in 3D stereoscopic through using a set of devices and tools connected to a computer such as gloves, glasses and headgear with headphones to enable him to touch and feel, see and hear. Pic. (1)

Pic. (1) Shows the devices used in VR

Programs that develop the virtual reality environment create an environment that allows the user to interact with it as a real environment. One of the most common definitions of virtual reality is computer generated environment which can be explored and interacted with by a person. That person becomes part of this virtual world or is immersed within this environment. Figure (1) shows the main requirements for virtual reality preparations which are data, motion tracking system, motion tracking software, simulation software, motion devices and display device.

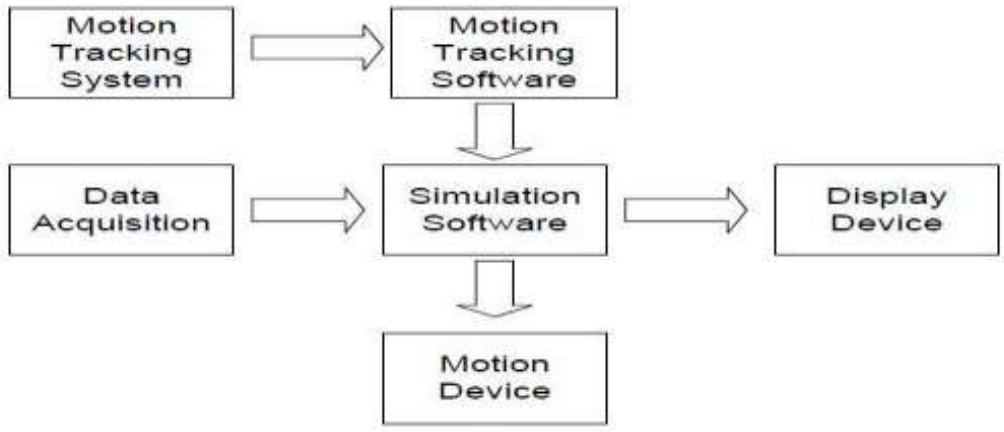


Figure (1) shows the main requirements for virtual reality (1)

Characteristics of VR environments (2):

The most important characteristics of VR environments are the following

• **Interactivity:** The degree of interactivity depends on the extent to which the system allows user interacting with the components of the system and the use of virtual reality tools. That allow full immersion and direct interaction with virtual environments.

• **Sharing:** Is one of the important and distinctive features of virtual reality presentations especially that are published on the Internet, and is designed according to variety of factors, including support for multiple users, where a group of individuals can use the same application of virtual reality at the same time.

•**Immersion:** The user's sense of virtual reality environments that he is fully surrounded by the components of this environment.

•**Representation:** Three-dimensional model generated at the virtual environment as an alternative to the real user. This embodiment behaves in a manner that matches the user's actions and contributes to the user's sense of presence in virtual reality environments.

• **Navigation:** Navigation in virtual reality environments is the basic technology that contributes to provide the user with a sense of immersion, which is found in all types and applications of virtual reality.

• **System Control:** The set of processes that allow a user of virtual reality environments to change in the interface or modify in something is not appropriate through the pre-defined commands to enter the system, and this feature aims to achieve all needs of users.

•**Presence and Tele Presence:** A person's sense of presence within a virtual reality environment. As if he had been moved to a place other than his physical location.

•**Ability to manipulation:** A distinctive feature of VR environments that utilizes a set of technologies that allow the user to directly modify objects in real time, whether they are repositioned, orientated, dimensioned, etc.

Augmented Reality (AR):

Augmented Reality is a new term that is a kind of virtual reality. AR aims to replicate the real environment in the computer and enhance it with virtual data that were not part of it. In other words, the augmented reality system generates a composite view of the user that combines the real scene that the user looks at and the computer-generated virtual scene that enhances the real scene with additional information (10). The computer-generated virtual scene aims to improve the perception of the real world that the user sees or interacts with. Augmented reality also aims to create a system in which the difference between the real world and what was added using AR technology is not realized.

AR technology is used in many fields including entertainment, engineering design, robotics, manufacturing and other industries. This technology can be applied in interior design by combining it with BIM (Building Information Modeling) on both smartphones and tablets. Picture (2) show the use of AR in smartphones.

Lasers as one of the most important applications of light and motion in design:

The name of the laser is derived from the initials light amplification stimulated emission radiation. The laser device is used to produce a parallel beam of highly concentrated monochromatic light. The most important characteristics of the laser beam are as follows (11):

- **Monochromatic:** The laser beam is often made up of single wavelength. If we pass a laser beam through a glass prism, it does not decay into the seven colors of the spectrum.
- **Collimation:** The laser travels large distances with a low diffraction beam without spreading or fading.
- **Coherence:** The lasers have similar characteristics in terms of phase, direction and energy. This property makes them overlap each other constructively.
- **High Intensity:** The intensity of the beam is high and concentrated in a beam with a narrow diameter not exceeding one mm. This intensity is caused by the exact match in the phase between the waves where the peaks of the waves are identical with each other.

There are many uses of lasers in artistic and theatrical shows, celebrations and open air shows such as sound and light.

One of the most important techniques that rely on lasers is the techniques of Holography. It differs from traditional photography that recording in holography is not only depends on the density of light-sensitive material but also the recording of body waves amplitude and phase, where it is recorded in a particular board. So that if it is illuminated, it is possible to reconstruct the wave chest. Thus the 3D image is formed on air and not on paper as normal photography.

Holography:

Holographic technology began to emerge in the late 19th century by British scientist (John Henry Pepper) when he successfully presented his theory named Pepper's Ghost to portray an imaginary ghost on stage in front of the audience (8). This was implemented by a simple idea is to reverse the image of an actor in the theater vault on a flat sloped transparent board to show him a fake picture above the theater deal with actors of the theater. Fig (2)

Figure (2) illustrates the concept of the beginning of the holograph idea Pepper's Ghost

But the history of Hologram technology dates back to the middle of the twentieth century as a result of Hungarian scientist (Dennis Gabor) interested in electronic photography, and his attempts to improve the magnification of the electron microscope to be able to see a single atom and look inside its components. But by luck it was found the features of his theory which related to building spectra. This discovery was called the Hologram technique, and because the light resources available at that time were not coherent or monochromatic, so the holographic photography was delayed until the time of the laser in the 1960s. When the scientists (Juris Upatnieks & Emmitt Leith) from the University of Michigan realized that hologram could be used as a 3D projector. So they decided to apply Gabor's theory using laser light. They

succeeded in displaying 3D images clearly and then followed the experiments. The first hologram was presented to a person in 1967.

Holography is one of the applications of laser to produce a virtual reality. It consists of two terms, (holo) means the whole and (graphy) means the coloring or drawing, the two sections express three-dimensional photography and the appearance of the 3D image in the space, which is a stereoscopic recording of all the information that produces the hologram. Holography is the process of recording wavelength interference from a laser beam into a light-sensitive medium (photographic film) in which images are formed. The holograph contains a complex distribution of transparent and dark areas.

Hologram:

The hologram or (preservative plate of the interference model) is a stereoscopic image obtained by using laser and stored on a flat surface of photographic plate. When that photographic plate illuminated by a beam of laser similar to that of the original reference beam, the beam will pass through transparent areas and be absorbed in dark areas to varying degrees, creating a composite passing wave. Which composite wave of the original body. It is the applied result of photography and display. Holograph is the recording of the art work but Hologram is the final product displayed (6).

Steps to create a hologram:

Holographic imaging is a method of photographing based on capturing light scattered from the target and then assembled in a way that appears in three dimensions. To make a hologram, this requires the illumination of the object to be photographed by a beam of lasers and recording medium or photographic plate, where the process of creating the hologram as shown in Figure (3) according to the following steps:

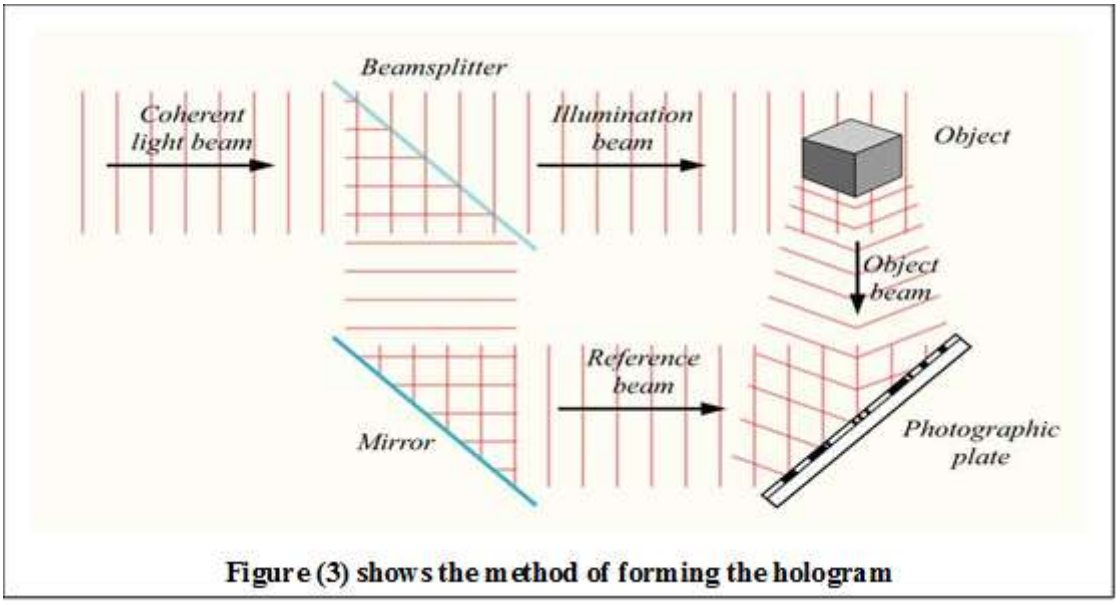


Figure (3) shows the method of forming the hologram

1-The laser beam falls on the Beam Splitter and then divided into two symmetrical beams and redirected by mirrors:

- One of them is named Illumination beam which is projected onto the object to be photographed directly, and then the Object beam is reflected from all points of the surface of

the object body carrying its information to reach the high sensitivity photographic plate in the form of a difference in light intensity and phase angles.

- The second beam, known as reference beam, reaches a flat mirror and is reflected to fall on the recording medium (photographic plate) directly through a lens.

2 - After that, the reference rays and body rays intersect with each other on the photographic plate, then the result is Interference Pattern, which is recorded on the photographic plate. After the acidification of the photographic plate, the pattern of rays' interference appears in the form of dark and luminous areas known as interferometry, which is an incomprehensible coded image. The photographic plate after acidification and recording the pattern of interference on it, is called a hologram.

3. The hologram can then be seen by lighting the photographic plate with the same laser beam (7).

From the above we find that obtaining a hologram passes two basic stages:

- **The first stage:** Interference patterns between light waves are recorded to obtain the holograph.
- **The second stage:** where the holograph is illuminated by a reference laser beam, so that part of the beam which penetrates from the hologram is identical to the wave of the body. Then we see 3D picture inclined in the air as the original object body. As shown in Figure (4) to get the hologram requires a set of tools which represented in the follows figure (9):

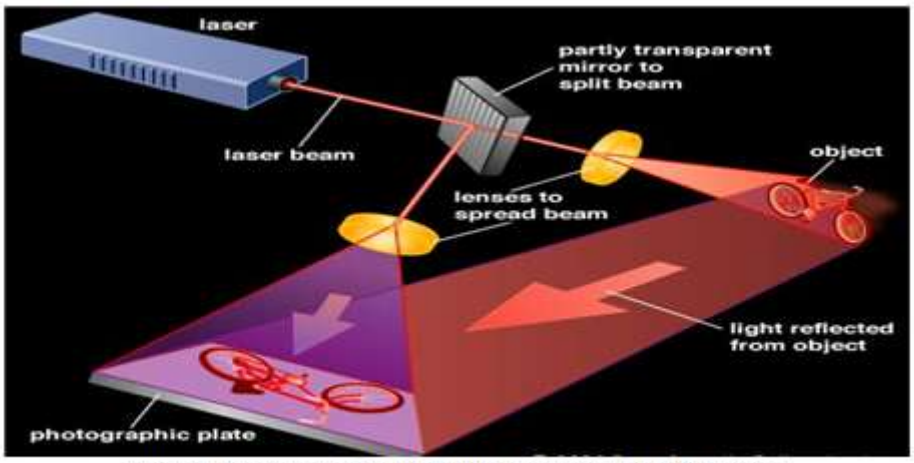


Figure (4) shows the tools required to create the hologram

1-Laser light: There are different types of laser according to the quality of the required image, including red light (helium-neon) high-quality and (diode) less quality in the production of images.

2-Beam Splitter: It is a mirror that separates the laser beam into two parts, one of them is implemented and the other is reflected.

3- Lenses: Lenses are used to disperse light and spread it to the entire body to be photographed.

4- Mirrors: Mirrors are used to redirect body ray and reference ray to the specified position on the photographic board.

5-Holographic Plate: It is a photographic film with a high analytical ability made of highly sensitive materials.

Types and characteristics of Hologram (4):

There are different types of Hologram, like thin slice Hologram (Plane Hologram), thick volumetric hologram (Volume Hologram), which is either the type of absorption or the phase type. All these types are based on Wave amplitude recording. The most important characteristics of the hologram are:

- It is possible to record more than one image on the same photographic board using a number of reference ray in different directions. Each image is independent of the other.
- Dozens of images can be stored on one hologram and can get color images of a 3D body on one hologram using three beams of laser beams of different colors. Then illuminated hologram in this case white color ray.
- The possibility of restoring the image by exposing any part of it to the laser.
- See one side of the images of the hologram concealed the other side.

Hologram applications in museum shows:

Hologram technique is used in stereoscopic exhibits by displaying three-dimensional models in space through transparent media to completely simulate the original artifacts and integrate into the surrounding space. This was used by the Heritage Documentation Center to mimic the original mask of Tutankhamun during its restoration, so that visitors of the museum can see the mask and its details as accurately and clearly as the real mask. As well as the possibility of displaying artifacts that the restorers could not restore, or completely missing pieces, which was used by the Museum of Islamic Art to display two bottles of enameled glass from the Mamluk era which are among the rarest archaeological glass in the world. Hologram technology is also used in electronic Hologram trips which aimed to introducing the most famous tourist places through virtual trips. However, there are many ideas in how to take advantage of this technology in several fields, including the field of museum shows to stimulate tourism and attract many tourists through achieving artistic dazzling in all its elements specially decoration.

Applied Project:

The idea of the applied project is to use the technique of Hologram to create a virtual scene similar to the scene of the archaeological site in the form it was built, before it was exposed to any of the factors that may affect the status of the archaeological site. Such as exposure to sudden disasters like earthquakes, floods, fires, wars or the results that occur by time. Thus, we restore the archaeological origin splendor.

Then visitors can see it in its actual, original form, as it was built thousands of years ago, as well as the addition of Stage show to an event from that historical period, which allow viewers to travel through time to experience the archaeological origin as if they see it in its actual form.

Pic. (3) Illustrates the use of transparent panels to complete the visual image of the ruined archaeological buildings

The idea is more like a sound and light show, but with a radical difference: the hologram scene will virtually reconstruct the crumbling or missing parts of the archaeological origin, restore colors to its surface and return it back to its actual form, as it was built thousands of years ago.

The idea of completing the ruined parts of the archaeological sites began with simple attempts to complete the visual image as shown in the picture (3).

The used technique:

Hologram technology has been utilized in the formation of three-dimensional light objects, which rely on the use of transparent foil at inclined angles to exchange the reflections of object's image (5), as shown in fig (5)

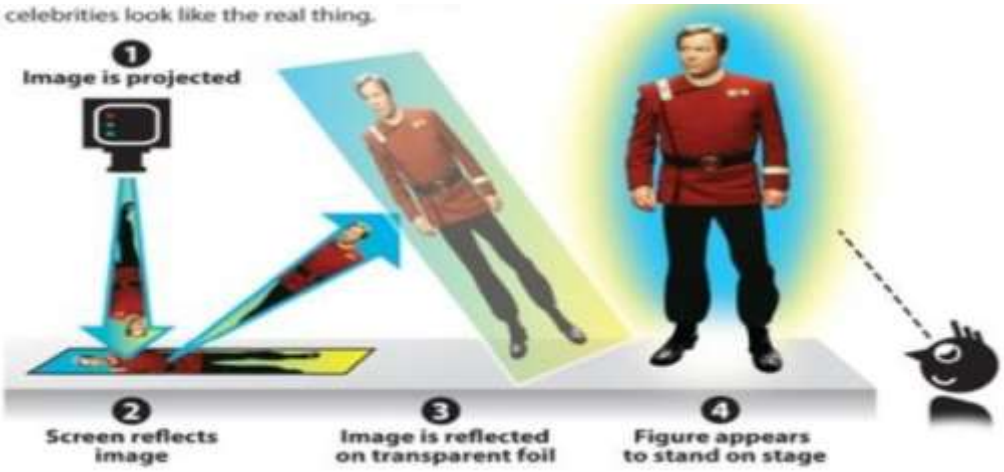


Figure 5 illustrates the use of inclined transparent foil to form a 3D image

The idea is to build a Hologram Theater, and create virtual model of the archaeological building in its original state, and then we create a holographic image to that model at the site of the original archaeological building. So that the virtual picture congruent to the archaeological building and from together a living decoration of the legendary historical scene where the viewer moves through time to view the history and image of the building at the time of its construction.

Implementation phases:

First: Prepare a virtual copy from the archaeological building in its original form at the time of its construction using specialized programs such as (3D Max) or Maya or similar programs (Fig. 6). The picture (4) shows the state of the museum at the present time, a picture taken from the site and shows the absence of many details of museum when it was built and the collapse of many parts.

(Fig.6) shows a virtual image of the facade of Luxor Temple that was prepared by 3D Max after a lot of researches by archaeologists to reach the closest form of the original temple when was built

Picture (4) A current image of the facade of Luxor Temple was taken from the site, Shows absence of many details and ornamentation of the building

Second: Using a projector to transfer the virtual image to a flat white screen as shown in (Fig. 7).

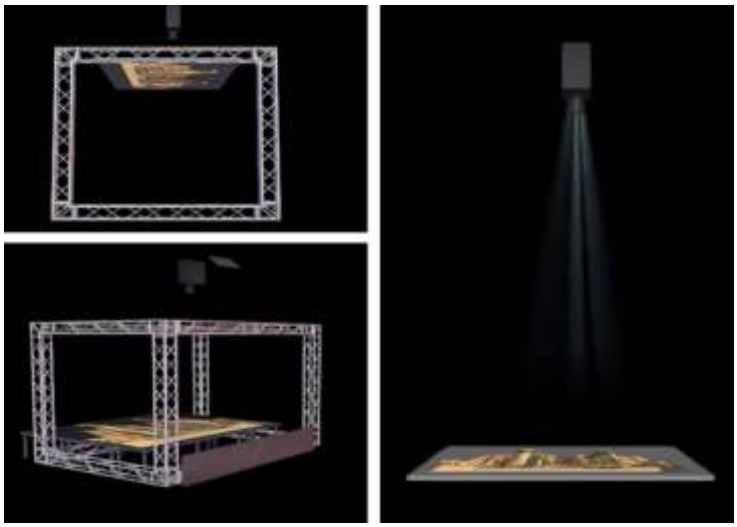
Figure (7) shows the transfer of virtual image from computer to the screen projector

Table (1) shows the proposed projector specifications to ensure the image quality.

Optical		
Light Output / Color Light Output		4500 lumens up to 14,000 hours*1 (constant brightness ON)
		5000 lumens*2 (constant brightness OFF)
LCD Panels		0.76" x 3 BrightEra LCD Panel
Panel Display Resolution		WUXGA (1920 x 1200 dots)
Contrast Ratio		500,000:1 (Full white/full black)*1
Light source		Laser diode
Projection Lens	Zoom / Focus	Approx. 1.45x Manual / Manual
	Lens Shift	Manual, Vertical : +20% to 55% Horizontal : +/- 10%
	Throw Ratio	1:28:1 to 1.88:1
Screen Size		40" to 300"

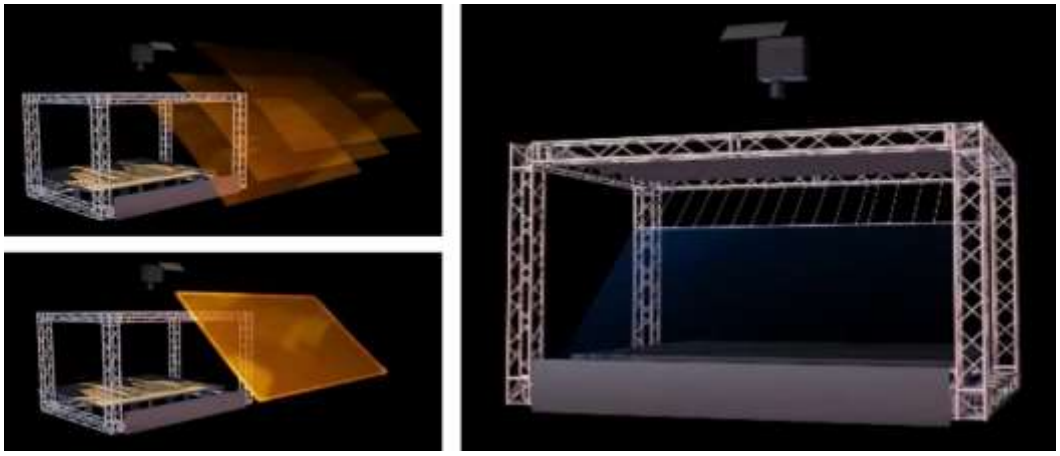
Table (1) shows the proposed projector specifications

Third: Build Steel Construced theater with dimensions commensurate with the dimensions of the archaeological building. Since the dimensions of the temple facade are 64 m wide and 23.5 m high, the dimensions of the theater are the same. According to the physical law known that the apparent dimensions of the objects are equal to the real dimensions divided by distance, the placement of the theater is 10 m from the facade means that the standard dimensions of the theater should be 6.4 m wide and 2.3 m high and the audience seats are 10 m away. Then the projector and the white screen are placed vertically up or down so that the audience does not see them as shown in(fig.8).



(Fig. 8) Shows how the projector and screen receive the picture vertically up or down

Fourth: the theater is equipped with three layers of transparent metal film that are congruent in one flat area. It is intensified along the width of the theater at a 45-degree angle from the horizontal display to reflect the holographic image within the theater space in front of the audience to see a holographic image because of the refraction that occurs during the reflection in the transparent film (Figure 9). Table (2) shows the specifications of the metallic film used in the light reflections to form the hologram.



(Figure 9) shows the mechanism of assembly and installation of layers of transparent metal film, which is used to reflect the image and turn it into a hologram.

Parameter

Item	Width	length	Thickness	Transmittance
Holographic Foil	5/8meter	50meter	95um	97%
Reflectance	**Viewing angle**	**Gain**	**Stretching Resistance**	**Hardness**
19.70%	160Degree	2	880.LBS%	3H

Table (2) shows the technical specifications of the transparent metal film used to reflect the image

Thus, the system of theater Hologrami has been completed and ready to display the virtual image as a hologram as shown in the form (10).

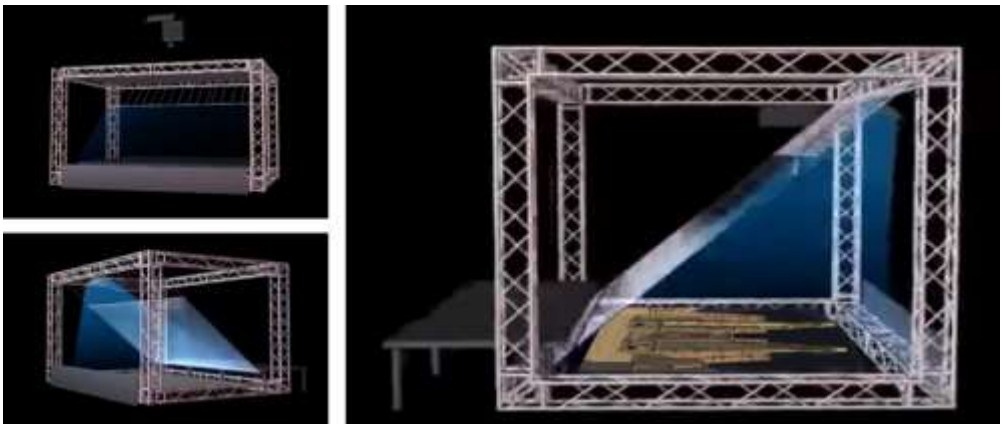


Figure (10) shows the final form of the theater after processing to display hologram

Fifth: Broadcast the virtual image on the projector, to drop it on the horizontal white screen, the film layers reflect a hologram image of the virtual building inside the theater vacuum, for the audience to see it as a hologram full-details. The audience of course does not see neither the projector nor the screen (Fig11).

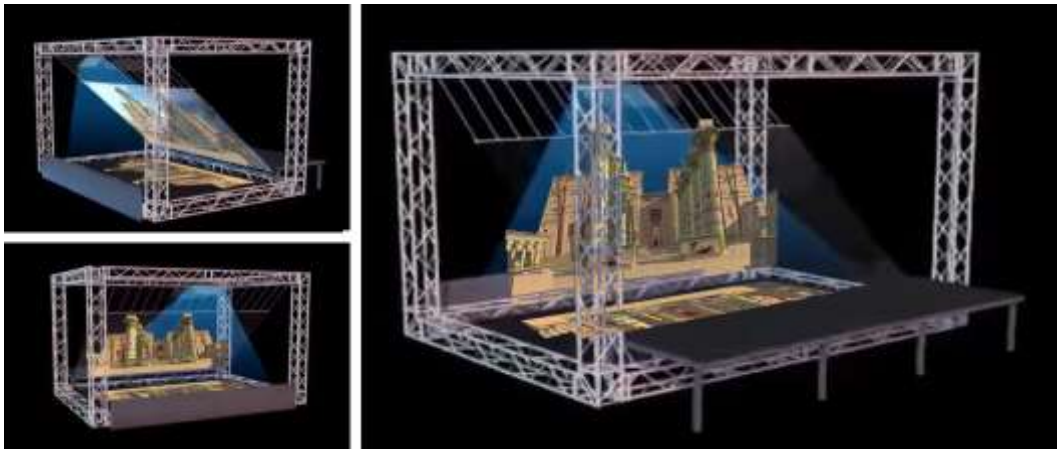


Figure (11) shows the holographic image shown to the audience

Sixth: Through the overlap of real and virtual images together and receiveing them in an integrated manner, the audience see the archaeological building during Hologram shows as original shape when it was built with full details, ornaments and colors as show in figure (12). Figure (13) shows the difference between the shape of the archaeological building (Luxor Temple) before and after the hologram show.

Fig. (12) is a conceptual figure showing the image of the archaeological building in the background overlaps with the hologram building

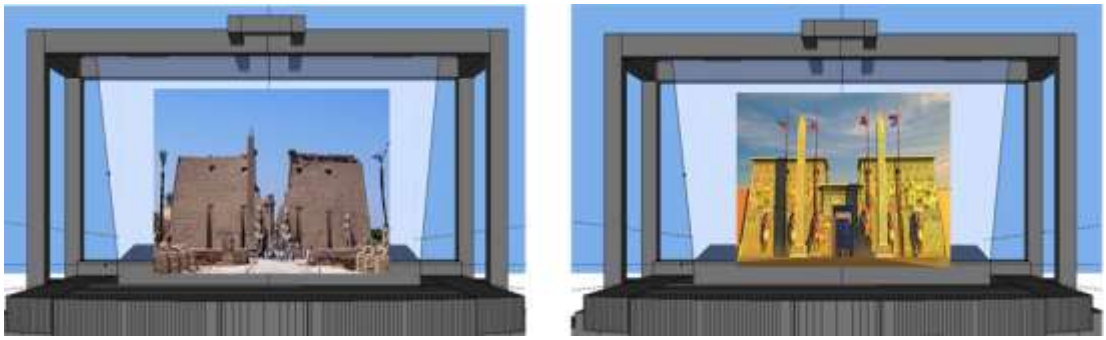


Fig. (13) shows the difference between shape of the archaeological building through the theater after Hologram (right) and before the Hologram (left)

This method is suitable for displaying one facade of the building and the theater is created at that facade, but if we want to use the same theory to display the four facades we create a quadrilateral pyramid structure and clad four faces with transparent metal film, and drop the four virtual facades in the same way above on The pyramid to show the holographic picture of the entire building. This method is suitable with small-sized artifacts. Physicists are currently

working to develop a technology to enlarge the image of the Hologram to enormous sizes suitable for the width of the planets and celestial bodies, but this technique is still in the process of experimenting and has not yet lived up to the level of generalization.

Results:

- Possibility of digital and optical technological processing for outer spaces of archeological sites.
- Hologram shows can be created with very simple and uncomplicated tools.
- There is no limit to the extent of the expected development in the display technology because it is developing rapidly and in many directions.
- Hologram theater technology is one of the Hologram shows that can be used effectively and flexibly in the field of tourism and culture.
- The preparation of a large-scale Hologram shows is still a problem, although researches have begun to solve this problem and offer solutions in the process of revision.

Recommendations:

- Designers' appetite for technology innovations and their use in their fields
- Egyptian society institutions must pay attention to the technology of Hologram, and strive to produce components of the Hologram shows locally, as all components are not complex, as they represent the technology of the near future.
- The importance of teaching Hologram technology to all disciplines because of its effective role in the transfer of science and display the applied aspects of all disciplines.

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