Studying the possibility of Using Hologram Technology, A Virtual Reality Technique, in Museum Display

دراسة إمكانية استخدام تقنية الهولوجرام: إحدى تقنيات الواقع الافتراضي في العرض المتحفي

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Abstract

The museum display is the window that allows the visitor to see the museum's collections and learn about its mission. According to the International Council of Museums' definition, museums are institutions aimed at serving communities and achieving their development. The methods of interactive museum display vary according to the nature of the museum, the type of collections, and the nature of visitors. With the evolution of modern technology and the development of the means that designers adopt in display methods and interactivity, new museum display methods have emerged in which the visitor participates and interacts both physically and mentally. Among the most prominent of these is hologram technology, which is one of the applications of lasers to produce a three-dimensional virtual reality. It provides three-dimensional images that accurately represent all information to create images that are almost identical to reality. The research aims to identify the advantages of using hologram technology in museum exhibitions and study the extent of visitor interaction with this technology as a representation of culture and art. This is achieved by creating an immersive environment that makes visitors feel as if they are part of the story being told by the museum, increasing their engagement with the museum experience. Additionally, it seeks to understand the differences between traditional museum exhibitions and the display of artifacts using holograms, as well as the challenges of implementing hologram technology in museums, given its effective role in enhancing cultural awareness and promoting museum tourism.

Keywords : Hologram, Virtual reality, Museum display, Interactivity, 3D models, Laser.

الملخص

العرض المتحفي هو النافذة التي يرى من خلالها الزائر مقتنيات المتحف، ويطلع على رسالته. ووفقًا لتعريف المجلس الدولي للمتاحف، المتاحف عبارة عن مؤسسات تهدف إلى خدمة المجتمعات وتحقيق تنميتها، وتتعدد أساليب العرض المتحفي التفاعلية، وفقا لطبيعة المتحف، ونوعية مقتنياته وطبيعة الزائرين. ومع تطور التقنيات الحديثة والوسائل التي يستعين بها المصمم في أساليب العرض، وتوظيف التفاعلية نتجت أساليب عرض متحفية جديدة يشارك فيها الزائر ويتفاعل معها جسديا وذهنياً، ولعل من أبرزها تقنية الهولوجرام، وهو أحد تطبيقات الليزر لإنتاج واقع افتراضي مجسم، حيث إنه يعطي صوراً تخيليه ثلاثية الأبعاد مسجلة لكل المعلومات لإنتاج صوراً مشابهه للواقع تماماً. ويهدف البحث إلى التعرف على مميزات استخدام تقنية الهولوجرام في العرض المتحفي، ودراسة مدى تفاعل زوار المتحف مع تلك التقنية باعتباره ممثلاً للثقافة والفن، وذلك بخلق بيئة غامرة تجعل الزوار يشعرون وكأنهم جزء من القصة التي يرويها المتحف، مما يزيد من انغماسهم في التجربة المتحفية، والتعرف على الفرق بين العرض المتحفي التقليدي، وعرض المقتنيات باستخدام تكنولوچيا الهولوجرام، والصعوبات التي تواجه تطبيق تقنية الهولوجرام بالمتاحف، وذلك لما لها من دور فعال في زيادة الوعي الثقافي وتعزيز السياحة المتحفية.

الكلمات الدالة: الهولوجرام، الواقع الافتراضي، العرض المتحفي، التفاعلية، نماذج ثلاثية الأبعاد، الليزر.

1. Introduction

Technology and information revolution have succeeded in attracting experiences and attention, contributing to the activation of renewal and innovation, developing design thinking, and creating new means of expression and unfamiliar innovative ideas. They have also significantly impacted museum display methods, creating a leap based on the concept of interactivity. The new technologies offer opportunities for developing techniques used in museums to showcase collections through the concept of participation, transitioning design from the second dimension to a deeper and more interactive design among visitors, which is a three-dimensional design, to capture attention and convey the museum's message interactively. Additionally, virtual reality technologies, led by hologram, have profoundly enriched the museum's message and changed the concept of traditional museum display. Hologram technology was introduced by Dennis Gabor in 1947 while he was improving the magnification power of the electron microscope; however, he did not achieve satisfactory results due to the available lighting sources, combining the Greek terms "Holos," which means whole and "Graph," i.e., writing. It simply implies that all optical information about the item— including the phase and amplitude of the light scattered from the object— is contained in the recorded holographic image of the object. Holography is the technique of reconstructing, and the ideal hologram is a three-dimensional image created from the interference pattern captured by coherent light beams. At first, the holograms created were two-dimensional transparencies that were flat and produced by the right amount of significantly coherent light from a sodium vapor lamp. The investigations at the University of Michigan in 1962 gave rise to the first three-dimensional holograms. Holograms were employed in the optical engineering industry, which gained worldwide popularity[1]. Holograms are truly 3D because they allow the viewer to see different perspectives of a reconstructed 3D object from different angles and locations. Holograms differ from photographs in that they are created using lasers[2], which can produce complex light interference patterns, including spatial data, required to re-create a complete 3D object. Holograms have the following essential properties[3]:

a) The light emitted from a hologram to the eye is physically like light received by the eye looking at the original scene.
b) The standards of a 3D hologram are not in natural color, but monochromatic at the color of the reconstructed wave.
c) Dividing a hologram into sections for reconstruction preserves a whole image.

[1] Y. M. Chang and C. L. Lai, "“Floating heart” application of holographic 3D imaging in nursing education," International Journal of Nursing Education, Vol. 10, 2018, pp. 25-30.
[2] Hussein, A., et al Impact of the interactive environment using hologram technology on children's cognitive development, Heritage and Design Magazine - Vol I - Issue IV, 2021, pp 1-17.
[3] S. Raza and S. Sharma, "Holography: A Review," International Journal of Applied Physics and Mathematics, Vol. 2, 2012, pp 184.

d) The feeling of 3D vision through a hologram is a real effect, not a psychological illusion[4].

e) The maximum depth of the field visible in a hologram is the function of the coherent length of the laser. The maximum brightness and details seen on the hologram depend on the function of the laser[5].

2. Steps of creating a hologram:

Holographic imaging is a method of photographing that captures light scattered from the target and then assembles it in a way that appears in 3D. To make a hologram, the following steps are employed:

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

- One beam is named the illumination beam, which is projected onto the object to be photographed directly. 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[6].
- The second beam, known as the reference beam, reaches a flat mirror. After that, it is reflected to fall on the recording medium (photographic plate) directly through a lens[7].

2- After that, the reference rays and body rays intersect with each other on the photographic plate, and the result is an 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[8].

3- The hologram can then be seen by lighting the photographic plate with the same laser beam (Fig 1).

3. Components of the Internal Structure of Hologram Technology

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

[4] Richardson, M. J., & Wiltshire, J. D. The hologram: principles and techniques. John Wiley & Sons, 2017.

[5] Elmarash, Gharsa A., Muna M. Adrah, and Entisar E. Eljadi. "3D hologram technology in Libyan educational institutions in future: Re-view." Journal of Pure & Applied Sciences 20.3 (2021), pp 6-10.

[6] Elmarash, Gharsa A., Muna M. Adrah, and Entisar E. Eljadi. "3D hologram technology in Libyan educational institutions in future: Re-view." Journal of Pure & Applied Sciences 20.3 (2021), pp 6-10.

[7] Richardson, Martin J., and John D. Wiltshire. Ibid, 2017.

[8] M. Kundalakesi, 7D Holographic Projection Display Technologies .International Journal for Scientific Research & Development, Vol. 6, Issue 01, 2018.

2- **Beam splitter**: It is a mirror that separates the laser beam into two parts, one implemented and the other reflected[9].
3- **Lenses**: They are used to disperse and spread light to the entire body to be photographed[10].
4- **Mirrors:** They redirect body rays and reference rays to the specified position on the photographic board.
5- **Holographic plate:** It is a high-resolution photographic film made of highly sensitive materials.

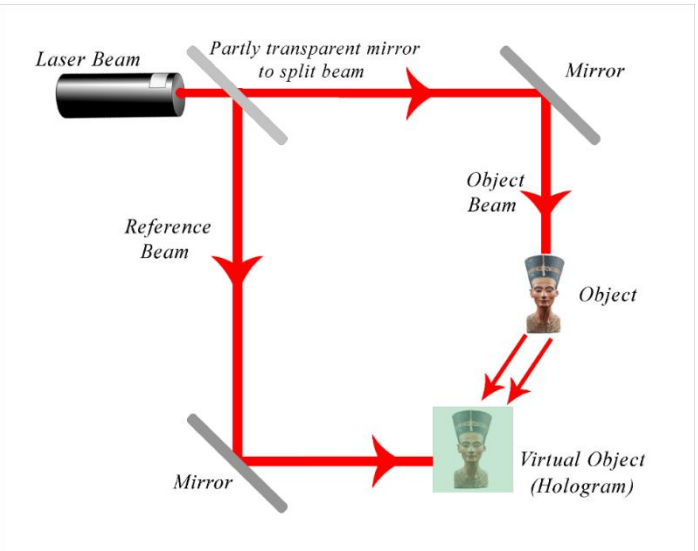

Fig 1: Steps of creating a hologram (researcher design)

Classification of 3D Hologram

There are many types of holograms, and they are classified according to different methods. The major types of the hologram are:

A. 3D Hologram

It is a flat surface that appears as a 3D image under appropriate lighting. The hologram can display and project a 3D image in the open air, resembling reality that can be depicted but not touched. The idea of viewing the holographic image is based on the concept of binocular vision from different perspectives. Each eye sees the perspective from a different angle, and the visitor's brain combines the two images into a single 3D form. It is a 3D advertisement that looks like the perspective of a real object, whether a human, animal, or solid object. It continuously changes with movement and rotation.

[9] Saleh, M. M., HOLOGRAM TECHNOLOGIES AS A NEW APPROACH IN ARCHITECTURAL EDUCATION PROCESS. Arts and Architecture Journal, 5(1), 2024, pp1-16.
[10] Ahmed Mohamed Hussein, F. A., & Safy El Deen, A., Using hologram technology in constructing virtual scenes in archaeological sites to support tourism in Egypt, Journal of Architecture, Arts and Humanities, Vol 5, Issue 20, 2020, pp 654- 668.

Moreover, it is complete and can be in full color; even if a visitor passes through it, its illusory reality appears[11].

B. Hologram Box

It is a glass box that displays the hologram inside. Its sizes range from 20 to 70 inches. It features high display clarity, as appropriate lighting is available inside the box. It is also characterized by durability and the ability to display content anywhere, as the box can be installed in any location, and audio and music players can be added inside the box[12].

C. Hologram Interactive Silkscreen Projection

It uses projection technology on the silkscreen, which can be adhered to any transparent surface, such as glass or acrylic, making the hologram appear as if it is inside that surface. It is interactive and displays a set of icons that visitors can touch with their hands to execute a specific command, such as browsing a particular menu or rotating the displayed object in the museum. This technique is a blend of holograms and touchscreens[13].

D. Projection-Mapping

It is not holographic but is classified as a type of hologram because it gives the visitor the same feeling as a hologram in terms of viewing the displayed 3D object. It uses a 3D projector to display on an uneven surface, such as building façades, and advanced computer programs are used to analyze the dimensions of the uneven reflection surface and process the image to be broadcast; thus, the image is reflected correctly. Since the displays are made in large areas and three dimensions, the visitor feels shortly after that the shapes are presented in 3D in space like a hologram[14].

4. The Difficulties of Applying Hologram Technology in Museums

A hologram is a laser application that creates 3D virtual reality. It provides 3D images with all the information about the object photographed. However, this technology may face some difficulties in application in museums, including, for example:

A. Design process requirements: Virtual display using hologram technology is relatively expensive and requires significant financial investment to obtain devices, software, and production costs. It also requires well-equipped studies to ensure effectiveness, success after its creation, and significant collaboration among a diverse group of experts in various fields, e.g., museum experts, information technology

[11] Song, S. S., Byung K. Kim, and Sung D. Hong. "Studies on reflection hologram technology applied miniature hologram types." Webology 19.1 (2022): 4716-4723.

[12] Algamal, M., et al, Hologram and their use in fashion design, Journal of Environmental Studies and Researches 2017, pp 171- 186.

[13] Ng, J. The post-screen through virtual reality, holograms and light projections: where screen boundaries lie , Amsterdam University Press, 2021, pp 110-114.

[14] Abdel Moneim, Heba, Maison Kotob, and Enas Mohamed. "Employment of interactivity in the design of museum display methods, Journal of Architecture, Arts and Humanities, Vol 11, 2018, pp 626- 649.

experts, computing experts, and museum content experts according to its type, to achieve an attractive museum display[15].

B. Quality assurance and effectiveness verification:

Those involved in the presentation process using hologram technology in the museum must monitor the quality of the 3D digital models in terms of the (length, width, height, and thickness) dimensions, colors, and material to ensure they match the original artifact.

C. Protection against hacking and piracy:

It is a major obstacle as museums are always threatened by the inability to preserve their properties online because their contents are at risk of being employed by others without obtaining any approval, which always puts museum contents out of control.

D. Lack of realism: It is manifested in the lack of real museum exhibits like those displayed for visitors in physical museums. All museum exhibits are 3D digital models, which deprives visitors of a significant amount of imagination or sense of the real exhibits. The impact of the museum exhibit has become linked to the efficiency of those responsible for the modeling process, as it controls the extent to which the digital model can mimic the original model[16].

E. The estimation of the actual size of exhibits is represented by the problem of scale in 3D virtual models, as they do not clarify the actual size of the exhibits and their proportion to the visitor, making an impact on the aesthetic value of the displayed artifact. For example, seeing a simulated model of a 3D digital dinosaur will not clarify the size of the relationship between the visitor and the dinosaur, as if the visitor stands in front of a real dinosaur in a physical museum (Fig 2).

Fig 2: Using hologram technology to display a dinosaur smaller than its size in nature

After https://www.stambol.com/2016/12/19/ar-vr-museum/ (Accessed on 16-9-2024).

[15] Vince, John. Introduction to virtual reality. Springer Science & Business Media, 2011.

[16] Ahmed, K., .et al.,"Virtual Reality and Digital Visualization as A Means of Documenting Heritage Costumes." International Design Journal ,2017,pp 461-474.

5. **Technological Requirements**

The hologram technology in museums requires several technological capabilities to ensure a satisfactory experience for museum visitors. For example:
A half-mirror that divides light into two halves, allowing half of the light to pass through while reflecting the other half.

Video film is the film material designed in a 3D manner, capable of displaying the model from various holographic devices.

LED screen is the most important component for producing manufactured holographic images.

Different lenses disperse and distribute the light emitted from the screen over the areas of the object to be photographed or displayed.

6. Using Hologram Technology in Museums

Hologram technology is a laser application for creating 3D images. It is a form of 3D virtual reality. It has surpassed computers in the production of models, as it appeared at a stage following photographic imaging. It records the light scattered from a specific object. Then, it displays a 3D object that can be seen with the naked eye without any special equipment, unlike 3D projections. Its use has spread significantly in various fields, especially the display of archaeological artifacts in museums. One of the types of museums in virtual reality is rooms that contain advanced display devices with special equipment that depends on the presence of a database, communication devices, and interaction devices that help convey the feeling to the recipient of the material presented to him in the form of simulation models of the unreal exhibits[17]. It helps preserve the antiquities, paintings, sculptures, etc., where the boundaries between the spaces and exhibitions are transformed from the
traditional form into open spaces and mixed, opening the field of vision and emphasizing the nature of the feeling of the nature of the exhibits. The design of the space is also in line with the techniques used in the shows in Egyptian and international museums.

A. Egyptian Museum

Hologram technology can be used to display some important artifacts in the museum, during their travel for an external exhibition, or while undergoing restoration. For example, the Heritage Documentation Center displayed a 3D image (hologram) placed in the original mask's location in the Egyptian Museum hall after it was transported to the restoration laboratory[18] (Fig 3).

[17] Alshereif, A., "The hologram and its importance in architecture," Journal of Al-Azhar University Engineering Sector, Vol 17, No 64, 2022, PP 1013-1027.

[18] Roshdy, A., "Techniques of museum display", literary square for publishing and distribution, first edition, 2023, p. 164.

Fig 3: Using hologram technology to display the mask of Tutankhamun
After https://www.fractalsystems.ae/holograms (accessed on 9-10-2024)

The difference between the display of the Tutankhamun mask in showcases and the virtual display using holograms

Hologram technology offers a unique and interactive experience that brings the mask of Tutankhamun to life, while the display in a showcase remains the traditional method that protects artifacts but does not provide the same level of interaction.

Property	Showcase	Hologram
Display method	Using (laser beams)	inside a glass box
Interaction	Non-interactive, static display	Interactive, visitors can see movement and speech
Experience	A traditional viewing experience	An immersive and innovative experience
Protection	Provides protection for the artifact	Does not require physical protection

B. Madame Tussauds Museum

Madame Tussauds Museum is famous for its iconic wax figures, which are currently part of a hologram experience. Visitors to the museum can get their holographic images by scanning their faces to create a 3D image that is later transformed into a digital character. Then, this character dances with similarly created images of celebrities, e.g., Marilyn Monroe, Leonardo DiCaprio, and Lady Gaga. Visitors can watch these holographic images on stage alongside 3D representations of those celebrities[19] (Fig 4).

[19] https://www.cbsnews.com/pictures/from-wax-figures-to-holograms-dance-with-beyonce-lady-gaga-brad-pitt-tokyo/3/ (Accessed on 20-8-2024).

Fig 4: A person named Mizuho Shinden watches the hologram of dancers with her face attached, far left, appearing with images of actors Brad Pitt and Leonardo DiCaprio.

C. The "Kings of the Sun" Exhibition in the Czech Republic

The "Kings of the Sun" exhibition in the Czech Republic utilizes hologram technology to enhance the presentation of cultural heritage. This innovative approach allows for a 3D experience that attracts audiences and provides a sense of realism, effectively showcasing historical artifacts in a new light. The museum displays 90 artifacts from the work of the Czech mission's excavations in the Abu Sir Archaeological Area, such as the head of a statue of King Ra-Nefer-Af, a collection of statues from the Old Kingdom, including a statue of a scribe and statues of high-ranking officials and employees, a collection of canopic jars, and ten ushabti statues made of faience (Fig 5)[20]

Fig 5: The "Kings of the Sun" exhibition in the Czech Republic utilizes hologram technology

After https://3dsense.cz/projects/kings-of-the-sun (accessed on 23-9-2024)

[20] Hammady, R., and Minhua Ma. "Interactive Mixed Reality Technology for Boosting the Level of Museum Engagement." Augmented Reality and Virtual Reality: New Trends in Immersive Technology. Cham: Springer International Publishing, 2021, pp77-91.

7. Types of Lasers Used in Hologram Technology

Holography, the technique for creating three-dimensional images, relies heavily on lasers due to their unique properties, such as coherence and monochromaticity. Various types of lasers are utilized in holographic applications, each with specific advantages and characteristics.

A. Helium-Neon Lasers

Helium lasers were historically the most common choice for amateur holography. They operate at a wavelength of 633 nm (orange light), providing a good balance of coherence length and cost-effectiveness. These lasers consist of a glass tube filled with helium and neon gases[21], which glow when a high voltage is applied between electrodes. Their simplicity and reliability make them a popular option for many holographers today[22].

B. Diode Lasers

Diode lasers have gained popularity due to their compact size and efficiency. They can be designed to operate at various wavelengths, including 405 nm, 633 nm, and 785 nm. These lasers can be frequency stabilized to ensure long coherence lengths, making them suitable for writing holograms. Additionally, advancements in technology allow for tunable diode lasers that can adjust their wavelength within a specified range, enhancing flexibility in applications[23].

C. Pulsed Lasers

Pulsed lasers, such as ruby lasers, were among the first used in holography. They emit short bursts of light that can capture dynamic scenes quickly. Although less common today compared to CW lasers, they still hold value in specific applications where rapid recording is advantageous[24].

8. The Development of Hologram Technology

A. Holograms using multicolor lighting:

This technology uses integrated fans with high-quality RGB multicolor lighting that can change colors in fractions of a second. With the movement of these fans at the correct speeds, they can create high-quality 3D images. It is the basis of this technology and has been developed through a device called the Hypervsn, capable of producing high-quality 3D images up to 3 meters long. Light field technology: Previously, this technology relied on circular glass that could display 3D images when viewed from a specific angle. Like other applications, this technology has evolved by leveraging the features of LCD screens, which enabled developers to create a device like Holo Player

[21] HESS, R, A., A survey of lasers at the birth of holography. In: Journal of Physics: Conference Series. IOP Publishing, 2013, pp 1-11.

[22] KHAN, N., et al. Experimental investigation of unidentified helium–neon lasers. Applied Optics, 2017, 56.36: 10030-10039.

[23] Nasim, H., & Jamil, Y., Diode lasers: From laboratory to industry. Optics & Laser Technology, 2014, pp 211-222.

[24] Owens, S. A., Spencer, M. F., Thornton, D. E., & Perram, G. P. Pulsed laser source digital holography efficiency measurements. Applied Optics, 61(16), 2022, pp 4823-4832.

One, capable of sending 32 views of a certain scene in specific directions simultaneously, producing what is known as a "light field." This device allows for interaction with the elements it produces in a manner very close to reality [25](Fig 6).

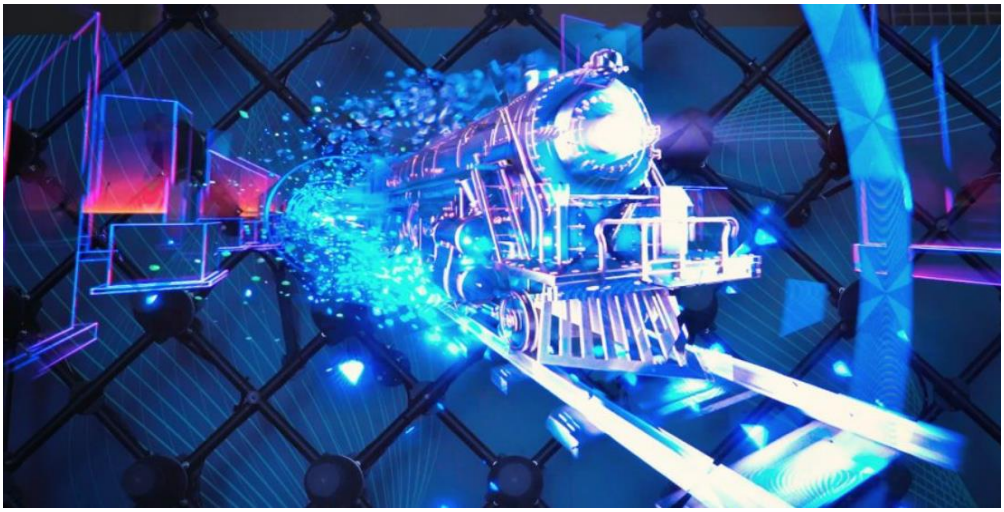

Fig 6: The method of creating holograms using multicolored lighting developed through Hypervsn

After https://hypervsn.com/blog/wall-of-wonder.html (Accessed on 16-9-2024)

B. Digital table holograms

It includes buttons, images, and icons floating in the air. It may seem fictional, but this fantasy has become a reality after a team from South Korea took an important step towards achieving it by creating the world's first hologram that can be viewed at a 360-degree angle simultaneously using a set of high-power, multi-colored laser beams along with mirrors that rotate at extremely high speeds. The team built this technology on a table, indicating the possibility of turning Tony Stark's table from a dream into reality (Fig 7).

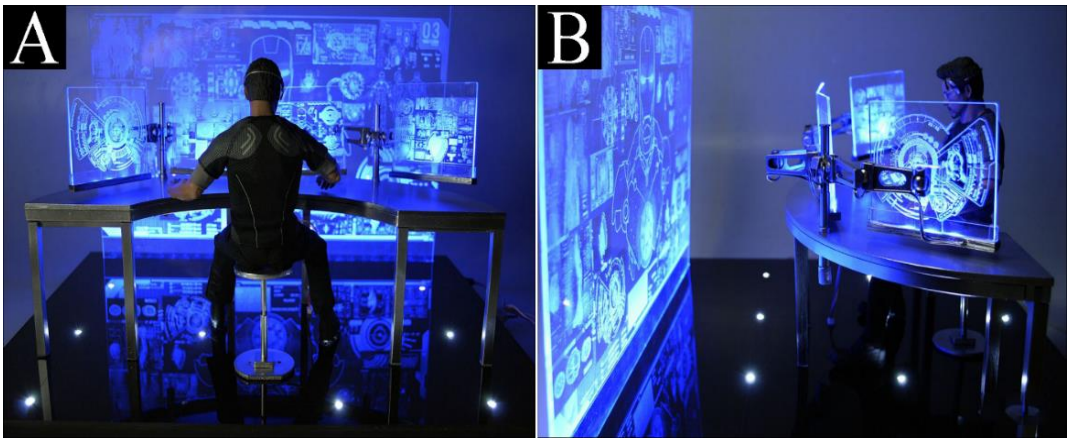

Fig 7: Tony Stark's Table (Digital Table Hologram)

After https://www.figurerealm.com/customfigure?action=view&id=81341 (Accessed on 17-9-2024)

[25] Eisa. M., The role of holographic imaging in dazzling scenes of motion pictures, Journal of Architecture, Arts and Humanities, 2021, pp 1419-1435.

9. **Using Holography in Preserving Archaeological Artifacts**

Holographic technology can be utilized in the restoration of archaeological pieces in various ways that contribute to the preservation of cultural heritage and enhance the visitor experience. Here are some key applications:

- **Digital Documentation:** Holograms can be used as a tool to document the condition of artifacts before, during, and after restoration. This helps maintain an accurate record of the item's condition, facilitating the assessment and review process[26].
- **Providing an alternative model:** Holograms can be used to display a three-dimensional model of artifacts during their restoration period. For example, King Tutankhamun's mask was exhibited using this technique, allowing visitors to see the details of the mask even while it was in the restoration laboratory.
- **Anti-Fraud Technology:** Holograms can be used as a means of protection against counterfeiting, as holographic elements can be incorporated into documents and valuable items to verify their authenticity[27].

10. The Difference between Traditional Museum Displays and Hologram Technology

The museum display enables visitors to see the museum's collections and learn about its knowledge and cultural mission. Traditional museums are physical buildings that house works of art, archaeological artifacts, and historical collections. They have always been a vital element of cultural heritage. The most significant feature of traditional museums is the tangibility of exhibits, such as the brushstrokes in oil paintings, the weight of the archaeological items, or the craftsmanship of sculptures, to draw the attention of visitors. Traditional museums allow the public to participate and share experiences by allowing them to engage in discussions on the exhibits and share perspectives. Additionally, the sense of place and authenticity provided by traditional museums makes the experience more intense and profound for the visitor. Traditional museum exhibitions have advantages that digital holographic displays cannot match; the physical presence of the exhibits is one of the significant benefits, as traditional displays give visitors the chance to view, touch, and perhaps even smell the artworks and archaeological artifacts, deepening their connection to them. The tour within the halls of a traditional museum crystallizes an interactive and visual experience that digital museums cannot replicate accurately. Moreover, it fosters a sense of community belonging, and social connectivity, as the museum allows visitors to communicate with one another, exchange insights, and benefit from the experiences of

[26] Emam. R., A proposed concept for a holographic historical museum using deepfake technology to revive historical figures. The International Journal of Heritage, Tourism, and Hospitality, Vol. 15, No. 3, 2021, pp 411- 435.

[27] Althagafi, A., Capturing Culture: The Practical Application of Holographic Recording for Artefacts Selected from the Heritage and Museums of the Arabian Peninsula, 2018, pp 451-455.

others contemplating the same exhibits[28]. The museum display can also be enriched through several technological uses to enhance and facilitate the museum experience. They include:

- Providing 3D display technologies to experience the museum: Integrating technology, art, and creativity by offering a unique experience for visitors simulates a world of imagination, as is the case of the "Art Paradise" museum in Langkawi, Malaysia, which opened in 2015. It allows visitors to be part of the museum's interactive artwork created using 3D technology to showcase collections, enabling visitors to take pictures with the museum's exhibits in a more interactive way, as if they are inside or part of the artworks[29]. The most significant feature of hologram technology, as a virtual reality technique, is that it can compile several exhibits with a common nature that do not belong to a single entity or civilization. Similarly, hologram technology allows for the creation of permanent and continuous change, aligning with the mechanisms of the present age, meeting the evolving needs of visitors, and facilitating the rotation and replacement of collections to satisfy the visitors' desires[30].

11. The Impact of Hologram Technology on Museum Visitor Interaction

Hologram technology is one of the technological innovations that can revolutionize the visitor experience in museums, contributing to an increase in their numbers. Here are some ways this technology can influence attracting visitors:

- **Providing Interactive and Immersive Experiences**
  Hologram technology allows for the display of three-dimensional content of historical figures or significant events, enhancing visitor interaction with the exhibits. For example, visitors can watch historical figures speaking or interacting with their surrounding environment, making the experience more vibrant and engaging.
- **Attracting New Visitors**
  Technologies such as holograms can attract a younger audience of youth or those seeking unique experiences. By integrating technology with culture[31].
- **Highlighting the historical and cultural context:**
  Holograms provide an effective means of displaying the cultural and historical

[28] Al- Adawi.H., "The role of interior design in developing museum display methods to achieve a balance between the historical legacy of the past and the technology of the present." Journal of Architecture, Arts and Humanities, 2024,pp 265-285.
[29] Abu Talib, A., Museums, history and culture in Malaysia. NUS Press, 2014.
[30] Plesniak, Wendy. "Incremental update of computer-generated holograms." Optical Engineering 42.6 2003, pp 1560-1571.
[31] Arviana, R. N., Ayu, M. A., & Wahyuni, M. J., A Hologram Prism Glass Visualization to Attract Young People's Interest to Poetry. In: 2020 6th International Conference on Computing Engineering and Design (ICCED). IEEE, 2020, pp. 1-5.

contexts of artifacts, helping visitors to better understand the significance of the exhibits and enhancing their appreciation of cultural heritage[32].

12. Disadvantages of Using Hologram Technology

Hologram technology is a technique of original digital content that allows the creation of 3D images using laser beams. Holographic images appear in the air as if they were real objects, somewhat resembling watching a 3D movie but without glasses or special tools. Despite the multiple advantages of holograms, there are some disadvantages, such as

- **High cost**: 3D imaging devices and software are expensive, making them less accessible to many museums, especially regional ones[33].
- **Limited interaction**: 3D images may attract a limited group of visitors, such as young people and children who are drawn to technology, unlike the older, who are attracted to artifacts in their classic form.
- **Inability to touch or interact with objects:** Since holographic images are images, users cannot touch or interact with objects in the same way they can with physical items.
- **Possibility of eyestrain or discomfort for the visitor**: Staring at 3D digital models for long periods may cause eyestrain or discomfort for some individuals[34].
- **Dependence on technology**: Holographic imaging technology relies on power sources and devices, making it susceptible to power outages or device malfunctions[35].

Conclusion

The preservation and transmission of national memory to current generations rely upon modern technology in museums for displays, especially holograms, which is a technique for original digital content, allowing for the creation of 3D digital images using laser beams. Holographic images appear in the air as if they were real objects, akin to watching a 3D movie without the need for glasses or special equipment. In museums, hologram technology is important for the following reasons:

Preservation of displayed artifacts: Displaying holographic digital models of archaeological artifacts helps exhibit and preserve rare items from damage and color fading due to human factors, such as photography or inappropriate human handling.

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Display of non-transportable artifacts: Some museum artifacts may be sensitive or large, making them difficult to transport easily. Holograms allow for their display without the need for physical relocation.

Hologram technology can be employed to display some important artifacts in the museum during their travel for an external exhibition or undergoing restoration. For instance, the Heritage Documentation Center displayed a 3D image (hologram) placed in the original mask's location in the Egyptian Museum hall after it was transported to the restoration laboratory.

Enhancing the visitor experience: Holograms can be integrated with interactive technologies such as games, making the experience more appealing to visitors, especially the youth.

Promoting education and awareness: Holograms can be used in educational presentations, allowing visitors to see how ancient tools were used or to understand historical contexts better through interactive displays.

Providing rich information: Holographic presentations can include audio and visual information that enhances the learning experience, making the information more engaging and easier for visitors to understand, especially for archaeology students.

Recommendations

Hologram technology in museums has become indispensable due to its significant role in enriching the educational and cultural experience of visitors. It serves as a vital educational and cultural platform, contributing to the preservation of cultural heritage. Therefore, hologram technology should be integrated into the educational process within museums.

The study showed that this technology enhances learning effectiveness and makes museum visits more interactive. It recommended organizing workshops and seminars to raise visitor awareness about the importance of using these technologies in education and engaging with cultural content. Additionally, hologram technology can improve museum displays by innovatively showcasing archaeological artifacts, attracting visitors, increasing tourism activity, and marketing the museum as a unique tourist destination, offering unconventional experiences for visitors.

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