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Metaverse in Heritage Conservation Evaluation "Using Fully Immersive Virtual Reality Techniques to Evaluate Preservation Quality"

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Abstract: The main problem facing the preservation of Egyptian antiquities, is the difficulty of moving an archaeological team of international experts and participants from foreign countries with the Egyptian teams together to inspect a specific antiquity in the western bank in Luxor, for example, causes the lack of periodic follow-up of antiquities and the lack of restoration quality assurance, which ultimately leads to bad results and sometimes having to remove the wrong repairs and do the restoration again. Also, Lack of funding is a serious problem facing the preservation of Egyptian antiquities, which leads to the poor architectural condition of these monuments. The Researcher suggests using the Metaverse concept in reviewing the proposals for restoration projects in the Metaverse environment, before actually carrying out the restoration process. And reviewing the restoration projects that have already been completed to ensure that it is compatible with the proposals specified in the plan before. This is done by the use of Metaverse Virtual Environment & Fully Immersive Virtual Reality technique in a mechanism that tracks the regular monument deterioration, allowing for conservation in sufficient time. Furthermore, this technique is useful for assessing the quality of the conservation process. That would be achieved by building a fully immersive 3D virtual model before and after the preservation process by comparing the changes that made to the monument. That method facilitates a good monitoring for the monument over time as well, and documenting that monument in detail. The practical part of this study describes 2 case studies that were actually carried out under the supervision of the researcher. In this study, two copies of virtual models were created for "PANEHSY" tomb (Mataria, Cairo). The first copy is based on images taken for the tomb on the day of its discovery. The second was built based on the images of the tomb after the conservation and restoration project. By applying the suggested method, the changes that occur to the tomb's drawings and ornaments were clearly observed (some defects in the colors of the drawings, and some differences in the thickness of the welds between the stones). The second case study is from the ottoman period; "ABEDY BEK RWEESH" Mosque (Nile Cornish, Masr ElKadema, Cairo), we use the same technique to compare the two copies and determine how restoration process succeed after restoration project (3 Column crowns were replaced, and minarets stairs were fell down).

Keywords: Metaverse, Archaeological Documentation, Image Processing, Change Detection Study, Information Technology, Virtual Reality

1. Introduction

After the Covid-19 pandemic, and the impact of it on Education generally, [24] and on Architecture Education specially [4], [6], [9], [11], [18], people are looking for a virtual world in which to escape from the horrors of reality, an idea that has re-emerged strongly with the world of "Metaverse." The term "Metaverse" appeared from few months, it consists of the prefix "meta" (meaning beyond) and "verse" (from "universe"); the term is usually used to describe the concept of a future iteration of the internet, consisting of a continuous, shared, 3D virtual spaces that are connected in a perceived virtual universe. Elements of the metaverse include video conferencing, gaming, email, virtual reality, augmented

reality, social media, and live streaming. The metaverse system considers user-centric elements including Avatar, Content Creation, Virtual Economy, Social Acceptance, Security and Privacy. Metaverse does not have practical applications till now but it is directed mainly towards *Games & Entertainment*. [14], [26], [27]

The research goal is to use *Metaverse* in Heritage Conservation Evaluation, The research aims to use the Metaverse concept in reviewing the proposals for restoration projects in the Metaverse environment, before actually carrying out the restoration process. And reviewing the restoration projects that have already been completed to ensure that it is compatible with the proposals specified in the plan before. This is done by develop an accurate and easy visual scientific technique that helps the Experts Teamwork from different countries to apprise the restoration process of Pharaonic tombs in progress or visually monitoring the effects of time on the tomb easily, by producing a set of interactive virtual copies of any Pharaonic tomb that It is undergoing 3D documentation & restoration on certain time frame, one before the restoration and maintenance process and one after restoration process to compare the two copies and determine how restoration process succeed.

This research aims to produce a two fully immersive interactive virtual reality models to scale 1:1 of a Pharaonic tomb (Panehsy tomb which located at Mataria, Near Heliopolis, Cairo) one before the restoration process and one after restoration process, then we compare the two copies to Evaluate the "Preservation Process", as well as providing the full opportunity to archeologist to walk inside this virtual versions to compare drawings, inscriptions, and hieroglyphic writings, in Metaverse Virtual Environment. This method will make the Evaluation process Easy & exiting to the Experts Teamwork. It is like they go to the real location & enjoy walking & discussing together via the site & can walk together inside the tomb itself. The same technique was repeated to Mosque from the ottoman period; "ABEDY BEK RWEESH" Mosque (Nile Cornish, Masr ElKadema, Cairo), to compare the two copies and determine how restoration process succeed after restoration project.

2. Methodology

2.1. Theoretical Approach

Investigating the idea of METAVERSE, and the possibility to use it in Heritage Conservation Evaluation. Then through a detailed study of fully immersive virtual reality techniques the paper presents a practical framework, to produce two (or more) virtual copies of buildings or Heritage buildings –within a time interval- to compare them by using Image processing techniques; especially *"Change Detection Study"*.

2.2. Practical Approach

The practical approach comprised the following actions: photographing from the site before & After restoration projects, image processing, 3d modeling using Sketchup or 3dmax software, then Exporting to *Unity Gaming Engine* 4, to create a fully immersive scale 1:1 two interactive virtual reality models (combined together) of a Pharaonic tomb, to detect changes & examine the quality of the preservation process.

The research ends up with Conclusions & recommendations, and also points out to new horizons along the same research interests.

3. Results

The practical part of this study describes 2 case studies. In this study, two copies of virtual models were created for "PANEHSY" tomb (Mataria, Cairo). The first copy is based on images taken for the tomb on the day of its discovery. The second was built based on the images of the tomb after the conservation and restoration project. By applying the suggested method, the changes that occur to the tomb's drawings and ornaments were clearly observed (some defects in the colors of the drawings, and some differences in the thickness of the welds between the stones). The second case study is from the ottoman period; "ABEDY BEK RWEESH" Mosque (Nile Cornish, Masr ElKadema, Cairo), we use the same technique to compare the two copies and determine how restoration process succeed after restoration project (3 Column crowns were replaced, and minarets stairs were fell down).

4. Discussion

4.1. Metaverse

At the beginning of 2019, the problem of Covid-19 began to appear and develop in a rapid manner. [17] After the pandemic, people are looking for a virtual world in which to escape from the horrors of reality, an idea that has re-emerged strongly with the world of "Metaverse."

Imagine a digital world where you can live a parallel life without leaving home, "Facebook" and other internet and video game giants see Metaverse as the next big leap in the evolution of the web. From dancing in the nightclub with friends in the form of an "avatar" to climbing Mount Everest through a virtual reality Head Mount, to holding meetings with colleagues in digitally reclaimed offices. Metaverse opens up avenues that push the boundaries of the physical world, bringing the real and virtual worlds closer together.

The concept was developed in 1992 by Neil Stephenson in the science fiction novel "Snow Crush", a reference book for entrepreneurs in Silicon Valley, the term "Metaverse" has become in recent months one of the most popular words in the world of technology and video games. Even the largest companies in the sector are investing millions of dollars in its development. The latest to join this field is "Facebook", which announced the creation of a team dedicated to "Metaverse". This is going to be a very big part of the next chapter for the tech industry, network president Mark Zuckerberg told The Verge, noting that "Metaverse is the heir to the mobile

Internet". [25] He wants to know the “Facebook” as the Metaverse Company, not Social Media Company. [28]

4.2. The Importance of Pharaonic Tombs as a Source for Heritage Study

Pharaonic tombs are considered one of the most important scientific sources for studying the heritage of our ancestors. Tombs are important because they were built with great care and by strong materials due the beliefs of the ancient Egyptians. The ancient Egyptian believes that those tombs were his immortal homes [19], so he uses the mountain slopes surrounding the narrow Nile Valley in Upper Egypt to crave special tombs inside the huge blocks of rock and under great depth to protect it from tomb robbers [3]. Those tombs have high resistance to erosion factors because of its down structures and upper buildings was constructed by strong stones or craved in the rock [3]. Actually, it was as a main source to know the life secrets in Ancient Egypt through the magnificent drawings and writings in the tombs’ walls [19].

These pharaonic tombs are exposed to great damage due to factors of physiochemical damage result of many environmental factors. The studies conducted that the great changes in the relative humidity levels at the atmosphere surrounding the walls of the monuments during the day and night hours in the different seasons of the year, it is a major cause of the physiochemical damage of some tombs [21]. While other tombs have destroyed because they were in densely populated areas or the high level of groundwater as a result of the human activities such as agriculture, sanitation, etc. It is well known that the groundwater and wastewater affect the colors and drawings of the tombs badly, because most of the Egyptian pigments were derived from natural mineral sources with a medium of water and glue or egg white [8]. Moreover, some of those tombs were exposed to natural disasters such as earthquakes, floods or fires.

Restoration projects suffer from three main problems that affect the final results;

1) Financial and Logistics factors concerning cooperation with foreign archaeology experts.
2) It is not so easy to compare the restoration results with the original tomb.
3) Accurate documents, photos and drawings of the tomb condition, in its discovering day and before it exposes to destruction, are not available.

For example, tomb like (BUSHIDO) was restored in 1994, due to its importance and to protect it from damage; glass shades, wooden walkways, and adequate lighting have been placed [15]. The tomb consists of one room; however, it includes more than 80 pictures showing the features of the tomb; including hieroglyphic drawings, inscriptions and texts which decorate the walls and ceil of the tomb (447 photos for the virtual version) [10]. To review the restoration results, old photos of the original tomb were compared with the tomb and its photos after restoration process. The restoration process is so difficult, especially in the large tombs and monuments that include many rooms and levels (because the review includes what stayed fixed and what varied in monuments), for example; Tomb of Nefertari contains about 891 pictures, Seti I (on the western blank in Luxor) contains about 1400 pictures, and this shows how much effort and time required to review one of those tombs. It took about two months to review the virtual version of the Bashido from the original photos and documentary films, however, the tomb consists of one room with only 4 walls and a ceil. Thus, the researcher tries to develop an accurate and scientific technique to compare the tomb condition before and after restoration in a short time and easy visual way by using interactive 3D documentation techniques in Metavers virtual Environment [10].

4.3. Virtual Reality and Its Applications in the Field of Archaeology

In the early 1960s, virtual reality sciences began to emerge as the development of modelling science. In the mid-1960s, the clearest idea of virtual reality was produced by Ivan Sutherland, when he wrote “The ultimate display” [12] & [13]. In the mid-1980s, this science was developed and introduced directly into architectural applications by a Brooks Group of Researchers. [16].

At first, virtual reality applications in the field of archaeology start in entertainment and games fields; when some American companies begin to make inaccurate virtual models of some Pharaonic monuments in order to add them in some electronic games or websites for entertainment purposes. The virtual reality applications were used by some entities interested in archaeology to introduce the original form of collapsed or demolished monuments. Later, the applications were developed to create virtual copies of the monuments that can be referenced, in 3D documentation [10]. There are many devices and programs that may use on fully immersive virtual reality field, but the researcher chooses to work on This research uses the *“Unity Gaming Engine 4”* & the display mainly on standalone *“Oculus Quest 2”* with internal storage 256 Mb)

4.4. Panehsy Tomb (Mataria)

In 1925, three tombs were discovered in Ard El Naam, which was part of City of Necropolis. The middle one thereof is decorated with petroglyphs. From 1931 to 1932, nine other tombs were discovered. Tomb of Panehsy was discovered in April 1988 in Mataria. Panehsy held the variant of titles; such as "Seal-bearer of Lower Egypt" and "Unique Master". His second name is Nefer-Ip-Re-Mrey-Re.

Since the New Kingdom, Mataria has been one of the most important areas. Sometimes, it was the religious capital of the Kingdom. There are still other tombs in that area that have not been discovered yet. Massive part in Mataria has been destroyed by water, environmental factors, as well as, thievery. Mataria is the site of Ỉwnw cemetery or Heliopolis (Ain Shams). However, Panehsy Tomb is a unique tomb in that area, as it is rich in the hieroglyphic writings. In addition, it was discovered in good condition. [23]

Panehsy Tomb belongs to the age of King Nefer-Ip-Ra (i.e Psamtik II) - 594 BC -588 BC. He is the third king of the

Twenty-Sixth Dynasty (Saite Period). This tomb consists of a corridor and a burial chamber. It also takes the shape of a domed sarcophagus. The burial chamber contains scenes and religious texts inscribed on its walls. No coffins or any other funerary furniture were found. Nevertheless, the main information about Panehsy and the age, when he had lived, was come up through the writings and inscriptions decorating the tomb walls. [23]

The Northern wall and Southern wall contain pieces of Amduat (i.e Book of What is in the Underworld). Amduat is a modern title of a royal text known by the Ancient Egyptians as the "The Book of the Hidden Chamber", whose purpose is to introduce the dead to the wonders happened afterworld. Amduat belongs to the age of New Kingdom. It is considered one of the oldest texts inscribed on the walls of the royal tombs in the Valley of the Kings. It demonstrates the idea of eternity. In addition, it provides a fully time-based description of the sun's night journey in afterworld. Amduat is characterized by illustrated lists of gods, along with a textual comment on the events and participants.

At the entrance to the burial chamber (Eastern wall), there is a scene on Panehsy kneeling in a position of worship, raising his hands in front of the sun that contains the scarab inside its disc (it represents the morning sun). In front of the scarab, there are pictures of other gods. Over Panehsy, his name and titles were inscribed. There are also two vertical lines of religious texts on either side. The Northern wall contains a scene of serpents, over which the name of each one was inscribed. In addition, there are two horizontal lines above the scene and a vertical line below it, below which there is vertical lines of religious texts. For the Southern wall, the serpents were replaced by divine bodies, over which the name of each one was inscribed. The Western wall is decorated with a scene on Panehsy worships the sun god in his boat. Around the boat, there are baboons cheering to the god of sun. The ceiling has a scene on Nut, names and titles and of Panehsy are a kind of funeral hymns. [23].

Panehsy tomb (Mataria, northern region of Greater Cairo) is so important because it has founded in good condition and it is rich of the hieroglyphic writings [23]. In April, 1988, PANEHSY tomb was discovered but unfortunately, the taken procedures were not enough to protect the tomb from the groundwater effects, especially, the tomb was located in densely populated area. Therefore, the level of groundwater and wastewater inside the tomb increased and all the magnificent colours and drawing were vanished as well as the tomb walls, but fortunately, in the tomb discovering day, the researcher has taken set of rare photos to the tomb by a professional photographer and before it is destroyed by groundwater (those photos are not available in Egyptian Antiquities Registration Center). Later, the researcher, was cooperate with Egyptian Antiquities Registration Center to create virtual version of the tomb by using the great progress in in computer science and its capabilities as well as the progress of virtual reality science and the development of visual and audio display devices, in order to show the tomb condition and its colours and drawings before it is vanished by groundwater, because the groundwater and wastewater have covered the whole tomb. A project to reduce the groundwater level was executed to complete documentation and dismantling process, in order to raise the level of the tomb and execute for which a full preservation and restoration project.

4.5. Abdy Bek Reweesh Mosque (Masr Elkadema)

This mosque was built in the year 1071 AH / 1660 AD, and the mosque was registered among the Islamic monuments with the number 524. The Abdy Bek Reweesh Mosque is located on the Nile Corniche Street in the Old Cairo district. It was established by Abdy Bek during the era of the Ottoman governor Ibrahim Pasha, as Abdy Bek was one of the senior state officials in his time, as he held the position of Emir of the Royal Brigade, and this title is given to senior princes Of the beks and the Sanjaks in particular, and these reached the rank of the Beks and the Sanjaks, according to their strength. There is a marble slab above the main door of this mosque inscribed with the date of construction. The plan of the Abdy Bek Mosque consists of a square area approximately, divided by two pillars into 3 intersecting arcades, each porch consists of two round columns, and the roof of the mosque consists of a group of small equal domes, except for the dome above the square in front of the mosque's mihrab, which is the highest dome. [30]

The mosque has a minaret that takes the shape of Ottoman minarets, and it rests on a square base that turns with inverted triangles into an octagonal body, then a muqarnas seat, then a round body on top of a conical helmet (pencil).

The Sheikh Reweesh Mosque is famous for the presence of a tomb in the Al-Khokha neighborhood from the southeastern side of the mosque next to the mosque. It is worth mentioning that the mosque was built on the ruins of the Al-Mu'izzy school, which was established by King Al-Muizz Aybak Al-Turkmani in the year 654 AH - 1256 AD. [29].

4.6. Explanation of Proposed Technique

When a tomb is discovered, a complete fully immersive virtual model is made according to the scientific rules for this type of 3D interactive archaeological documentation. [10]. After completing the restoration project and delivering the tomb to the Supreme Council of Antiquities, another model is photographed in the same order, overlay (overlap) and angles of every photo; using surveying techniques and instruments. [10] The aim of the same is to set 3D ground control points, as ground constants, attributed to the corners of the tomb, like points of closed polygon traverse of defined lengths and angles. When possible, to obtain more accurate results, Total Station instruments can be used with the same lenses, camera and lighting. Thus, we make a complete model of photos that express the state of such tomb, after the restoration. Then, these new photos stick on the previous 3D model, in the same linking method used previously. So, we make a new complete virtual model of the tomb reflects the state of the tomb, after the restoration. Using the programming, both models are integrated (old and new, before and after the

restoration) and two keys are created to move between both models (for instance, a key of up arrow and a key of down arrow). Then, you can scroll around slowly the tomb or scroll around quickly between the new and old models through the aforementioned keys, observing any differences in the inscriptions, soldering of stones or colors. The main aims of any restoration project is to restore the original colors without any additives [22]. Such easy visual method may be substitute for reviewing thousands of images, since it identifies accurately any defects in the restoration or any missing parts (as if you are inside the tomb). Moreover, its importance for security cannot be disregarded, as any piece stolen from the tomb can easily be seen.

This technique can also be developed, thereby some scientific techniques are used to adjust the places and angles of photography with extreme accuracy, in case of working in open, large and sprawling archaeological sites (such as the Karnak Temple Complex). In addition, the comparison procedures may carry out electronically, through digital image processing technologies, for getting accurate results very quickly.

Scientific Techniques Used in Developing the Technique Proposed by Researcher:

Researcher proposes to use a number of important scientific techniques, which help to develop the proposed method, make it very accurate and fast and expand its use to not be limited to tombs only. These techniques are as follow:

1) Differential Global Positioning System & Global Navigation Satellite System
2) Digital Image Processing
3) Change Detection Study

4.6.1. Differential Global Positioning System (DGPS) & Global Navigation Satellite System (GNSS)

This improved technology is only used, in case of working in open, large, and sprawling archaeological sites (such as the Karnak Temple Complex - or El Bar El Gharbi). It does not work in the small tombs. It set the points in an accurate three-dimensional manner, using measurement instruments and stations, which receive wireless signals and connected wirelessly to satellites. Upon these signals, the geographical coordinates of the required points are determined with accuracy [20]; since determining the location of a certain point on the Earth is carried out by measuring the distance to at least four satellites. This system has been improved with a new frequency range from the beginning of 2005. A system of multiple signals has been used. This system was stronger and more accurate, which helps to raise the degree of accuracy in determining the locations with 30 cm x 30 cm accuracy, to work in the city center under dense tree trunks and even inside buildings. Some other developments, which go into service with a third frequency band. [7] Recently, researches says that the higher accuracy will be millimeters; for example, Kinetic GNSS* (Global Navigation Satellite System) surveys allow obtaining decimeter or even sub-decimeter accuracy, while Static GNSS surveys allow obtaining centimeter or even sub-centimeter accuracy for baselines with the length of a few or even several kilometers during land surveying. The accuracy of obtained coordinates for short observation sessions depends mainly on signal multipath and geometry of satellites. [2].

* GNSS is a system connected to multi satellite; American, European, Russian, and Chinese Satellites.

4.6.2. Digital Image Processing Technologies

These technologies were developed rapidly. They have made a development in the late eighties and early nineties, in order to keep up to date with the rapid and intense development in remote sensing applications and to rapidly analysis the satellite photos captured by different satellites orbiting the planet day and night. There are several methods and algorithms that related to many applications, which designed based on the analysis of digital images; such as searching for natural resources and mining, searching for ground or surface water sources, searching for oil pools under the land surface or under the sea, exploring for bleached or drowned monuments, analyzing spy satellites' information on armies conditions and intercontinental launch pads and many other applications, for which there is no room to mention. Change Detection Study is the most important one of these technologies. [5]

4.6.3. Change Detection Study (C.D.S)

It is one of remote sensing image analysis techniques. This method has been developed to make use of satellite images of earth, especially in fields that require comparing photos of same items or areas within a specified time difference or over certain period such as; study of water currents trends and its temperature in the sea and ocean, analysis of the impact of natural disasters such as; earthquakes, volcanoes, torrents and forest fires, analysis of the information of reconnaissance satellites about the movements of armies or above ground and underground nuclear power plants, analysis of satellite images of river delta in order to study the rate of agricultural land erosion for buildings, study of erosion the shores of seas and rivers as a result of erosion and siltation, study the phenomenon of desertification and the encroachment of sand towards the agricultural areas, and analysis of urban expansion in terms of time for the purpose of urban planning. [5]. The idea of comparison in this method is that if the points of two (Old and Latest) images coincide, the program convert the spaces that not changed to shades of gray (Or any other way to distinguish it). However, if the two images differ, spots (for example) in red or light blue appear in order to determine and find the difference between the two images subject to the program. The comparisons have been made according to the following formulas:

$$A+A=Gray \quad \& \quad A+B=C$$

"C" may be red or blue color …. which refers to a change in this area.

4.7. Method Proposed by Researcher After Improvement

The idea of improving the method proposed by the

researcher is based on comparing the images, as the comparison is executed electronically by one of digital image processing techniques which is change detection study technique, so the computer compares the location of each point on the old image to the new one, and its RGB Color Model, thus, if the computer detects a difference in the location of the point or its RGB Color Model, a caution will be issued and the different areas will be colored in specific colors, then he writes a report on these differences. Therefore, the cemetery is reviewed easily and have a detailed report on all restoration defects and any other pieces differ in shape from the original shape or stolen pieces that not existed in the new photo.

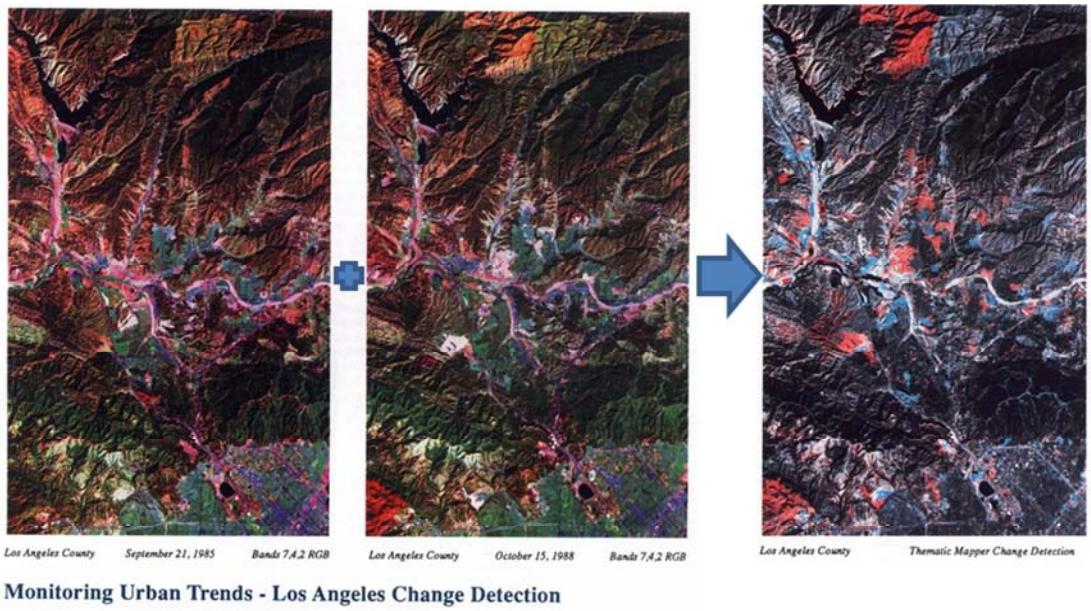

Figure 1. *Los Angeles County 1985 & 1988 Thematic Mapper Change Detection Study. Sourse: [5].*

The defects include three types of differences according to digital image analysis programs, as follows:

1) Different location of specific point between old/modern model

It means that the stone at this point was moved either horizontally or vertically and was not placed in its exact correct place.

2) Different RGB for the same point between the old / modern model:

This means that the coloring process occurred during the restoration phase was not completed in sufficient accuracy, so the colors of the restored drawings differed from the colors of the original drawings, or the mechanical and chemical cleaning of the stone surfaces may not be completed well which caused a difference in the color of the stone or the grooves between the old /modern model. A specialist in monuments maintenance can adjust the colors by performing a large number of color measurements throughout the cemetery using a chromometer (Color Scale) before starting any maintenance work so that the colors after restoration can be compared to the original colors [1]

3) Different places and RGB of many points in one converging spot:

It means that there is damage and loss of a certain piece of stones or a theft of a decorative element that was in this piece. The lost item can be identified by immediately returning to the old model and sending the missing part of data and its 3D image to all museums over the world, ports and airports to quickly control the piece before smuggling it abroad.

4.8. Periodic Monitoring of Monument

This method and another method derived from it can be applied to make periodic reviews on the monument as the monument is photographed and a fully immersive virtual copy is made annually or monthly according to the value and conditions of the monument in order to have a 3D archaeological record of the monument periodically used for accurate inspection of monument status and to what extent it is affected by erosion factors or natural disasters; such as earthquakes, floods, fires and etc. In the case of making a first virtual copy of the antiquities, and after for example a year, another virtual copy was made without any restoration works, then by image analysis - by digital image processing technology - we can judge the level of deterioration of the antiquities as follows:

1) Different locations of the specific point between the old / modern model:

This means that a subsidence or deformation of the antiquities surfaces occurred as a result of soil subsidence caused by an earthquake or damage to the foundations of the antiquities or the like.

2) Different RGB color model for the same point between the old / modern model:

This means the colors and patterns of the monument are damaged as a result of floods, rain or condensation of water vapor on the colors of the drawings.

3) Different locations and RGB color model of many points in one converging spot:

In this case, we have three possibilities:

A) If the locations of the points differed as some of which turned to the right, while the other turned to the left in line, and the RGB color model differed between them to a dark color, then this means that a *vertical crack* occurred in the wall of the monument.

B) If the locations of the points are changed, some of which went down and the other moved up or remained in place and the RGB color model differed between them to the dark color, then this means that a *horizontal crack* occurred in the walls of the impact in this area.

C) If the locations of the points and RGB color model in a large area, then this means *the fall, loss or theft of the element in this area* or the deployment of some valuable stone blocks and smuggled out. In addition, the fall of this part can be confirmed by comparing the lower images of this area till the surface of the earth to make sure that the piece is on the ground or not. Of course, the improvement of digital image processing systems has become so great to extant that it deals with millions of information about millions of points in any images of any kind. These programs are already used in the analysis of remote sensing images by satellites and in the analysis of satellite images sent by ships and space probes back to Earth daily.

4.9. The Benefit of Periodic Monitoring of Monument

The importance of the visual periodic monitoring proposed in this research by means of fully immersive 3D VR modeling or documenting methods as it provides an interactive visual model as a record of the monument by which the monument can be quickly saved in the event of a deterioration of its architectural or structural condition. For example, if the consecutive (monthly) models showed an increase in the rate of difference in the locations of the different points, it referred to the necessity of consolidation of the monument before its collapse, and if the models indicated an increase in the number of spots in which the locations of the points and RGB color model changed at the same time, it means that the inscriptions and drawings deteriorate very quickly or there are cases of stealing some parts of the monument. Through the previous archaeological record of the theft, the specifications of the stolen piece can be identified and published in the museums around the world, which helps prevent smuggling and recovering it as soon as possible. The idea of the comparison is that if the two images are identical, no difference in colors will result, as if there is a transparent glass surface on the drawing (or the program converts the areas in which no change has occurred into degrees of gray to distinguish them), but if there are differences between the two images, colored spots appear as a result of mixing the two different images on each other can be distinguished by the points that have changed their places in red, while the points that change RGB color model have a light blue color. As for the points that have changed their locations and color content at the same time, they are distinguished for example by the purple color. Thus, a quick walk inside the tomb can identify the points of change and damage occurring in the restoration process.

The proposed method can be developed by the researcher to work in open, large and extensive archaeological sites; thus, another copy of the images is controlled in the same order and the same overlap [10] and from the same locations and angles (for each image) - by improved technology DGPS using the same lens, camera and lighting, then a complete copy of the images is resulted expressing the state of the same archaeological site after restoration (or the required time range) and from exactly the same points, a copy of the previous 3D model is taken, and new images are fixed on 3D model in the same way as the previous linking method, resulting in a new, virtual copy of the archaeological site expressing its state after restoration (or the required time range). The same method can also be applied to important buildings (even if they are not monument) and museums, but under the inferred method, it depends on moving all digital video cameras (CCTV - used in security surveillance) continuously under specific schedule (daily, weekly, or monthly) using the computer and processing images in the same way as the proposed method to identify any damage to the building, any thefts of museums or the disappearance of any monument in a showcase in any museum.

After applying the proposed methods and its development, it can help in preserving the monuments and saving them in time, reducing the theft of their parts and finding the stolen parts in the event that the theft is done. It also provides a 3D documentary record to reconstruct the monument as its original state, in the event that it collapses or is damaged by natural disasters such as earthquakes, floods or fires.

5. Conclusion

We can use *Metaverse* in Heritage Conservation Evaluation, in reviewing the proposals for restoration projects in the Metaverse environment, before actually carrying out the restoration process. And reviewing the restoration projects that have already been completed to ensure that it is compatible with the proposals specified in the plan before. In the proposed system, it is possible to join archaeological team of international experts and participants from foreign countries with the Egyptian teams together to inspect a specific antiquity in the western bank in Luxor, for example, virtually. This is done by the use of Metaverse Virtual Environment & Fully Immersive Virtual Reality technique in a mechanism that tracks the regular monument deterioration, allowing for conservation in sufficient time. Furthermore, this technique is useful for assessing the quality of the conservation process. That would be achieved by building a fully immersive 3D virtual model before and after the preservation process by comparing the changes that made to the monument. That method facilitates a good monitoring for the monument over time as well, and documenting that monument in detail.

5.1. The First Case Study: "PANEHSY" Tomb

1. The proposed method was applied to PANEHSY tomb located at Mataria, and some defects in the colors of the drawings and inscriptions were discovered after the restoration, in addition to, some differences were found in the thickness of the welds between the stones. See

(figures from 2 to 9).

2. We now have two complete virtual copies of the tomb. The first one is in its original state, upon its discovery in 1988, so we have a full 3D interactive model and recording of the state of the tomb on the day it was discovered, and another copy after its restoration and raising the level of its floor to avoid the seepage water and sewage that flooded it, which was completed in 2000, so we have a complete model and a 3D Documentation of the tomb after its restoration. These copies can be used for educational, scientific or documentary purposes. [10]

Figure 2. *Western wall of the virtual model before restoration.*

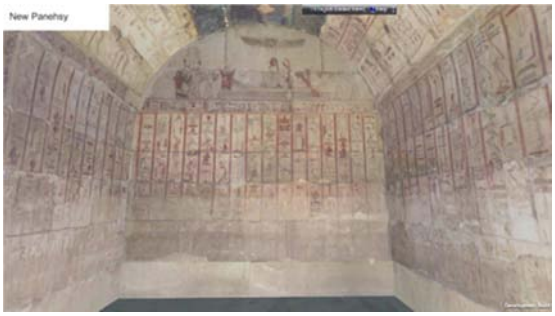

Figure 3. *Western wall of the virtual model after restoration.*

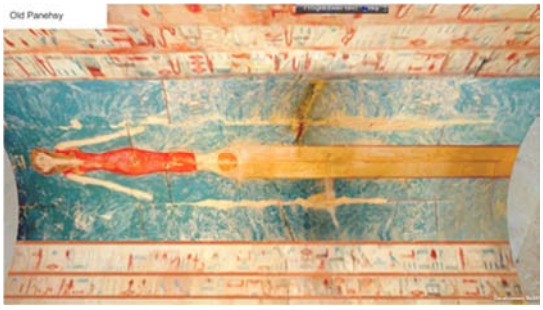

Figure 4. *The ceiling of the virtual model before restoration.*

Figure 5. *The ceiling of the virtual model after restoration.*

Figure 6 *Southwest corner of the virtual model before restoration.*

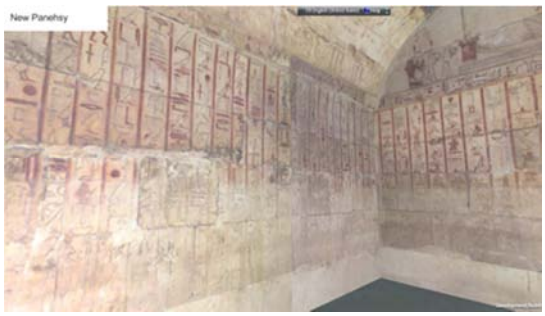

Figure 7. *Southwest corner of the virtual model after restoration.*

Figure 8. *Northwest corner of the virtual model before restoration..*

Figure 9. *Northwest corner of the virtual model after restoration.*

5.2. The Second Case Study: "Abedy Bek Reweesh" Mousque

The proposed method was applied to "Abedy Bek Reweesh" Mousque located on the Nile Corniche Street in the Old Cairo district, and we discover that; 3 Column crowns were replaced, and minarets stairs were fell down.

Figure 10 Shows screen shots from Sckethup Model After adding textures, and before exporting the FBX file to the *"Unity game engine"*.

Figure 10. *Screen shots from Sckethup Model After adding textures.*

Figure 11 Shows screen shots after exporting the BFX file to *Unity Gaming Engine.*

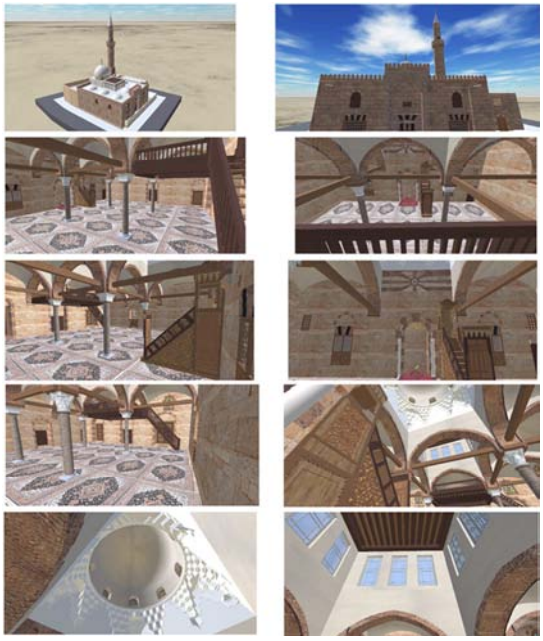

Figure 11. *Screen shots After exporting to Unity Gaming Engine.*

6. Recommendations

6.1. General Recommendations

1) A copy of the notes resulting from the comparison of the two projects has been sent to the Egyptian Antiquities Registration Center at the Supreme Council of Antiquities.
2) Attempt to apply this method to tombs exposed to danger or to theft periodically.
3) Establish a VR department at the Supreme Council of Antiquities to apply these methods to Pharaonic, Islamic, Coptic and Roman antiquities.
4) The remote sensing agency is requested to analyze satellite images of public sites of archaeological areas to detect any infringements or thefts of large parts of the sites.
5) The latest digital image processing software is used in conjunction with the proposed method for easy handling of large and complex models that contain tens of millions of points.
6) Study the extent to which the method developed inside museum buildings can be applied so that all digital video cameras (CCTV) used in security surveillance are moved successively according to certain schedule in the same path periodically by computer and image processing in the same proposed method to identify any museum thefts or the disappearance of monuments in any museum.

6.2. Big Projects Technical Recommendations

After finishing the Model on Sketchup software we can view it on Computer Screen or we can view it on Curved Screen with Stereoscopic glasses to make final review before exporting the FBX file to the "*Unity game engine"*. To make it fully Immersive VR Model (to Scale 1:1) we must add the following steps to view it on *"Oculus Quest 2"* Device:

1) Importing 3d model in Unity game engine (Figure 11)
2) Assigning model textures to its corresponding UVmap
3) Adjust lighting for outdoors and indoors to add a sense of realism
4) Add movement logic and restrictions inside the environment
5) Import VR related libraries and program the user movement to respond to HMD and controllers movements and commands.
6) Convert assets to mobile usage using Android studio and publish it to be able to use it in the headset itself. (Oculus Quist 2). [10]

But we Notice that the *"Abedy Bek Reweesh"* Mousque Model have 4 million polygons because it has a complex ornaments & muqarnas elements in the big doom and in the minaret, Thus the VGA card of the Oculus Quist 2 cannot display such huge number of polygons without connecting to the VGA card of the desktop computer. If we want to examine it with standalone Oculus Quist 2 without connecting a cable or USB to the desktop computer, then we can eliminate the Minbar unit or we can reduce the number of polygons by simplifying the models as possible.

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