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Employing Augmented Reality for Reviving Heritage Sites: An AR Vision for Qasr Al-Abd in Jordan

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Professionals in the heritage sector are currently focusing on using new, innovative methods to attract and engage visitors in heritage sites. One of their main strategies in achieving this goal is employing the latest technological applications that allow the visitor's interaction with the cultural heritage site and content. Augmented reality is one of these latest technological trends utilized in heritage sites to enhance the visitors' experience. This paper shed light on the role of augmented reality in bringing ruined cultural heritage sites and its history back to life. It specifically, proposes applying augmented reality on Qasr al-Abd or the Palace of the Slave in Jordan to revive its significance. It emphasizes the reasons and advantages of applying AR on Qasr al-Abd and provides a vision for how some AR systems can be utilized for demonstrating its original look and revealing its cultural and archeological uniqueness and beauty.

Key Words: Augmented reality, Qasr al-Abd, Iraq al-Amir site, Out-door heritage sites, cultural tourism

Introduction

Augmented reality is extensively growing with the continuous emergence of its new applications and products. It has been successfully employed in different sectors including medical field, industry, entertainment and education (Chen, 2014; Spacca *et al*., 2018; Reality Technologies, 2018). The term augmented reality is simply defined as a "combination of real and computer-generated digital information into the user's view of the real world in a way that they appear as one environment" (de los Ríos *et al*., 2014, p.663). Thus, it is a type of mixed reality that enhances the user's experience by allowing him to see virtual objects superimposed or over laid upon a real-world scene in real-time. These virtual objects are computer-generated data in the form of text, audio, video, graphics and geo-positioning data (Chen, 2014; Kysela and Štorková, 2015; Marr,2018; Spacca *et al*., 2018; Reality Technologies, 2018).

Recent development in augmented reality applications and devices has allowed its expansion and use in various fields by a wide range of audience (Marr, 2018; Chung *et al*., 2015).

Tourism and cultural heritage specifically have taken advantage of this new technology in enhancing the tourists' and visitors' experience, both indoors and outdoors, by providing information about destinations; tourist attractions and services; cultural history and archeological sites in an appealing, engaging and edu-taining way (de los Ríos *et al*., 2014; Chung *et al*., 2015; Spacca *et al*., 2018; Martínez *et al*., 2018).

Employing augmented reality to serve cultural tourism and cultural heritage is dated back to the end of the last century when a new generation of personal devices enabled augmented reality or AR guides to be used within the real environment. Since then, several museums and cultural sites have started providing their visitors with AR experience. One of the pioneer augmented reality projects in this field was the Archeoguide (Vlahakis *et al*., 2002; Spacca *et al*., 2018). Subsequently, more developed and sophisticated AR applications emerged to serve the cultural heritage sector and cultural tourism. Recent studies (Spacca *et al*., 2018; Pucihar & Kljun, 2018) pointed out that out of 87 AR applications used in art galleries, museums and cultural sites, (47%) are dedicated to cultural heritage sites where (61%) of those applications depend on handheld devices. All these applications aim at engaging the visitor with the cultural heritage site through both virtual and real experience.

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With the help of these systems, visitors are able to learn and comprehend more about the cultural heritage site and history; obtain extensive information about any object or monument within the site at any time; interact with cultural artifacts and see buildings and elements that are not currently present in the place, but have been existing there in the past (Wolfenstetter, 2007; de los Ríos *et al*., 2014; Martínez *et al*., 2018).

Many case studies have involved the application of specific AR systems in definite cultural heritage sites (Vlahakis *et al.* 2002; Angelopoulou *et al*., 2012; Banterle *et al.,* 2015; Galatis *et al*., 2016).
The current study complies with these studies in choosing a specific heritage site for AR application which is Qasr al-Abd or the Palace of the Slave located within the site of Iraq al-Amir in Jordan. Nevertheless, it does not discuss a particular AR system to be implemented at the site. Instead, it proposes generally the application of the AR technology on the palace for reviving and revealing its heritage, authenticity and cultural significance, thus, enhances its potential of being a core heritage site for cultural tourism in Jordan.

In this context, the paper first highlights some of the AR technology and devices applied in heritage sites. Then, it introduces Qasr al-Abd with a brief background about its location, history and significance. Additionally, it discusses the idea of applying AR in Qasr al-Abd and its advantages for the site. Then, it offers a hypothetical view of how the discussed AR technology can be applied on Qasr el-Abd to emphasize the beauty of its architecture and artistic elements and bring its ancient appearance back to life.

Augmented reality systems

The Augmented reality technology simply relies on two aspects: the visualization devices and the AR software or applications. This section gives a brief explanation for both aspects focusing on the types that can be utilized in outdoor heritage sites generally and in Qasr al-Abd specifically.

Visualization devices

They are simply the devices that enable the AR data to be displayed and viewed by the user. There are several types of these devices, however, the main types that concern this study are the wearable devices and the handheld devices (Wolfenstetter, 2007; RealityTechnologies, 2018).

Wearable devices can be head-mounted displays (HMD) like a helmet with a projector or a lighter version would be the smart glasses (Wolfenstetter, 2007; Chen 2014; Zen, 2018).The greatest advantage of those devices that make them comply specifically with cultural heritage sites are that they allow displaying pictures and data right before the user´s eyes, thus, the visitor can move around the heritage site freely and the information will always appear in front of his sight (Kysela & Štorková, 2015; Spacca *et al*., 2018; Zen, 2018). On the other hand, there are the hand-held devices, including smart phones and tablets, the most popular type used in AR applications generally and in AR cultural heritage sites specifically due to their availability in every user's hand (Wolfenstetter, 2007; Chen 2014; Zen, 2018). However, these devices do not allow the user's to be hand free and they do not give him the chance to get absorbed into the augmented world. Thus, recent studies (Pucihar & Kljun, 2018; Spacca *et al*., 2018) claim that wearable devices will likely become more important in the near future. Some historical sites have already been using the smart glasses and earphones in their AR applications to enhance the visitor's experience, among them several UNESCO World Heritage Sites in Italy, such as: The Residences of the Royal House of Savoy, Santa Maria Church/Convent, The Village of Crespi and The UNESCO Sites Exhibit Taormina, Sicily (Chen 2014, Artglass, 2018). Whether the AR application uses a handheld device or a wearable device, the user should be able to interact with the device either by voice, touch or gesture to be able to retrieve the AR textual, auditory and visual information (Galatis *et al*., 2016; Spacca *et al*., 2018; RealityTechnologies, 2018).

The AR applications

They involve the various softwares and systems that the AR technology relies on.
This includes:

Motion, Geolocation and Tracking systems

These systems are responsible for the alignment of the AR content and its visibility in correlation with the visitor's position (Vlahakis *et al.,* 2002; Wolfenstetter, 2007; Kysela & Štorková, 2015; Spacca *et al*., 2018).

AR Ruin Reconstruction

These systems provide 3D reconstructed models of cultural artifacts, monuments and buildings on top of ruins within their original setting and natural surroundings. The visitor can even interact with the 3D reconstructed monuments and artifacts by examining it or learning more about their uses in the

past. Many AR projects currently utilize those AR systems to reconstruct lost heritage sites and no longer existing places and buildings (Vlahakis *et al.*, 2002; Wolfenstetter, 2007; Jung *et al.*, 2011; Kysela & Štorková, 2015; Billock, 2017; ArtGlass, 2018).. AR reconstruction also involves what is known by *exterior reconstruction*, demonstrating buildings or parts of buildings that have never existed before, and *interior restoration*, that helps visualize how the inside of the building looked like in the past, adding even virtual furniture and décor (ArtGlass, 2018).

AR Life Simulator

These systems allow creating virtual ancient life scenes in their original setting. Through the animation and storytelling features, these systems provide virtual figures, objects and characters demonstrating ancient daily life activities and historical events, enabling the visitor to understand and visualize the ancient life and culture related to the place (Papagiannakis *et al*., 2004; Wolfenstetter, 2007; ArtGlass, 2018; Machidon *et al*., 2018).

AR Guide

This system is responsible for the continuous guidance to the user during the visit. It provides him with information related to the site such as names of buildings, historical, cultural and archeological contexts and events. This information can be presented in a textual, audible or visual form. The system should guarantee to the visitor a user-friendly presentation and ease of navigation (Wolfenstetter, 2007; Kysela & Štorková, 2015).

Avatar Animation

These are 3D virtual humans showing appearance and behavior similar to that of the original ancient people that once lived in the heritage site. The role of these avatars can range from being a virtual guide, that interacts with the visitor and provides him with information and explanation related to the site and its history, or they can demonstrate daily life activities and interact with the cultural heritage site and environment, mimicking the original people's behavior of moving, talking or using tools, to engage the visitor with a sensible experience (Vlahakis *et al.*, 2002; Billock, 2017; Machidon *et al*., 2018; Martínez *et al*., 2018).

Other applications of augmented reality involve

Architectural Interpretation and Art Analysis which emphasize architectural details, segments and sectors of the architectural design and provide information about the art piece or artifact. In addition to *Artifacts Interpretation* that interpret texts and scripts from an ancient language to English or other modern languages (ArtGlass, 2018).

The following section gives a brief background of Qasr al-Abd in Jordan before explaining how AR technology can be applied on it.

Qasr al-Abd: location and brief history

Qasr al-Abd, which means the Palace of the Slave, is a part of a bigger site called Iraq al-Amir located east of Jericho, on the west side of Wadi Seer and 12 miles southwest of the capital city Amman (Ji, 1998; Rosenberg, 2012). The site encompasses the palace or Qasr al-Abd, seventeen rock-cut caves and a number of water springs (Sal, 2008; Kopsacheili, 2012). This paper will only focus on Qasr al-Abd or the palace of the slave for applying the AR vision on it.

It is believed that Qasr al-Abd was most probably built by Hyrkanos, member of the Tobiad family and the governor of ancient Ammon, between 182 and 175 BC (Rosenberg, 2006; Kopsacheili, 2012).

Archeologists suggest that the Qasr or the palace was a part of a much larger agricultural estate that was bounded by great walls with gates where this estate is now covered by the village of Iraq al-Emir (Kopsacheili, 2012; Art and Archaeology, 2019).

Many references highlighted the importance of Qasr al-Abd as a significant Hellenistic monument not only in Jordan but also in the Middle East. Others pointed out the uniqueness and originality of its design and decoration that were somehow influenced by the monumental architecture in Egypt at that time and Asia Minor (Shuqum, 2015; Salle, 2013; Rosenberg, 2012; Kopsacheili, 2012). Due to the early death of Hyrcanus who committed suicide for political conflicts, the palace was left unfinished and it was never used (Universes in Universe, 2019; Art and Archaeology, 2019; Kopsacheili, 2012). For this reason, the main purpose behind building Qasr al-Abd remains unknown. However, according to its design, some scholars suggest it was meant to serve as a mausoleum for the Tobiad family where banquets in honor of the dead would be held and others believe it was meant to be a residential/recreational palace for Hyrkanos or particularly a royal countryside lodge that would also be used for storage (Rosenberg, 2006; Kopsacheili, 2012).

After the death of its founder, the palace was disregarded and later it was completely destroyed by earthquakes leaving only ruins and remains at the site (Zayadine, 1997; Universes in Universe, 2019).

Concerning its name, some suggest that the palace was named Qasr al-Abd or the Palace of the Slave referring to Hyrkanos himself as he was considered the "slave of the people" by being the governor who served them (Shuqum, 2015; Only Mark Trip Report, 2019). Others relate its name to the legend that claims that a slave fell in love with his master's daughter. The master ordered him to build her a unique palace to win her hand. He started to build a gorgeous palace carved with eagles, lions and leopards but when the slave was about to finish the palace, the master killed him (Rosenberg 2006; Universes in Universe, 2019).

Many scholars and travelers visited the site of Iraq al-Amir and wrote about it. Irby and Mangles (1823) for example described the ruins of Qasr al-Abd and the caves of Iraq al-Amir. The French de Vogue was the first scholar who published drawings of Iraq al-Amir site and recorded many architectural details about Qasr al-Abd. Healso described the embankment as holding back a possible lake, in which Qasr al-Abd stood. In 1863 De Saulcy visited the area and gave a brief characterization of the site including Qasr al-Abd (Rosenberg, 2006). Furthermore, Conder (1889) described the ruins of the village of Iraq al-Amir, the cliffs, the caves and Qasr al-Abd. Later in 1904, the Princeton Expedition, led by Professor Butler, visited Iraq al-Amir with the goal of fully investigating the ruins of Qasr al-Abd and its surroundings (Brett, 1963; Butler, 1907). They provided detailed descriptions and plans of the palace and surrounding constructions and published "two alternative reconstructions of the plan and tentative restoration" of Qasr al-Abd in 1919 (Butler, 1907; Brett, 1963,p.39).

Furthermore, many archaeological excavations and survey projects have taken place in the site of Iraq al-Amir since 1961 (Lapp, 1962, 1963). The main goal of one of these projects was to maintain Jordan's cultural heritage and to preserve and restore monumental buildings for tourism (Lapp, 1979). Another project aimed at exploring whether Qasr al-Abd reflected the type of human settlement in the entire region or it is a structure unrelated to the area. Under this survey project, 88 archaeological sites were identified and were dated to the Chalcolithic, early Bronze Age, Iron Age II, Hellenistic and Byzantine Periods and in 2000, another 42 archaeological sites were explored in Wadi Kafrayn and Iraq al-Amir (Ji and Lee, 1999).

The excavation projects that were carried out in Iraq al-Amir generally and on Qasr al-Abd specifically provided a great deal of knowledge about its construction and architecture. Additionally, a large number of the original blocks used in its construction were still present at the site. This helped in the restoration of some parts of it, especially on the first floor and some of the sculptures and figures decorating its exterior (Sauer, 1979; Larché, 1982; Brown, 1983; Kopsacheili, 2012; universe, 2019).

Why augmented reality for Qasr al-Abd?

The main reasons that support the idea of applying augmented reality on Qasr al-Abd are as follows:

The compatibility of the idea to the site status

Studies have discussed before the usefulness of employing augmented reality in cultural sites and presented some of these applications on heritage sites with very much similar conditions and circumstances like Qasr al-Abd in Iraq al-Amir (Angelopoulou, 2012; Han *et al*., 2013; Banterle, 2015; Jashemski, 2018). Through the AR technology, ancient structures are restored or reconstructed virtually in their original settings by overlaying the 3D model of the historical building in its past state on its existing ruins, enabling visitors to see it and visualize its ancient appearance (Armanno *et al.*, 2012; Panou *et al*., 2018).A good example of these heritage sites is Greece's Olympia archaeological site where only ruins are left. Through the Archeoguide outdoor AR system archeological monuments, artifacts and other elements are virtually reconstructed and returned to life from the ancient world (Vlahakis *et al.*, 2002, Jung *et al.* 2011; Dutra and Ebel, 2014).

Another good example involves the old town of Chania in Crete, Greece where mobile augmented reality can be applied to virtually restore the destroyed and demolished parts of three ancient monuments; the Glass Mosque; the Saint Rocco temple and the Byzantine wall (Panou *et al*., 2018). Some of these monuments were only partially restored, similar to Qasr al-Abd where a complete physical restoration and reconstruction is unattainable; others suffer from current conditions that generate a great risk on their historical value like Qasr al-Abd (Panou *et al*., 2018; Salles, 2013; Shuqum, 2015; Kopsacheili, 2012).

All the previously mentioned sites share one or more aspect with Qasr al-Abd concerning their current status: Outdoor, cultural heritage sites; only ruins and remains are left, partially restored, and endangered historical significance due to current obstructions.

AR was considered and presented for all these sites as a great opportunity to revive the place, bring it back to life, enrich it and enhance its potential as a tourist attraction. This encourages that the same path would be taken for Qasr al-Abd and other sites with similar conditions.

It is also worth mentioning that some studies have pointed out the difficulty and uncertainty of restoring the whole building, especially the second floor (Kopsacheili, 2012) while others stated clearly that the second floor "can only be reproduced graphically" (Salle, 2013). This reinforces the idea of applying AR on Qasr al-Abd as a relevant alternative plan for its reconstruction or restoration. It will give the visitor the chance to see the beauty of the ancient architecture on the remains of the actual monument and at the same time visualize how the entire palace was meant to look like if it was ever completed and still standing. Thus, applying AR on Qasr al-Abd will help bypass the challenges of reconstructing and restoring the whole building in an effective way that will save time and money and at the same time light up the glory of the palace and satisfy its visitor.

Tourism development

Despite the uniqueness and importance of Iraq al-Amir site generally and Qasr al-Abd specifically, it suffers from neglect and deterioration. It does not gain much attention on the official level for guarding it, improving its condition and enhancing its chances of becoming a major cultural tourist attraction in Jordan (Shuqum, 2015).

Spreading the awareness of the site importance and providing it with the necessary facilities and infrastructure is crucial for expanding and practicing tourism on a wider scale within the area.

Applying an AR project on Qasr al-Abd will also offer the entire site key advantages including the following:

- Reviving a cultural heritage structure that has its significance and importance, giving its visitor the chance to appreciate how it once looked like instead of seeing only ruins and remains.
- Assisting the promotion of the entire site globally, as a unique innovative heritage site for cultural tourism. This will increase the number of its visitors both locally and internationally.
- Creating an edutainment atmosphere that guarantees the visitor's engagement, amusement and learning (Chung *et al*., (2015).
- Providing the visitor with the basic knowledge and information about the history of the site in a dynamic and creative way (Galatis *et al*., 2016).
- Engaging the visitor with the place and drawing his attention to details related to the architecture, decoration and people related to the place (Galatis *et al*., 2016).
- Enhancing the visitor's experience that encourages for return visits and recommendation of the site to others through reviews, word of mouth and social media.

A vision for AR application on Qasr al-Abd

The AR application content in any site should focus on certain hotspots or points of interest [POI]. These POIs should be selected according to their significance to the site and their importance to the visitor to see and learn about (Angelopoulou *et al*., 2012; Galatis *et al*., 2016).

The current study suggests that the AR application at Iraq al-Amir archeological site would focus initially on Qasr al-Abd, the palace, as the point of interest.

The AR project at Qasr al-Abd can rely on the hand held devices of the visitors such as their mobile phones or tablets for AR visualization like many other AR projects implemented in cultural and heritage sites (de los Ríos *et al*., 2014; Martínez *et al*., 2018). However, using recent wearable devices, like smart glasses, and earphones for audio will allow the visitors' full engagement while exploring the site and will enhance their experience during the visit (Janžekovič, 2018).

The AR experience at the site would start once the visitor enters the AR app. through his handheld or wearable device and select to begin the tour giving a brief audio background description about Iraq al-Amir site in general, the location, the caves, the springs and the shrubs surrounding the palace (de los Ríos *et al*., 2014; Galatis *et al*., 2016).

Led to the palace through the geo-location and tracking system embedded in the app., an audio announcement would notify the visitor about the POI's name and identity: *Qasr al-Abd , Palace of the Slave* (de los Ríos *et al*., 2014; Galatis *et al*., 2016).

The inclusion of a virtual avatar acting as an AR guide might be interesting in this journey (Wolfenstetter, 2007; Janžekovič, 2018). An imaginary character from the Hellenistic period in Jordan or even a virtual figure of Hyrcanus himself, the palace founder, can act as the guide throughout the AR journey of the palace.

The avatar would start by greeting the visitor and introducing himself then begin narrating a brief story about when, how and why the palace was build and why it has never been completed.

The AR guide will then proceed by describing how the landscape of the palace initially looked like. The AR life simulator would be employed at this point to demonstrate the ancient scene in the original setting hiding the current shrubs that cover the area and visualizing instead the walls and the artificial

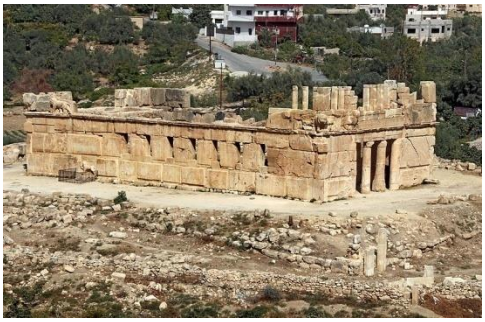
lake that used to surround the palace, the dam that had to be crossed and the gate through which the palace was accessed in the past (Kopsacheili, 2012; Art and Archaeology, 2019; Universes in Universe, 2019).Coming closer to the palace, the AR guide would point out the simplicity of its design as a large two-story structure, built of white, large rectangular stones made of local limestone (Zayadine, 1997; Kopsacheili, 2012).

The AR ruin reconstruction system would be utilized to provide a 3D reconstructed model of the palace on top of its ruins [illustrations 1. a & b]. Thus, through animation, the visitor could see how the whole palace looked like [illustration 2.] in the past and even how it was assumed to look like if it was completed according to the archaeological hypothesis (Wolfenstetter, 2007; ArtGlass, 2018). Then, the AR guide would describe the exterior view of the virtual reconstructed palace with its four corner towers and their balconies, the 21 Corinthian columns and how the whole structure was once richly decorated, emphasizing specifically the sculptured lions and leopards in addition to the eagles at the corners of the upper level (Kopsacheili, 2012; Shuqum, 2015; Zayadine, 1997).

Approaching the entrance of the palace, on the North side, the AR guide would start describing the entrance with its two Corinthian columns in the front and two additional columns, on the sides (Kopsacheili, 2012; Art and Archaeology, 2019).Heading to the West Wall, the AR guide would state that the walls are constructed out of large stone blocks, up to 6 m long and 3 m high, but only about a meter thick (Art and Archaeology, 2019). He would then mention the rectangular windows and the lions' frieze on the top corners where only remains could be seen (Kopsacheili, 2012; Salle, 2013; Art and Archaeology, 2019). However, through the AR reconstruction and architectural interpretation systems, the visitor would be able to visualize the windows and how these friezes of confronting lions looked like in the past.

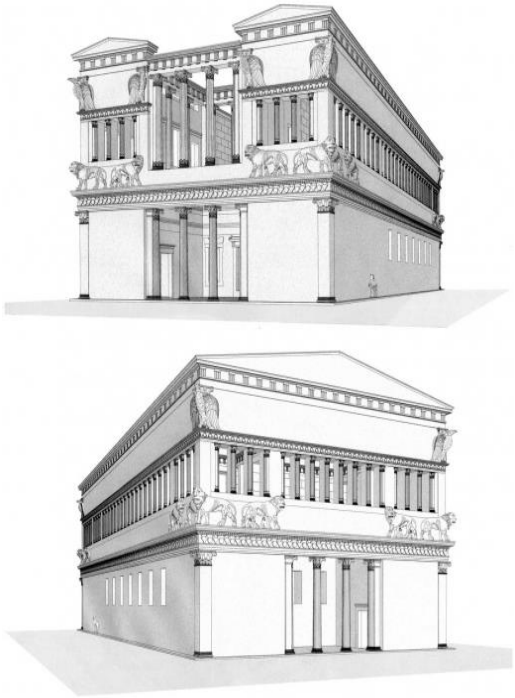
Illustration (1)a., b.: Qasr al-Abd: real current image

a. Source: The Arab Weekly: https://thearabweekly.com/iraq-al-amir-hellenistic-splendour-stands-out-near-amman



b. Source:https://universes.art/en/art-destinations/jordan/iraq-al-amir/qasr-al-abd/view-4/ (Haupt & Binder)

Illustration (2): Qasr al-Abd: a visualized image



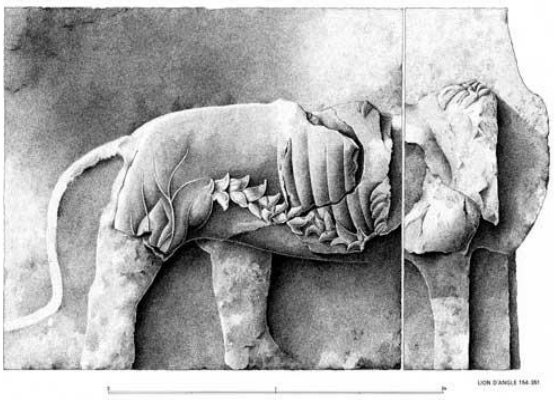
Source: Presses de l'Ifpo. http://books.openedition.org/ifpo/docannexe/image/4894/img-4.jpg (F. Larché)

On the top of the Northwest corner, the AR guide would identify the figure of a carved lioness with a suckling cub. Architectural interpretation and art analysis systems would demonstrate the architectural and artistic details of the lioness, including its mane that only male lions possess [illustrations 3. a &b]. Similarly, the AR guide would point out, the leopard figure on the ground at the West wall and that it is corresponded by an identical one on the East side of the building. He would explain their original role as fountains that were supplied by water from two basins located inside the building (Kopsacheili, 2012; Salles, 2013; Art and Archaeology, 2019; Universes in Universe, 2019). The AR reconstruction, architectural interpretation and art analysis systems would demonstrate the architectural and artistic details of the leopard artifact [illustrations 4. a & b.] while the animation would show how the water used to come out of the leopard's wide open mouth (Billock, 2017; Martínez *et al.*, 2018; ArtGlass, 2018).

Ilustration 3. a) : Lioness and cub artistic details demolished

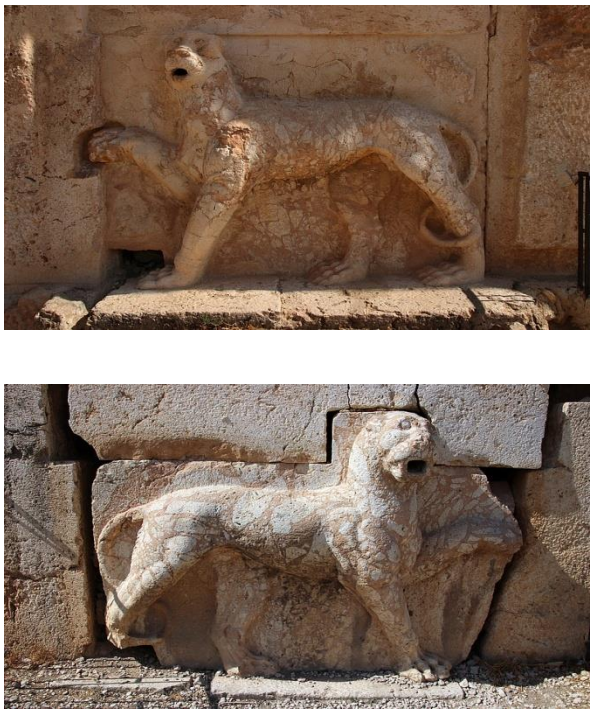
Source: https://universes.art/en/art-destinations/jordan/iraq-al-amir/qasr-al-abd/lioness / (Haupt & Binder)

Illustration 3.b): Lioness and cub artistic details emphasized



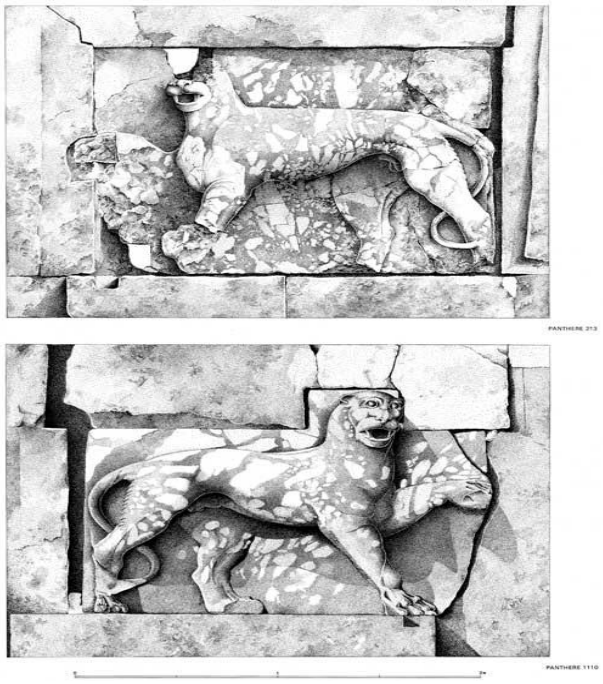
Source: Presses de l'Ifpo. http://books.openedition.org/ifpo/docannexe/image/4894/img-5.jpg (J.-P. Lange)

Illustration 4.a): Leopard figures actual image



Source: https://universes.art/en/art-destinations/jordan/iraq-al-amir/qasr-al-abd/leopard-fountain/ (Haupt & Binder)

Illustration 4.b): Leopard figures artistic details pointed out



Source: Presses de l'Ifpo. https://books.openedition.org/ifpo/docannexe/image/4894/img-6.jpg (J.-P. Lange)

The visitor would then head towards the South side and the AR guide would indicate that it was identical to the entrance at the North for symmetrical reasons, but did not serve as a second entrance (Kopsacheili, 2012; Art and Archaeology, 2019).

AR reconstruction systems would demonstrate how the Southern façade looked like in the past visualizing its columns that are now partially destroyed and its Corinthian capitals; the remains of the top lions' frieze at each corner; the remains of the frame and half-columns of the upper floor and the artistic details that have been demolished (Universes in Universe, 2019).

Turning to the Eastern wall, the AR guide would mention the rectangular windows correspondent to those on the Western wall, the second leopard fountain on the ground and point out the remains of a carved capital on the northeastern corner of the eastern wall (Art and Archaeology, 2019; Universes in Universe, 2019). Again, AR reconstruction, architectural interpretation and art analysis systems in addition to animation would be utilized to visualize how the Eastern side looked like in the past(Billock , 2017; Martínez *et al.*, 2018; ArtGlass, 2018).

The visitor would then head back to the Entrance at the North to enter the building where only ruins and remains indicates that there once have been rooms, passages and stairs (Only Mark Trip Report, 2019). AR ruin reconstruction and interior restoration systems would be utilized to demonstrate how the inside of the palace was assumed to look like in the past (ArtGlass, 2018). It would feature the hall on the first floor and the four rooms with their seven high windows that open out along a corridor or hallway on the west and east sides. The AR guide would describe all that and indicate that these rooms were most probably used for storage (Zayadine, 1997; Kopsacheili, 2012). In addition, animation would feature the two interior basins on the East and the West sides and the AR guide would emphasize their role of supplying the two leopard fountains outside with water (Zayadine, 1997; Shuqum, 2015; ArtGlass, 2018).

The AR ruin reconstruction and interior restoration systems would also illustrate the staircase at the corner where only ruins and remains indicate their earlier existence (Kopsacheili, 2012; ArtGlass, 2018; Universes in Universe, 2019). The AR guide would then indicate that the second floor might have been designed or planned to be used for accommodation or religious purposes but it was never completed (Zayadine, 1997; Shuqum, 2015). AR reconstruction and interior restoration systems

could also visualize the assumed hall and corridor of the second floor corresponding those on the first floor and the half and three-quarter columns decorating its walls (Kopsacheili, 2012).

Finally, the AR guide would announce that the AR journey of Qasr al-Abd has come to its end; he would salute the visitor hoping that he would have had a good time during the journey and wish him a pleasant time exploring the rest of Iraq al-Amir site.

Conclusion and Future Work

This study discussed augmented reality as one of the latest technologies employed by cultural tourism and cultural heritage sites. It pointed out the advantages of utilizing AR in reviving ancient heritage sites, especially, where only ruins and remains could be seen. In this vein, it suggested applying AR on Qasr al-Abd or the Palace of the Slave in Jordan for safeguarding its remains, revealing its cultural and archeological authenticity and transforming it to a major tourist attraction in Jordan.

Finally, the study presented a hypothetical model or a vision for how some AR systems can be applied on Qasr al-Abd to virtually demonstrate the palace on its ruins and emphasize the beauty and uniqueness of it architectural and artistic details. However, applying AR on Qasr al-Abd is not enough for promoting the area of Iraq al-Amir where it is located as a major tourist site. Future work may involve examining other methods for developing the entire region to serve tourism. This can include studying the possibility of applying AR or other appropriate technology on the ancient caves located in the site. Future studies may also explore options other than those related to the technological applications for developing the region. Furthermore, the current study agrees with the general suggestion of Chung *et al*., (2015) that future studies should focus on the effects of AR application at heritage destinations on the tourists' experiences which should be examined from the heritage tourism viewpoint. Consequently, the current study recommends investigating the expected impact of applying AR in Qasr al-Abd on the tourism development and tourism flow in the site of Iraq al-Amir generally. In addition, it recommends exploring the potential effect of using AR application in Qasr al-Abd on its visitor's experiences from the cultural tourism perspective.

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