Augmented Reality and Gamification in Heritage museums

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Abstract. Augmented Reality (AR) technology is one of the fastest growing areas in the computing field and it has pervaded many applications in the market including museums. However, there is a need for a survey exploring the effectiveness of augmented reality as a communication medium in museums. This paper reviews the development of Augmented Reality as a mass communication [1] tool in museums. We introduce a communication model which would work as a roadmap building AR guidance system with ensuring this system will be a successful method of communication with users. Besides, we propose a novel way to enhance the visitors' experience and learning by combining AR with games in museums.

Keywords: Augmented Reality, gamification, museums, communication methods, visualisation, interactions.

1. Introduction

Augmented Reality (AR) was introduced to the heritage sector in the last decade as a technology that has the potential to assist visitors inside museums [2] [4]. As the technology kept evolving, acoustical tools were combined with AR tools to enhance visualisation especially in archaeology and cultural heritage sites [3]. *LIFEPLUS* in 2003 was considered a good example of the AR development that occurred to be capitalized in indoor and outdoor guided tours in cultural sites and museums [4]. In the following year, the augmented visualisation using the technology of mixed reality [5] engaged visitors by immersing them in a virtual world and stimulating them for long discussions after the visit. Another system in 2004 named *ARCO* [6] enriched the interaction in museums and offer the chance to use AR outside museums as well.

Mobile multimedia guide on handheld devices started to appear widely with some revolutionary features especially used in museums and cultural heritage sites. A good example was in 2007 [7] when the level of interaction became higher and the geolocalisation prospects became accessible via mobile devices. In 2008 Damala, Cubaud [8] argued that the multimedia guided system which functions by AR techniques could be altered by the experience gained from museum visitors by observing and monitoring the visiting patterns and the real-time communications including pre and post visit [9]. In 2010, Naemura, Kakehi [9] built an inclusive system that could create augmentation using optical displays without mediums, navigations system, and diverse ways to let visitors express their feelings and a chance for visitors to contribute in order to develop the system.

Based on the literature, this paper proposes communication models that can be applied to multimedia guiding systems, which use augmented reality technologies. The

last section introduces ideas for combining serious games with AR in museums in order to engage and educate visitors about the history and culture of ancient Egypt.

2. Communication Mix and the 'Noise' concept

In this section we discuss the position of AR guiding tools in Hooper-Greenhill [1] communication categories. They might be considered as *direct communication* or *mass communication*. Hooper-Greenhill's *communication mix* is a key concept in museums settings as it captures a wide variety of museum communication methods, which has shifted over the decades, and exploits their benefits.

Figure 1 demonstrates the communication processes that involve all parties of the communication in AR methods. The model starts with the sender which could be the person who is responsible to prepare the content that needed to be delivered. That person might be an archaeologist or a curator or a tour guide in the context of heritage museums. This person carefully delivers the information and interpretations which could be textual, visual or auditory. In addition to that, this person should construct a coherent scenario for the whole visit based on a sensible route that he suggests. Furthermore, a part of the sender's role is to give all of the sufficient information needed for the augmented reality developer/designer. The role of AR developer/designer is to choose the most suitable devices, which do not burden or distract visitors during the tour, and to encode the message and ensure that the technology and tools are reliable to deliver the narratives associated with the exhibited objects and collections, taking user experience into consideration. The Internet/Servers are channel through which the data is conveyed. This project focuses on the collaboration between the archaeologist/curator and the AR developer.

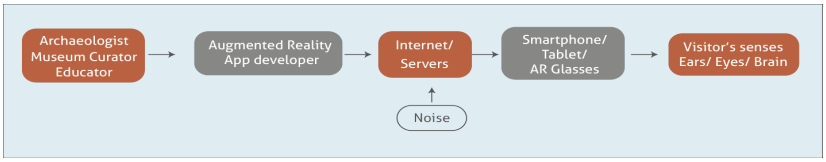

Fig. 1. The communication model of Augmented Reality guided tools in museums settings

'Noise' is defined as any internal or external source that may interrupt the communication or confuse the receiver [10]. External noise could occur for various reasons, for instances, overcrowded museum when visitors use the AR guide, insufficient lighting especially when the system is based on visual tracking. Internal noises could relate to functionality, usability of the system and other aspects.

In Figure 2 we categorize internal noise that users may experience during their tour in museums using AR guide. Internal noise may occur due to tracking technologies, interaction and UI, and display techniques. Sensor-based tracking is very sensitive to noise. It may be disturbed by an ambient magnetic field. Vision based tracking can be feature-based or model-based. Feature-based tracking could be a problematic if the marker is occluded. Model-based tracking might be a problem if the 3D model is lack of distinguished edges or poor textures. Finally, hybrid tracking is a combination of several sensing technologies including the vision-based tracking. Regarding the vision-based tracking, there are some possibilities of low speed of the tracking process. Moreover, the outlines could be happened and the speedy motions might lose the tracking process and the attempts to recover will take considerable time [11].

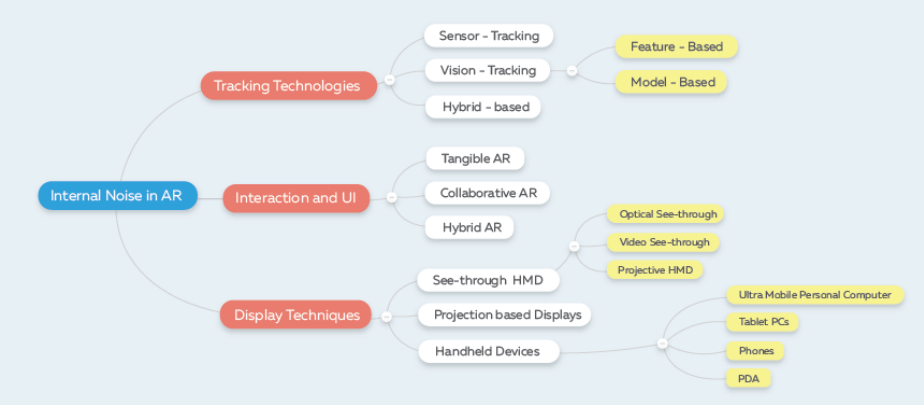

Fig. 2. Internal noise could occur from a structure of Augmented Reality technologies and devices

The second category of internal noise is due to AR interaction and user interfaces. They consist of tangible AR, collaborative AR and hybrid AR. Regarding the 'Tangible AR', it is difficult to determine the state of the computerized data that associated with the physical tools [12]. Besides, using a markerless tracking technique without the clarity of the textures, the system will fail to proceed [13]. 'Collaborative AR': it could cause internal noise if people would like to be more independent during the tour. Moreover, if the museum is crowded, this method will be not work successfully. 'Hybrid AR': these interfaces could be complex if the user in a situation that needed to deal with all of these functions together. Sometimes, the sophisticated design might be hard to be used [14] and the user will not be satisfied eventually.

The third category is 'Display techniques', which consisted of 'See-through HMD', 'Projection-Based displays', and 'Handheld devices'. See-through Head Mounted Displays (HMD): The VST-HMD that State, Keller [15] and their team created was having a very sophisticated design. The devices were in a need of feedback that obtained from users who wear it in order to identify the satisfactory level. Regarding the Head-mounted projection displays, the light in HMPD needs to go through many optics which can occur a reduction in the brightness of the image. Moreover, this paper assumes that it might not be convenient to the end user. Concerning the 'Projection-Based Displays (HMD)', these devices do not support the privilege of mobility to guide on the walk. Regarding the 'Handheld devices**', t**he drawbacks of these devices are allocated in the AR interfaces which designed for these devices are having small screens with small keypads. Comparing to HMDs, the images that are displayed on the screen and generated by processors are not in high quality [14]. In addition, holding handheld devices and pointing the camera to targets with lifting arms up might considers a constraint for most of the people. Therefore, if this paper takes the account of human factors, these devices are fatigue and not helpful enough for long visits inside museums.

3. The 'Feedback' Factor

Feedback is considered one of the significant factors in the communication method. Besides, the message itself will be changes [1]. What usually differentiate the mass communication methods and the direct communication methods is feedback.

Figure 3 depicting a flowchart of the developed communication model based on current AR guiding systems after taking the account of the feedback factor.

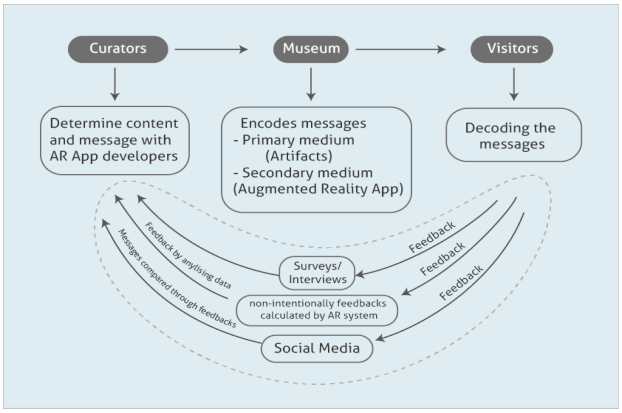

Fig. 3. The feedback channel in AR systems as a communication method

In this flowchart, the augmented reality became the second medium in the model after the artefacts were the first medium. Thus, the curators create the targeted content and the role of the AR developer/designer is to encode and transmit the message towards the channel of the museum which contains the exhibited artefacts and the AR guided system. Then the visitors' mission is to decode the messages that conveyed from the exhibited objects and AR system. Feedback channel comprises of three ways of getting feedbacks from visitors; The first way follows the research methods which could be surveying [16] , interviews or recording their facial expressions, verbal and non-verbal reactions along the visit. The previous way is considered an intentional surveying and visitors are aware of the feedback process and they can contribute in it. The next following feedback process that introduced in communication process is a part of Ph.D. research conducting at this moment. This method extracts feedback from visitors by the system statistics. In other words, if the visitor points his device's camera to run AR guided system in order to reveal the information, a numeric counter in the system will count the time that visitor consumes. The time calculated highlights the level of the visitor's engaging and how much the visitor was interested in this object in particular. The third method of receiving feedbacks from visitors is the world of 'Social Media'. This could be done by exploiting social media websites and attaching the AR system with social media websites [9].

4. Gamification

This section made to emphasise the concept of considering AR a vital medium in museums especially if AR in a combination with gamification techniques in one application. Gamification is defined as "the adoption of game technology and game design methods outside of the games industry"Helgason [17]. Gamification has been utilized and exploited in various domains including the museum sector [18].

The dynamics of gaming are built on the human desires; moreover, they are might be the reasons which influence the player's behaviour. These mechanics are synthesised by McCurdy [19] including: rewards, status, achievement, self-expression, competition and altruism. There are some studies combine AR with gamification for various purposes [20]. However, Rubino [16] built an AR mobile application that can engage

visitors on-site. The combination of AR and gamification not only served the previous purposes but it could support attracting visitors in external world [21].

The current research is working on adding the games elements in order to educate visitors the history and the culture of ancient Egyptian. The game 'Horus' will take place in the context of ancient Egypt and it will be applied in the Egyptian museum in Cairo. The content of the game deployed is telling and educating the Egyptian story of deities Osiris, Seth and Isis. The image depicted in Fig. 4 represents Seth, the chaotic and violated god with enemies are trying to attach visitors and his dogs. The principles of defeating the evils after knowing the story will have a good influence on visitors.

Simply, the augmented reality game will be registered in a specific location in the museum. This registration on the floor is created in order to recognize the fixed tags in the wide hall of the Egyptian museum. The scenario of this game is to start with a narrative of the Egyptian superstitious story with a 2D graphics video. Followed by starting the actual game and the player will take the avatar of Horus which represents the hero who has good principles. The monsters of this game are the god SETH who is flying and some scary dogs running on the ground. The player is supposed to shot the evil monsters and get the highest scores. The player has the opportunity to post this results on social media website to obtain the sense of achievement. After playing this immersive and engaging game, this research expects the player might learn that story and get distinguished experience in the context of Egyptian culture.

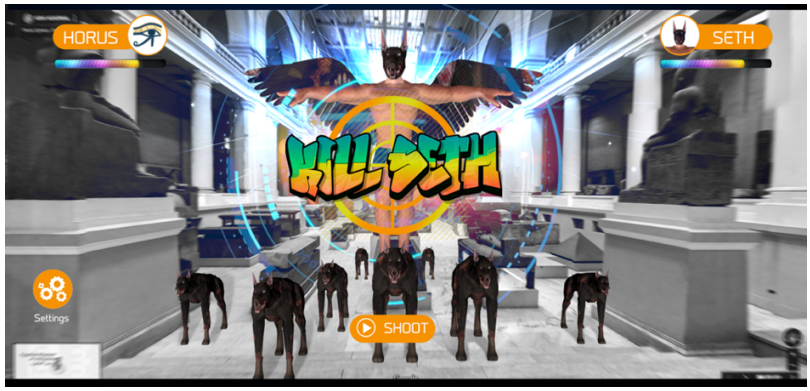

Fig. 4. The 'Horus' game mockup (Museum image source: Google maps)

5. Conclusions

This paper emphasises on the multi-shapes of 'Noise' that can occur in the equation of the communication method runs by AR guided systems in museums. Likewise, this research paper emphasises the importance of the feedback factor in the AR communication model and revealed new approaches to follow in order to enhance the existed AR guided systems. Moreover, this paper gives an example of using AR in a combination with gamification technique in the Egyptian museum in Cairo.

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