An Exploratory Study on Mobile Augmented Reality (AR) Application for Heritage Content

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Abstract—Augmented reality (AR) is still in infancy stage. Therefore, future possible applications are infinite. In ancient times, AR is only a stuff of science film and fiction. However nowadays, because of the advances in mobile technology, anyone who uses mobile devices such as smartphone, iPad and webcam can experience it. By using AR, an application is designed inside your tablet which is similar to the live view of the physical world. The objective of this study is to review related literature that could highlight several significant knowledge gap for new exploration of AR study. The content analysis method was used in analysing the literature. An effective AR system must be built with real-time performance in mind and accurate timestamps must be available. Accurate registration and positioning of virtual objects in the real environment requires accurate tracking of the user's head and sensing the positions of other objects in the surroundings. Moreover, application field is limited such as mobile application. AR can be used to develop mobile application due to its capability which can blend virtual imaging into the video stream of a mobile device's camera in real time. There is very limited study in improving user experience in usi\ng the application. This paper provides a review on related literature in augmented reality application. Thus, the review analysis and findings could provide future direction for future research and contribute to the body of knowledge for this area specifically to improve the usability of the software and multimedia product.

Index Terms—augmented reality, virtual reality, infographic, virtual environment, mobile application

I. INTRODUCTION

Augmented reality (AR) is a variation of virtual environments (VE), or virtual reality as it is more commonly addressed. This study is concerned with the supplementation of a live view of physical real-world environment where the features are augmented by virtual computer generated imagery. The AR technology has a varied range of potential applications. Lately, it has been widely investigated and speedily progressed. An AR application provides a mixed reality environment by superimposing virtual element on live video footage of the real surroundings. Its application might also support tangible interfaces for interactions in the augmented space [1]. AR allows the user to see the real world, with virtual objects superimposed upon or composited with the real world. Therefore, AR supplements reality, rather than completely replacing it [2].

AR technology is applied to help us hear, see and feel our surroundings in new means and also enhanced our perception [3]. In mobile augmented reality (AR), users look at the live image of the video camera on their mobile phone and the scene that they see is enriched by integrated three-dimensional virtual objects. The live object captured through camera is actual environment but the 3D image on the camera is augmented reality [4].

II. AUGMENTED REALITY FUNDAMENTAL CONCEPTS

Many manufacturing companies and computer scientists have been studying the AR technology as a new human machine interface with the development of VR technologies [5]. For this cause VR is used to analyze the dynamic and static behavior of system or product. However, most of software and methods for digital manufacturing require the perfect 3D models of the whole product or the whole system in virtual environment to represent the target system and surrounding environment. Certain manufacturing companies which realize the weaknesses of VR based digital manufacturing technologies have been studying AR technology as new interface between man and machine [6]-[8].

In other words, AR is an application is designed inside your tablet which is similar to the live view of the physical world. Fig. 1 illustrates the basic concept of AR technology.



Figure 1. Generic concept of augmented reality.

©2016 Journal of Advanced Management Science doi: 10.18178/joams.4.6.489-493

Manuscript received March 12, 2015; revised June 13, 2015.

III. METHODOLOGY

For the purpose of this preliminary study, the content analysis method was used to explore and analyze several related literature in order to achieve the objective of the study. Fig. 2 illustrates the methodology overview used for the study.



Figure 2. Methodology overview.

The exploratory started to review several related theories and previous literature then analyzed the contents. Souce of contents collected from various documentary material.

IV. CONTENT ANALYSIS RESULTS AND DISCUSSION

The content analysis on various related theories and literatures discovered several significant results and interesting findings that lead to the futher direction in this study. The results of the analysis will be discussed further in the following sections.

A. Augmented Reality (AR) Evolutions

AR technology is actually existed since 1960s when the first AR prototype was created by computer graphics pioneer Ivan Sutherland and his students at Harvard University and the University of Utah. They used a seethrough to present 3D graphics [9]. The research was continued by Massachusetts Institute of Technology and the University of North Carolina at Chapel Hill during the 1970s and 1980s. At the same time, mobile devices like the Sony Walkman (1979), digital watches and personal digital organizers were introduced.

Today, AR technology is growing and has been applied in various fields such as telecommunication. Recently, many mobile platforms exist that may support AR, such as personal digital assistants (PDAs), tablet PCs and mobile phones.

It took about ten years when in early 1990s, the term "augmented reality" was coined by Caudell and Mizel. In fact, true mobile AR was still out of reach. However, a few years later a GPS-based outdoor system that presents navigational assistance to the visually impaired with spatial audio overlays was developed. In 1997, an earliest prototype of a mobile AR system (MARS) was created. It registers the 3D graphical tour guide information with buildings and artifacts the visitor sees [10].

By 2001, AR became an interesting area of research when it was first applied in the field of cultural heritage. ARCHEOGUIDE is actually a new system bringing state of the art visualization technology and mobile computing in cultural heritage. The 3D reconstructions of artifacts and monuments are presented to the user through a special augmented reality interface while he has constant visual contact with the natural environment and listens to audio commentary. This feature renders the system more user-friendly and avoids the weaknesses of other alike systems where the user is isolated or immersed in a purely synthetic world [11]. In order to help visitors and scientists better appreciate and enjoy the past glory of these sites, it provides personalized augmented reality tours and reconstructions of ruined cultural heritage sites [12].

In 2007, a research was conducted on emulation of the human feelings and behaviors in an animated artwork. The researchers used the behavioral control technique which is actually developed to control the mobile robots Cassinis, 2007 [13]. Meanwhile in 2008, an investigation has made on how mobile technologies can be designed to facilitate the practice of collaborative inquiry for two contrasting outdoor settings. The suggested study proved that the groups were also able to integrate the accessed digital information with their observations and begin to make generalizations from them [14]. Another study was conducted on how to augments mobile learning by applying web page adaptation techniques in the same year. This study was experimented by applying web page adaptation to facilitate mobile learning on the blackboard learning system and the results show that the method provides effective and efficient delivery of web-based learning material over the mobile internet [15].

AR technology is continuing growing. In 2009, a new method was introduced to encode the context-dependent information in cultural heritage collections. The advantage of this technique is users are able to have a thorough picture of the collection, since information concerning the past and all the states which the collection has passed through time is provided to them [16]. Cultural heritage research is not only stopping there when a study is done on semantic-based retrieval of cultural heritage multimedia objects. This study discussed about two important issues regarding the suggested solutions based on a rich semantic model. Firstly is, the study indicated how that semantic transitions can be ordered to the user in a user friendly and efficient way and secondly it discussed how a user may be navigating between objects [17].

By 2012, mobile AR application has been introduced for library uses and next generation library services. This application usage was include augmenting physical book stacks browsing, library navigation, optical character recognition, facial recognition, and building identification mobile software for compelling library experiences [18].

B. The Future of Augmented Reality (AR)

Researcher believed that AR is not well used in new mobile devices like Android based devices, iPad and iPhone. However because most of the current applications include entertainment, gaming and education used this technology, most already believe that these are "amazing apps" [19].

In the digital domain, augmented reality and mobile computing have for many years been identified as promising technologies. An increasing number of devices are capable of running several of mobile augmented reality applications and higher education stands to benefit from these interesting technologies [20]. As a result, many services become available on smart phones [21].

C. Augmented Reality (AR) Issues and Challenges

Historically, there is a large amount of information in digital format, including electronic texts, audio visual content and multimedia applications or geographical information systems. Up to now, this information is barely used by electronic guides, staying unreachable for the visitor. In tourism, existing multimedia presentations are far away from the real environment. It means that tourists need to leave the tourist site to gain additional information. The tourist organizations need to build an attractive multimedia content that attracts tourists [22].

Generally, many AR technologies were not applied on construction sites due to tracking and alignment complications; instead they were generally used at the home office for collaboration or simulation during the design stage of a project. Nevertheless, as the technology developed in latest years, the majority of these technologies have been used on construction sites for defect detection and progress monitoring [23].

An effective AR system must be built with real-time performance in mind and accurate timestamps must be available [24]. The objects in the virtual and real worlds must be properly aligned with respect to each other, or the illusion that the two worlds coexist will be compromised. Particularly, many applications demand accurate registration [25].

D. Key Augmented Reality (AR) Element: Inforgraphics

any define as Infographic graphic visual representations of information, data or knowledge intended to present complex information quickly and clearly [26] and [27]. The process of creating infographics can be referred to as data visualization, information design, or information architecture [27]. Infographics are becoming increasingly popular, not in the least bit because of the Internet and in certain social media like Twitter. They can improve cognition by utilizing graphics to enhance the human visual system's ability to see patterns and trends [28] and [29].

They are so ubiquitous, on the web, in newspapers and also magazines. Today, animated information graphics are serving to communicate complex correlations succinctly even more so than static versions. The production of such animations on the basis of up-to-theminute data is already common practice in select TV shows. Now, these moving formats are finding broader application in television and on the internet, as well as in public places and on an increasing number of mobile devices. They can be seen in editorial contexts and in the areas of corporate communication and advertising [30].

E. Virtual Heritage through Augmented Reality (AR) Technology

Naturally, cultural heritage is strongly interlinked such as thematically and historically. However, at the same

time it is distributed in heterogeneous collections of different memory organizations at different locations [31]. Mobile augmented reality for cultural applications represents a very challenging study. In order to produce the apparently simple and intuitive overlay of virtual information onto images of the reality, highly advanced and complex systems and technologies need to work in a balanced way [32].

Heritage is as much about the living and evolving place, environment, people, static monuments and landscapes. Virtual environments which are culturally embedded are often classified as virtual heritage [26]. Generally, cultural heritage and virtual heritage have independent meanings. Cultural heritage refers to properties and sites with archaeological, historical value and aesthetic while heritage is defined as the instances of these properties and sites within a technological domain [27]. Fig. 3 illustrates the example of adaptation of augmented reality into virtual heritage environment.



Figure 3. Augmented reality for virtual heritage.

Some historical building captured several memorable events and facts. Through Augmented Reality (AR), its could be used as an effective tools for Virtual Heritage conservations. Fig. 4 illustrates the example of adaptation of augmented reality (AR) to bring back the historical building and heritage artifacts into live though mobile application.



Figure 4. AR mobile applications for heritage content (historical building and artifacts).

Furthermore the similar Augmented Reality (AR) application could be used as 'Time Machine' to visualize historical events for the purpose teaching , learning and research. Through this approach, it's gives more impact

for user understanding about the historical events. Fig. 5 illustrates the example of adaptation of augmented reality as 'Time Machine'.



Figure 5. AR Mobile applications for heritage content (time machine).

Augmented Reality (AR) could be implemented in various heritage content to develop more interactive interaction with virtual environment and improve user experience in using the mobile devices and software.

V. CONCLUSION

Augmented reality is relatively novel area. Most of the research efforts have happened in the past years as mentioned earlier. The review highlighted some previous studies and technology application in Augmented Reality (AR) in order to discover their related issues and knowledge in the field. The issues and knowledge found through the review lead to preliminary study on the integration of the mobile application and Augmented Reality (AR) conserving the intangible and tangible heritage and cultural assets virtually. Through this preliminary work of review analysis and findings could provide future direction for future research. Furthermore, its contribute to the body of knowledge for this area specifically to improve the usability of the software and multimedia product. Finally it's could provide another alternative approach and effective way to present knowledge and application through augmented reality. It is a starting point for anyone who is interested in researching or using augmented reality application.

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