The Impact of Augmented Reality (AR) Technology on Tourist Satisfaction

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Abstract Augmented Reality (AR) is currently one of the most popular technologies among global technological applications. Aside from completely immersing the user in a synthetic environment in which the user cannot experience the real world around herself, as Virtual Reality (VR) technology does, AR superimposes the computer-generated data while allowing the user to enhance her perception of reality and of the surrounding. Furthermore, AR has many application areas, varied from medical treatment to educational purposes. Particularly, AR technology is employed in tourism sector, increasing the involvement of touristic activity while diversifying the bundle of tourism experiences. The literature, however, is insufficient, in terms of capturing the main impact of AR technology on the satisfaction levels of tourists. This paper aims to fill the gap by investigating the past literature on AR technology and then presenting a naïve model where the significant effect of AR technology can be seen on the basis of tourist satisfaction.

Keywords Augmented reality · Virtual reality · Tourism · Satisfaction

1 Introduction

By definition, augmented reality (AR) is a variation of virtual reality (VR) as commonly known or in other terms virtual environments (Azuma 1997). Until recently, VR technologies were accepted as the most outstanding technologies based on the idea of total immersion of the user in a virtual world generated by computer technology (Fritz et al. 2005). While VR Technologies completely immerse a user in a synthetic environment where the user cannot see the real environment around, AR technologies allows the user to see the real world around by the means of virtual objects superimposed upon or composited into real world

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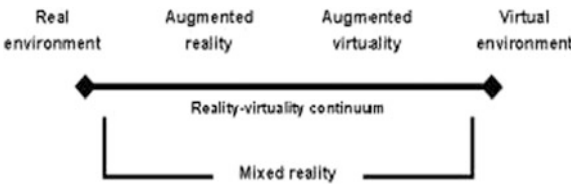

Fig. 1 Real—virtual continuum (Van Krevelen and Poelman 2010)

(Azuma 1997). In general, AR is a visualization technique which superimposes the computer-generated data such as text, video, graphics, GPS data and other multimedia formats on top of the real world view, like captured by the camera of a mobile phone, computer or other technologic devices (Kounavis et al. 2012), augmenting one's view and transforming it so that user's perception of reality and of the surrounding environment would be enhanced (Osterlund and Lawrence 2012). Hence, AR technologies have become increasingly popular, both in scientific world and for the general use of public (Fritz et al. 2005).

Figure 1 reflects the continuum between the real and virtual environment. As seen in the figure, AR stands within the mixed reality. AR provides local virtuality as opposed to virtual reality or virtual environment and augmented virtuality, where real objects are added to virtual objects (Van Krevelen and Poelman 2010).

The application of AR technology can be found in numerous areas, including medical, manufacturing and repair, annotation and visualization, robot path planning, entertainment, military aircraft, education and stimulated training (Azuma 1997; Yu, Jin et al. 2010). AR technology is also used in tourism sector, targeting to improve the tourist experiences (Kounavis et al. 2012).

Previous research clearly depicts the potential of AR technology to create an interactive and enjoyable tourism experience (Yovcheva et al. 2014; Tom Dieck and Jung 2015). However, there has been no such research modelling the impact of AR on tourist satisfaction in a quantitative sense. The aim of this paper is to investigate the role of AR technology in tourism sector, specifically focusing on the effect of AR technology on tourist satisfaction. The paper will start with a basic literature review of what has happened in tourism sector after the development of AR technology. Then, the paper will present a naïve model, considering the impact of AR technology on tourist satisfaction. Lastly, concluding remarks will be presented and possible contributions of AR technology to tourism sector will be discussed.

2 Literature Review

2.1 Augmented Reality in Tourism

Based on the available frameworks and toolkits, many applications of AR technology have been developed for several decades. Although some of these applications have started as pilot applications or research projects, a number of them are

still available in commercial areas. Nevertheless the examples are extremely varied (Kounavis et al. 2012). Mobile AR applications, for instance, are significantly different from each other, while they are all designed for specific tourist purposes. AR technologies can be used to create informative and interactive tours regardless of it is real estate or an art museum (http://www.businessnewsdaily.com/9245-augmented-reality-for-business.html#sthash.ZqS1PuKq.dpuf [Dec. 9, 2016]).

To begin with the historical progress of AR technology in tourism industry, Tuscany+ appears as the first AR application in 2010, specifically developed for Tuscany region in Italy, by Fondazione Sistema Toscana and operates as a digital tourist guide. Tuscany+ delivers tourist information, including accommodation, dining, the city's nightlife and sightseeing, in Italian and English by drawing the information from internet sources, such as Wikipedia and Google Places (http://www.turismo.intoscana.it).

Next, Basel is another city with its own AR tourist guide, the project "Augmented Reality for Basel", which is accessible through the Layar AR browser and available in English, German, French and Spanish as of 2011. In general, the content is drawn from the city of Basel's dedicated database where the users can retrieve valuable information for the city of Basel and its outskirts, and in particular with respect to Basel's sites, museums, restaurants and hotels, as well as the information for events and shopping centres are accessible (http://www.perey.com/AugmentedRealityForBasel/ [Dec. 9, 2016]).

Last example of AR technology application in touristic activities can be given as the StreetMuseum application, which has been developed by Thumbspark Limited particularly for the needs of the Museum of London in 2010. This application offers users the opportunity to visualize the city of London from numerous points of history. By pointing the camera of their mobile phones at present day street views, the users have historical pictures of these places. The pictures are drawn from the Museum of London's vast collection and they are superimposed on top of the real view. Moreover, additional information can be accessed through the information buttons of the system. In general, StreetMuseum provides tourists a chance to design their route at their own selection and discover the history of London, its altered landscapes and important landmarks (http://www.museumoflondon.org.uk).

Furthermore, there are numerous AR applications that are suitable for road trips and currently used by travellers all around the world. WikiTude, Yelp Monocle, Google Search App and Metro AR Pro can be counted as the examples of this kind of applications, highly suggested by well-known blogs designed for travellers' use (http://www.cntraveler.com).

2.2 The Impact of Augmented Reality on Tourist Satisfaction

Having discussed the examples of AR technology in tourism, the benefits of AR technology in tourism sector can be discussed as the next step. According to Garcia-Crespo et al. (2009) tourism sector is currently in need of technology-based integrated value added services which offer interactivity and entertainment throughout their highly dynamic structure. Augmented Reality appears as a technology which is capable of providing tourists much more personalized content and services shaped by their own preferences. In particular, AR tourist guides can display content upon request while tourists are travelling around a city, discovering the city landscape, sites and landmarks. Parallel to the development of mobile AR applications, tourists are able to discover the world by adding new layers to their perception of reality and of surroundings. These developments, in turn, provide tourists a new interactive and highly dynamic experience (Kounavis et al. 2012). Furthermore, accessing these applications over mobile devices with GPS functionalities, tourists have become capable of navigating themselves interactively with the help of direct annotations of the preferred destinations (Takada et al. 2009).

Considering the functionality, the contribution of AR technology on tourist satisfaction will be better understood. There are numerous functions of AR technology which cannot be achieved by any other touristic applications, specifically comparing it with VR technology. First, search and browsing (i.e. categorical search) mechanism provides tourists to access relevant information (Rasinger et al. 2009). Routing and navigation are the fundamental elements of AR technology, which also provides tourists an opportunity to plan their own tours for a better leisure experience (Umlauft et al. 2003). An important part of the generating the tours is naturally communication, which has been enhanced by the AR technology through realizing direct contact with accommodation providers, exhibition owners, or any other service providers (Rasinger et al. 2009). Moreover, AR technology helps tourists to obtain an overview of larger territory via map services (Suh et al. 2010), interactive view (Wither et al. 2009) or filtering out unnecessary content (Tokusho and Feiner 2009). The technology is also context-aware, allowing tourists to catch important or interesting information, particularly in urban areas which are rich in information (Rasinger et al. 2009) and exploration of visible surroundings without pre-defined criteria (Ajanki et al. 2010).

Although some scholars claim that AR applications at touristic destinations and attractions have no direct positive impact on tourist experiences (Yovcheva et al. 2013), introduction of AR technologies are found to be valuable by numerous scholars for various reasons. For instance, Martínez-Graña et al. (2013) claim that AR applications are specifically valuable for the tourism industry since they improve tourists' social awareness of the immediate surroundings and unknown territory. Furthermore, AR applications help tourists gain a deeper understanding of the origins of geoheritage such as volcanic sites (Martínez-Graña, et al. 2013). On the other hand, AR technology has been acknowledged as a popular tool for the

education of museum visitors (Casella and Coelho 2013), and they are capable of presenting historical events and introducing tourism destinations (Benyon et al. 2014). Finally, it has been also concluded that AR technology may be used by the mass market, and naturally, tourism industry will likely to engage with these new and developing applications (Jung et al. 2015).

In this section, the historical progress of AR technology has been discussed by giving worldwide examples as well as current applications popularly used by travellers on internet. Then, the benefits and functionality of AR has been presented in order to depict the possible impacts of AR on the satisfaction levels of tourists. In the next section, a naïve model will be developed to reveal these possible impacts of AR on a quantitatively measurable structure for tourist satisfaction.

3 Method

The impact of Augmented Reality can be measured on the basis of overall satisfaction of tourists as well the alterations in technology. Tourist satisfaction, as stated in the beginning of this paper, is the ultimate goal for explaining the impact of Augmented Reality. Moreover, impact of Augmented Reality is fundamentally dependent on technological progress. Adding these two variables, the model will be as following:

$$\mathrm{AR} = \beta_1 \mathrm{TS} + \beta_2 \mathrm{TP}^{\mathrm{t}} + \varepsilon \tag{1}$$

where,

AR implies *impact of Augmented Reality*,
TS implies *tourist satisfaction*
TP implies *technological progress*
t implies *time* (or periods/seasons in which touristic markets work)
β_1 and β_2 imply coefficients
ε implies residual
The hypothesis of the study will be as following:
H_1: $\beta_1 > 0$, tourist satisfaction is a significant determinant for the impact of Augmented Reality
And,
H_2: $\beta_2 > 0$, technological progress is a significant determinant for the impact of Augmented Reality

4 Findings

According to the model used in the study, the impact of Augmented Reality is measured through two main variables, these are: tourist satisfaction and technological progress. First of all, tourist satisfaction is a crucial factor since the applications of AR technology in tourism sector mainly target to increase the satisfaction of tourists that they receive from their touristic experiences. Quantitative measurement of tourist satisfaction may be achieved through measuring the changes in Quality of Life (Genç 2012). There are two main indicators for measuring the term quality of life; these are objective and subjective measures. In accordance with the scientific purposes, we need to focus on objective indicators, such as economic indices (Gross Domestic Product, poverty rate, etc.), social indicators (unemployment rate, school attendance rate), life expectancy and literacy rate (Genç 2012). Secondly, technological progress forms the basis of further development of AR technology. Without taking technological progress into consideration, changes in AR technology cannot be captured; hence the impact of changing AR technology cannot be understood properly. Moreover, technology has the characteristics of developing exponentially. In other terms, it has acceleration for doubling itself, which phenomenon is known as Moore's Law named after the work of Gordon Moore (1965) on integrated circuits. These two variables, tourist satisfaction and technological progress are assumed to increase linearly with the coefficients $ß_1$ and $ß_2$, respectively.

Furthermore, there may be other variables which have a significant impact on measuring the effect of innovations; hence they are represented with ε. Although the model has not been tested on real variables, it will be useful to focus on a quantitative analysis, in order to measure the impact of innovations on a scientific basis.

5 Conclusions

In summary, the AR technology allows people to view images which blend into and sit on top of the existing physical landscape as opposed to VR technology, which delivers an entirely immersive, virtual experience without providing any interaction with the surrounding environment (http://realbusiness.co.uk/tech-and-innovation/2016/11/22/will-2017-be-watershed-businesses-using-augmented-reality/ [Dec. 9, 2016]). By providing people a different opportunity for the perception of reality and of their surroundings, AR technology creates a significant impact in tourism sector, specifically on the satisfaction levels of tourists. Tourists may enjoy with this new kind of reality in all over the world, hence their level of satisfaction increases parallel to the advancements in AR technology. Although the analysis in this paper does not include real world data, it is still intuitive for further research, based on the dynamics of the model developed in this paper. Quantitative measurement is the most reliable way to reveal the impact of any particular phenomenon; hence the

impact of AR should be examined according to a model, constructed by taking possible effects into consideration. The model above is restricted in two components, tourist satisfaction and technological progress; however this model is open to renew itself with new findings. In conclusion, the benefits and functionality of AR technology are the reasons why AR technology has become increasingly popular over last decades, especially in tourism sector. Since technological progress is merely unstoppable, there will be much more contributions of AR technology to tourist satisfaction in near future. All in all, a satisfied touristic experience is one of the valuable parts of overall human life and AR technology contributes to overall increase in life quality, by allowing diversified tourism activity, along with other functions in education, business and so on.

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