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AR and NFC Technologies in Smart Tourism Experience

The transformation of traditional tourism to smart presupposes an already existing concept of smart cities using a developed technological infrastructure. In this dynamic environment the experience of visitors, which is implicitly connected to multimedia devices and their interfaces, is examined. Augmented Reality (AR) can digitally enhance travelers' experience through Edutainment (Education+entertainment) elements in a gamified or not format. Simultaneously, Near Field Communication (NFC) has been repeatedly used in industry and research, but its recent utilization in everyday applications, such as tickets and payment cards, has brought it to the foreground of tourism. In this paper, we briefly present the possibilities of applications from their combined use in smart tourism.

Keywords: augmented reality, NFC, smart tourism

1 Introduction

The fourth industrial revolution and the rapid development of Information Communication Technologies (ICT) have pushed the traditional phenomenon of tourism to be transformed into "smart". According to Buhalis [1] the concept of "smartness" is related to integrated technologies for the production of innovative services and processes in real-time, while new ways of connectivity and exchange of information are being shaped by the smart elements [2]. The term "smart" has practically been involved in tourism where integrated technologies create an intelligent, ubiquitous, and fast-growing environment driven mainly by marketing strategies and government projects [3].

Experience is an important factor considered by the tourism research field. It is essentially a continuous process of producing and exporting knowledge, habits, senses, and emotions through a set of activities. In the case that a wide range of personal needs has been covered, then the travel experience can be described as unforgettable and enjoyable. Both emotional expression and imagination are caused by events, activities, and interactions, as well as the multisensory nature of the tourist products are related to tourist behavior [4, 5]. At this point, to mention that little research has been done about the relationship of the smart tourism experience, however, researchers predict the creation of memorable experiences by the use of smart technologies [3].

The aspects of tourism are being reshaped by the automation and technological developments in Web 5.0, 4G, 5G, IoT, Internet of People (IoP), RFID, NFC, AR, VR, and Gamification [6]. These technologies have pushed the concentration and development of Big Data that being manipulated mainly by Artificial Intelligence (AI) to provide a better-customized tourism experience [7]. Most of these technologies have already been included by Buhalis [8] under the context of Ambient Intelligence (AmI) in tourism.

AR can be supported by the next-generation mobile smart devices, where in combination with other rapidly evolving technologies enhance the exposure of the destination through personalized interaction with layers of environmental information and independent navigation. It is observed that during the last decades, the industry has shown a particular interest in interactive imaging technologies for entertainment experiences [9, 10, 11]. AR is an immersive Human-Computer Interaction (HCI) and Extended Reality (XR) technology whereby adding or removing interactive audiovisual stimuli in the real space and time in computer-generated environments is predominantly used in tourism for the production of experiences [12, 13, 14].

Alongside the existence of a multimodal mobile network, the IoT and incorporated NFC readers on smartphones and devices have generated multiple applications in tourism with many benefits and potentials which lead to the total renewal of the industry [3]. According to the literature NFC, it is a subset of RFID technology and a short-range (operating typically within about 8 cm in the 13.56 MHz band), wireless, peer-to-peer communication technology that makes use of radiofrequency signals in order to communicate between two devices[1] with a data transfer of up to 424 Kbit/s [15]. The technology is considered ideal for innovative marketing applications in tourism due to the extremely low energy consumption, the ease of use, tag invisibility through the objects, a unique tag ID number verified by a server, safest way to transfer data, avoiding data monitoring [16, 17].

In this paper, we shortly review the beneficial possibilities for the smart tourism phenomenon and its four components (attractions, accommodation, catering, and transportation) raised by the conjunction of AR and NFC. This consolidation had led us to the outcome where smart destinations can be utilized in a way of producing pleasant applications for the promotion of their services and products.

2 The need for AR and NFC in smart tourism

The development of the smart tourism phenomenon is based entirely on technology. A recent example is the IoT and its concept for a more significant, imposing, and pervasive new age internet connecting everyday objects in order to make communication between them possible [18, 19]. The smart tourism concept has been evolved as an element of smart cities research for the visitors' experience upgrade [15]. Smart destinations are based on the aforementioned technologies for either modern concepts (e.x. smart people and smart hotels) either applications (smart devices, smart cards, Gamification, AR, and personalized experiences) [20, 21]. The most important attributes of smart tourism are informativeness, accessibility, interactivity, personalization, and security, while Pai et al. [3] mention accessibility as the most significant factor for the smart tourism experience.

The continuous need for technological solutions and applications in the tourism experience is raised by the incorporation of ICT [2], which contributes to the enhancement of mobile devices. It is important here to state that the ICT are not developed directly for the sake of tourism, but they influenced multiple services [22]. Thus, AR is capable of meeting the challenge of smart tourism by improving the interaction between the users and the destination services [2]. Additionally, the current generation of mobile devices has shown its essentiality for the development of easy-to-use NFC interactive applications. Up to recently NFC research and utilization in tourism was almost nonexistent. However, more and more

[1] NFC works with three modes of communication. The first mode refers to two active devices (reader - tag) where both of them produce the radiofrequency signal for the data transmission. The second mode works between an active device that generates the signal while the passive device communicates it back, and the peer-to-peer mode when the tag uses more power supply than the reader [15].

devices incorporated with NFC readers create opportunities for all the stakeholders involved in the destination [22].

3 AR and NFC in the tourism experience

Both technologies can be used in combination for enhancing the experience in the four components of tourism (heritage attractions, accommodation, catering, and transportation). Firstly, we should clarify that AR applications and functions can be activated by NFC tags as access points, replacing the no longer useful[2] 1D/2D QR codes (Quick Response code). Note at this point that the user experience is realized through a multimedia device interface in conjunction with NFC communication. Typically the process is initiated by tapping the smart device on the attached NFC tags that can be placed on packages, posters, cultural spaces, or objects, and then the AR function is launched [15].

Tourism is enhanced by personalized elements based on the needs of each user. By personalization, we refer to the key which is a prerequisite for smart tourism to receive information through Big Data and Cloud Computing. These elements are tailored to the profile of the same user according to the visitors' individual needs, preferences, and personality (e.x. age, physical disabilities, educational background, etc.) [3, 17]. NFC tags with their ability to store data and connect to the network are suitable for these personalized applications according to the user's preferences. Having said these, put yourself in the case of enjoying your destination services with a tool that is able to activate unique access to benefits and activities with reinforced accessibility and individualized augmented content [17].

The flexibility of AR transforms and expands mixed environments of "outdoor augmentation" with mobile games (e.x. *Pokémon GO*) as well as "on-site augmentation" and "off-site augmentation" for heritage attractions [17]. To give a more detailed view of these technologies we include some already existing examples. Smart tickets with NFC can launch mobile AR and utilize GPS to replace the traditional tour guides and present the local cultural heritage through 3D reconstructions and multi-character story games [23, 24].

The technologies can be extended to organize the visitors' stay with customized tags (posters, maps/wall maps/wallpapers) on accommodation services in order to receive discounts and notifications for the arrival time and the location of means of public transportation, while AR translators can make them understand foreign languages [25, 26, 27, 15]. Furthermore, the visitor can scan product packages from distance (without touching the product surface: an essential feature for the case of the COVID-19 pandemic) and reveal their content and the ingredients having personalized information of food allergies. Restaurant bookings can be achieved electronically while their menu can be displayed on 3D representation for commercial competition (15). Finally, the use of these technologies also gives a great advantage to people with disabilities, enhancing their accessibility to the selected activities, without being marginalized by the destination.

4 Conclusions

The current technological developments of recent years have not only had a catalytic effect on improving the quality of our daily lives but also on the way we interact with the environment, whether it is work, social, educational. The emergence of new technologies and ways of connectivity such as ICT, IoT, 5G, etc, brought to the forefront the term "smart

[2] Usefulness due to properly adjustment of camera (poor lighting depending by the light glare and the light, camera rotation and vibration), environmental obstructions, the non-rewritable mode, the limited amount of information, the inability to be hidden behind layers and the easily distorted and destroyed [15].

cities" which is closely associated with the promotion and strengthening of applications in the field of smart tourism.

Very important to mention is the particular interest in interactive imaging technologies that the tourism industry shows. In order for this interest to assert at the HCI and XR level the extensive use of AR is necessary not only to produce the desired result but also to be evaluated and achieve the ultimate goal, enhancing traveler's satisfaction.

Additionally, NFC comes also to reinforces the user experience, and in combination with mobile AR and marketing a smart destination can be enriched by benefiting local products and services. The implementation of both technologies will offer in destinations' services new management and promotional planning leading to a significant visiting amplification and financial growth.

The aforementioned examples of possible applications in the basic four components of tourism can work either individually for each one of them or be utilized in combination for an overall result. Through the mobile AR, usability users can easily be informed and assisted for the exploration of the destination, while NFC's accessibility provides them with ubiquitous access to services and activities in situ. The personalized AR interaction comes in the foreground to strengthen the overall experience, where NFC plays the crucial role of medium between data storage and final content.

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