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AUGMENTED REALITY SERVICES IMPLEMENTED WITHIN SMART CITIES, BASED ON AN INTERNET OF THINGS INFRASTRUCTURE, CONCEPTS AND CHALLENGES: AN OVERVIEW

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Abstract

The increasing use of connected devices (smartphones, watches, tablets) equipped with more and more precise sensors and cameras, allows the development of many augmented reality services, targeting smart city concept, based on Internet of Things infrastructure. This paper gives a general presentation, of Smart City concept and Internet of Things infrastructure, and presents some examples of Augmented Reality services, for Smart City using Internet of Things. Moreover, a synthesis of their current limitation factors is presented.

Keywords:

Smart Cities;
Internet of Things (IoT);
Augmented Reality (AR);
Connected devices;
Sensors.

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1. Introduction

The world population is growing rapidly, nowadays, 50% of the world's population lives in cities. By 2050, this percentage will jump to 70%. Cities occupy 2% of the earth's surface and produce 80% of gas emissions [1]. New urban challenges have emerged in terms of health, environment, mobility, governance, and others. To respond effectively and pragmatically to these needs, many cities started to exploit new technologies and its paradigms, like Augmented reality and Internet of Things, to became more intelligent and smart, to solve urbanism problems, and consequently improve the quality of citizens' life.

One of the new technologies that is still to be widely exploited within the Smart city concept, is the Augmented Reality which can improve the human-machine interaction, but in general is not yet widely available, and if it exists, it still lacks sufficient and robust monitoring techniques, to make applications reliable and widely deployed. This study will present some recent applications of Augmented Reality technology as well as some known limitations regarding different factors that developers will need to overcome.

The second and third chapters, presents consecutively the concept of Smart City, and Internet of Things architecture. The fourth chapter shed light on three examples of Augmented Reality applications developed within Smart City. The last chapter, presents analysis and challenges, and possible prospects for the future works.

2. Smart City Concept

Smart City means a city that use IT systems to increase operational efficiency, disseminate information to citizens, to improve the quality of public services. Cities are increasingly using technologies such as sensors, data management systems, and analytics tools to monitor and analyze traffic flows, energy consumption, and public transport. Therefore, cities want to preserve and optimize their resources and their organization.

Figure 1: Some aspect of Smart city concept

Today, to become smart, cities must develop new robust and performant services in many key domains [5]:

Transport and mobility: The vehicular traffic information is a rich source of data in smart cities, an efficient exploitation can solve the problems of traffic congestion, pollution, and existing infrastructure, and Intelligent Transportation Systems. Many cities already installed cameras and sensors to manage traffic and parkings [2], but it's still not an efficient solution to all problems.

Environment: Environmental parameters such as temperature, humidity and carbon dioxide, are important in a smart city, air and water quality must be monitored, by using outdoor sensors [2-3]. Garbage management is becoming a real issue for cities, a Smart City must connect the end entities such as smart garbage collectors so that proper utilization of the resources can be achieved [6].

Health: we cannot imagine a Smart City, if the residents are not healthy. Identification of people through sensor devices, and providing real-time information on patient health indicators (heartbeat, temperature, breathing), will help to analyzed remotely, and in real time, to make decisions better and faster, such as sending doctor or ambulance, in case of any abnormal indicators are transmitted [1-2].

Energy: In terms of energy, a Smart City can also control and monitor the amount of energy consumed and distributed, it will lead to reliability improvement, a good power quality and profit growth [6].

Education: To improve teaching and understanding in classrooms, a smart education is suggested. The deployment of technologies in schools provides the collect of several information from the classroom. This information can be used by both the students and university. on the one hand, the university can have a clear vision of the level of each student, so it can for example target low-level students well. And on the other side the student, can learn easier and more productively, using all the technological means at their disposal.

3. Internet of Things (IoT)

Internet of Things or Internet of Objects, represents the materialization of the Internet in the physical world through devices (mobiles, watches, sensors), allowing them to communicate, collect and exchange data. The concept is still young, it does not yet have an official and common definition. Recently, many researchers have focused on urban IoT, designed to support the Smart City vision [7], for many reasons. The main one is the exponential growth of connected devices and smart objects (see Fig. 2).

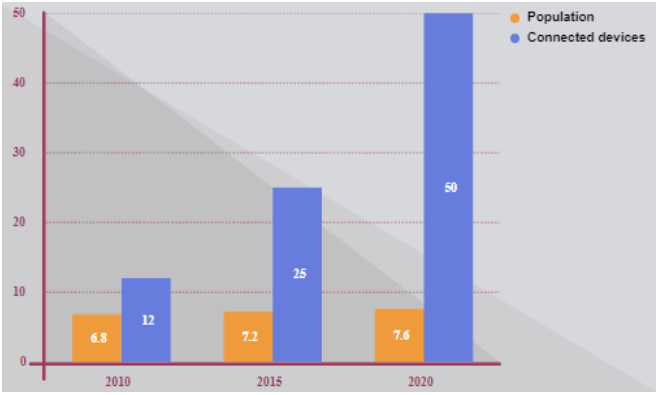

Figure 2: Number of connected devices and population (Billion)

There is no standard common architecture for IoT which is agreed universally. Different architectures have been proposed by researchers. The most known one, is the three-layers architecture [2-4-8]. (see Fig. 3):

perception layer: is the physical layer, which include sensors that can perceive, detect objects, collect information, and exchange information with other devices through the Internet communication networks, (RFID), cameras, and sensors.

Network layer: which is aimed at transferring data across different networks (4G, 3G, Bluetooth, etc.) and the application layer.

Application layer: deliver application specific services to the user, it's a sort of an interface, that provides modules to control, and monitor various aspects of the IoT system.

This architecture is characterized by several important advantages like scalability, safety, heterogeneity, and interconnectivity, which explains its success [9].

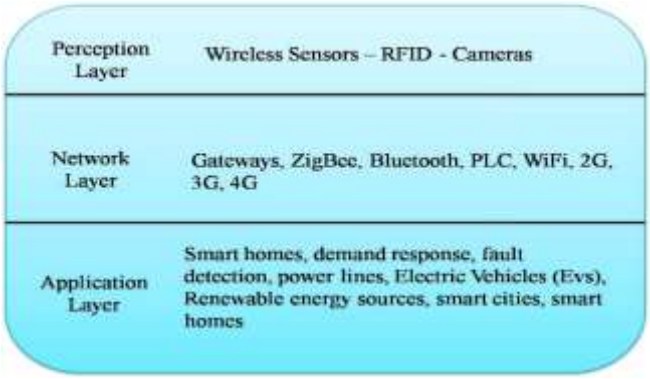

Figure 3: IOT three-layers architecture

4. Augmented Reality (AR)

Announced as the next digital revolution, Augmented Reality (AR) is a concept that allows to integrate virtual elements (such as images, videos, sound, GPS data etc.) within a real environment, to give the illusion of a perfect integration to the user. Augmented reality is increasingly present in several other domains, such as medical application [14], tourism and education [17], and will connect more object to the IoT infrastructure, by enabling shared interactions with objects [15].

Ikea Place

The awesome smartphone application Ikea Places, is a perfect representation of Augmented Reality (see Fig. 4), the coffee table is materialized on the screen of the smartphone and is placed in the middle of the living room, with a fact sheet, integrating naturally with the decor.

Ikea Place is developed on ARKit [18], Apple's Augmented Reality development platform for iOS mobile. However, ARKit relies on details of the device's physical environment that are not always consistent or are difficult to measure in real time without some degree of error [22].

Figure 4: Ikea Place AR application

SmartSantanderRA

Since 2010, the city of Santander launched the SmartSantander program, and deployed more than 20,000 sensors throughout the city, which has allowed to collect a lot of data and thus to develop many applications.

The University of Cantabria (Santander) has published SmartSantanderRA, a mobile application based on Augmented Reality that has been developed within the SmartSantander project (see Fig. 5) and based on Iot Infrastructure. The application enables the real-time access to the traffic and beach cameras, weather reports and forecast, public buses information and bike-rental service, generating a unique ecosystem for citizens and visitors when walking around the city [12].

The Application includes information about 2700 places in the city of Santander divided in different categories: beaches, park and gardens, monuments, Points of Interest (POI), tourism offices, shops, art galleries, museums, libraries, culture events agenda, shops, public buses, taxis, bikes, parking places, etc [11-13]. Despite the success of this application to its launch, it was quickly abandoned, the latest update ride up to July 17, 2015 [20].

Figure 5: SmartSantander AR Application

Google Glass

Google Glass is a big research project launched by google in 2013. The idea was to market a pair of augmented reality glasses (see Fig. 6). to the public. Due to privacy fears, and social acceptance reasons Google Glass was suspended just one year after.

Google Glass was equipped with a built-in camera, a microphone, and internet access. It allowed to access most of Google's features, take photos and videos, and mostly develop its own applications using the API 'Mirror'.

One of the big brakes of Google Glass, was also the target audience. We can say that this pair of glasses was not suitable for public use but rather to a professional use, it is for that, that Google, has personalized a version dedicated to the industrialists, and health professionals, called Glass EE (Enterprise Edition) [21].

Figure 6: Prototype of Google Glass

3. Challenges and discussions

After reading several articles, we have been able to build a general idea about the problems currently encountered by augmented reality applications, and that we can divide into three main types: the added value of the service, the hardware, or the devices needed to make these applications work, and the issue of safety and privacy.

Purpose of the service

The Gartner hype cycle [19] (see Fig. 7), is an approximate illustration of what most augmented reality services encounter to the present day [21]. In the beginning, the public expects usable services and products, but in most cases, they are only prototypes and trial versions not perfected yet. Then with marketing and media runaway, expectations become exaggerated. Once the services available, they fail to meet the expectations of users and the real need. Consequently, the interest in these services diminishes, and their use becomes restricted. This is what happened with Google Glass and SmartSantanderRA.

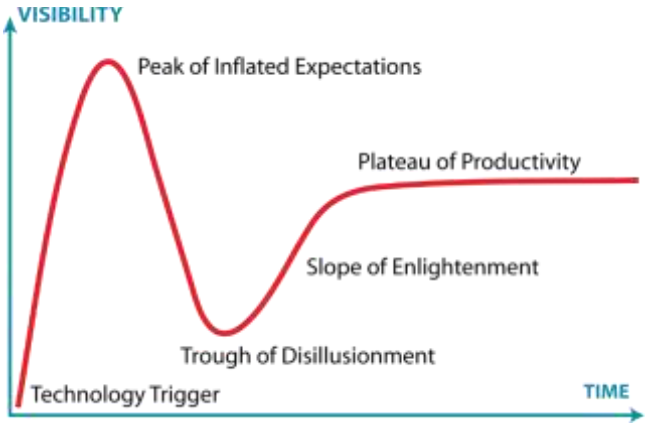

Figure 7: Gartner hype cycle for emerging technologies

Corresponding hardware

Running augmented reality applications on your phone requires high bandwidth, real-time data transfer, and computing power using the complex algorithms of augmented reality. But unfortunately, not everyone has powerful phones to make these applications work. And, hardware companies are not really in sync with the advancement of augmented reality and their hardware level need [1-10-16].

Security and privacy

One of the main cause of Google Glass fail, is the issue of privacy [21]. People did not feel comfortable with the use of these powerful glasses in public spaces, bars, etc. It is possible to film

or photograph someone discreetly, with a simple movement of the eye. The security and privacy of information is a big question to study before any idea of service.

4. Conclusion

The aim of this article was to make general presentation of the Augmented Reality services within Smart Cities, and pointing their limits, which are also the limits of this new technology in general. The article starts with a presentation of smart city concept and internet of Things infrastructure, then consider some Augmented Reality services within Smart City.

From these review, we have proposed some prospects for improvement and possible research fields for the future works.

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