
Interacting with the Augmented City: Sensors and Mixed Reality

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Abstract

In the cities of the future interactions will inevitably be mediated through technology. Users will interact through public displays, mobile location-based applications, and augmented reality systems. The cities of the future will have an increasing number of sensors that can track every aspect of the everyday life. This immense data potential can be used to improve the urban living experience by enabling an Augmented City, not only from the perspective of its services, but also in the scope of entertainment and learning activities. A city where pervasive custom content can be provided to its visitors and citizens, depending on the output of a large variety of environmental sensors deployed in a smart-city grid. This paper discusses the feasibility of creating location based augmented reality games and other applications for urban environments where the content and interaction adapts to the real time state of the urban environment, enabled by the sensing city paradigm.

Author Keywords

Smart-cities, Public Interaction, Augmented Reality, urban sensors, Pervasive Games.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction

In the past, users navigated through cities using paper maps, they bought newspapers to get a sense of the city dynamics and events, the weather and the surrounding environment. With the advent of mobile technologies, maps were inserted into smartphones and tablets; they are constantly updated and can suggest routes (e.g., Google maps, OpenStreetMap, Bing Maps). Users can now obtain information about many points of interest (POI), with multiple services allowing collaborative reviewing and sharing (e.g., Foursquare, Tripadvisor) of places. Users can share images and videos of cities seamlessly (e.g., Instagram). Augmented Reality (AR) applications (e.g., Junaio, LayAR) help in the creation of an immersive environment where virtual information is superimposed on top of the city buildings. This technology can also be further explored in entertainment, such as games (e.g., Ingress, TravelPlot). These previous examples are part of a mobile revolution that is currently taking place. An increasing number of citizens and visitors are now equipped with smartphones, which are high processing units capable of capturing images and sound while connected to the internet and knowing its global position.

“Smart-city” environments such as the one presented in the Future Cities’ project [3] – in the city of Porto, Portugal – aim to promote sustainability, social evolution, and change behaviors for a better future in cities. With the propagation of city sensors (the so-called Smart-City [7]) and the intercommunication between devices (also known as the Internet of Things), how are people going to live, in the future, in the cities [8]?

The huge investment and effective real-time data available from multiple sensors installed around the cities, as is the case in Porto, raises questions about how this technological infrastructure can be beneficial for the people that use the city.

Cities evolve with the help of architects and planners to provide the best experiences, and the Smart-City infrastructure can provide us with the potential to extend this magic circle of play to the entire city. From the work of Salen and Zimmerman [11] “the magic circle of a game is where the game takes place. To play a game means entering into a magic circle...”, thus enhancing the potential of games for entertainment and learning in the urban environment. This paper discusses possible interaction changes and creative initiatives in the future that can arise from these developments, namely through the creation of location-based games and using augmented reality features.

The Sensing Environment

In a world where multiple sensors capture environmental input from buildings, rooms, buses, cars, devices, people, gardens, chairs or just “space”, where everything is geo-referenced and traceable in a digital map, where everything is a display with tangible embedded interfaces everywhere, how will humans interact?

Using already available technologies, it is possible to obtain a large quantity of information about a certain place. In the Future Cities project [3], several sensors have been introduced in units deployed in streets of Porto [2]. Each system measures the activity of streets every minute, namely:

- Temperature
- Humidity
- Precipitation
- Wind velocity and direction
- Luminosity
- Solar radiation
- Noise (dBa)

These are essentially environmental sensors, which can be used as input for a future interaction system or an in-depth geographic visualization system [10]. Other sources of information include: GPS/accelerometer/locations from devices, cars or people [3, 5], and photos or videos from freely available social networks [1].

Visualization through Augmented Reality

Currently, city information is communicated through static outdoor information or through dynamic mobile applications. Using augmented reality applications [4, 6, 9], it is possible to increase the immersion level between citizens and their city by providing *in-loco* information in the context of where they are. Current augmented reality technologies allow the introduction of virtual objects in images and video, simulating physical properties [6]. Simple implementations can be created using interactive gaming platforms such as Unity¹, with AR add-ons such as Vuforia².

Using location-based technologies [5], applications can understand where the user is and present differentiated content according to: location, sensor activity, and

¹ Unity 3D, 3D framework for the creation of interactive multi-platform games, <http://unity3d.com>

² Vuforia, Qualcomm's augmented reality framework with an add-on for the Unity 3D framework.

surrounding social context. The visualization can be done in mobile devices or in public interactive displays, or in interactive surfaces (see *ACM ITS*) using the city as a canvas. Mixed reality in cities, based on active sensors, will allow new forms of entertainment, infotainment and services.

Interaction in Urban Space

Using the Sensing Environment and Augmented Reality systems, it is important to discuss *How will people interact in the future inside cities?* Taking into consideration current trends in society and technology³, these are some of the topics that will be important for the future.

Interactive augmented reality will change how users will interact with streets, shops, and leisure spaces:

Interactive content can lead city visitors to certain places or pay additional attention to special POIs. Using data from city sensors and social networks, it is possible to create surprise media effects for the city visitors [10].

Personalization will be a key factor: Information about the city should be presented in a relevant personalized format to avoid overwhelming the user with excessive information [12]. Personalization will also be important for the inclusion of specific target groups of people.

Public displays will dematerialize mobile devices and paper maps: why carry a mobile device, if every surface can be an interactive display? Interactive surfaces and clothing can interact with the city sensors.

³ The 2013 Emerging Technologies Hype Cycle by Gartner Inc., <http://www.gartner.com>

Communication between devices will eliminate waiting times: If every device is interconnected, cars can drive themselves (with an increase in security), augmented information can be presented to see through buildings or provide real-time sneak peeks of events located in different areas of the city.

The flow of citizens can be changed to encourage desired behaviors: serious games can be used, based on the data input from the city. This can be used to create adapted mixed reality games, which lead the user to change their behaviors for the benefit of society (e.g., avoid polluted areas while driving).

Privacy issues will always concern everyone: finally, the city-grid sensor information should be transparent for its users to avoid privacy issues.

Conclusion and Future Discussion

The immense potential of the currently available "Smart-City" grids of sensors is only now being fully explored. Mixed reality applications are already starting to engage users and players to interact with the city environment. The combination of virtual content with citywide sensors presents a perfect combination for the creation of an interactive Augmented City, where citizens will experience more intense and immersive experiences.

Having identified what kind of information can be extracted from the city and what type of interactions we want to engage it is important to understand and discuss the following topics:

- What kind of map, AR, location-based applications exist and are successful today *versus* what kind of apps could exist in the near future for the city.

- How can we implement behavior change in cities, and is it a desirable thing? Can we create a global city-wide learning experience?
- How can this technological setup increase the safety of people, the inclusiveness of excluded groups and provide a better environment?

Acknowledgements

The Media Arts and Technologies project (MAT), NORTE-07-0124-FEDER-000061, is financed by the North Portugal Regional Operational Programme (ON.2 – O Novo Norte), under the National Strategic Reference Framework (NSRF), through the European Regional Development Fund (ERDF), and by national funds, through the Portuguese funding agency, Fundação para a Ciência e a Tecnologia (FCT). The authors also thank the Project I-City for Future Mobility: NORTE-07-0124-FEDER-000064, and European Project FP7 – Future Cities: FP7-REGPOT-2012-2013-1.

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