Architectural Rehabilitation and Conservation Processes informed by Augmented Reality

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Abstract. The goal of the presented research is to explore human-machine interaction and to study how Augmented Reality (AR) may be a potential tool to inform Architectural Rehabilitation and Conservation processes. Nowadays obtaining data to inform both architecture projects and real estate investments is a very bureaucratic process. City councils technicians suffers from the same difficulties when are in fieldwork to do inspections and lack a complete sort of information. This proposal considers that the use of mobile technologies as smart phones and tablets can empower these technicians to obtain building related data. The specific goal of the study aims to develop a data model and an interface that can be made available to professionals which allows an efficiently reply to the user's needs as the system enables the gathering of updated information considering a particular building.

Keywords. Augmented reality; interface; architecture; rehabilitation; data.

Introduction

Urban rehabilitation is a current topic that has been highlighted by the industry, by the political and by the actors in the construction field.

The presented study explores the potential of the new mobile communication echnologies, as smart phone devices (e.g. iOS, Android, Windows Phone, Symbian, BlackBerry) and tablet with Internet access and GPS. By using AR with optical markers in loco or by geo-reference, these equipments turn into powerful assistant tools to the real estate development helping both the architectural process and the supervision one. In the particular case of old buildings the information provided by AR can give relevant technical data specifications to their work and understand the building which will be operated, rehabilitated or restored.

Our goal is that, using the above-mentioned technologies, the user may get documental, constructional, functional and historical information as well as being aware of the projects that have been or are being developed for a specific site. This data will be given to the licensed user after he points the device to a building. For the architectural designer this tool intends to be useful for the development of his work. For the City Council technicians this tool may be powerful to help the supervision of works being developed and to provide information regarding which buildings in the geographical area are currently being approved by the municipality. Real estate may use the platform to

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access information of a specific building. The application will provide different information for different users and different equipments.

In this paper we firstly provide a framework in the issues of Augmented Reality and its applications for informing Architecture and/or Urban related research. Secondly we explain the goals of our proposal and the current phase of research. At the end conclusions and future phases of the research are highlighted.

Framework

Technical innovations in the field of human-machine interaction constitute a future challenge with great potential. Several digital devices are part of our daily lives and they have had a huge responsibility in the changes that occur in current lifestyles. Under this influence, the way of produce architecture or study it is changing day by day and it is clear that new concepts and new tools are constantly emerging in the market.

The execution of restoration and rehabilitation architectural or interventions projects requires firstly a technical knowledge of the building which is currently achieved by the traditional way, and still involves the collection of many elements in paper. In the presented study it is considered that new digital technologies can be a powerful tool for the architects helping in the acquisition of technical information.

New digital revolution technologies are not simple tools; they generate new realities, an expanded artificial reality that overlaps the natural world. (Moura 2010)

Augmented Reality

AR is an emerging technology where virtual objects are correctly superimposed (registered) onto real ones. The goal of AR is that virtual objects coexist in the same space as the real ones adding relevant information, coming from different sources. (Dias, 2004) AR can overlap computer graphics to the natural world in order to "increase" the environment where the user is, enhancing his perception and his interaction with the real world.

The required user and/or object tracking for AR may be obtained, depending on the type of scenarios (indoor/outdoor, /fully unknown), via real-time analysis of visual markers placed in the scene (for indoor/outdoor instrumented settings), or from the analysis of natural features in planar structures of the scene, assuming some prior knowledge of such structures (Rodrigues 2010), or more recently, from the analysis of 3D structures of fully unknown indoor scenes (Steder et al 2010; Rusu et al 2009; Hinterstoisser et al 2010; Besl and McKay 1992). In mobility settings, hybrid tracking using inertia devices, such as gyroscopes and accelerometers aided by geo- referencing, using Egonos-compatible differential GPS devices, which are available in many commercial smartphones, is already state-of-the-art.

The geo-referencing technology is carried out in loco through mobile devices equipped with GPS and compass while optical markers are placed in strategic points where GPS signal is not reliable.

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Augmented Reality in Architecture

Nowadays there are several AR applications which augmented the architectural experience of space. The following examples were chosen due to their interest to the presented proposal.

Microsoft developed tools which enable users to explore the real world in a very immersive way and sharing it in a virtual ambient such as the net. Photosynth application consists on a set of tools for capturing and viewing the world in 3D. The use of this kind of application allows obtaining more digital information on buildings and urban areas which may be integrated in an AR application enabling e.g. a 360-degree observation of a specific place. Microsoft's Bing Maps application helps creating immersive end-user experiences, visualize business information, and manage resources and StreetSide allows a true-to-life view of a place providing the needed information to know a place and plan our activities.

The application Streetmuseum, created by the Museum of London, allows us to view old photographs on the real world, through a mobile device providing the user with a quick look at how was the site in the past (Zhang 2010).

Work by Berridge (Berridge et al 2002; Berridge et al 2003) aimed at developing city models, with underlying data, that can be accessed through a palmtop device quickly and efficiently. The application allows city planners to better know the city's past and present growing patterns in order to inform future design decision.

This study focuses on a database which has inputs from several origins - from the common citizen, to the municipal technicians, architects, planners and others - in order to provide digital information about the urban cultural structure with direct and real urban environment reading. The possibility of allowing different people to enter data in the city's database that is immediately available to all users could raise redundancy and lack of precision information. However, this work enables to provide more relevant information about the whole city, especially when it comes to facilities, events, food and entertainment, with the aim to support decision-making, e.g. during the development of an urban intervention, providing development standards including current and historical and cultural background information.

Available information on buildings

Today the process to obtain procedural or technical information of a building is very complex, slow and bureaucratic. This difficulty is aggravated by the lack of elements of the processes saved in the City Council archives and also by the distance between the user and where the data is available.

A technician who wants to analyze one building process has to fill a request order to ask for a copy of the paper and he have to consult the process inside the City Council archives.

Recently the Portuguese City Councils have established new compulsory requirement to the Architectural offices to deliver all projects documentation in electronic format.

These procedures will potential the presented research proposals since the available data may be used to inform the database that can be accessed directly by licensed technicians.

The presented research is a reinvention of the past since markers have been used since ancient buildings as in the Roman Empire [FIGURE1]. These markers told histories about the buildings they were placed in and inform people who passed through them. More recently, some buildings were marked with insurance seals which display a specific kind of information related to the buildings.

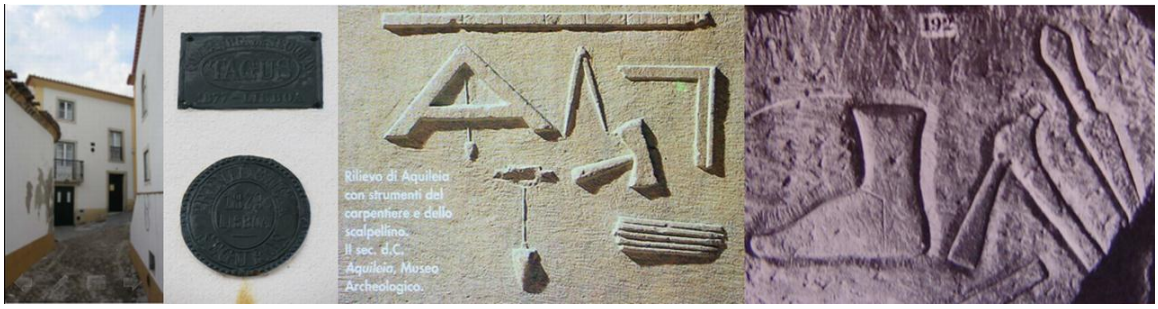

Figure 1
Old markers on buildings: left and middle left - Fire Marks in Vila de Constância; middle right - Mason's tool (http://homepages.unituebingende/peter.rempis/aalen/sqhm/werkzeug/werkzeug.htm); right – Shoemaker (http://homepages.unituebingen.de/peter.rempis/aalen/sqhm/werkzeug/werkzeug.htm)

Proposals

This study aims to develop an AR application to be use by all the different technicians involved in rehabilitation processes in order to access specific information concerning a specific building. The first approaches to the application will address old buildings because they are the ones from which is more difficult to obtain valid information. Using a smart phone device (e.g iPhone, Andriod, Blackberry) or tablet with internet connection and GPS, the user will be able to point at a specific building and obtain a large variety of information – administrative, physical and functional characterization, among others.

The aim of the present study is to help all designers and architects, city council technicians, and other technicians licensed for this purpose, engineers, planners and real estate developers that need specific information about a particular building inserted in an urban or rural area.

The information available in the database would be provided in different ways between different users depending on their credentials to access the platform. For example, the real state promoters and developers would have access to less information then the architects or the technicians from the city council.

These data will allow technicians to get important information of the building that will inform their projects or supervision works. Besides the stated information, AR may also inform the projects that have been or are being licensed or developed for the site.

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The shadow of GPS signal and the possible resulting errors as well as the distance between the user and the building, such as in side scenes, constitute frequent difficulties in the use of AR applications. To solve this problem we propose to use optical marker placed on the building's facade or in interior scenes as a complementary method to obtain information that we has internet signal. The optical marker allows the device to do an easy in loco recognition of the building or the recognition been done by navigation e.g in StreetSide.

With punctual placement of optical markers in the scene we can get additional information about building elements.

The menu that is displayed in the mobile device when the building is recognized gives the user several possibilities of getting data: architecture, structure/stability, building services (water supplies, water drainage, heating/cooling/ventilation, electricity supply, special building services) and a technical chart [FIGURE2]. Each one of these options will conduct the user through menus that enable the acquisition of specific data related to the subject he wants to know.

Figure 2
Simulation of the system Interface for a tablet: on the left the device shows the different menu options after georeferenced recognition and on the right the device shows some technical drawings of the architecture project.

As an alternative to the georeferencing building recognition, in case of lack of GPS or any other difficulty, is the direct reading of the optical markers placed on the facades of the buildings. Other optional readings inside the buildings can also be achieved by reading a marker strategically placed on the scene, and, since there is internet signal available, the platform will provide the information [FIGURE3].

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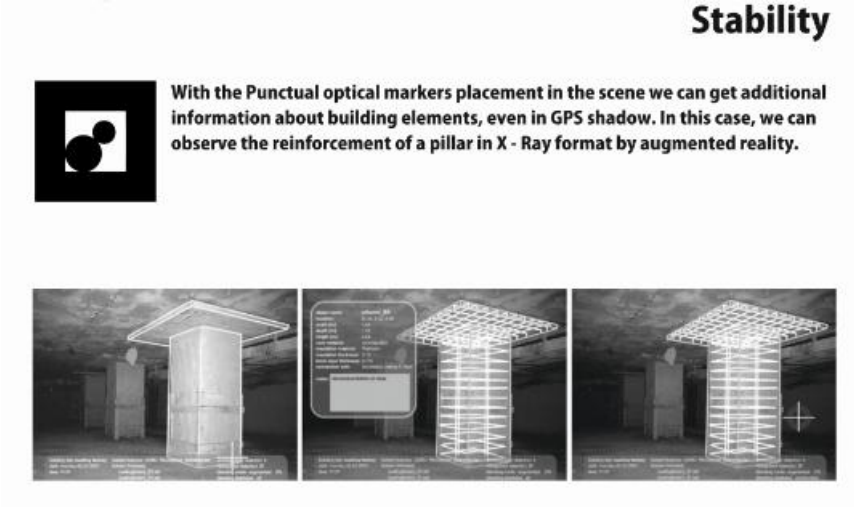

Figure 3
Simulation of the system Interface for a tablet: the device shows the possible optical marker strategically placed on the scene and the technical information provided about stability elements by AR in X-Ray Format.

If the user chooses the architecture button various technical drawings are displayed that can be then analyzed (in the mobile device or by downloading the data to later viewing) [FIGURE2]. Additional information may be found regarding the building loadbearing structure [FIGURE4], and historical information (documents, pictures, videos) [FIGURE5] .

The proposed tool will be very useful for the development of designers work and for the technicians of Municipalities the tool will also be a powerful aid to the supervision works. If these technicians need to identify the building sewerage infrastructure or its connections to the city infrastructure, they can choose the water and sewerage infrastructure button followed by the sewerage system button, then through augmented reality the existing building system layout will be showed overlapped to the real building [FIGURE6] .

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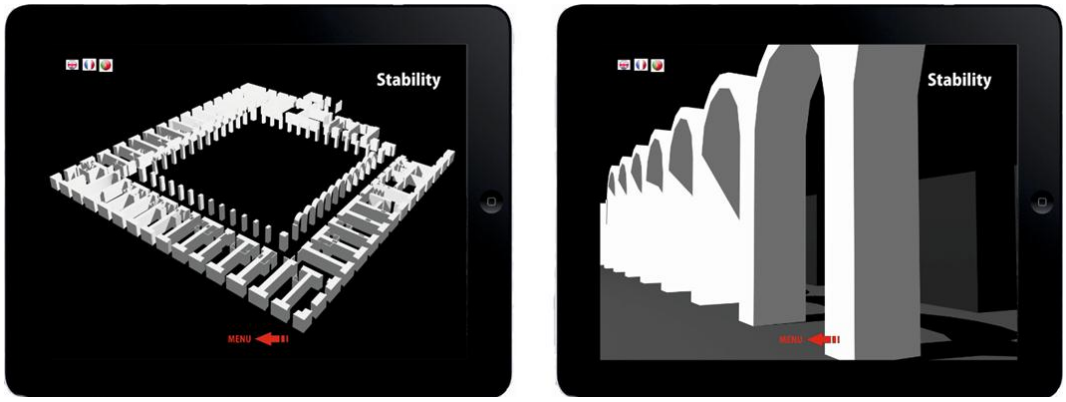

Figure 4
Simulation of the system Interface for a tablet: on the left the device shows the building structural elements of the first floor and on the right the device shows some of the structural elements.

Figure 5
Simulation of the system Interface for a tablet: on the left the device shows historical information and on the right the device shows a 3D model of the building.

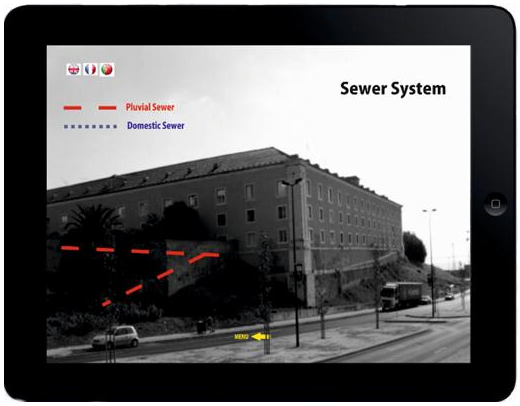

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Figure 6
Simulation of the system Interface for a tablet: the device shows a real building image and by AR the sewerage infrastructure overlapping the building.

In the first phase of the research a possibility of building classification was studied in order to establish the way information in catalogued by characteristics such as construction, functionality, aesthetics, cultural (Habraken, 1988), building tenure, property rights and rates, among others. To assist this procedure, a data sheet was developed to characterize information about the building in order to enable that all the information provided is equal for different buildings. This will support the basis for uploading data information to the platform [FIGURE7].

Figure 7
Simulation of the data sheet containing the building characterizon information.

In the second phase the information to be provided by the platform (photographs, tables, text, plans, video and 3D models) is being managed according to the equipment in use. This information is being divided by hierarchies of relevance so that the user can choose the information he wants without the screen being too confusing. It is also intended that the application provides different interfaces depending on the size of the display panel [FIGURE8].

Despite the similarities between the initial menu images of the Smartphone and tablet, the information provided by the platform will be suitable for the equipment in use. The available information will be the essential to be shown and operated in the equipment screen.

Figure 8
Simulation of the system Interface for a smart phone: on the left the device shows the building to be recognized and on the right the device as recognized the building and shows the menu options.

To do so, the information should be divided by hierarchies of relevance so that the user could choose the information he wants without the screen being too full of information.

In a third phase of the research some simulations of interfaces will be done in order to test the feasibility of the application and its ability to respond to the users (architects and other technicians) requirements.

The proposed application has several potentialities but also some development obstacles that will require special attention to ensure that the system is as functional and reliable as possible:

- The development of this platform is essentially supported by online system that allows the user to receive information directly from the database without needing to install heavy software. However, if there is no internet signal there is no application because the system won't perform;
- The data processing and the constant need to access Internet may cause an anomaly consumption of battery power and it might impede the proper use of the equipment;
- The great amount of information to be transmitted by the platform for immediate reading must be lightweighted to be quickly treated by the device. At same time, the platform can provide some heaviest technical files to download for future use;
- The brightness and bed atmospheric conditions may interfere with the reading on the equipment and could create difficulties in reading data;
- The reading and recognition of the optical markers may also be affected by the type of material used in its production and in the presence of bad atmospheric conditions, lighting or obstacles.

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Discussion

This research intends to explore an AR-based application that will solve a current problem of access to the data which characterize the urban buildings potentially subjected to rehabilitation in urban centers.

AR applications have already proved to be a useful technology to be used as a complete to reality since it augments our perception of the world with important information. In the architecture field of research, digital technologies are witnessing a great impact in optimizing the building performance by efficient design. The present research intends to enlarge that optimization to a prior phase of acquiring information on the building and a later phase of improving the inspection works.

The use of AR through geo-reference or optical markers placed on the building's facade allows an improvement in the technician's works as well as an acceleration of the intervention process.

Fieldworks Inspectors technicians from City Councils who are provided with an AR device may employ this technology in their daily work routine, allowing them to work with the latest information without using the inconvenient large construction drawings which forms the architectural processes as well as other sources of information. The impact and potential use of AR applications in architecture will increase as this technology is linked to other applications.

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