On the Characteristics of Combined Augmented Reality and GIS in Urban Planning Applications

Mohammad H. Vahidnia*, Ali A. Alesheikh, Abbas Alimohammadi, Farhad Hosseinali

Faculty of Geodesy and Geomatics Eng. K.N.Toosi University of Technology No 1346, Mirdamad Cross, Valiasr Street. 19967-15433 Tehran, IRAN, E-mail: *vahidnia84@gmail.com, alesheikh@kntu.ac.ir, alimoh_abb@yahoo.com, frdhal@gmail.com

Abstract* – Combination of the Augmented Reality (AR) technologies with Geographic Information System (GIS) and Global Positioning System (GPS) may lead to a system that supports navigation and delivers real time geospatial information for a real world viewer. However the use of AR has been limited mainly to military, medical research due to some factors like expensive technologies, resource demanding and needing to advance knowledge in the field but the expression of its advantages in this study can convince the planners and decision makers in the domains of urban and architecture for further usage.

Key words – Augmend Reality, GIS, urban planning, architecture

I. Introduction

Augmented Reality (AR) is an extended form of the Virtual Reality (VR) model which combines the real physical world with additional information. An AR system generates a composite view with a combination of a virtual model or scene and the physical, real life setting in which the viewer is located and permit user to move discretionarily in information spaces [1]. It should also provide real time interactivity and be presentable in 3D. Whereas virtual world completely replace the real environment, users in AR see the real environment for example through a head mounted transparent display and combine the virtual with the real.

Multi modal interactivity and mobile AR interfaces are becoming possible now through emerging technologies such as outdoor systems with GPS [2]. Using this technology wider use can be made of available GIS data, text, graphics, 3D animation, sound, or any other digitized data in the field.

A reality-virtual spectrum consists of Reality and Virtual Reality (VR) at two sides, mixed reality (MR) in the middle, and AR near to the real environment side [3] (Fig. 1). It can be briefly explained by an example: Reality Locked at the real world, VR explore digital 3D model, Augmented Virtually (AV) put for example textures from a video on virtual object via an automatic way but AR displays a blend of virtual information or video and real world.

A problem is then to position the virtual and the real objects in the 3D scene in order to produce a coherent visualization of the mixed reality; this sophisticated problem called registration problem. To solve the challenging registration problem, some well-defined steps have to be studied [4].

The recovery of the user initial position relative to the real scene is known as user position calibration. The subsequent tracking of its movements to update the position in the real world is the tracking phase. Next phase is devoted the techniques to recover geometry of real objects. The final step is the visualization of the real world composite together with the virtual object. The AR systems generally provide the ability of dynamically selecting the geographical data, design objects, and simulation models. They also have the ability of Information Intensity that deals with how the levels of details. Virtual information changes according to the movement, just like that virtual information truly exists in real environment.

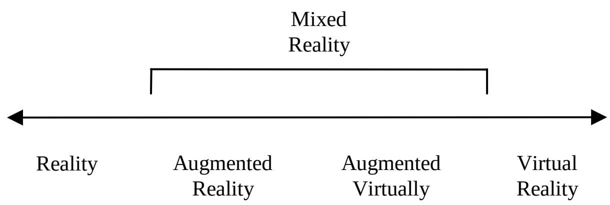

Fig. 1. Virtual-Reality spectrum

II. Sample Applications

Numerous studies have been done about AR systems in recent years; some of them are related to the combination of AR and GIS and rarely with applications to architecture and urban planning.

The association of AR has been accomplished with GIS virtual world in order to construct an imaginary-real man-made world [5]. Also, head mounted display can use for visualization and management of modern or old constructions, and display information, video, and temporal changes at them (Fig. 2) [6].

Other technologies moved toward Mobile AR (MAR) (Fig. 3). Using a MAR system, user can see for example a certain constructions' related information in campus [7]. Such a system may adopt some sensors and difference GPS for positioning and tracking. More researches included designing new types of user interface and new interactive method, exploiting interactive distributed 3D environment, accuracy tracking and registration system [8].

The other work aims to develop a better understanding of the urban landscape when augmented with a digital landscape, for example how do the physical and digital flow of people through the city interrelate [9].

III. Explaining the Characteristics

There exist common problem of understanding scale, quality and implications of proposed buildings in structures and urban projects. In these situations, the use of AR Systems to display metadata on the real environment can help to an intuitive decision making.

Fig. 2 AR from a head mounted display

Fig 3. A prototype of Mobile AR

Such systems that apply real world textures to 3D graphical objects in a 3D virtual world seem not to be common in urban planning and landscape architecture yet, so needs to more attentions. Landscape architects should make use of AR and GIS as such new forms of data visualization across environment landscapes. Such technologies can help planners as well as clients to overcome the gap between the public and the expert planner and the virtual and the real world [10]. In this way, for example, the effects of moving building blocks relative to each other on patterns could be visualized through a real time simulation. The 3D view is another advantage of an AR system. It allows construction of an intuitive and understandable environment for managing objects in the scene. The users of the system can enjoy an intuitive understanding of the area and easy identification of the target, which have been accomplished by generating natural views at any viewpoints and reconstructing shapes of objects suitably. A combined AR and GIS can solve the deficiencies that exist in a 3D GIS. 3D GIS is used for acquisition and visualization with the abilities such as specifying a site and parameters for analysis, making up the building shape on 3D, controlling the building shape and location automatically, overlaying the planned building on existing buildings, and visualizing capacity of the block [11]. In addition to these benefits a combined AR and GIS, can overcome on major difficulties with 3D data. In this case, data is acquired on site, geo-referenced and then introduced in the urban GIS later. In the latter, the lack of landmarks and the difficulty of representing physical phenomena are obviated using on-site real-time data but it needs to solve the inherit challenges of outdoor AR.

The architecture of buildings in an urban environment needs to a strategic plan and can be monitored and controlled with aid of AR systems. Simonds (1997) [12] introduced three important conceptual architectural objects in landscape architecture: base planes, vertical planes and overhead planes. The size and shape of each object as such is an important feature in the design process but the topological relation between these objects is sometimes even more important considering architectural concepts like unity, rhythm, proportion and symmetry. These characteristics may be enhanced in a virtual environment.

Conclusion

In this study we described the conceptions of Augmented Reality (AR) and its combination with GIS and the main characteristics and benefits in architecture and urban planning. This results of this study shows that these areas can be considered one of the potential applications for AR. The real time management, 3D visualization, monitoring and evaluation of spatial and non spatial data make a combines AR and GIS of the prime importance for extending in the domains of architecture and urban planning. Considering that real environment is a 3D space at least and the territory of user is usually large scale environment so as to need a large amount of 3D information, using 3D GIS as the base of AR system GIS is not avoidable. Based on the results of this study the main challenges of a real time AR is related the difficulties of outdoor positioning and tracking and the expensive instrument for developing such technology. New approaches in these situations may be beneficial.

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