Contents lists available at **SCCE**

Journal of Soft Computing in Civil Engineering

Journal homepage: www.jsoftcivil.com

GIS 3D and Science of Augmented Reality: Modeling a 3D Geospatial Environment

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https://doi.org/10.22115/SCCE.2020.212254.1148

ARTICLE INFO

ABSTRACT

The objective of this paper is to integrate all the 3D data into a Geographic Information System (GIS), from *.skp files that it modeled by applying augmented reality (AR). The application of the RA to a 3D model integrated into the GIS will be a valuable means of communication for the enhancement of our learning environment. Accessible to all, including those who cannot visit the site, it allows discovering for example ruins in a pedagogical and relevant way. From an architectural point of view, the 3D model provides an overview and a perspective on the constitution of the environment, which a 2D document can hardly offer. 3D navigation and the integration of 2D data into the model make it possible to analyze the remains in another way, contributing to the faster establishment of new hypotheses. Complementary to the other methods already exploited in geology, the analysis by 3D vision is, for the scientists, a non-negligible gain of time which they can thus devote to the more in-depth study of certain hypotheses put aside.

1. Introduction

Man always has been in progressive search for a platform, scenario and technologies to make reasonable and rational comparisons of the real environment with a virtual environment. During

this quest, a lot of technologies have been deployed, it is obvious that making this quest a possibility, things will get easier for some establishments that are into environmental management, control and planning. AR, sktechup and ArcGis has one of the best approaches to this and it is not written off as this new technology comes onboard. This paper focuses on the technology of combining augmented reality, sketchup and ArcGIS.

Sketchup in creating not just models of the study area, but also 3D GIS that is functional and interactive with augmented reality. This paper gives a breakdown of the technologies applied in this project and how they were applied.

What can augmented reality bring to 3D GIS?

To do this, one must first understand what augmented reality is, then understand how this concept works and then know how to add and use it in the most relevant way with 3D GIS.

A report for the Scottish Government, "Use of Digital and integration 3D data new Technology in Planning for New Development" noted the potential of 3D visualization to help to communicate the Environmental Impact better to planners and the general public (Miller et al., 2016). Furthermore, given its ability to geo-reference data both horizontally and vertically, 3D GIS has the potential to 'index' the data presented in the report, allowing users to click on a component of a 3D model and access relevant information (e.g. as a PDF).
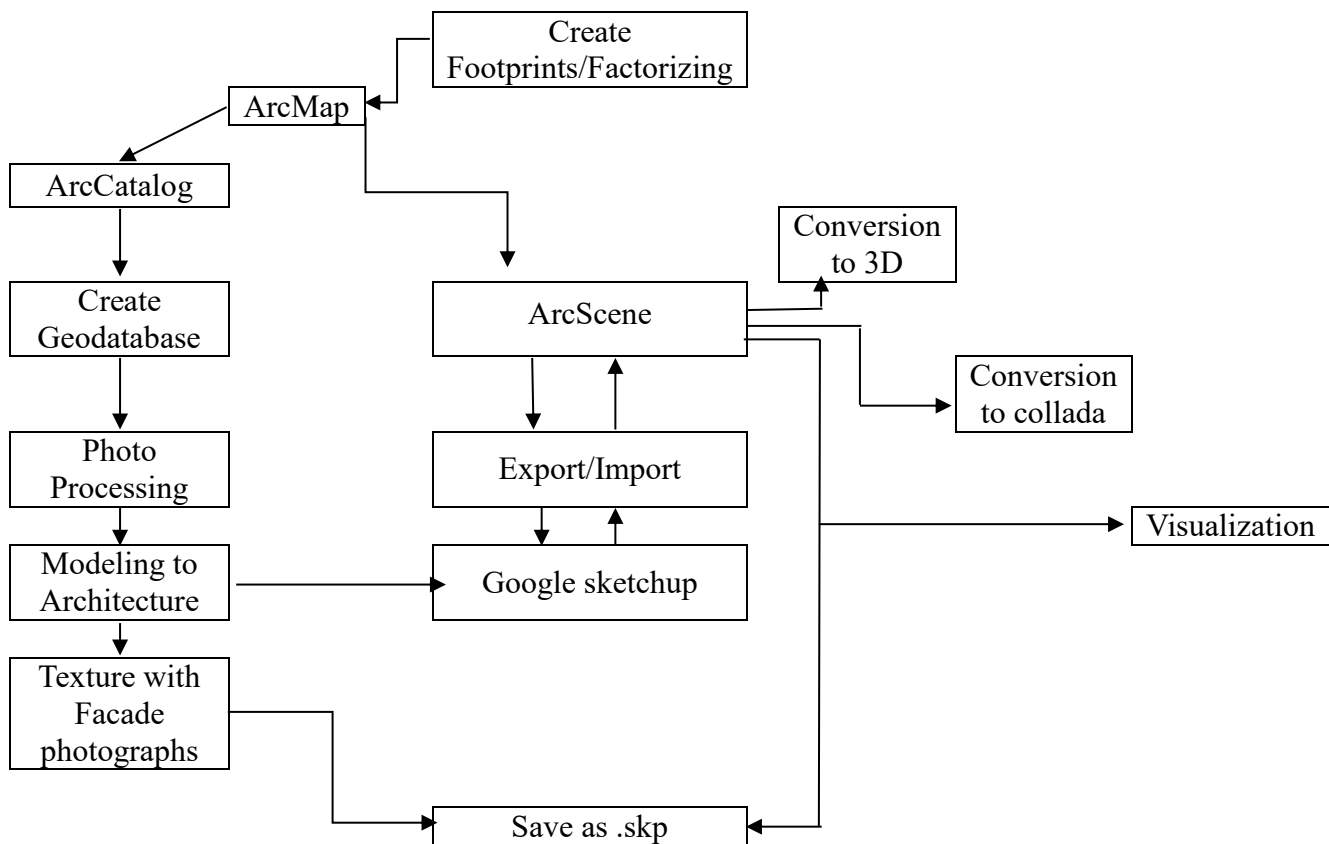

Fig. 1. The simple 3D modeling of a geospatial environment.

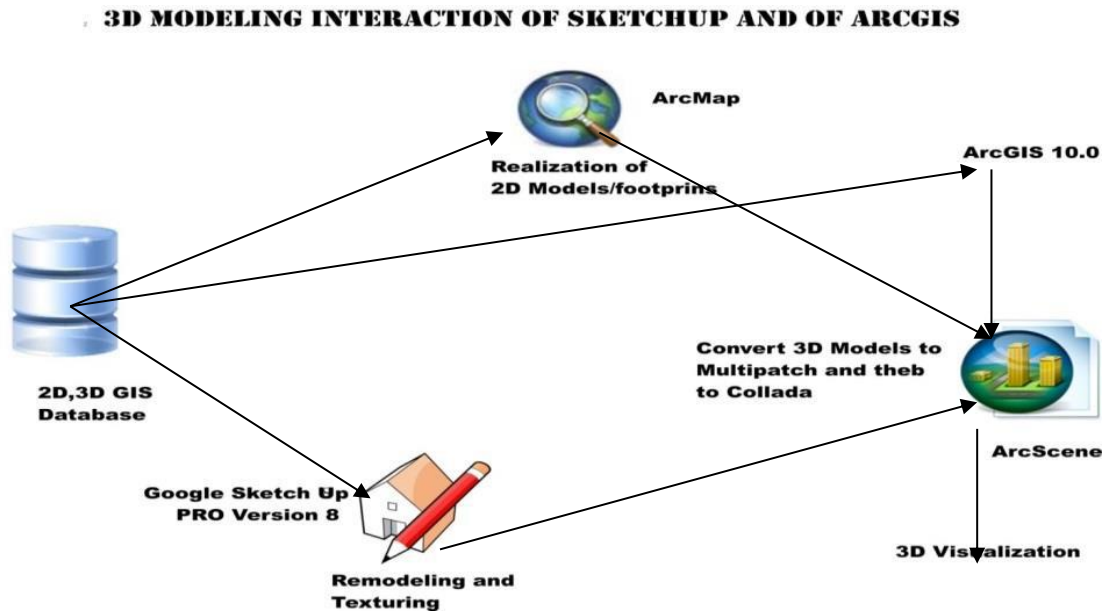**3D MODELING INTERACTION OF SKETCHUP AND OF ARCGIS**

Fig. 2. 3D modeling with sketchup and ArcGis.

It is necessary explore two aspects of the problem. Firstly, can the data currently used be georeferenced as required – which datasets are fit-for-purpose in terms of visualization, integration and georeferencing using 3D GIS and what, if anything, needs to be done when preparing these datasets (i.e. during the creation process) to ensure that they can be used as part of an interactive presentation. Secondly, what tools are available to present the information in a usable manner? To assess which visualization tool can provide the best results for 3D GIS (Fig. 2).

2. Augmented reality

The term AR is commonly used by the popular media to describe imaginary and interactive worlds that only exist in computers and our minds. However, let us more precisely define the term. According to [1] virtual is a reproduction of an environment generated by a computer source. To a certain extent, it is possible to interact with the space in which one evolves. This can be done by capturing motion or recording commands from a data glove or a controller. The sensory experience thus makes it possible to favor immersion within this artificial or fictitious replica.

2.1. Theoretical foundations

This section brings us to the question of calculating a viewing point on a simple type. To answer the problem, he considered the example scene as composed of many points [2,3]. However, the exercise of calculating the pose of the camera is generalized with all types of primitives (points, lines, contours). From an observation point, we consider a host resolution camera with a perspective projection model, a point $P=(X, Y, Z, 1)^T$ in which the coordinates are expressed in point of reference of the scene the first scene is thus projected on the plane photo $p = (x, y, 1)^T$ with:

P= $\quad {}^c M_0 P\ K$

$$\begin{bmatrix} X \\ Y \\ 1 \end{bmatrix} \alpha \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} {}^c R_0 & {}^c T_0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \\ 1 \end{bmatrix} \tag{1}$$

$$\text{With} \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} = K \quad \text{and} \quad \begin{bmatrix} {}^c R_0 & {}^c T_0 \\ 0 & 1 \end{bmatrix} = \ {}^c M_0 \tag{2}$$

or $\ {}^c T_0$ and $\ {}^c R_0$ is the translation vector and the rotation matrix defining the camera position relative to the scene ($\ {}^c R_0$ being a rotation matrix who must respected the orthogonality properties) and K is the perspective projection matrix. The objective of the pose estimation, in the case of primitive type point, is to estimate the relative pose $\ {}^c M_0$ knowing the Three D model, ${}^0 P$, and the measures in the image P. This is in itself a non-linear problem that amounts to minimize the error of adjustment between the image measures p_i and the projection model K $\ {}^c M_0 \ {}^c P_i$

$$\widehat{{}^c M_0} = \text{argmin } \Delta \text{ with } \Delta \sum_{i=1}^N (p_i K \ {}^c M_0 \ {}^c P_i) \tag{3}$$

2.2. Outdoor 3D registration technology

The stereo AR display requires four coordinate systems (Fig. 1), the real geo-spatial coordinate system xyz; coordinate system of avatars ξης, it is used for a geometric representation of the avatar to be added; user's coordinate x 'y' z 'is the axis o' z 'coincides with the user's line of sight; coordinate of the projective **uv**, it is a coordinate of two dimensions and directly on the projection of the axis o'z 'which is also the plane that l 'users see. The appearance of the avatars which must be added in the real geo-spatial coordinate system is determined by the function which must be completed in our system. It is the relation between the avatar coordinate system ξης and the real geo-spatial coordinate system xyz is known, the geometric representation of the three D avatars (ξης) in the avatar coordinate system ξης can be transformed into absolute geometric representation of the geo-spatial coordinate xyz (xyz). After registration, the location of the augmented reality system user head (tx, ty, tz) and the azimuth (θ, φ, ψ) are confirmed in the actual environment. Then, the transformative matrix B between the user's coordinate x 'y' z 'and the real geo-spatial coordinate xyz can be counted. We can therefore change the representation of Three D avatars (ξης) in the coordinates of virtual objects to (x 'y' z ') in the user's coordinate, then project the avatars into the user's coordinate on the planar coordinate system to obtain the representation of oavatars in AR system.

(Fig. 3.) Arithmetic of recording the projection of avatars the users' visual system consists of two relatively independent optical channels on the right and on the left. The fields of vision of the 2 eyes overlap but the scenes they see are different. This overlapping field of vision forming the perception of human depth is called double-eye stereoscopy. In the augmented reality system, use this feature to separately provide a more different photo corresponding to its sight light to the right and left eyes to realize the stereo display of avatars and increase its reality [4].
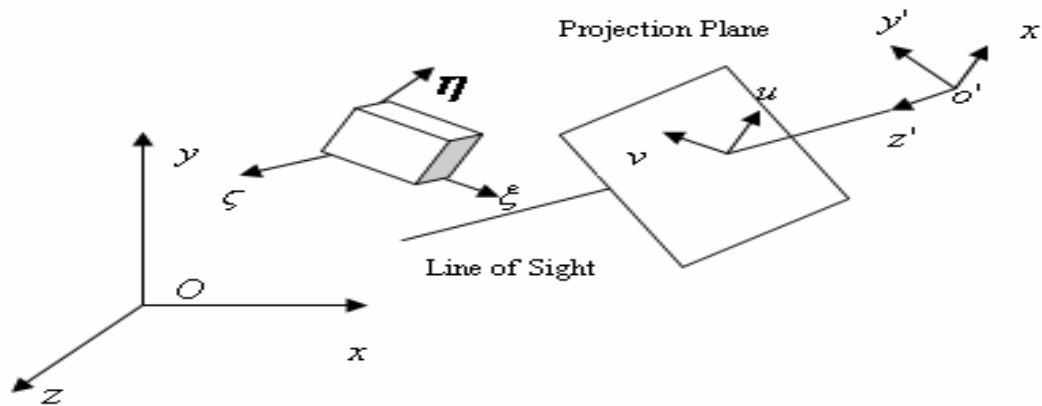
Fig. 3. Geometry of augmented reality.

3. Discussion

3.1. Methodology

The 3D model makes it possible to have before you a multitude of structured information and to highlight their links. Useful for archiving, restitution, manipulation and analysis of geospatial information, modeling, also called "augmented reality", is gradually emerging in the geospatial domain. From laser data, 3D point clouds undergo a whole chain of treatments: filtering, meshes, modeling and texturing. Depending on the processing steps, the software finds its advantages and limitations. For rough cloud processing and mesh. The modeling can be done with the Google SketchUp software, available in free version. Intended primarily for the design and design of 3D models, it is possible to import meshes and to work them manually. There is no specific command to modeling but the framework of our study is particular, it is interesting to look in this direction. Indeed, the laser survey of the site extends over several months, and depending on the season and the progress of development planned for the development of the site, the topography of the land continues to evolve. The vegetation becomes denser as the project progresses, and the earthworks upset the ground level. The gluing of sectors on the mesh is therefore delicate and it is essential to act manually to avoid discontinuities. It is also difficult to automatically filter the vegetation, and it is necessary to interpret the meaning of the points of the cloud does not eliminate essential data and stay true to the reality of the site. Google SketchUp allows you to create specific applications by adding plugins, available on the net, or by developing them via a Ruby scripting console. Thus, it is possible to adapt the tools, to create and combine them, to obtain an optimal result.

Use AR basic function library of Sketchup it to build a prototype system. This system can make image 3D registration and displaying function. The figure below is simulating outdoor registration effect. Fig .4 (Fig. 4. a-d).
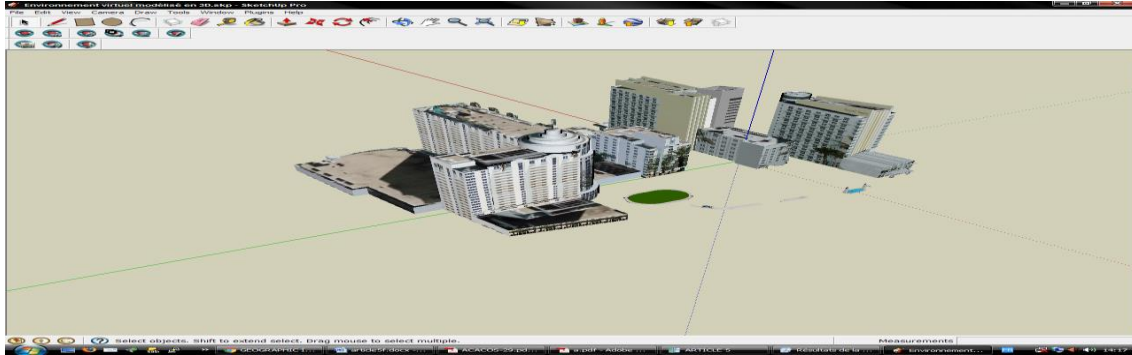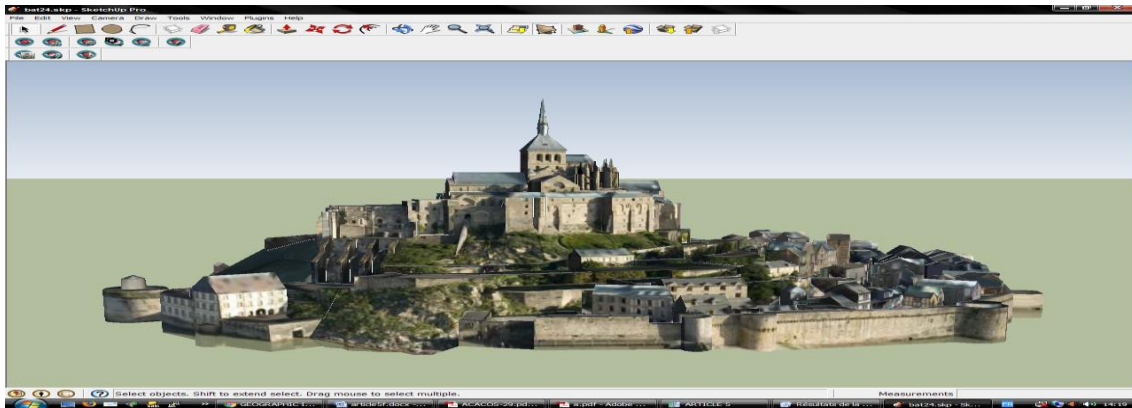
Fig. 4.a. modeling a building.
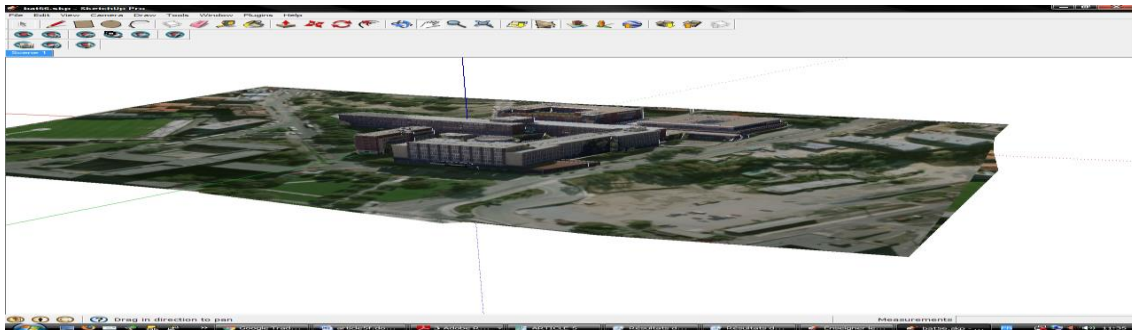

Fig. 4.b. modeling a small town.

Fig. 4.c. modeling of a land with building.
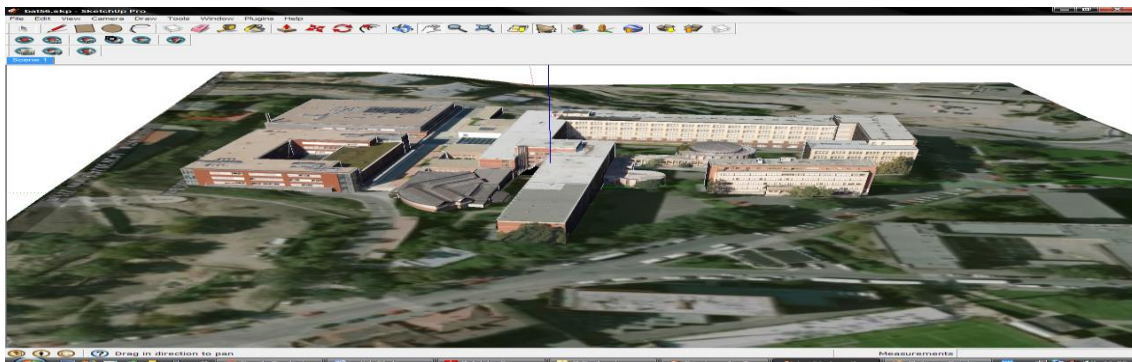

Fig. 4.d. same ground located in the fig04c but with a second face.

Fig.4. The figure below is simulating outdoor registration effect. **(Fig. 4.a-d).**

3.2. Applications of AR

Augmented Reality enhances a user's perception of and interaction with the real world. The virtual objects display information that the user cannot directly detect with his own senses. The information conveyed by the virtual objects helps a user perform real-world tasks. AR is a specific example of what Fred Brooks called Intelligence Amplification (IA): using the computer as a tool to make a task easier for a human to perform

3.2.1. Potential for use of AR in GIS

The main difference between 3D GIS and augmented reality is that 3D GIS is just a representation of objects on a map that is not interactive and even less removable. The most that has the augmented reality is that the subject, for the example of a future building to create, while moving in the street, could thanks to the visiocasque to see the building as it really existed. Moreover, if you take the principles of the functioning of the AR, the person is integrated into his environment and can interact with the objects he surrounds. Therefore here, the professional could manipulate the different layers created and change it without having to return to the office but simply by putting a helmet and gloves that would replace the mouse. However a special arrangement can be created for the use of augmented reality as can be seen below (Fig.04).

3.3. Visualization

Augmented reality is a complex technique to overlay computer graphics model on the daily environment. AR can make a complex combination of a visualization method to apply to many applications [5] A vision scene based AR system was presented for visualization interaction in a real time [6] A device, GeoScope, was developed to support some applications such as an environment, landscape and architectural visualization in [7].

3.4. Geospatial

The practical and theoretical means were described for collaborative geographic data representation and manipulation using two interfaces based augmented reality [8] Augmented reality can be used for planning of military training in urban environment [9] How to demonstrate ecological barrier and show their locations in the landscape was discussed based on AR technology in [10]. An approach was proposed for realistic landscape visualisation based on integration of AR and GIS [11] where using AR to represent GIS-model-based landscape changes in an immersive environment. AR interface paradigms were addressed to provide enhanced location based services for urban navigation and way finding in [12] A tangible augmented street map (TASM) based AR was developed in One system based MAR techniques was developed for building and presenting geographical information in [12].

4. Contributions

The 3D model makes it possible to have before you a multitude of structured information and to highlight their links. Useful for archiving, restitution, manipulation and analysis of geospatial information, (Fig. 5).
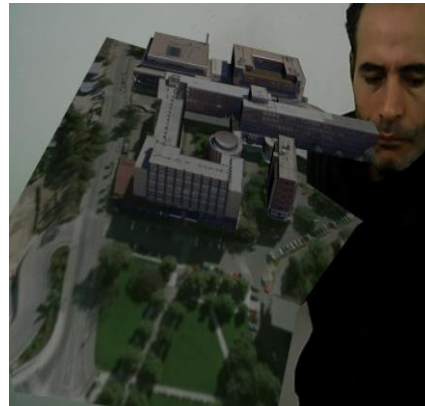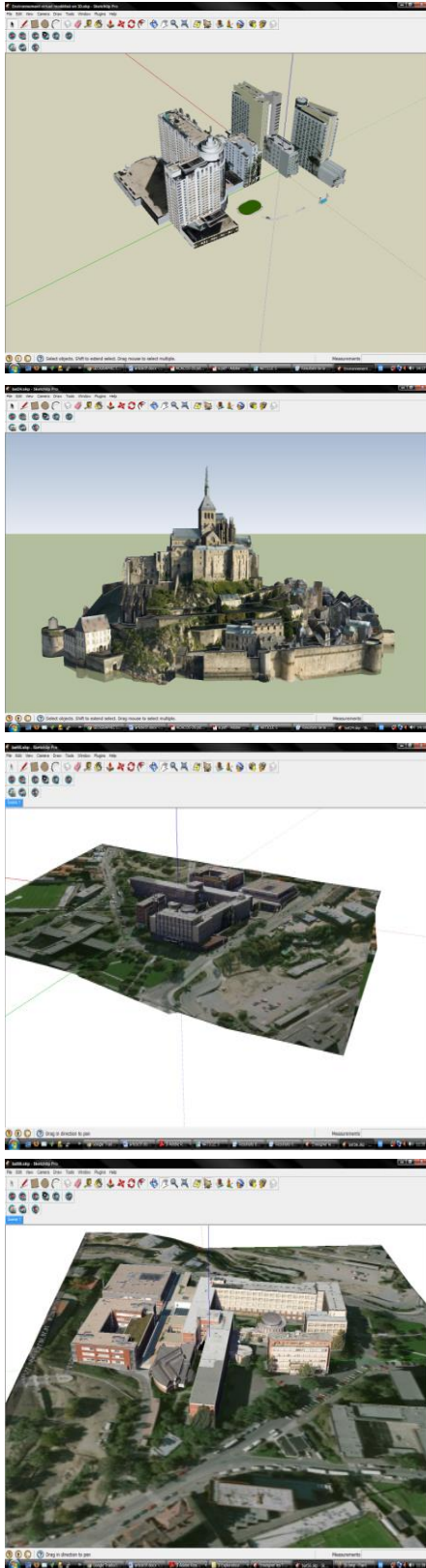
3Dmodeling interaction for sketchup and ArcGis   Application of augmented reality
Fig. 5. Application of augmented reality after modelization.

Finally, the incorporation of 3D GIS into AR would give a more realistic sense of future projects. Hence, for the training of future professionals, it would be a very useful and easily usable tool despite a cost that remains high today despite the concept is becoming more democratic. As can be seen for example in this image (Fig.05).

5. Conclusion

The application of the AR on GIS 3D is a real revolution in the field of geomatics. Its creation is fairly recent on the scale of human history but old compared to that of virtual history.

The AR can be a good support for 3D GIS in the areas of use of 3D but also for the training of future employees.

Today the mastery of 3D GIS is becoming more common has become a recruitment element. Mastering and applying AR on 3D GIS can ultimately be an asset for building construction and visualization of geospatial environments.

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