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The Importance of Geometry Combined with New Techniques for Augmented Reality.

Karle Olalde[a]*, Beñat García [b], Andres Seco[c]

[a]Dpto. Expresión Grafica y Proyectos de Ingeniería, Escuela de Ingeniería de Vitoria-Gasteiz, University of Basque Country, UPV/EHU, c/ Nieves Cano 12, Vitoria-Gasteiz. Spain.

[b] Dpto. de Ingeniería Minera y Metalurgia y Ciencia de los Materiales, Escuela de Ingeniería de Vitoria-Gasteiz, University of Basque Country UPV/EHU, c/ Nieves Cano 12, Vitoria-Gasteiz, Spain

[c]Dpto. Proyectos e Ingeniería rural, U. Pública de Navarra, Campus Arrosadia s/n 31006 Pamplona, Spain.

Abstract

From the field of the "Geomatics Engineering"[1], better known as "Topographic Engineering" and other fields as "surveyors", has always driven the knowledge of our environment in order to capture it on a support then allow other users to work, taking decisions on where you've never been, and are known early nautical charts, the world map, the cartographic maps of cities and countries, orthophotos and more recently around the digital medium, satellite images, google earth, etc... Augmented reality allows us to make visible developing products that take years but it was very difficult to bring them to the general public (requiring knowledge of cartographic techniques, knowledge of graphic expression, heritage documentation methods, ...) in this article want to show the techniques that allow us to make measurements of complete geometric precision to ensure that the final product is not only attractive but strictly accurate to the real model. We explain how we use robotic total stations with reflectorless measurement, centimeter GPS, 3D scanner, close range photogrammetry[2], all so that our model is strictly accurate. There are models that have intrinsic value in their own actions, no escape ancient Egyptian pyramid is not enough just to model it in an attractive way, but measurements have to be geometrically accurate if you want to test any hypothesis about their mathematical knowledge , astronomical, etc. For all this we believe that both techniques can support each other in achieving the best possible models, augmented reality will showcase showing geometrically exact elements obtained with geomatics techniques that can be displayed to the general public or even to researchers who know they are working real and exact values (an archaeological dig, a pyramid, a sculpture, caves, ...).

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Keywords: Augmented reality; geometry; geomatics.

* Corresponding author. Tel.: +34 945 01 41 38
E-mail address: karle.olalde@ehu.es

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1. Introduction

Augmented reality techniques allow manufacturing, inventing, reconstructing scenes that bring us closer to a virtual world where a user can interact with their environment[3].

These new technologies have a premise that stands out from the others and is the visual quality of the model and its ability to interact with the user on the geometric definition of the same.

But can you understand an archaeological site or a pyramid without a rigorous geometric representation?.

Nomenclature

AR	Augmented Reality
GPS	Global Positioning System
UAV	Unmanned Aerial Vehicle

1.1. The Idea

Traditionally expert users employ the models obtained for measurement necessary for different jobs architectural and / or engineering, these products rarely went out to the general public.

This article is intended to record you can get a visual quality product but keep the original geometry as a working premise. For many years, engineers have tried to transfer surveyors reality workbenches, which are called topographic maps[4]. They sought to capture the real world on a plane as support for easy manipulation. Today's modern computers and advanced software that support us to be a 3d model using the corresponding textures generates a virtual reality model in turn by augmented reality techniques can be consulted by the general public.

This article will dissect the different techniques used in surveying to ensure rigorous geometry Fig. 1, each with varying degrees of ability to work and more or less impressive results.

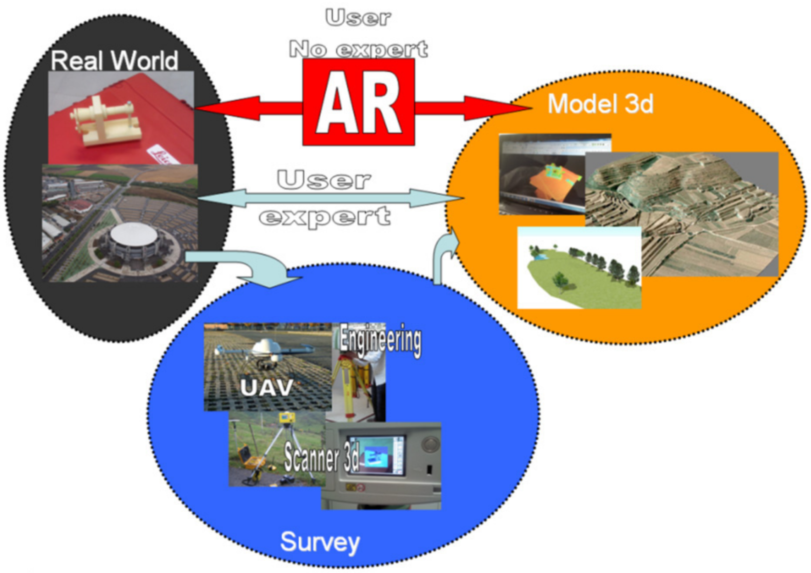

Fig. 1. Augmented reality techniques allow a novice user to interpret complex technical models in a simple

Data collection:

- Classical Topography:
  - Digital Terrain Models, 3D Mapping.
  - Angular intersections on planes at different levels.
  - Total station with reflectorless measurement.
- Close range photogrammetry.
- 3D scanner.
- Using UAV.
- Photogrammetry convergent.

1.2. Data collection

The first techniques to generate geometrically rigorous 3d models, were performed by using theodolite and angular measurements[5]. Evolve gradually as it incorporated electronic distance measurement and digital storage of information going to topographic notebook notebooks. Data collection is timely and then either by a sketch or by automatic processing each joined to obtain the simplified model based on topographic criteria made by the engineer. There is both a virtual reality model of the object but an interpretation, simplified topographic criteria.

For performing elevations are worked by intersecting lines against a projection plane and the need to define as many planes as the model had depths. A breakthrough occurred with the advent of total stations, capable of performing distance measurements without placing a reflective prism which allowed more reliable measures at points of the facade of a building. In the next graph appreciate measurements performed. To simplify the calculation traditionally not been considered as the intersection of a line and a plane in 3D space, but it has been done by a mapping side (intersection of two lines contained in the same plane, Z = 0) and the other altimetry side thus simplifying the calculation.

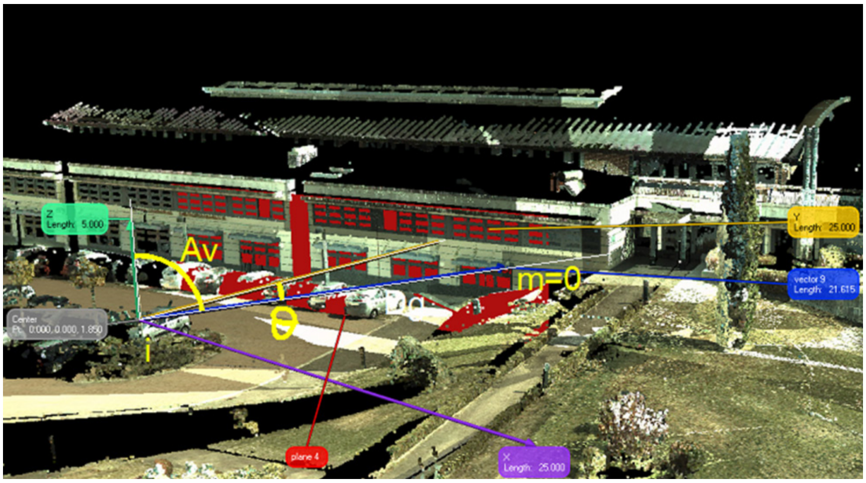

Fig. 2: Measurement Group to consider in a survey of facades from angular and distance measures

The system equations are solved:

$$X_v = X_0 + (Dg \cdot seno(Av_0^v)) \cdot seno(\theta_0^v)$$
$$Y_v = Y_0 + (Dg \cdot seno(Av_0^v)) \cdot \cos eno(\theta_0^v)$$
$$Z_v = Z_0 + Dg \cdot \cos eno(Av_0^v) + i - m$$

With the evolution and development of photogrammetric techniques occurred in the second half of the twentieth century, could enhance the use of photography initially terrestrial processes geometric heritage documentation and subsequently to generate 3D models. It required a calibrated camera, the establishment of targets for georeferencing and taking pictures with overlap in order to have stereoscopic vision necessary for restitution and / or correction[6].

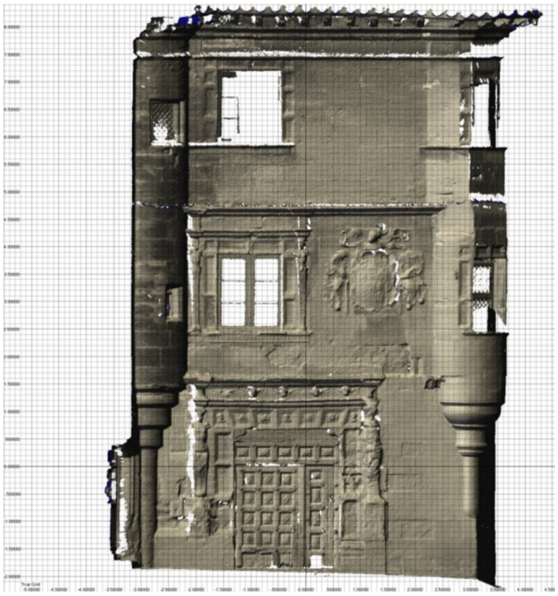

Fig. 3: Bendaña Palace facade in Haro (spain), obtained by photogrammetric techniques

With the development and evolution of hardware and software could be treated at the end of the twentieth century, the first massive clouds of points. The concept of 3D laser scanner has a history of over 50 years, but the taking of more than 2000 points per second was limited, first by hardware and recording systems access as fast, but mainly because the limited office for a long time was not feasible to develop software capable of handling clouds 50-100 million points with some ease operational. This technology allows to reconstruct a scene from points.

The topology of a point is very simple, are coordinates X, Y, Z and their relationship with their environment is only proximity, this prevents data collection generate a continuous model 3d

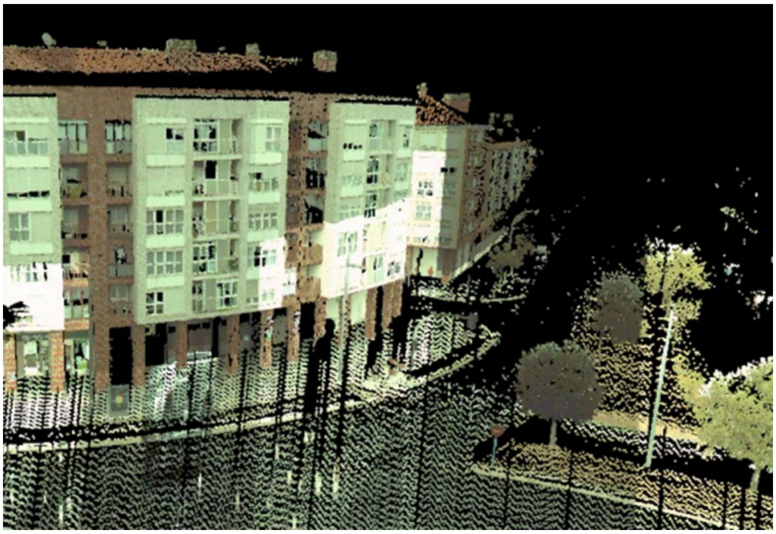

Fig. 4: Average resolution scanning façades of houses in Vitoria-Gasteiz by using Leica ScanStation scanner C-10 and geo referenced by targets whose coordinates were obtained with GPS

The UAV unmanned aerial vehicles are being a revolution in the last 10 years. This type of equipment for which there is still no legislation, no specific legal regulations can fly with many different sensors, was initially limiting their weight (auxiliaries under 1 kg), but at present there are already commercial equipment that can carry loads over 50 kg, approach allows to model objects at any distance, let impossible perspectives photo shots from a few years ago, so they are an essential aid in difficult access areas.

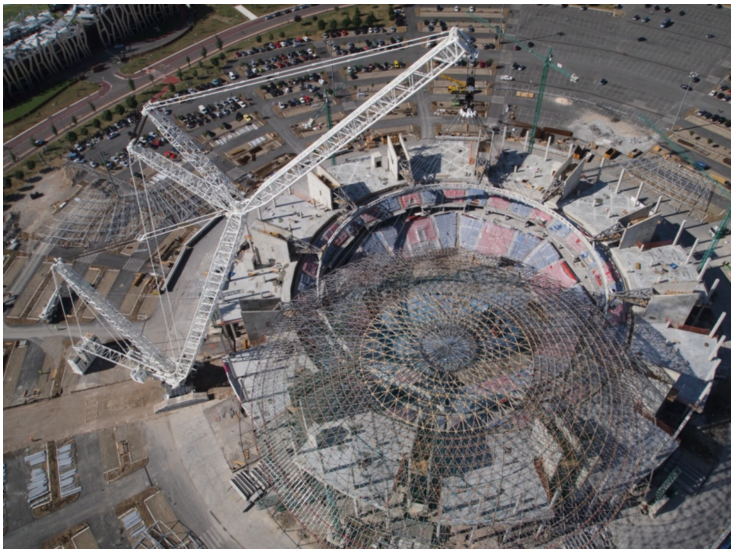

Fig. 5: Image obtained from a drone of the time it is withdrawn by special cranes multipurpose center dome Buesa Arena in July 2011 reform

The convergent photography techniques consisting of the automatic recognition of homologous points and reconstruction of the beams and their position in space the relative position in which the photographs were made, allows the generation of a continuous pattern.

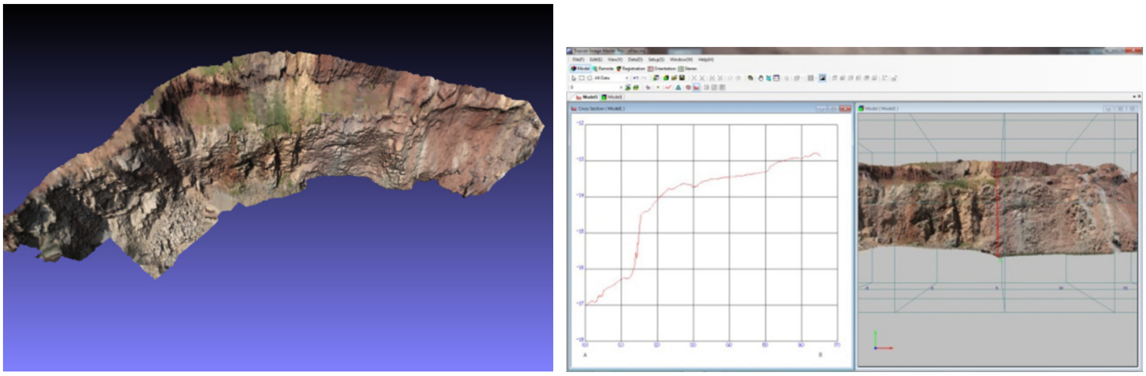

Fig. 6: Model obtained by converging photographs Ofitas quarry in San Felices, La Rioja

These new techniques have been replaced by photography in a direct competition with the scanner, and the obtained models can be similar but the picture quality is much cheaper than a scan.
Finally these geometrically correct models are adapted to be treated themselves augmented reality programs for distribution to non-expert users.

1.3. The transformation to AR

The transformation to augmented reality, can come from different types of specific programs, which require a model, able to be interpreted by the software. In our case we chose, Skectup, ease of sharing information with topography programs. Once the DXF file, using a vectorized CAD software (Autocad, or similar), is imported to Skectup pro, to transform it into a *. Skp,
Once loaded you can preview and / or edit, to stay with the image we want to show in Augmented Reality. See fig. 7.

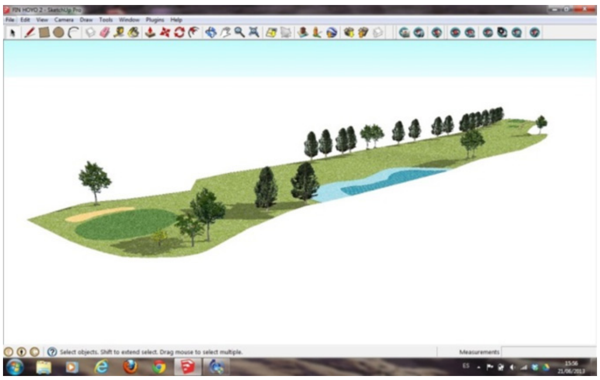

Fig. 7. E.g. Golf land in skectup, with real measures

By AR-media plugin, preloaded on pro Skectup program, we can choose from several options.

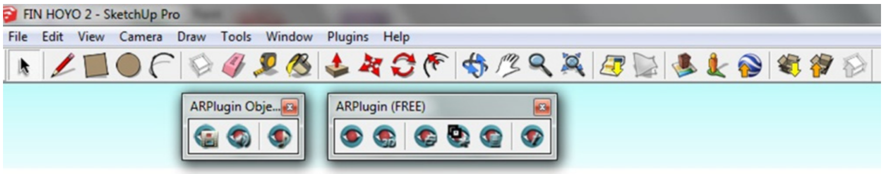

Fig. 8. AR-pluging show the different options.

The first three icons, refer to the ability to add, Video, Audio *. Avi, *. Mov, *. Mpeg, or Soundtrack (*. Wav) (Sountrack, *. Ogg), representation Augmented Reality.

The result is an AR actual plane through the plugin AR-media as shown below , Fig.9, in this case the result is the vision of the golf course, pudiem do vary, their point of view, scale and add sound, but in other cases the results can be more dynamic and spectacular, with the possibility of the use of layers or objects moving such vehicles, or turbines, as referenced below.(Link 1, Link 2, Link 3, Link 4)

Fig. 9: Scene with AR pattern for Golf.

2. Conclusions

The aim of these geometric science is getting a 3D model based [7] on rigorous survey techniques, employability was restricted to expert forums, rehabilitation of heritage architects, planners in planning, hydrological studies, etc ...[8]

However, augmented reality opens the door for these works of high technical complexity can be accessible to non-experts, with uses including education, tourism or leisure, these techniques being a showcase to show this type of rigorous geometrical models where the model is adapted to the needs of all stakeholders:

- The general public, where what matters is to be a particularly nice model that will impact and easily manageable.
- For an advanced user, you are looking textures, interpretations of the figure, recognizing architectural style.
- The technical user who has to make decisions based on accurate geometrical measurements (height of a window, a pillar diameter cylindrical diameter bells, and others.).

Acknowledgements

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Link 1: http://www.youtube.com/watch?v=kAF9kW1zzFg&list=PLDC3A729E0FD9DF86
Link 2: http://www.youtube.com/watch?v=w0Uk-u_hZ3M&list=PLDC3A729E0FD9DF86&index=38
Link 3: http://www.youtube.com/watch?v=KGSa73fPCQA&list=PLDC3A729E0FD9DF86
Link 4: http://www.youtube.com/watch?v=g4_G6VtCssI&list=PLDC3A729E0FD9DF86&index=62