COMMUNICATING THE CUTURAL HERITAGE THROUGH THE USE OF DRONES, 3D MODELS AND APP. CASE OF STUDY: "FERRAN3DINA"

DIFUNDIR EL PATRIMONIO CULTURAL A TRAVÉS DEL USO DE DRONES, MODELOS 3D Y APPS. CASO DE ESTUDIO: "FERRAN3DINA"

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Abstract:

In recent years we have witnessed to a great change in the archaeological and architectural relief due to the introduction of the laser scanner (Böhler 2006; Vosselman and Maas 2010) and to the improvement of the Structure from Motion techniques (Remondino and El-Hakim 2006; Caprioli and Scognamiglio 2009). These new methods allow the restitution of accurate 3D models of small objects, monuments, and territories, for the purpose of study, documentation, divulging, monitoring and restauration (Kourtzellis 2009; De Reu 2013; Hörr and Brunnett 2013; Forte *et al.* 2015). The data acquisition is made through the use of UAVs (Unmanned Aerial Vehicles) (Colomina and Molina 2014), tools that are becoming ever more economic and efficient. Through the utilization of a drone and by the application of SFM techniques we can realize 3D models in a short time and with reduced costs. This models can be published on the internet or implemented on an APP for tablet or smartphone. Through new technologies we can take advantage of digital content in 3D (Bruno *et al.* 2010) to observe artifacts, historic buildings and archaeological sites through a different, intriguing and interactive approach, improving communication as well as encouraging real visits of the objects. In the following contribution we first create the 3D models of particular prestigious buildings of the city of Ferrandina (Basilicata, Italy) and after an APP for smartphones and tablets that allows viewing in three dimensions of some monuments, accompanied by a descriptive card and useful information such as opening times, etc. This is a work-in-progress project so the early interesting results presented here are partial.

Key words: UAV, 3d model, APP, SfM, cultural heritage, tourism.

Resumen:

En los últimos años hemos asistido a un gran cambio en el levantamiento arqueológico y arquitectónico, debido a la introducción del escáner láser (Böhler 2006; Vosselman and Maas 2010) y la mejora de las técnicas de SFM (Remondino and El-Hakim 2006; Caprioli and Scognamiglio 2009). Estos nuevos métodos permiten la restitución de los modelos 3D precisos de pequeños objetos, monumentos y sitios, con el propósito de estudio, documentación, divulgación, vigilancia y restauración (Kourtzellis 2009; De Reu 2013; Hörr and Brunnett 2013; Forte *et al.* 2015). La adquisición de datos se hizo en su mayoría desde arriba, mediante el uso de UAVs (Unmanned Aerial Vehicles) (Colomina and Molina 2014), es más económica y eficiente. A través de la utilización de un dron y mediante la aplicación de técnicas de SFM podemos tener modelos 3D en un poco tiempo y a coste reducido, los modelos pueden ser publicados en Internet o implementados en una aplicación para tablet o smartphone. A través de las nuevas tecnologías podemos ayudarnos de los contenidos digitales en 3D (Bruno *et al.* 2010) para observar objetos, edificios históricos, sitios arqueológicos a través de un enfoque diferente, interesante e interactivo, mejorar la comunicación, así como fomentar las visitas reales de objeto. En la siguiente contribución se procedió en primer lugar a la creación del modelo 3D de determinados edificios prestigiosos de la ciudad de Ferrandina (Basilicata, Italia) y después a la creación de una aplicación para teléfonos inteligentes y tabletas que permiten ver en tres dimensiones algunos monumentos, acompañados de un tarjeta descriptiva e información útil, como los horarios de apertura, las direcciones de las rutas, etc. En este artículo presento el trabajo parcial, dejando al descubierto los primeros resultados interesantes.

Palabras clave: UAV, modelo 3d, APP, SfM, patrimonio cultural, turismo.

1. Introduction

Ferrandina (Basilicata, Italy) is located on a hill on the right side of the river Basento, 480 m. above sea level, thirty kilometers from Matera (European Capital of Culture in 2019) and about forty kilometers from the Ionian coast of Basilicata (Fig.1). The old town of Ferrandina has a continuity of life from the VIII century B.C. until to the present day, but the most important and impressive monuments are dated to the modern age

(Lisanti and Barbone 1987; Palestina 1994; Palestina 1996). From the XV century, during the Aragonese period, prestigious buildings and noble palaces were built and they are attractors of tourists coming mainly from Matera and Metaponto. To increase the awareness of the cultural heritage of Ferrandina was born "Ferran3dina", an APP for Android smartphones which displays some cultural goods in 3D, made through the use of drones and SFM (Neitzel and Klonowski 2011; Nex and Remondino 2013; Pecci *et al.* 2015; Lasaponara *et al.* 2016). The sites identified to detect using the drone are about ten (although the list is absolutely provisional): the castle of Uggiano, the monastery of San Domenico, the convent of Santa Chiara, the church of Santa Maria della Croce, some houses of historical center characterized by their unique architecture, the monastery of San Francesco. At present have been detected and included in the APP the first two of the list.

Figure 1: Ferrandina (Basilicata, Italy).

2. The castle of Uggiano

The castle of Uggiano (Fig.2), a very important fortified medieval site, is situated a few kilometers from Ferrandina (Matera, Basilicata). It stands on a hill at 420 meters above sea level to control the valleys of Vella and Salandrella streams. The ruins of its towers still dominate a very extensive area from the Ionian coast of Basilicata until the Calabrian mountains. The written sources, although they are very rare, allow us to dated the castle before 1029 (Protospata 1731, p. 102). Some episodes, like the retreat in the walls of the castle of Robert the Guiscard (he was not able to conquer the city of Montepeluso in 1068[1]) lets us know the names of many owners from Norman period[2] until the end of the fourteenth century, period in which the castle was probably abandoned (Alberti 1595). Although the Uggiano castle has an architectural structure of considerable interest among the castles of the south of Italy, archaeological excavations, research and study projects have never been carried out. The defensive structure, articulated on an irregular polygonal plan, was made up of high walls of three meters thick and imponent towers. In the defensive circuit there are the ruins of several buildings, a noble residence and a chapel.

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[1] Ibidem, pag. 109; SALERNITANUS R., 1804, p. 187.
[2] In the *Catalogus Baronum* it is mentioned Rogerius de Ogiano.

Figure 2: General outer view of the castel of Uggiano (Ferrandina, Basilicata, Italy).

3. The monastery of San Domenico

The construction of the monastery of San Domenico (Fig.3) began in 1721 and the opera project was entrusted to the engineer Andrea Moltó of Rome, who used skilled workers from Puglia and Campania. It is a very large building with cloister, directly connected to the sixteenth century's San Domenico church. The dominant element is the dome covered with majolica that overhangs the entire building. Inside the monastery there is a cloister with a square layout; the central space is composed of twenty pillars as a continuous porch of twenty cross vaults. At the center of the cloister there is a well and the courtyard is paved. Above the vaults are located different rooms that currently home the high school. After the recent restauration work, the monumental complex houses the municipal library, the municipal historical archive, the high school and the cloister is used for cultural activities.

Figure 3: View from the drone of the monastery of San Domenico (Ferrandina, Basilicata, Italy).

4. Acquisition and processing data

Before making a photogrammetric capture, the drones require flight planning and the control of the area, these are fundamental operation for the acquisition of the images to the desired resolution. The photogrammetric acquisition is conditioned by the topography of the site, the presence of potential dangers such as electrical cables, buildings, the weather conditions and the stability of the flying platform. In our case, and according to our configuration, displacements of the drone are monitored on our smartphone and controlled in real time, the shots are automatic by setting the time-lapse feature to 3

seconds. After we have been planned the flight and prepared the UAV[3] (Fig.4), we proceed with the flight and in the acquisition of the images.

Figure 4: Phantom Vision 2 plus

To achieve a complete and detailed photogrammetric coverage in the two cases in exam we made acquisitions of zenith photographs (at a constant height of 30 meters above the ground) and of oblique photos to resume the elevations of buildings. After that, the photos were processed to obtain the point cloud, mesh and textured 3D model AgisoftPhotoScan. This software is characterized by user-friendly interface and is based on a semi-automated workflow (the program manages the entire phase of work, from the orientation of the picture until the creation of the outputs).
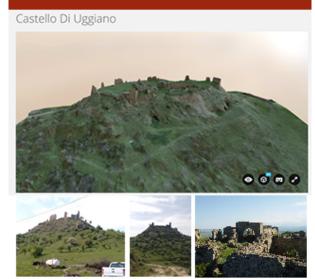
5. Ferran3dina

The APP for Android devices "Ferran3dina" comes from a similar project dedicated to the fortified heritage of Basilicata, "BasiliCastle[4]" (Masini *et al.* 2014) made by IBAM CNR of Tito Scalo (Potenza, Italy) and in collaboration with the Italian Castle Institute (section Basilicata). "Ferran3dina" has been realized through the free platform "App inventor 2"[5]. This suite features a quick and simple interface for the realization of very complex applications and also it does not require the knowledge of programming languages. After created the graphics and added contents you proceed to the creation of the basic logical scheme that allows operation. For each monument there is a descriptive card (Fig.5) with some information such as the location on google maps, directions, photos, opening hours, etc.) and the link for the 3D visualization of the object on "Sketchfab"[6] website. When we upload our 3D models we proceeded to decoding web links related to the models of QR codes. The QR Code can be inserted

everywhere, from brochures to books, from the website informative panels to the map of the city of Ferran3dina, in correspondence of its monuments made in 3D.

Figure 5: Screenshot from "Ferran3dina". Datasheet of the castel of Uggiano.

6. Conclusions

The city of Ferrandina presents an important cultural heritage but little valued. Each monument chosen by us for its historical value and importance, inserted inside in the APP "Ferran3dina", has requested a bibliographical search and a deep study. The creation of the APP for Android through the online platform free "App Inventor" does not require a deep or specific computer knowledge, allowing its use even to beginners. One of the strengths is the card of each monument is precisely in the visualization in 3D of the same, realized through the use of drones and SFM techniques. The processing of these three-dimensional models requires, however, a deep practical knowledge in the use of the drone and the Structure from Motion technology. Through new technologies, students, researchers and tourists can take advantages from 3D digital contents observing historic buildings, archaeological sites, artifacts, etc. They allow exploration of the assets in a new, fast, complete and intriguing perspective. In our case, the 3D models were realized used to create innovative digital content, virtual tours and to improve the communication of information of the cultural heritage of the city of Ferran3dina. The digital cultural offerings must be planned on key points such as storytelling, emotional experience related to cognitive processes. The elements created by augmented reality fascinate the user without forgetting the historical and scientific reference. The

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[3] Dji Phantom Vision 2 plus:

http://www.dji.com/product/phantom-2-vision-plus
[4] http://www.basilicastle.it/pages/Home.html
[5] https://ai2.appinventor.mit.edu/
[6] https://sketchfab.com/

technology has to be a real support to learning traditional knowledge, the dissemination and the promotion of the cultural heritage.

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