GIS-BASED MAP GENERATION USING NEW SURVEY TECHNIQUES

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Abstract: Conservation of historical sites depends on acquiring all data related to their life history and their shape. We are using modern survey technologies such as GPS, satellite images, photogrammetry and classical instrumentation to build a Geographic Information System (GIS), digital library and precise base map with all its embedded benefits at a low cost.
GIS offers digital documentation of the site and its surrounding environment, which is essential for the conservation and protection process of any heritage. In this work we are presenting GIS, digital base map and an orthophoto for a newly established museum and its surrounding to be used in GIS modeling.
Global Positioning System (GPS) precise measurements and a high resolution satellite image were used to produce a Digital Terrain Model (DTM) and an orthophoto for the site in order to create a three Dimensional model (3D). Finally, GIS and (3D) texture model for the museum were produced to conserve, protect, monitor and manage the facility. It offered as well, the scheme to create a web site to post all acquired information to publicize the new museum and the ability to employ any modern location based service (LBS) technologies (emergency, security, guiding etc.).

1 INTRODUCTION

It is very important to use modern technologies such as satellite images, remote sensing, photogrammetry and GIS (Grosman, 2000) to conserve cultural and historical sites. New survey technologies are very valuable in the mapping and the management of the archeological data (Kvamme, 1999), (Bewley and Raczkowski, 2002).

The objective of this work is the development of a base-map: to display a detailed map of the site and its general components, in order to portray an in-depth data of any selected part and to create 3-D model with the possibility of a walk through visit so as to conserve and manage the site efficiently.

To achieve our objectives we had produced a Digital Elevation Model (DEM) and orthophoto using some satellite images and a photogrammetry software. Then, the DTM produced is used to create 3D model (Baltsavias et al., 2001). Using digital photogrammetry and computing capabilities we were able to digitally document and 3D model the cultural site. The produced digital map by means of satellite images, digital photogrammetry and GIS, will offer endless of working possibilities (Bayari, 2005).

The site we intended to conserve is a museum located to the west of Amman, Jordan which was the house of a national hero. It is beauty and significance is due to its location and the Islamic arcade architecture of its quarters. It is the first of its kind in the country and need to be digitally conserved to allow the usage of modern LBS technologies in its operation. Satellite images were used to extract features with real dimensions and a base-map was extracted from a topographic map and othorectified Image for the site. Moreover, a three dimensional texture model for the museum was built using field survey and GIS starting from topographic planner. Real measurements were translated to a database in a GIS environment to build the 3D solid model. Then, sketch up texture mapping software was used for building texture based on capturing field photos. Using Arc GIS environment we provided a real 3D model with true virtual reality model to allow all 3D GIS spatial analysis. We

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designed a website that offers all the needed information (Location, base-map, photos, videos of the 3D model etc.). GIS has a great Capability to integrate and update graphic and non-graphic data according to user inputs to produce all kind of maps.

2 METHODOLOGY AND SOFTWARE USED

A Geographic Information System for the site was built to house all the digital data to allow it's updating, posting on the web and the usage of modern LBS technologies. The digital data allows better analysis, presentations, updating in addition to the production of 3D GIS texture model and a web site.

Several Software packages were used in the process including:

- Auto Desk Land Desk Top 2004: is used to create DTM, feature layer and data base, in order to produce a topographic plan for the site and to export AutoCAD layers to shape files to use in Arc Map.
- ENVI 4.3, (the Environment for Visualizing Images) is used to create a high-resolution color image; PC sharpening fuses high-resolution panchromatic imagery with multispectral imagery and to correct the images from the distortion by Orthorectification algorithm.
- ArcGIS (version 9.1), is used to Produce Base-Map from digitizing the ortho and classic map. 3D model was built in ArcScene depending on the attributes tables (extrusion the building according to height). Finally it Generates Triangulation Irregular Networks (TIN) for the site and compose all the data (images, 3D features, TIN, Sketch Up file, ENVI) together.
- Sketch up Pro 5: is used in exporting and importing 3D building from and to ArcGIS. It is a powerful tool for creating, viewing, and modifying 3D ideas quickly and easily. Although it had been developed for the conceptual stages of design, Sketch UP is a very powerful 3D tool for creating presentations.
- Photoshop: is used to eliminate any appearing effect on photos (shadow on facades, trees, humans and cars, etc.).

By providing measurements from the field and processing them we produced the topographic plane. Then, we used digital photogrammetry technique to orthorectify Quick Bird image to construct orthophoto. We used the topographic map and the orthophoto to produce a base-map. A solid 3D model of the building was produced in GIS. The sketch up texture mapping software was used to build texture based on capturing field photos, then converting the 3D building texture to Arc scene so as to produce 3D GIS Texture Model. Finally, the beautiful arcade house with the Umayyad Arabesque style (Fig.1) was turned into a digital data base museum.

A Topographic Survey of selected natural and built up features was done to produce the needed maps and plans with true features to scale. GPS Real-Time Kinematic (RTK) and total station provide identical output coordinate data to perform topographic surveys of the terrain, facilities, and infrastructure.

Figure 1: Main Building.

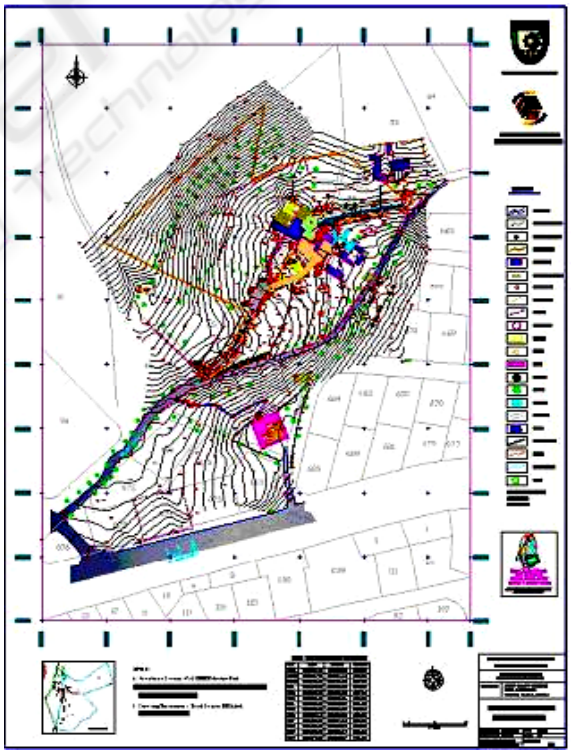

Figure 2: Topographic Plane for the museum site scale 1: 500.

Both systems employ similar (or identical) data collector devices, feature coding, attribution of

features, stakeout methods, COGO functions, etc. COGO is a suite of programs aimed at coordinate geometry problems in Civil and Gemomatics Engineering.

Land Desk Top 2004, field observations (1500 points) were loaded to produce the final topographic plane. Processing starts by adding the data, building the surface and the TIN. Finally, a topographic plan was created using land Desk Top 2004 as shown in Figure 2.

Digital photogrammetry technique is used to Orthorectify Quick Bird image which was available as black and white multispectral, color, or PC-sharpened product. We chose 8 GPS points that can be used as GCP's, and 5 points by Total Station from topographic plane. In order to orthorectify the image in GeoTIFF format, and files containing the RPCs for the Quick Bird Image, Digital Elevation Model (DEM) was used (Certer, 1988). All the data had been used as input to the ENVI software to produce the orthophoto high resolution 0.6m and multispectral RGB (Fig.3) and 3D surface (Fig.4).

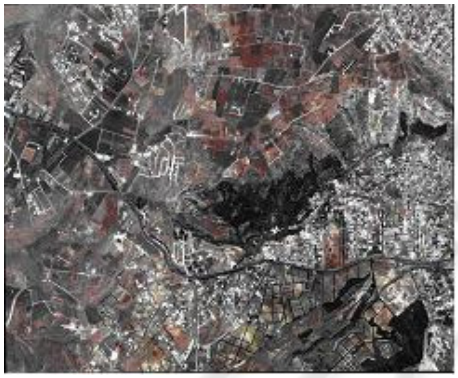

Figure 3: Orthophoto.

Figure 4: 3D surface view.

3 BASE MAP GENERATION

A base map is the graphic representation at a specified scale of selected fundamental map information that is used as a framework upon which additional data of a specialized nature may be compiled. It is as well, a map from which other maps are prepared by the addition of information. To produce the base-map we had to do a topographic survey, and then to use a Quick Bird Orthorectified image to digitize roads network, agricultural features, buildings and finally to use a topographic map of Swieleh; a suburb in Amman. The collected data produced an orthorectified image and topographic plane. The flow chart of map generation is presented in Figure 5.

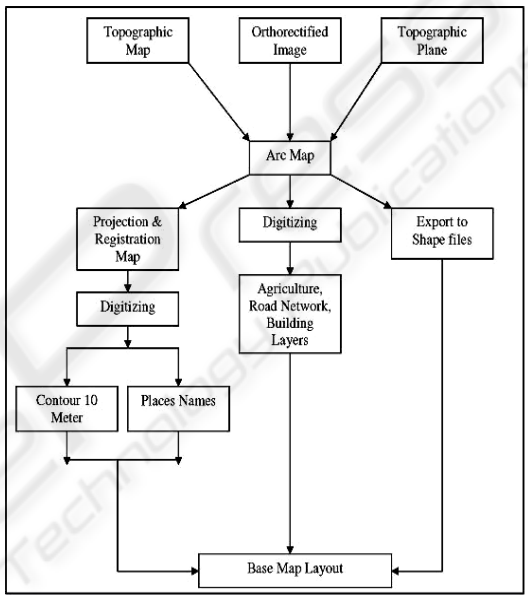

Figure 5: Map generation flowchart.

Map projection is a systematic transformation that allows the orderly representation of the earth's spherical graticule on flat map. Registration is based on a family of mathematical tools that are used to modify the spatial arrangement of objects in a dataset into some other spatial arrangement. The purpose is to modify these geometric relationships without substantively changing the contents of the data itself. The registration process involves changing one of the views of the surface spatial relationships to agree with the other, without concern about any particular geodetic referencing system.

Digitizers are the most common device for extracting spatial information from maps, photograph or other documents. In the Swieleh topographic map we digitized the contour lines and names of places. In the Orthorectified image we digitized the Agricultural lands (Fig. 6), Buildings (Fig.7), drainage pattern and roads network (Fig. 8).

Figure 6: Agricultural lands.

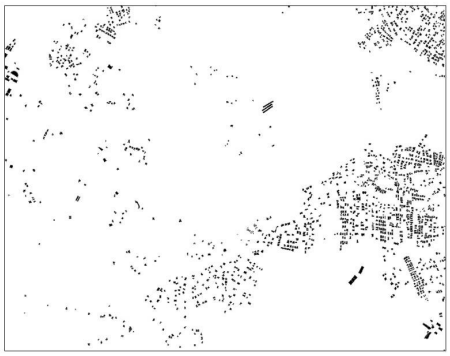

Figure 7: Layer Buildings.

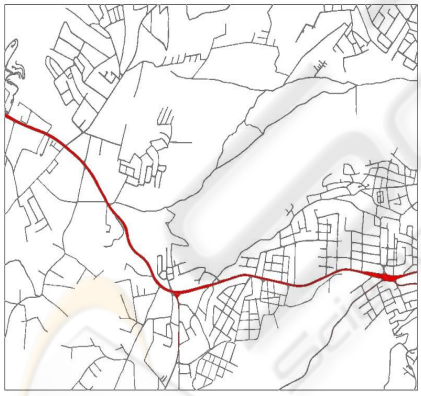

Figure 8: Main and sub street Layer.

As for the final base map layout (Fig. 9), we collected all Layers and added north arrow, legend, scale, etc...

Architectural Heritage Conservation is better achieved through building 3D photo-texture model integrated with GIS. The modernization of our world needs technical document production. Digital documentation of cultural heritage is not an end in itself but serves as a tool to make accessible information and better presentations.

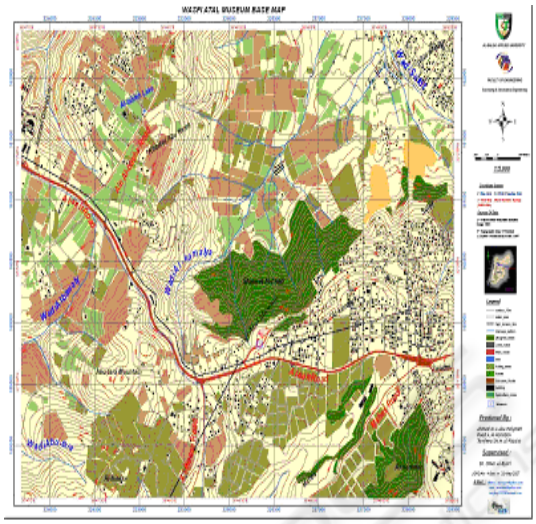

Figure 9: Final base map layout scale 1:5000.

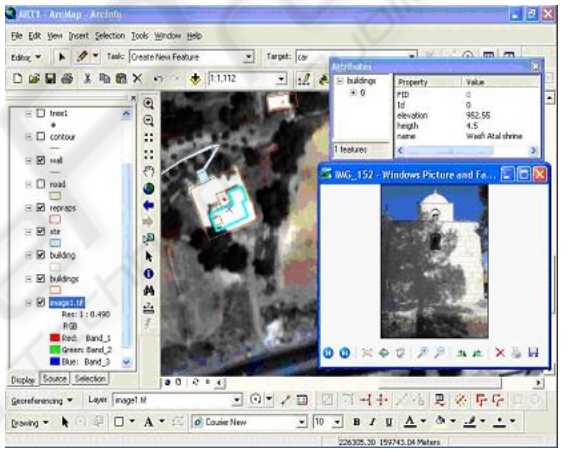

Figure 10: GIS data for Wasfi Atal memorial.

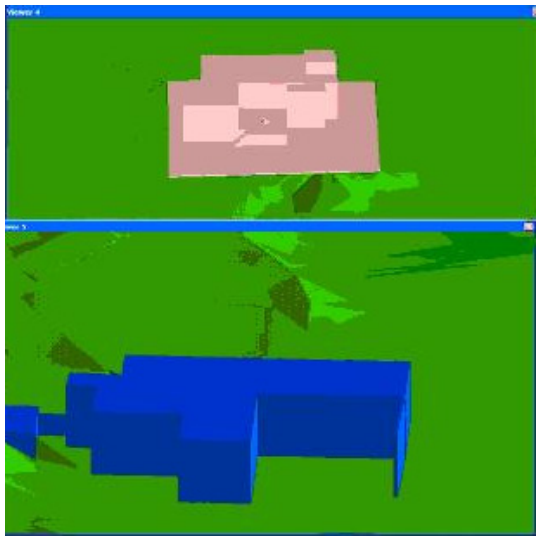

Figure 11: Three solid model after extraction in GIS

In the process of 3D modeling and building the height database we used the digital maps to implement the field height data through GIS (Fig. 10).
Then, we applied the heights to their corresponding features to produce 3D solid model (Fig. 11) in GIS environment.

To build real texture 3D model under GIS environment (to conserve the real texture of all the facades), digital photos for the sides of the buildings were captured using a high resolution digital camera. Then, Photoshop software was used to eliminate any extra features captured in the photos such as trees, cars and people as it is presented in Figure 12.

Figure 12: Photo processing.

Finally, Sketch Up software was used to export and import to and from ArcGIS (Using the SketchUp ArcGIS Plugin). The SketchUp ArcGIS Plugin was installed in the GIS environment to enable the transformation of 2D GIS data to sketchUp, seamlessly and transfer 3D texture model to an ArcGIS geodatabase. Figure 13 presents the real and the 3D texture model for comparison purposes.

Figure 13: Actual and 3D texture model.

4 CONCLUSIONS

GIS is an effective tool in managing, sorting, analyzing and presenting any architectural or other attribute data to serve in the field of conservation, management and the employment of modern technologies (LBS for emergency, guided tours, planning etc.).

- The production of a digital base-map by means of satellite images and digital photogrammetry is a new and fast technique, which allows the updating and the production of endless needed maps.
- The production of 3-D texture model helps in performing advanced analysis and studies. Processing topographic surveys and high-resolution satellite images is an excellent technology to conserve important sites accurately with real features.
- Finally, the creation of an important web site rich in information to allow global visitors, researchers and concerned groups is the optimal benefit of the work.

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