

TRIDIMENSIONAL MODEL FOR A UNIVERSITY CAMPUS USING DTM

Cláudio Márcio Penna de Moraes
Luiz Alberto Vieira Dias

Paraíba Valley University - UNIVAP
São José dos Campos, SP, Brazil
mclaudio@univap.br and vdias@univap.br

Commission IV, WG IV/6

KEY WORDS: DTM, Tridimensional model, Computer Graphics, ArcView, Environment

ABSTRACT

This work presents a method for viewing in three dimensions an university campus and its associated buildings, when the cartographic data was not completely available. The authors had to rely on old and outdated maps to prepare a Digital Terrain Model of the campus. Another difficulty was that the data was divided into seven maps and an adjustment had to be made on the borders of them. Based on the recovered data a Delaunay Triangulation was performed. However, the model so acquired did not represent properly the terrain features, because of the shape of the triangles in the automatic triangulation. To solve this problem, the authors did generate a new isoline, with an altitude one meter below the minimum of the region, circulating the whole campus area. Once these models were created, it was possible to navigate and fly over the campus terrain thus obtained.

1. INTRODUCTION

Paraíba Valley University, UNIVAP is a young and fast growing university, with about ten thousand students on the undergraduate and graduate levels. When UNIVAP that, at the time, was located only at downtown São José dos Campos, São Paulo State, Brazil decided to expand and build another campus, the Urbanova Campus, on the mentioned city suburbs, the selected area was on a hilly terrain with no detailed geographical maps available.

2. DISCUSSION

The existing area maps were old and outdated, with contour lines spaced by 20 m. This was the cartographic material on hand when the construction of the new campus was begun, in 1993. In 1998, the Cartography Course students, under the guidance of Prof. Vicente Maia (MAIA, 1998), divided the area into seven sections, and carefully produced a map of each section of the area under consideration, not geo-referenced (about 4 million square meters), but with contour lines 1 m apart.

It was a huge progress, but what was needed was one digital map of the whole area. This task was then passed on to the Geo-processing Laboratory of the Institute for Research and Development, IP&D, Paraíba Valley University, UNIVAP at Urbanova Campus. In order to fulfill this task the work that is described in this paper was performed. It consisted in:

a) based on these seven student conventional maps, it was prepared a new digital map, from now on to be called MAP1, integrating all the seven previous student maps;

b) the information contained on the student maps was geo-referenced into UTM coordinates;
c) from MAP1, it was generated a DTM of the region, using ESRI's ArcView 3.0;
d) Finally a 3D visualization of the resulting DTM was prepared.

In order to prepare the new integrated map, MAP1, it was necessary, using a GPS, to identify three known terrain points, to geo-reference all the points on the student's original seven maps.

The next step was to assure the continuity of the isolines at the borders of the adjoining maps. The altitude correction for each isoline joint was then performed.

After that a first terrain model was generated (TIN = triangular irregular network), using Delaunay triangulation (MILITÃO, 1996). However, the model so acquired did not represent properly the terrain features, because the triangles in the automatic triangulation program ArcView 3.0 (BAROS & MORAIN, 1996) produces lines, to join triangle vertices, that lay outside the real terrain. In order to solve this problem, the authors did generate a new isoline, with an altitude one meter below the minimum of the region, circulating the whole campus area. The level of this isoline, in this case, was 544 meters, since the minimum level of the campus was 545 meters. The creation of this new line, one meter below did not caused the generation of new features.

Figure 1 - Three-dimensional isolines

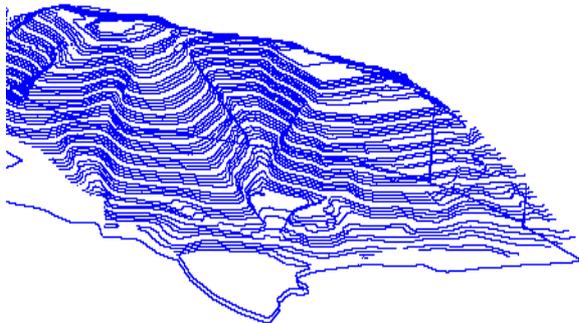
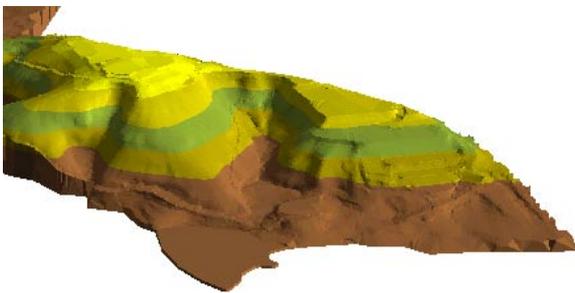


Figure 2 - Rendered DTM



3. RESULTS

Partial results are shown in Figures 1 and 2. Figure 1 presents part of the three-dimensional isolines obtained, while Figure 2 depicts the rendered digital terrain model (DTM) for the same part of the region under study. In both figures it is possible to calculate areas, volumes and distances. Figure 2 is drawn in such a way that different altitudes are shown in different colors (from a maximum of 630 meters, depicted in yellow, to minimum of 545, depicted in brown).

A new isoline at an altitude of 544 meters encircling the whole area under study, was artificially created, in order that the all the Delaunay triangles (MILITÃO, 1996) would fall within the real terrain. Once these models were created, it was possible to navigate and fly over the campus terrain thus obtained.

The campus DTM so created was then used with the VRML language (ENVI, 1997), and visualized on a internet browser. With the availability of the DTM it was possible to simulate the location of new buildings on the

campus, navigate between the already constructed architectural structures, and assess its environmental impact.

4. CONCLUSIONS

Since 35% of the campus is located on an environment preservation area, defined by a specific law, the University has to follow strict construction and landscape limiting rules. Every new construction, earth move, or even the cutting of a single tree has to be authorized by the City Council on Environment, and consequentially, has to be carefully planned in order to reduce to a minimum the impact on the ambient. The DTM, as well as the digital MAP1, has been in use by the Civil Engineering Section of the University, on its planning of the campus expansion. The geographical region centered around São José dos Campos, São Paulo State, Brazil, has about one million inhabitants and is heavily industrialized, including chemical, pharmaceutical, automobile and aircraft industries, so the environment is a major concern of the local government.

This work is far from complete, since new studies on interpolation and three-dimensional plotting are under way, and will use as model the structures on the Urbanova Campus. Especially the plotting of the buildings on the terrain, and how to do it integrating DTM and Computer Graphics (FOLEY et al., 1992).

REFERENCES

- Baros, S. V. L.; Morain, S. (1996) "Raster Imagery in Geographic Information Systems". Santa Fe, NM, USA, OnWord Press.
- ENVI (1997) "Tutorials". Lafayette, Co, USA: Better Solutions Consulting (BSC).
- Foley, J. D.; VanDam, A.; Feiner, S. K.; Hughes, J. F. (1992) "Computer Graphics - Principle and Practice". 2nd Edition. Addison-Wesley.
- Maia, V.P.S. (1998) Private Communication.
- Militão, J.G.O. (1996) "Uma metodologia para o posicionamento de prédios em terrenos acidentados ("A Methodology for Building Positioning in Hilly Terrain)". Master's Thesis. Catholic University, Rio de Janeiro, RJ, Brazil.