Virtual Reality Fly-Through Model for the UL Lafayette Campus

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Abstract

Data transformations applied to different sets of GIS data packages and digital photo imagery can reveal useful information of a geographical area. In this paper we report the construction of a 3D model of the University of Louisiana (UL) at Lafayette campus. We extruded 3D building models from 2D imagery, DOQQ, DEM, CAD and GIS datasets. We processed airborne-collected LIDAR data to extrude the height of the buildings. These 3D models are placed in their real-world coordinates, and realistic texture is then draped on the sides of the buildings. Finally, we can create a virtual reality fly-through of the UL, Lafayette campus. The fly-through is rendered in an immersive display environment. Our ongoing work includes automating this process for larger areas of interest.

***Index Terms*—GIS, GPS, CAD, LiDAR, VRML. DOQQ, DEM.**

1. Introduction

Many software packages are available to display Geographical Information Systems (GIS) data and Geo-spatial photo imagery. Different data packages can be viewed in different ways and can be applied to different method of transformation and image processing. This paper was originally done to study the ability to extrude 3 D model of buildings from 2 D imagery and GIS data sets. Elevation data which can be extracted from the Light Detection And Ranging data (LiDAR) can be used to extrude the height of the buildings by subtracting the Data Elevation Model (DEM) from the raw global positioning system (GPS) points. The DEM provides a terrain that allows us to drape an aerial photography or Digital Ortho-photo Quarter Quadrangle (DOQQ) on top of it, to create a virtual reality image of the study area if it was viewed in our 3D Virtual Reality Model (VRML).

The DOQQ, is a color photograph of a section of topographic map made from an airplane; however, the film record in infrared light instead of the visible light that our eyes use. Each photograph covers an area that is approximately four (4) miles across the top by over four and a half (4.5) miles on the side. The photographs are detailed in that each pixel or block of light on the photograph represents one (1) meter or about three (3) feet square on the ground. The photographs are digital in that they have been scanned to create electronic files that are somewhat like the images you see on the web but not exactly. An image on the web is small - usually 3 Kilobytes (Kb) to 100Kb in size. In contrast, each DOQQ is normally 150 Megabytes (Mb) in size, which is approximately 1,500 times larger than most web images. To make the DOQQs manageable and downloadable, the DOQQs have been compressed into MultiResolution Seamless Image Database (MrSid) image format. MrSid format files allow the DOQQs to be compressed from 150Mb to about 3Mb - about 50 times smaller, making the images available through standard modem Internet connections. These MrSID files are georeferenced, that is, they fit on the true coordinates of the earth's surface so that one can measure distances and positions in an image using GIS software. One can measure distances along features such as roads and buildings on the photographs. One could even combine the photographs with other digital maps to print scaled maps. [4]

LiDAR data can be represented in many forms. These data are available in the contour form (as shapefiles), the DEM form, the raw point form, and the edited point form of the LiIDAR data. [4]

2. Objective of the study

a) Gather all the available data for the study area from LiDAR, DEM, Contour, CAD, DOQQ, GIS and GPS points. b) Study each data package and see what process can by applied on each data set that can be helpful in the study, if converted to the right format. For example one can get the elevation from the DEM and the building height from the GPS raw points. c) Build a 3-D model of the ULL campus by applying extrude-function on the geo-referenced CAD file. d) Insert the 3D model in the real world coordinates and with realistic texture draped on the sides of the buildings. e) Create a fly-through of ULL campus. Try to automate this process for larger areas of interest.

3. Procedure of the project

All the available data were gathered and categorized in groups for further processing and transformation to the right format. Below is the list of the data package and the original format with the extension:

3.1. DOQQ:

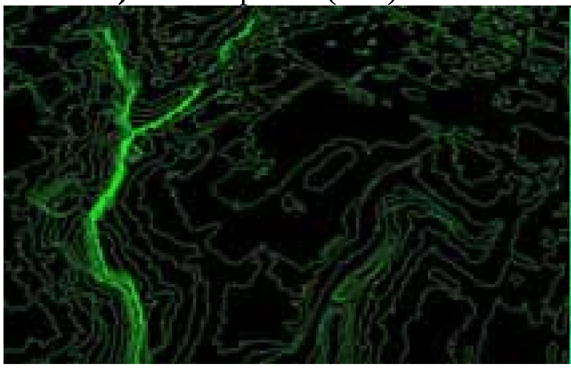
- **a)** 1998 MrSid format
- **b)** 2004 2000 jpeg format

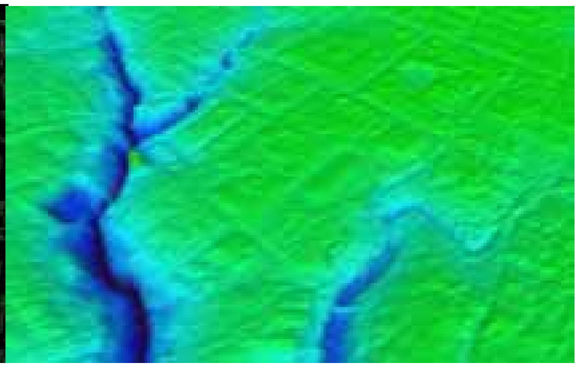
(a) 1998 MrSID (.Sid) (b) 2004 2000 jpeg (.jp2)

3.2. LiDAR:

- **a)** Contour ESRI shapefiles (.shp)
- **b)** DEM (.dem)
- **c)** Raw points (.csv)

d) Edited points (.csv)

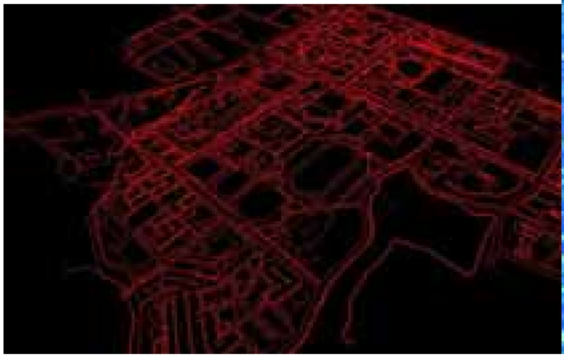


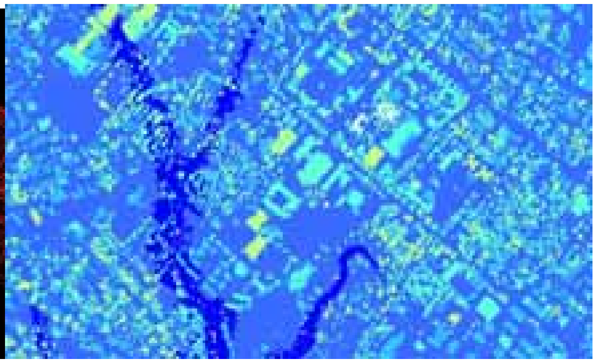


Contour (.shp) DEM (.dem)

3.3. CAD

– AutoCAD files (.dwg)





AutoCAD files (.dwg) raw points (.csv)

3.4. GIS

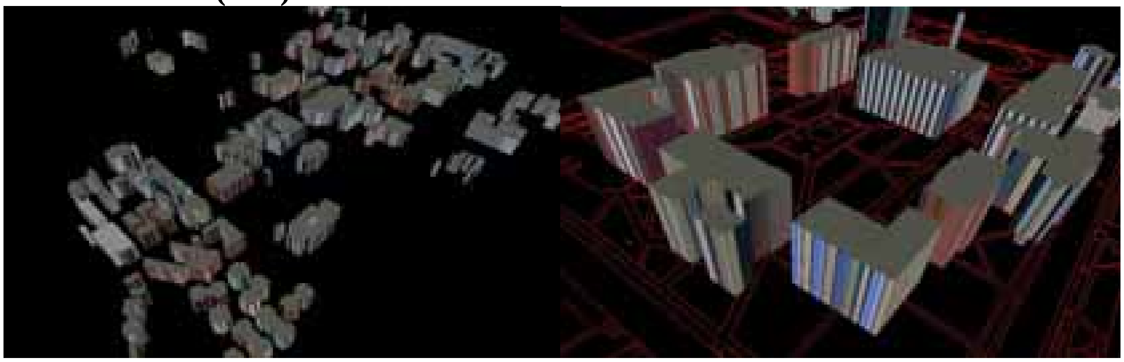
a) Points, Lines, Polygon (.shp)

b) databases (.dbf)

3.5. Images

– Jpg, tiff

3.6. VRML (.wrl)



3ds max (.wrl)

4. Data Processing and Transformation

After gathering the data, some processes were applied on each data set to convert and massage it from raw form to a dataset that can be helpful to create the 3D fly through model. Here is the list of the data sets and the processes.

4.1. Aerial photos or DOQQ:

The DOQQ from Louisiana State University Atlas website [3] are in MrSid and JP2 format, were processed in image processing software to convert them to GeoTIff format and a world file (.tfw) created for the correct projection and specific coordinate system. The gaps in the data were interpolated when needed. Sometime the pixel size needed to be altered to fit the 3D environment by calculating the pixel size or import the pixel size from an already known grid raster file.

4.2. LiDAR:

a) DEM:

The Data Elevation Model was used in The Virtual Global Explorer and Observatory (vGeo) software. It was also used to determine the elevation range [5]. Since Louisiana is flat or below sea level, an exaggeration was applied to the elevation so it can be noticed in the 3D model.

On the other hand the DEM (.dem) cannot be opened directly in ArcMap, it first must to be converted from Dem to grid using Arctool box in the conversion tool, But one has to pay attention of the pixel size and the floating/integer value of output file. The result was saved in one syllabus folder name under the hard drive other wise the function was not going to work correctly. The color or elevation was changed from integer to floating based on the height color schema.

b) Contours:

Contrours come in simple line shapefile hence no need to convert and were used as is to import to GIS or the 3D model.

c) Raw and Edited Points:

The raw and edited GPS points available in (.csv) format. They were edited in MS-Access database software, and then exported to .dbf format. It was important to use an integer format for the Z value column. It should be noted however that Excel can hold no more than 65,536 records. The (.dbf) format was then inserted in Arcmap as an X, Y event then exported to shapefile. This shapefile can be converted to a raster image using the conversion tool feature and raster by the value of Z.

We subtract the DEM from the Raw Grid to get the heights of the buildings using ArcGIS ArcEditor or higher license and reclassify the new output to get rid of all the unnecessary points such as the negative values, zero values, unrealistic points such as too much high elevation and No Data values. This method allowed us to get a shapefile with attribute table for all the building heights.

4.3. CAD:

CAD files were gathered from the University of Louisiana at Lafayette physical plant as an AutoCAD (.dwg) format. Viewed, Cleaned and updated in AutoCAD software then exported to ArcMap. The most important step was to Geo-Rectify the CAD file to be in the right projecting and coordinate system by creating world file (.wld) file and presented into GIS line shape file type. We applied a coordinate transformation to a CAD layer [3], then Imported into 3DsMax to extrude and drape the texture on the surfaces of the buildings.

4.4. VRML

CAD polyline was imported into 3dsMax then extruded to the height of the buildings based on the raster subtraction the DEM data from the raw data. The surface texture images were draped onto the sides of the buildings [9]. To determine the center of the building analyze your data in ArcGIS to get the correct insertion point, scale and rotation of the object from the world file. Export the file to VRML (.wrl) format then convert to (.iv) to insert into a (.vgeo) configuration file. Pay attention to the translation, the cameras and the images directory paths and edit it in Notepad.

5. Results and systems implementation

All the aerial photography and the DOQQ either MrSid or JP2 format we converted to GeoTiff format and created the world (.tfw) files, CAD files were exported to ArcMap and geo-rectified (.wld) then imported as a shapefile (.shp) files with (.jpr) in the right projection and exact coordinate system.

CAD files were imported into 3dsMax Software and extruded to the correct height as mentioned before, texture images were draped onto the side surfaces of the 3 D buildings; the files were then exported to VRML (.wrl) format and converted to (.iv).

DEM data was used to create the coordinate configuration file and decreased by about fifty percent (to retrieve the data faster) to create the terrain to drape the ortho- photos, CAD, shape files, contour, and 3D models on top of it. Also the DEM, Raw data, were imported into GIS ArcMap software. The raster math option from the 3D analyst tool in the Toolbox was used to subtract the DEM from the raw data to get the height of the buildings. Then the raster was reclassified to determine the correct buildings heights and positions.

6. Conclusion

Although the 3D model was created and implemented with all the Data sets packages from Aerial photography, DEM, LiDar, CAD and 3D models in vGeo; the Buildings heights can be approximately determined subtraction by means of the DEM from the raw GPS point and can be used for larger areas too by comparing to the aerial photography and CAD files with the DEM data. The building can be divided into groups or can be studied individually to increase the precision against the productivity.

7. Future endeavors

This project is just a startup on the 3D modeling; this project will require more work on the reclassification of the subtraction of the raster data set to decrease the noise and the clutter. Also we will try to convert the raster of z values to polygons of the same values. On the other hand these points should be exported directly into vGeo or 3D models, and databases created for all the buildings and the surrounded surfaces to automatically drape the right images to the right building. Our goal is to make the whole system automated to increase the speed of the process, by reducing the translation and conversion of the imagery or by writing simple algorithms that can be efficient for a large scales urban areas.

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Machine: Dell 650 workstation, Xeon (Dual processors) 3.6 GHz, 3.0 GHz RAM, NVIDIA QuadroFX 4500, 1GB, 256 bit, stereo panel, passive goggles.

References:

[1] Andrew Richman, Andy Hamilton, Yusuf arayici, John Counsell, Besik Tkhelidze, “Remote Sensing, LIDAR, automated data capture and the VEPS project,” *iv, IEEE Ninth International Conference on Information Visualization* (IV'05), 2005, pp. 151-156.

[2] Brian Farrimond, Robina Hetherington, “Compiliing 3D models of European Heritage from User Domain XML,” *iv*, *IEEE Ninth International Conference on Information Visualization* (IV'05), 2005, pp. 163-171.

[3] ESRI Support article “Applying a coordinate transformation to a CAD layer”

[4] Farrell Jones, Atlas webmaster website http://www.atlas.lsu.edu/

[5] John Holdzkom, “vGeo User Guide”, VRCO, Inc.,2005

[6] Katja Ewald, Volker Coors, “Appraisal of standards for 3D City Models,” *iv*, *IEEE Ninth International Conference on Information Visualization* (IV'05), 2005, pp. 157-162.

[7] Md Mahbubur R Meenar, Andreea Ambrus, “Three-Dimensional Models (Encourage Public Participation),” *ArcUser* April-June 2006, pp. 34-37.

[8] Nada Bates-Brkljac, Dr. Stefanie Duhr, John Counsell, “The VEPS Project: Planning Information Visualization”, *IEEE Ninth International Conference on Information Visualisation* (IV'05), 2005, pp. 145-150.

[9] Sean Bonney, Steve Anzovin, Jon A. Bell “Inside 3ds Max 7” (Texture Mapping), New Riders publishing Berkeley, CA 2005 pp. 327 ch 10.

[10] Sham Tickoo, “AutoCAD 2005”, Delmar Learning, New York, 2005.

[11] Stan Aronoff, “Remote Sensing for GIS managers”, ESRI press, Redlands, CA, 2005.

[12] Suzanne Gross, Patrick J. Kennelly, “Virtual Campus 101(A Primer for Greating 3D Models in ArcScene),” *ArcUser* April-June 2005, pp. 26-29.

[13] Yusuf Arayici, Andy Hamilton, "Modeling 3D Scanned Data to Visualize the Built Environment,” *iv*, *IEEE Ninth International Conference on Information Visualization* (IV'05), 2005, pp. 509-514.