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Surveying and Mapping for a Localized GIS

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ABSTRACT

Surveying and Mapping for Localized GIS. INDIA S.CALHOUN (Savannah State University, Savannah, GA 31414) BRIAN FUSS (Stanford Linear Accelerator Center Menlo Park, CA 94309)

The Alignment Engineering Group (AEG) is responsible for an extensive array of alignment and positioning activities at the Stanford Linear Accelerator Center (SLAC). In particular, the location of accelerator components using specialized tools and data adjustment procedures are the center mission(s) of the group. My established goals for this project are to accurately measure a set of buildings known as Forte Apache to produce a 3-dimensional CAD drawing that will be used to create a 2-dimensional Geographic Information Systems (GIS). Computer Aided Design (CAD) is the use of a wide range of computer-based tools that assist engineers, architects and other design professionals in their design activities [5]. Overall, in the project, I will construct a 2-dimensional GIS that can be used to analyze relationships between features.

INTRODUCTION

Geographic Information Systems (GIS) are tools which are used for making and using spatial information. GIS can be defined as a computer-based system to aid in the collection, maintenance, storage, analysis, output, and distribution of spatial data and information. [1]. In this project, Geographic Information Systems will play a vital role allowing mapped objects to be identified using queries. Surveying data is collected using GPS and a TotalStation. From the raw surveying data, a map is created that will be used for the GIS. More specifically, the positions of some buildings at SLAC will be measured using GPS. Surveying is one of the vital factors in creating an accurate GIS. Surveying deals primarily with geometric measurements on the earth's surface, the computation of derived quantities, such as coordinates, area, and the representation of numerical data in geographical form, such as in plans or maps [4].

GPS is known as the Global Positioning System, "which is a worldwide radio-navigation system formed from a constellation of satellites and their ground stations" [2]. With the GPS surveying at SLAC, the GPS instruments use these satellites as reference points to calculate positions accurate to a matter of centimeters. GPS equipment is used to aid the surveying tools for accurate measurements which will later be recorded and used as points in the 2D/3D drawing.

The program with the imported data for which my drawing will be created is called MicroStation TriForma V8 2004 Edition. MicroStation TriForma is a computer application for the building design, management and construction industry [2] [3]. It provides the essential tool(s) to design projects in 3D. TriForma is a complete 3D application that can model a project in plan view as well as isometric and perspective views. Plan view meaning “a view looking down from above at a horizontal plane located in a position of interest” or flat view [3]. Isometric view means visually represents three-dimensional objects and perspective view is “a view of a three-dimensional image that portrays height, width, and depth” [3]. This program supplies volume elements or forms to build a 3D model. A form can be line-based to add walls, or shape-based to add floor slabs, columns, or roof planes [2] [3]. MicroStation TriForma helps visualization for this project by allowing the creation of a 3D representation of a set of buildings at SLAC.

Once the objects are added to the CAD model, the resulting information on the positions of the buildings will be used to create a Geographic Information System using MicroStation Geographics that can then help with queries such as what buildings are affected by power outages at SLAC. The information is directly usable from the CAD data that was measured using GPS and the TotalStation.

Surveying is one of the vital factors in creating a GIS due to it providing accurate spatial information. GIS and GPS speculation is becoming even more valuable as it helps the planning for the purchase of hardware and software. “It is a new science that is used to design future information systems and will expand into new fields and application areas” [5].

METHODS and MATERIALS

It is assumed that all equipment listed is used. First, we measured control points with GPS. Then, we set up two tripods; one with a reflector, the second with the TotalStation 1105 and the third tripod with a 360 degree Prism. The locations around the buildings are known as Miho Control Point (MCP) 1, MCP 2 and MCP3 respectively. These points are designated markers for the project. They consist of a nail in the ground which indicates the center of the control point. In setting up the tripods, we have to make certain that the middle leg of the back sight tripod is on the center of the nail. An accurate way of centering the tripods is to adjust the bubble level to the center of a circle; this is located on the TotalStation. Then, we can measure the different corners of the buildings. Later, we will use the coordinates as data to import into the computer's database. Various tools were used to make the necessary measurements. The Allegro Field PC is an electronic device that stores the input data that is exported from the TCRA 1105 Plus [8].

The 1105 is known as a TotalStation. The TCRA Plus is robotic, which means it is programmed to create data that would aid in measuring the distance between each survey point as well as, building points. However, a data collector was used to compile all information gained from surveying. Also, I used a GPH1 reflector and 360 degree Prism were used to assist the TotalStation with sights to lower building corners that could not be seen or were difficult to measure. For the GIS, MicroStation and MicroStation Geographics programs were used for the graphical interface in addition, for the 3D drawings. Microsoft Access was the database used to store attributes data of the features (see Section 7).

RESULTS

Tables 1 and 2 illustrate the text data which are the survey point coordinates of each of the three buildings that were measured through surveying. The values indicate the coordinate position of corners of the buildings. Northeast (NE), Northwest (NW), Southeast (SE) and Southwest (SW) refer to the particular corner of each building; while T and B refer to the top or bottom position respectively (see Tables 1 & 2). In addition, the buildings' name is represented by B as the first part of the name. In Table 2, are survey points and the coordinate measurements for the control points. These are used to draw an accurate CAD drawing of the area. Table 3 displays GIS queries for thematic mapping and topology analysis. Thematic mapping categorizes feature types by various colors. Topology analysis examines relationships of features [9]. This project allowed three new buildings to be added to the growing AEG base map.

DISCUSSION and CONCLUSION

In order to design an efficient GIS, the first basic goal is to get accurate measurements (locations) of the buildings. By gaining this information it was vital to use surveying equipment, such as the TotalStation along with the reflector and 360 degree prism. Collecting this data was essential for setting the foundations in drawing a 3 dimensional picture. It was necessary that the coordinates and measurements be exact so that GIS topological queries will be accurate. Along with this, a key factor for creating a 3D version of data was the use of MicroStation TriForma.

With MicroStation TriForma, I was able to import data from the surveying equipment into the computer's database. As the information was received, survey points could be processed into making accurate positions to form the foundation of the buildings. I used existing GIS data from the Alignment Engineering Group's project known as AEGis. This allowed me to add my buildings to the existing database and map. The GIS also allowed me to post queries that in turn gave me the results required to relate the buildings to other results in the GIS. There were eight queries that were used and worked efficiently (see Table 3). The results of each query were represented by various colors. In Figure 2, an example of a query result for a thematic map including a legend. After the completion of the buildings in MicroStation TriForma, they were added to the AEGis. There was no analysis that went wrong. The buildings are located southeast of the Computer Building (SCS) and west of the Cryogenics Laboratory. In conclusion, my purpose was to assist the Alignment Engineering Group to create a GIS that will, in the near future, store and use surveying data for measurements that will allow scientists to also use themselves.

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Tables

Building Name-Position	X Coordinate (m)	Y Coordinate (m)	Z Coordinate (m)
B281-NWB	1849256.7822	603143.7332	90.2950
B281-NEB	1849274.3111	603149.1609	90.2950
B281-SEB	1849276.4570	603142.1609	90.2950
B281-SWB	1849258.9281	603136.8031	90.2950
B281-NWT	1849256.7822	603143.7332	93.2127
B281-NET	1849274.3111	603149.1609	93.2127
B281-SET	1849276.4570	603142.2307	93.2127
B281-SWT	1849258.9281	603136.8031	93.2127
B282-SWB	1849262.9585	603123.7186	90.2828
B282-SEB	1849280.4913	603129.1299	90.2828
B282-NEB	1849278.3480	603136.0743	90.2828
B282-NWB	1849260.8152	603130.6631	90.2828
B282-SWT	1849262.9585	603123.7186	93.2160
B282-SET	1849280.4913	603129.1299	93.2160
B282-NET	1849278.3480	603136.0743	93.2160
B282-NWT	1849260.8152	603130.6631	93.2160
B283-NWB	1849276.2989	603149.7645	89.6423
B283-SWB	1849281.7995	603132.3070	89.6423
B283-SEB	1849292.1681	603135.5740	89.6423
B283-NEB	1849286.6675	603153.0315	89.6423
B283-NWT	1849276.2989	603149.7645	92.8623
B283-SWT	1849281.7995	603132.3070	92.8623
B283-SET	1849292.1681	603135.5740	92.8623
B283-NET	1849286.6675	603153.0315	92.8623

Table 1 Surveying points of angle/position measurements of buildings.

Survey Points Name	X Coordinate (m)	Y Coordinate (m)	Z Coordinate(m)
MCP1	1849279.488	603161.261	88.989
MCP2	1849305.078	603157.163	88.525
MCP3	1849256.949	603133.204	89.799
MCP4	1849245.151	603149.309	89.985
MCP5	1849295.372	603122.043	92.645
MCP6	1849264.333	603115.563	92.669

Table 2. Indicates survey control point's coordinates in meters on the XYZ scale.

List of GIS Queries
1. SELECT * FROM BUILDINGS WHERE Type = 'Office' **2. SELECT * FROM BUILDINGS WHERE Type = 'Laboratory'** **3. SELECT * FROM BUILDINGS WHERE Type = 'Service'** **4. SELECT * FROM BUILDINGS WHERE Type = 'Fire Station'** **5. SELECT * FROM BUILDINGS WHERE Type = 'Utility'** **6. SELECT * FROM BUILDINGS WHERE Type = 'Utility'** **7. SELECT * FROM BUILDINGS WHERE Type = 'Gate'** **8. SELECT * FROM BUILDINGS WHERE Type = 'Cooling Tower'**

Table 3. Queries used in the GIS portion of this project.

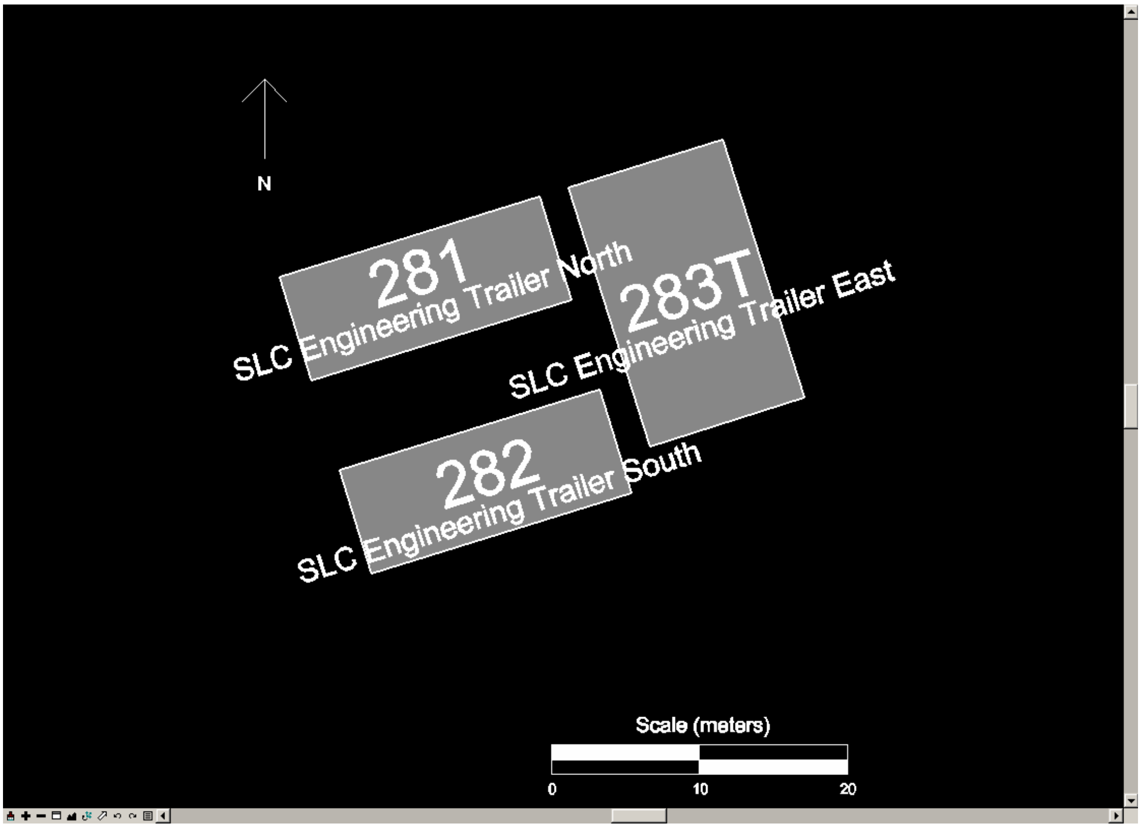

Figure 1. Query results of building type = “offices”**.**

Figure 2. Query result showing a thematic map of various building types.