

Comparison among Height Observation of GPS, Total Station and Level and their suitability in Mining Works by using GIS Technology

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Abstract - Due to the advancement in the computer industry and information technology and evolution of Geographic Information Systems (GIS), the world is moving towards to automating the mining industry to overcome traditional operations that require more time, effort and have many sources of errors. Therefore this research aim to use GIS technique to Compare among Height Observation of GPS, Total Station and Level to suitable the Requirements of Mining Works. Measurement of height or height differences by level is one of the best methods of measurement. However, in this research I wanted to show the degree of homogeneity of the observations taken by the level versus other methods such as Total station and GPS by using statistical analysis and concluded at the end of the research to that result. Although there are some errors in the measurement of the height or height differences by using the total station and GPS, but their accuracy is sufficient in mining works. This demonstrated by using GIS in topographic map for each observation from the three devices used, showing that the differences are simple and any of the three devices can be used in mining works.

Key Words: GIS, GPS, Level, Total Station, Mining works

1.INTRODUCTION

Leveling is the general term, which applied to any of the various processes by which elevations of points or differences in elevation are determined. It is a vital operation in producing necessary data for engineering design, mapping, and construction. Leveling results usually used to:

- 1) Design highways, railroads, canals, sewers, water supply systems, and other facilities having grade lines that best conform to existing topography;
- 2) Lay out construction projects according to planned elevations;
- 3) Calculate volumes of earthwork and other materials;
- 4) Investigate drainage characteristics of an area;
- 5) Develop maps showing general ground configurations;
- 6) Study earth subsidence and crustal motion.

Leveling is the measurement of geodetic height using an optical leveling instrument and a level staff or rod having a numbered scale. Common levelling instruments include the spirit level, the dumpy level, the digital level, and the laser level [1].

Total station instruments can accomplish all of the tasks that could be done with transits and theodolites and do them much more efficiently. In addition, they can also observe distances accurately and quickly. Furthermore, they can make computations with the angle and distance observations, and display the results in real time. These and many other significant advantages have made total stations the predominant instruments used in surveying practice today. These instruments are usually use for all types of surveys including topographic, hydrographic, cadastral, and construction surveys [1].

The Global Positioning System (GPS) used to obtain very accurate heights relative to an ellipsoid. Where several field techniques as well as geoid modeling software have been developed in order to use GPS to obtain elevations based on the geoid. GPS can provide 3D accuracies from several meters down to a few millimeters. These accuracies are dependent on the processing techniques used [2,8].

GIS is one kind of computer system gathering, managing, storing, analyzing, demonstrating and applying geographic information. A general technology can analyze and process enormous amounts of geographic data. It takes a geographic space database as its foundation, uses a geographic model analysis method to provide many kinds of spatial and dynamic geographic information and serves as a geographic research and decision-making tool. GIS has some basic functions such as electronic mapping, spatial data management and spatial information analysis. GIS has been applied in many fields to establish all kinds of spatial databases (Geodatabases) and decision support systems, each with different criteria and provide answers to many different formal spatial inquiries, spatial analyses and assistance plans and decision-making functions [2].

GIS can be applied to many operations in mining industry such as land ownerships, exploration, borehole calculations, volume computations, stoping faces calculations, planning, production and selective mining, development of three-dimensional modeling, 3D analysis, site selection for dumping and waste rocks, transportation, mine reclamation, safety and others [3]. Therefore, the objective of this research to use GIS technique Compare among Height Observation of GPS, Total Station and Level to suitable the requirements of mining works.

1.1 GIS Models

GIS applications enable the storage, management and analysis of large quantities of spatially Distributed data. These data are associated with their respective geographic features. For example, water quality data would be associated with a sampling site, represented by a point. Geodetic and geological data might be associated with fields or experimental plots, represented on a map by polygons [2,3]. Spatial data presented in various models that represent the main GIS types, vector, raster and Triangulated Irregular Network (TIN). Vector data models are suitable for producing various types of high quality and conventional maps. Raster data models are suitable for representing data that varies continuously over geographic area and surface analysis, or overlay functions [4]. TIN represents a surface as a set of irregularly located points, joined by lines to form a network of contiguous, non-overlapping triangles that vary in size and proportion. Each triangle node stores an x, y, and z value [5]. Utilizing TIN is easy to draw contours, make a three-dimensional view of an area and calculate areas and volumes [3].

1.2 Instruments and Software's

- Instruments, which used during field tests includes:
- Trimble R4 GPS system (dual frequency) used to collect GPS observations.
 - Trimble Business Center 2.2 used to process all GPS observations.
 - A Total Station TOPCON (GTS-723) and Level TOPCON AT-B4 used for collecting surveying observations.

In this research statistical, analysis used for modeling the elevation distribution in the three instruments by using GS+ (Geostatistics for the Environmental Sciences) software. GS+ allows user to readily measure and illustrate spatial relationships in geo-referenced data. In addition, it can used to analyze spatial data for autocorrelation and then uses this information to make optimal, statistically rigorous maps of the area sampled [6].

ArcInfo is a powerful, easy-to-use tool that brings geographic information to desktop. ArcInfo gives the users the power to visualize, explore, query and analyze data spatially. In the present study GIS ArcInfo 9.3 software package and (GS+) were used to achieve this work.

1.3. Description of study area

The field test is located at Al-Azhar university, Cairo, Egypt (N 30° 03' 22" and E 31° 18' 54"). Shown in fig.1.



Fig -1: location of study area

2. Data entry

The data used in this study are considered that; excel sheets containing coordinates and elevations for observations of GPS, total station and level.

2.1. Statistical Analysis

Traditional statistics plays an important role to summarize the variability of any variable. Statistical analysis gives the standard parameters, such as mean, standard deviation, and coefficient of variation. These parameters can differentiate between the distributions of any variable.

Statistical analysis gives the distribution of elevations which produced by level, GPS, and T.S. and the standard parameters; Minimum, Maximum, Range, Mean, Median, Standard deviation, Variance, Skewness, Kurtosis, Coefficient of variation, and Root mean square. Table.1 gives the summary statistics of the data sets.

The results show that the distribution is negatively skewed in level and T.S. and positively skewed in GPS while the coefficient of variation indicated that the elevation values does not have the same distribution within all methods.

Table -1: Summary statistics of elevation values in studied methods

Statistical parameters	Level	GPS	T.S.
Number of points	121	200	256
Elevation Min.	72.14	72.84	71.46
Elevation Max.	75.27	89.53	74.55
Elevation Range	3.13	16.69	3.09
Elevation Mean	73.74	74.65	73.63

Elevation Median	73.85	74.70	73.82
Standard deviation	0.45	1.19	0.58
Variance	0.203	1.41	0.34
Skewness	-1.03	9.65	-1.35
Kurtosis	5.76	122.70	4.57
Coefficient of variation	0.006	0.016	0.008
Root mean square	73.74	74.66	73.63

2.2. GIS Database

A key geodatabase concept is the dataset. It is the primary mechanism used to organize and use geographic information in ArcGIS software. The geodatabase contains three primary types of dataset which, feature classes, raster datasets and tables. Creating a collection of these dataset types is the first step in designing and building a geodatabase [7]. The geodatabase for study area created by export above-mentioned data from Microsoft excel to feature class ArcInfo 9.3 software packages. Where many analysis and operations can done on this data.

3. Retrieving Attributes of Features

Any information in geodatabase of study area such as (elevation, coordinatesect) which associated with any feature can be retrieved in ArcInfo 9.3 software by using identify icon from tools menu as shown in figure 2.

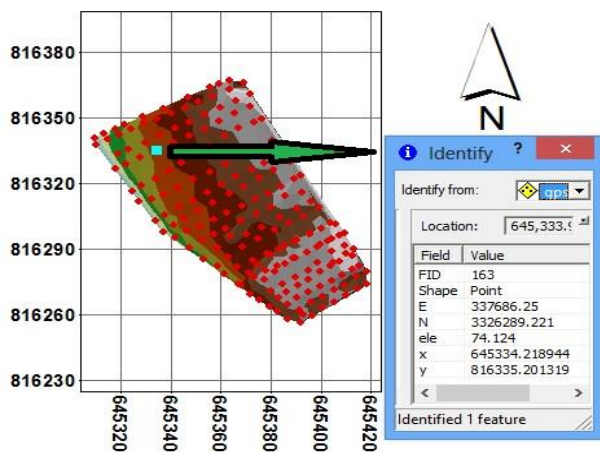


Fig -2: The attributes associated with features in geodatabase.

3.1. GPS Observation

The height observations of GPS was used to create topographic map as shown in figure 3 which consider as interpolated TIN for height. This TIN classified into classes, each class represent specific percentage range from height and colored with specific color, which helps in showing the values of height at different locations in the study area.

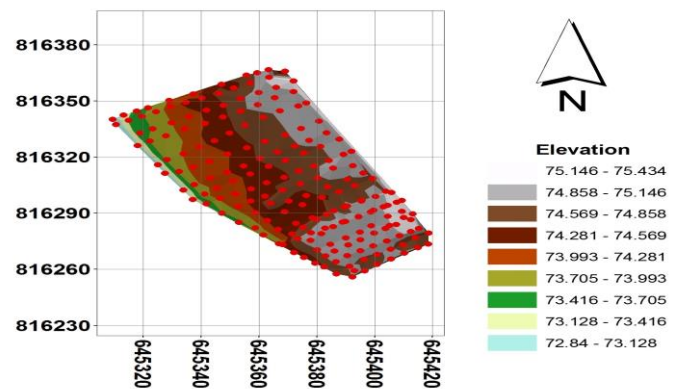


Fig -3: Topographic map of GPS observation.

3.2. Total Station Observation

The height observations of Total Station was used to create topographic map as shown in figure 4 which consider as interpolated TIN for height. This TIN classified into classes, each class represent specific percentage range from height and colored with specific color, which helps in showing the values of height at different locations in the study area.

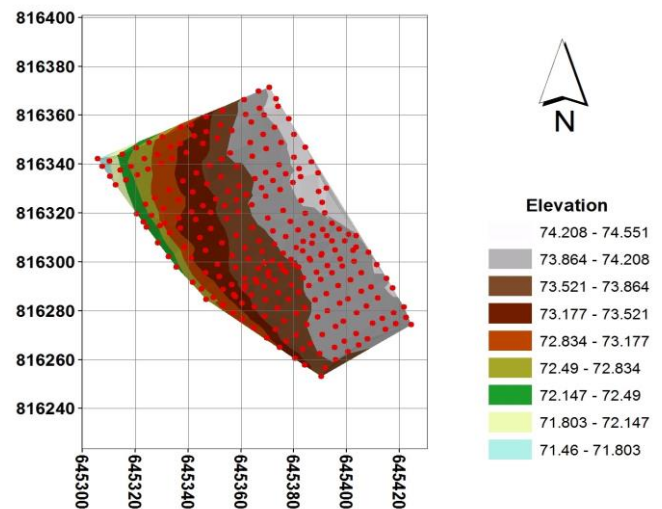


Fig -4: Topographic map of total station observation.

3.3. Level Observation

The height observations of level was used to create topographic map as shown in figure 5 which consider as interpolated TIN for height. This TIN is classified into classes, each class of them represent specific percentage range from height and colored with specific color, which helps in showing the values of height at different locations in the study area.

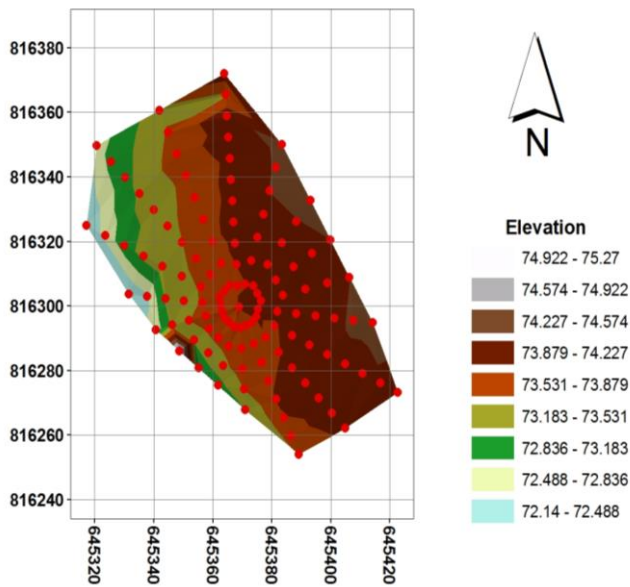


Fig -5: Topographic map of level.

4. Results and discussion

The results of three topographic maps that produced by three instruments give approximately the same results. These results refer to the value of the height in the study area increase in east direction and decrease in the west direction. Topographic maps which consider the basic for many mining works such as opening up, stockpiles, planning for layout of the mine,.....etc. Therefore, we can use any available instrument to measure the heights at different locations to assist in performing many mining works.

5. CONCLUSIONS

1. Statistical analysis proved homogeneity of observation data from level than other instruments.
2. Topographic maps that produced by three instruments give approximately the same results, so we can use any of them to achieve our goal at mining works.
3. GIS database for study area help in editing, storing, analyzing and retrieving any data associated with study area.
4. Many operations in mining industry can be facilitated by using GIS ArcInfo software package.

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