Evaluation of Land Surveying and Mapping using Total Station, GPS and GIS

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*Abstract***— Most surveying works for mapping or GIS applications are performed with total station. Due to the remote nature of many of the sites surveyed, the surveys are often done in unprotected, local, assumed coordinate systems. However, without the survey data projected in real world coordinates, the range of possible analyses is limited and the value of existing imagery, elevation models, and hydrologic layers cannot be exploited. This requires a transformation from the local assumed to the real world coordinate systems. There are various built-in and add-in tools to perform transform- tons through GIS programs. This paper studies the effect of using Georeferencing tool, Spatial Adjustment tool (Affine and similarity) and Champ tool on the precision and relative accuracy of total station survey. This transformation re- quires real-world coordinates of at least two control points, which can be collected from different sources. This research also studies the effect of using geodetic GPS, hand-held GPS, Google Earth (GE) and Bing Base maps as sources for control points on the precision and relative accuracy of total station survey. These effects have been tested by using 128 points covered area of 60,000 m2 and the results have shown that the Champ tool is the best for preserving the relative accuracy of the transformed points. The Georeferencing and spatial adjustment (similarity) tools give the same results and their accuracy are between 1/1000 and 1/300 depending on the source of control points. The indirect leveling method using total station for leveling is considered to have due accuracy, applications of the indirect leveling is gradually expanding for public works such as construction of roads, airports and cities. The results are expected to be used for many public works including routine survey, wide residential land development and subsidence measuring instruments.**

I. INTRODUCTION

Total station surveys are a widely used method to survey topography. With applications ranging from traditional land surveying. Land form evolution monitoring. To land use monitoring. In the geosciences and bio- logical sciences, total stations are now becoming standard tools in monitoring geomorphic change detection of rivers. Streams. Beaches. And mass wasting of hill slopes. Since many total station surveys are now undertaken in remote and/or undeveloped localities, there is often not an established local control network tied to a projected real world coordinate system. Thus, many of these surveys are done from a un- projected local assumed coordinate system. However, as GIS has become more of an everyday tool for visualization, modeling and analysis of topographic data. There is an increasing demand for such surveys. World coordinate system. Transforming total station surveys from unprojected local assumed coordinate system to real world coordinates makes the power of overlaying those data with other datasets (e.g., aerial imagery, vector datasets of roads, political boundaries, etc.) and certain analyses possible.

There are various built-in and add-in tools to perform transformations through GIS programs. This paper studies the effect of using Georeferencing tool, Spatial Adjustment tool (Affine and similarity) and Champ tool on the precision and relative accuracy of total station survey. This transformation requires real-world co-ordinates of at least two control points, which can be collected from different sources. This paper also studies the effect of using geodetic GPS, hand-held GPS, Google Earth (GE) and Bing maps as sources for control points on the precision and Base relative accuracy of total station survey.

II. SIGNIFICANCE OF THE STUDY

1. Determine and evaluate the position of spatial co-ordination by using Global Positioning System.
2. Determine and evaluate the surveying points by using Total station in the form of points, polyline and polygon.
3. Process of Geotransformation of Global Positioning System and Total station survey data.
4. Process of Georeferencing the spatial data (GPS) and assume value data (Total station)
5. Collection of non-spatial data and attribute entity information in Geographic Information System (GIS).
6. To conclude surveying and mapping for the case study with information about research area.

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III. OBJECTIVES OF THE RESEARCH

The general objectives are intended to evaluation of surveying by using two survey methods, there are Total station and Global Positioning System (GPS) and compile with Geographic Information System (GIS). The specifically the research intends to

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4. Process of Georeferencing the spatial data (GPS) and assume value data (Total station)
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studied. To achieve the objectives, test scene was selected and various hardware-software tools were used in present study.

MATERIALS

1) HARDWARE tools used
2) SOFTWARE tools used

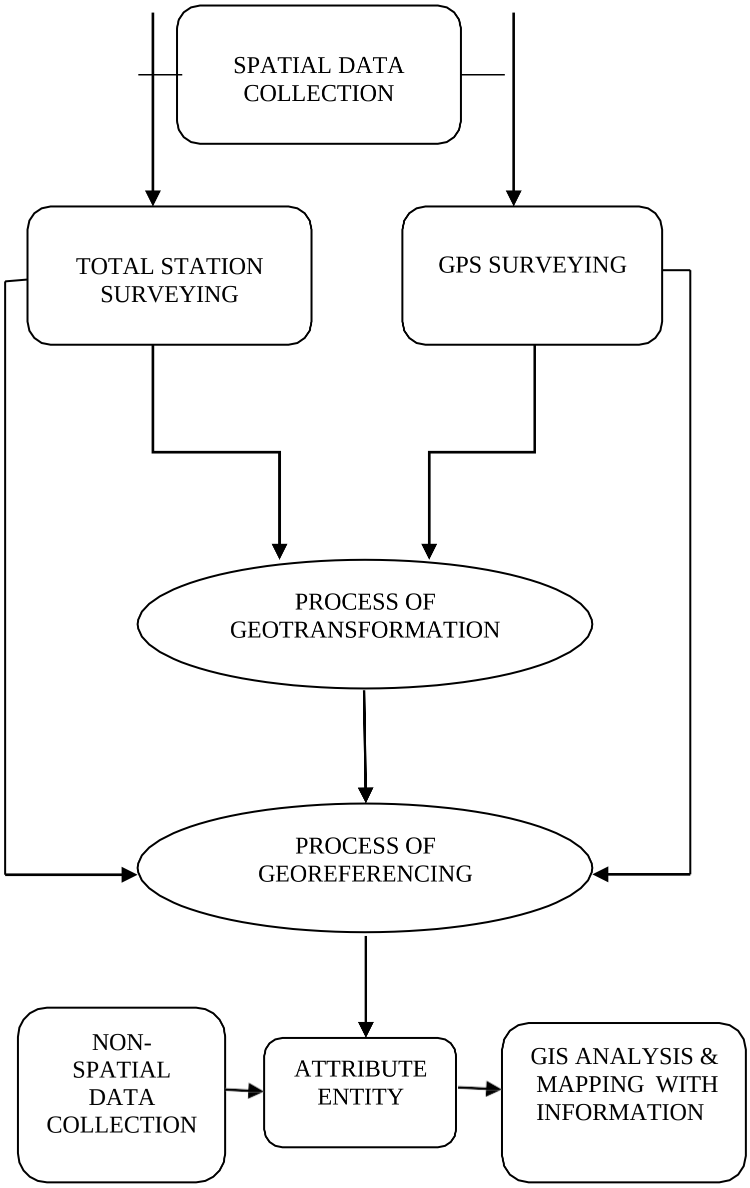
1) HARDWARE TOOLS USED

S.NO	HARDWARE	MODEL NO.	USED FOR
1	Camera	Nikon D-80 SLR	Capturing images
2	GPS system	Garmin Etrex 10 with base and rover (single frequency)	Measuring position of exposure station
3	Total station	Pentax R-425VN	Evaluation of point cloud (for marking locators)
4	Measuring tape , Plumb- bob	Standard(30m) Standard	Object measurement and for centering tripod respectively.
5	Laptop	Hp (Intel Core i3, 64bit, 2.10GHz, 4GB RAM)	Processing work

2) *SOFTWARE TOOLS USED*

S.NO	SOFTWARE /PACKAGES	USED FOR
1	Microsoft Office Picture Manager 2007	Re-sampling pf captured images
2	Photo Modeler Scanner v6.2.2.596	Camera calibration(to find out interior (intrinsic) orientation parameters.)
3	Microsoft Word, Power Point and Excel 2007	Prepare time schedule, report, attribute tables, statistical analysis, and study workflow and presentation slides.
4	ESRI Arc GIS 9.0	Measuring the actual distance between consequent exposure stations Visualization of DGPS points,site and scene.

this study two types of survey methods implemented, there are global positioning system and Total station. The mapping and information part done with the help of GIS software.



GPS SEGMENTS

GPS consists of three segments: the space segment, the control segment, the user segment . The space segment consists of the 24- satellite constellation introduced in the previous section. Each GPS satellite transmits a signal, which has a number of components: two sine waves (also known as carrier frequencies), two digital codes, and a navigation message. The codes and the navigation message are added to carriers as binary biphasic modulations [5].

The carriers and the codes are used mainly to determine the distance from the user's receiver to the GPS Satellites.

The navigation message contains, along with other information, the coordinates (the location) of the satellites as a function of time. The transmitted signals are controlled by highly accurate atomic clocks onboard the satellites. More about the GPS signal Provided.

The control segment of the GPS system consists of a worldwide network of tracking stations, with a master control station (MCS) located in the United States at Colorado Springs, Colorado. The primary task of the operational control segment is tracking the GPS satellites in order to determine and predict satellite locations, System integrity, and behavior of the satellite atomic clocks, atmospheric data, the satellite almanac, and other considerations. This information is then packed and uploaded into the GPS satellites through the S-band link.

System integrity, and behavior of the satellite atomic clocks, atmospheric data, the satellite almanac, and other considerations. This information is then packed and uploaded into the GPS satellites through the S-band link. The user segment includes all military and civilian users. With a GPS receiver connected to a GPS antenna, a user can receive the GPS signals, which can be used to determine his or her position anywhere in the world.

GPS is currently available to all users worldwide at no direct charge.

a) TOTAL STATION

Total station surveying - defined as the use of electronic survey equipment used to perform horizontal and vertical measurements in reference to a grid system (e.g. UTM, mine grid). Total station surveys are a widely used method to survey topography with applications ranging from traditional land surveying.

The Total station is an electronic theodolite (Transit) integrated with an electronic distance meter (EDM) to read slope distances from the instrument to be a particular point.

Robotic Total station allow the operator to control the instrument from a distance via remote control.

At present, Total Station has been widely spread and used in many survey sites, and sometimes it is not fully used since users misunderstand the principles of this unit.

One of them is the leveling, and in case we use Total Station for leveling, this is classified as the indirect leveling method, and since it is judged that this method can maintain the considerable accuracy, now it has been increasingly used for many public works such as road, airport and city etc.

This study empirically made a research in the improvement of accuracy of precise leveling by using the indirect leveling method, Total Station that can more simply and quickly find elevation by replacing the direct leveling.

Drawback that extensive traversing is required. Moreover, extensive clear- cutting and intervening private properties might be required as well. GPS overcomes these conventional-method drawbacks.

Any of the GPS surveying methods, such as kinematic GPS or RTK GPS, can be used depending on the project requirements, location, and other factors. The RTK surveying, however, seems to be the most suitable method, especially in unobstructed areas.

GIS maps are interactive. On the computer screen, map users can scan a GIS map in any direction, zoom in or out, and change the nature of the information contained in the map.

They can choose whether to see the roads, how many roads to see, and how roads should be depicted. Then they can select what other items they wish to view alongside these roads such as storm drains, gas lines, rare plants, or hospitals. Some GIS programs are designed to perform sophisticated calculations for tracking storms or predicting erosion patterns.

GIS applications can be embedded into common activities such as verifying an address. From routinely performing work- related tasks to scientifically exploring the complexities of our world, GIS gives people the geographic advantage to become more productive, more aware, and more responsive citizens of planet Earth.

1) **CO-ORDINATES METHODS***:-* There are numerous transformation methods for transforming between coordinate systems ranging from simple to sophisticated.

The choice of appropriate method depends on the specifics of the application and is generally one that should be made by someone with proper training in surveying and geometrics' as well as a solid understanding of the source data and how it was collected In this paper, the transformation tools built in ArcGIS (e.g. spatial adjustment tool and georeferencing tool), and add-in tools such as Champ tool were used to transform unprojected total station precise observations into projected real world coordinates.

All of these tools use affine transformation. An affine transformation is any transformation that preserves collinearity (i.e., all points lying on a line initially still lie on a line after transformation) and ratios of distances.

In general, an affine trans- formation is a composition of rotations, translations, dilations (scales), and shears (skews) the transformation functions are based on the comparison of the co- ordinates of source and destination points, also called control points .

2) FIELD DATA METHOD:-

Topcon total station GPT-7501 was used to collect the coordinates of more than 100 point in a parking and open space area in King Abdul-Aziz University campus. The total station was first set up on a point with assumed co- ordinates.

Then the total station was oriented with "back-sight azimuth" setup which uses bearing to the back sight point, using assumed bearing for the line connected the two points. Once the survey is begun on this assumed coordinate system, all additional station setups and all data, including three control points (which acquired during the survey course), collected in a single unprojected local assumed coordinate system. The collected data was exported to and once again to The file was used to generate shape file while the file represents the CAD file. Both files are needed to apply the transformation on.

The projected coordinates of the three control points were collected using four methods.

1) RTK GPS with two Topcon GR3 geodetic receivers; one receiver was setup on existing control point at the university main gate while the other receiver was used to acquire the needed points.

2) Garmin handheld GPS.

3) Google Earth at Eye altitude equal to 50 m.

Bing Imagery that is available in ArcGIS as an online base map layer at scale 1:100. ANALYSIS OF SURVEYING AND MAPPING

A. ESTABLISHING REFERENCE NETWORK:-

In order to evaluate the accuracy and precision of the surveyed data, primary it has been established a network of control points which can serve as a reference for comparison with RTK and TLS measurement. The reference network was established fourteen control points using a Leica 1201 total station. To determine the network with high precision, measurements have been taken in two faces with two rounds. Four points of the reference network were also measured with static GPS in order to transform the datum from the local coordinate system to the required coordinate system, SWEREF 99.

Thus, this network served as a reference value. The precision of the remaining RTK and TLS measurements were evaluated depending on this reference value.

Therefore, to accomplish the objectives of this project, data were collected from field measurement. The field measurements were taken using three different surveying instruments: -

1) Global Positioning System (GPS)

2) laser scaner (LS)

3) total station (TS).

To eliminate instrumental errors such as line of sight errors, tilting axis errors and vertical index errors, two face measurements were taken. Since the coordinates determined with total station are provided in local coordinate system, static GPS measurement was needed to transform the datum to SWEREF 99. Then, precision of the network has been obtained from network adjustment and verified for if there have been gross errors were occurred. Detail measurements (RTK on the network and, TLS and TS on the façade) were taken five times to evaluate the precision of the measurement. Finally, accuracy and precision of the detail measurements were tested by RMS and standard deviation analysis respectively.

B. EVALUATION OF ACCURACY AND PRECISION

To evaluate the accuracy and precision of the measurement, RMS and standard deviation of the individual measurements were computed. RMS (root mean square error) is a measure of accuracy of the individual measurement. It can be computed from the deviations between true and measured values. True value of the measured quantity is the value which was determined with significantly higher precision. In this project the coordinates of the reference network were considered as 'true' which is determined in 1mm level.

C. CHOOSING SUITABLE CONTROL POINTS FOR THE NETWROK AND DETAIL SURVEY

Reconnaissance of the project area was the first step in the establishment of control network and followed by marking fourteen control points which are visible each other. Those control points were also suitable for satellite visibility, because RTK method was needed to compare with the TS control points. The points are marked with nails for sustainability reason. The project area was close to L building in the campus of PITS.

D. SETTING UP TARGETS FOR LASER SCANING

In order to compare the results from total station and laser scanner, 21 target points were chosen at the North Eastern façade of the L building. Six black and white target papers were marked as control points for the registration of Scan Worlds. Those target points were also measured with total station. There are requirements to be fulfilled when choosing black and white targets. As Quintero et al, (2008) stated out, not only is the station position important, the positioning of the targets carries equal importance. And so, it is important to note that:

a) Targets be widely separated.

b) Targets have different heights.

c) As few targets as possible on one single line.

IV. GPS APPLICATIONS

The Global Positioning System (GPS) is an all-weather, space- based navigation system. The real time kinematic (RTK) positioning is one of the most popular topics in civilian applications.

Normally, RTK can be used to collect the land use change information successfully and quickly. However, RTK doesn't work due to the overhead obstructions, such as in urban areas or under trees.

Then, all conventional terrestrial survey methods, such as total station (TS), can be used to aid RTK. Since the collected land use change information using either RTK or total station system will be entered to an existed land management system.

Hence, the land use change styles of the interested region could be classified into a certain number of groups from the point view of Geographic Information System (GIS).

In order to reduce the field surveying works of RTK and/or total station (TS), it is necessary to design an optimized and effective field surveying procedure by means of analyzing the land use change styles and environmental characteristics of the interested region.

The following issues will be addressed in this paper:

Performance comparisons between using RTK and using total station system on land use data capture and updating in terms of accuracy, speed, etc.,

Land use change styles analysis on the interested regions. The campus of NCCU was selected as a test region to test the performances of applying RTK and/or total station system on land use change data collection.

The cadastral maps (on different times) of Mu-Za district of Taipei City were analyzed to find the possible land use change styles. The section 2 will introduce the basic concept of integrating RTK and TS on land use change data collection.

The concept of land use change style analysis will be given in section 3. The test procedures and test results will be described and presented in section 4, and some conclusions based on the tests results will be given in section 5.

To check the accuracy of coordinate transformation tools available in ArcGIS, the relative position of surveyed points were calculated before and after transformation using the different tools and compared to the original positions.

The most upper left point was chosen as an origin and the distances from it to all other points were computed using the raw data and data after transforming the coordinates.

The difference between distances to the corresponding points were calculated for control points acquired using geodetic GPS. The relative error in point position using bing basemap control point,using google earth control points and poins using garmin GPS control points represents the errors in relative positions for control point's collected using Bing base map imagery, Google Earth and Hand-held GPS respectively.

There are four types of relative error in point positions using GPS control points and different types of error will be provided. At the same time control points collected using google maps and hand held GPS.

Tapping from baselines Road and Highway surveys

c) GIS

Making decisions based on geography is basic to human thinking. Where we go, what will it shall be like, and what shall we do when we get there are applied to the simple event of going to the store or to the major event of launching a bathysphere into the ocean's depths.

By understanding geography and people's relationship to location, we can make informed decisions about the way we live on our planet. A geographic information system (GIS) is a technological tool for comprehending geography and making intelligent decisions.

GIS organizes geographic data so that a person reading a map can select data necessary for a specific project or task. A thematic map has a table of contents that allows the reader to add layers of information to a base map of real-world locations.

For example, a social analyst might use the base map of Eugene, Oregon, and select datasets from the U.S. Census Bureau to add data layers to a map that shows residents' education levels, ages, and employment status. With an ability to combine a variety of datasets in an infinite number of ways, GIS is a useful tool for nearly every field of knowledge from archaeology to zoology.

A good GIS program is able to process geographic

V. CONCLUSION

The purpose of this research was to evaluate survey between two surveying methods such as GPS and Total station with GIS applications.

In every task survey measurements was recorded and converted to GIS environment. Then in order to evaluate survey with information about details pf the case study.

Therefore, it can be concluded that there were no gross errors in the environments because accuracy maintain compiling with total station and GIS.

In this case study needful for our advanced environment information.

1) USES OF TOTAL STATION

Slope stacking Building corners
Construction project layout
Control and offset lines Levelling
Topographic surveys
Traverse surveying and adjustments

2) BUILDING FACE SURVEYING

Areas Resections Intersections Point projection

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data from a variety of sources and integrate it into a map project.

Many countries have an abundance of geographic data for analysis, and governments often make GIS datasets publicly available. Map fi le databases often come included with GIS packages; others can be obtained from both commercial vendors and government agencies.

This is mainly because of its ease of use and the availability of the results while in the field .In accessible locations or obstructed areas can be surveyed with integrated systems such as GPS/LRF or GPS/total station.

In some cases, such as the case of GPS, the obtained heights are referred to the reference ellipsoid, not the geoid Therefore, these heights are known as the ellipsoidal heights.

An ellipsoidal height can also be positive or negative depending on whether the point is located above or below the surface of the reference ellipsoid. Unfortunately, ellipsoidal heights are purely geometrical and do not have any physical meaning. As such, the various Geomatic instruments (e.g., the total stations) cannot directly sense them.

The uses of total station surveying are Slope stacking, Building corners, Construction project layout, Control and offset lines, Levelling, Topographic surveys, Traverse surveying and adjustments.

In building face surveying are Areas, Resections, and Intersections, Point projection, tapping from baselines, Road and Highway surveys.

Some data is gathered in the field by global positioning units that attach a location coordinate (latitude and longitude) to a feature such as a pump station.

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VI. METHODOLOGY

2) In this thesis, the feasibility of evaluation of land surveying using total station and global positioning system with GIS compilation and transformation method for mapping is