COLLAGE OF ENGINEERING

DEPARTEMENT OF SURVEYING ENGINEERING

SENIOR PROJECT

Title: *Evaluation and Comparison Of Precision Error & Accuracy of Total Station And Differential GPS*

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MAY, 2021

Assosa, Ethiopia

Abstract

Evaluation and comparison of precision, accuracy and time expenditure of two surveying methods. These methods are total station (TS), Differential (GPS).Surveying has been an essential element in the development of the human environment for so many centuries. It is an imperative requirement in the planning and execution of nearly every form of construction. In the area of engineering projects, more sophisticated instruments are employed (total station, and GPS) to improve the efficiency and accuracy. Campus of Assosa University was selected as the study area for this study. GPS was used to locate ground position and track logs of different objects within the study area. Differenicial GPS could receive and track satellite signals between 0 to 3 meters of positional accuracy

Keywords*; Evaluation; comparison; Accuracy; precision; Total station; Differenicial GPS*

CHAPTER ONE

1INTRODUCTION

1.1. Background of the study

In surveying, there are many different disciplines that use instruments to determine the where about of points of interest. Disciplines such as map production, cadastral surveying, measuring and stakeouts on building sites, machine control and analysis are examples among others. Nowadays, there is a large of techniques available for measuring a buildings / areas etc. In surveying, specifically in the area of engineering projects, more sophisticated instruments are employed (total station, and GPS) to improve the efficiency and accuracy. Individual surveying techniques has been commonly used in the history of surveying area to collect data from field measurements for various applications with different accuracy capabilities and requirements. Global Positioning System (GPS) has become as an important tool in data collection. Using GPS, it is possible to conduct survey with less manpower and less time. In this study data collecting analysis was carried out using handheld GPS and Total Station.

The research deals with evaluation and comparison of precision, accuracy and time expenditure of these methods are total station (TS), hand (GPS).

Surveying has been an essential element in the development of the human environment for so many centuries. It is an imperative requirement in the planning and execution of nearly every forms of construction. Where it not for the contribution of surveying. Its principal modern uses are in the fields of transportation, construction building, apportionment of land, and detail mapping.

The significant development of surveying techniques enabled surveying professionals to evaluate precision and accuracy of different surveying techniques. As a result of this evaluation, many advantages has been gained; basically such as improving the efficiency and accuracy of the results. The accuracy of surveying measurements can be improved almost indefinitely with increased cost (time, effort and money). The survey results demonstrated that even though GPS-RTK system was not only practical and efficient(time saving and more efficient in human resources)but also yielded acceptable accurate any maps for moderate accuracy engineering purposes, GPS-RTK system cannot be conducted for every terrain feature.

The role of surveying got much attention to be used in many applications with better accuracy. The term accuracy is common in many applications to express the quality of observations, measurements or/and calculations.

Accuracy and precision for those in the surveying profession (as well as other technical and scientific fields) are defined in different way. Accuracy refers to how closely a measurement or observation comes to measure a true or established value, since measurements and observations are always subject to errors. Precision refers to how closely repeated measurements or observations come to duplicate the measured or observed value.

1.2 Problem statement

Surveying is the technique and science of accurately determining three-dimensional position of points and the distances and angles between them by using (hand GPS, total station). GPS are improving the accuracy of positioning information In some critical locations such as urban areas, the satellite availability is difficult due to the signal blocking problem, multipath etc. which degrade (minimize) the required accuracy in these cause we study about total station and hand GPS.In surveying major problem are measurement errors in hand GPS and total station to collect data in field. Total station can measure a single point coordinate precisely, but the computed coordinates are in local or target coordinate system, which needs datum transformation. The accuracy is affected with angle and distance of sight, weather condition, etc.

1.3 Objective of the research

1.3.1 General objective

The General Objective Of This Research Is Intended To Evaluate And Compare The Accuracy & Precision of Differential GPS And Total Station.

1.4.2 Specific objective:

1) To determine and evaluate precision and accuracy of the total station and hand GPS.
2) To determine the cost (time expenditure) of the two data collection methods.
3) To compare the result of the two method based on RMS and standard deviation analysis

1.4 .3 Research question.

1) How to evaluate precision and accuracy of total station and hand GPS?
2) Which one is more time expenditure from the two data collection methods?
4) Which method is gate best result by RMS and standard deviation analysis

1.5 Significance of the study

In this proposal study will attempt to contribute the proper understanding how to error occur during total station and hand GPS measurement and can be used as a base for further studies for those who are interested in the area. On the other hand, the study can help we to choose appropriate methods from the two (total station, hand GPS). Moreover, since coordinates of the reference points are determined with high precision, it can be serves as a reference values for other users.

1.6 Scope

The scope of this study is limited within Benshangul reign Assosa University evaluating and comparing the accuracy, precision and time expenditure of two surveying methods. Determining and evaluating the accuracy of the measurement need quite stable weather condition.

1.7 Limitation of the study

During this work there have been a lot of limitations especially related with instrument shortage. and also the time is not enough to collect data at field because of these shortage and in climate condition to collect data by GPS so it have been difficult to complete according to the time frame work.

CHAPTER TWO

2. LITRATURE REVIEW

This section describes some of what others have done in related work in order to give brief idea about the overall concept of precision, accuracy and time expenditure of total station and hand GPS. Any blockage from natural or man-made obstacles such as trees and buildings can make use of Campus of Assosa University was selected as the study area for this study. Differenicial GPS was used to locate ground position and track logs of different objects within the study area. Differenicial GPS could receive and track satellite signals between 0 to 3 meters of positional accuracy

GPS method limited or impossible In such cases, total stations are used. Borgelt et al, (1996) compared the accuracy of GPS with total station on the free area and they reported a standard deviation of 12 cm in a vertical position with GPS. But in the case of total station, better results (below 5 mm) have been achieved.

In order to check the compatibility of the RTK method with that of total station method. Ahmed, E.(2012) tested RTK and total station measurements on an existing network. The objective of the test was to assess the RTK achievable accuracy, to check the repeatability of the results under Different satellite configurations and to evaluate RTK performance in urban area. In the test, accuracy and repeatability assessment of the RTK was carried out by comparing the coordinates of points with that of independently precisely determined using a total station. According to the result, the difference between the coordinates of total station and RTK was 2 cm for the horizontal and 3 cm for the vertical coordinates.

According to the work by Ehsani et al, (2004) was surveyed with RTK-GPS. The base station and four reference points were established over the highest point in the survey area Corrected GPS signals are transmitted in real time from a base receiver at a known location to one or more rover receivers

Accuracy and precision for those in the surveying profession (as well as other technical and scientific fields) are defined in different way. Accuracy refers to how closely a measurement or observation comes to measure a true or established value, since measurements and observations are always subject to errors. Precision refers to how closely repeated measurements or observations come to duplicate the measured or observed values

As Csanyi et al, (2007) stated out, small magnitude errors of each individual measurement may affect the quality of the final result by considerable large amount. Therefore, the final result may depend on the quality achieved from each individual measurement.

Habib et al, (1999), he states to evaluate the accuracy and precision of the measurement, RMS and standard deviation of the individual measurements were computed the resulting RMS value is a measure of the external and absolute quality of the scanned derived surface.

To ensure the quality and accuracy of data being collected using total station and differenicial GPS the methodologies chosen for a particular study (Roe, D., 2008).

According to the studies conducted by Jonsson, et al (2003), the measurement was applied to test accuracy of different GPS instruments. It is true that any measurement would not be free from errors. In most cases gross errors may happen in a measurement and therefore the accuracy of the measurement needs to be checked in order to avoid the gross errors.

According to Lin, (2004), accuracy test was made between GPS and total station. The results showed that appositional accuracy of 14 mm has been achieved using GPS while using total station it was possible to determine16mm positional accuracy.

According to per Habitat al, (1999), the resulting RMS value is a measure of the external and absolute quality of the scanned derived surface. The coordinates of the extracted targets are then compared with the independently TS surveyed coordinates using slandered deviation analysis.

The Real-Time Kinematic Global Positioning System (RTK-GPS) is an integral part of surveys. RTK is a technique employed in practices where precision is a must. In RTK, corrected GPS signals are transmitted in real time from a base receiver at a known location to one or more rover receivers. With the recent developments in RTK-based GPS systems, a horizontal accuracy of 1 cm can be achieved by compensating for atmospheric delay, orbital errors and other variables in GPS geometry (Ehsani et al 2004).

2.1 Comparison of Total Station and GPS

Despite many advantages, surveying using total stations or GPS has disadvantages. Surveying with a total station, unlike GPS, is not disadvantaged by overhead obstructions but, it is restricted to measurements between inter-visible points. Often control points are located distant to the survey area, and traversing with a total station to propagate the control is a time consuming task.

For this reason, GPS is used to bring control to the survey site through before continuing the survey with a total station in areas that limit the use of GPS.

GPS can measure points without any line of sight requirement. Since total stations work on the principle of signal reflection, line of sight must be there between total station and prism reflector. This makes GPS more effective tool for control point establishment. However, GPS cannot be used in areas with lot of trees, high rise buildings because of satellite signal interference 6.

- Total station
  - ✓ Both horizontal and vertical accuracies are comparable.
  - ✓ The accuracy depends on the distance, angle and the used prism.
  - ✓ More precise than GPS.
  - ✓ Satellite independent.
  - ✓ Needed inter-visibility between the instrument and the prism.
- **GPS**
  - ✓ The horizontal accuracy is better than the vertical accuracy
  - ✓ The accuracy depends on the satellite availability, atmospheric effect, satellite geometry, multipath
  - ✓ Less precise than total station
  - ✓ Satellite dependent
  - ✓ Visibility is not needed

  Type equation here.Finally, the overall expended time on the reference network using total station and GPS RTK measurement has been recorded and compared. The time needed for the total station measurement use 4 hours and that of GPS RTK measurement use 1:30 hours. When comparing required time of the two methods, total station was consumed more time than RTK.

CHAPTER THREE

3 METHODOLOGY OF THE STUDY

3.1 Study area

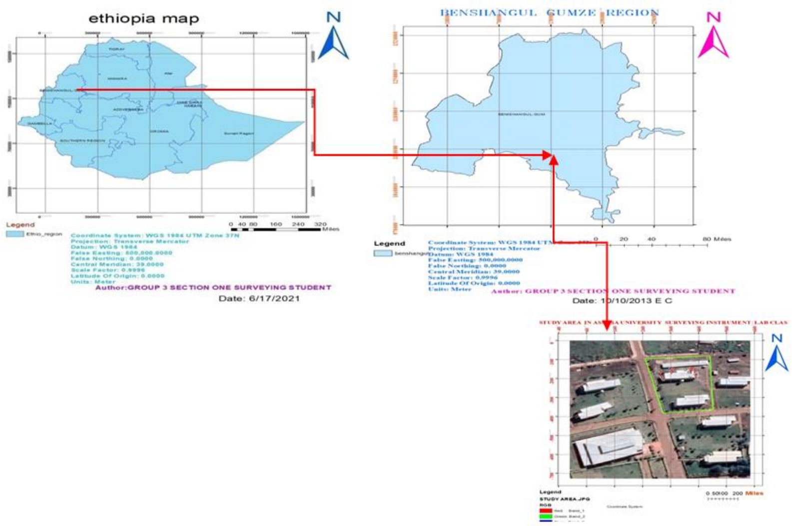

Figure 1 study area.

3. 2 Study of period

We study about evaluation and compare the accuracy and precision of total station and GPS.it will be take the time from month of April 2013 up to jun 2013 to collecting data on the field by the two methods.

3.3 Study procedure

For the implementation of any work, planning is essential and a step by step procedure of work should be followed from beginning to end of the work. In this case study we have planned to proceed in a systematic way.

First, we know the standard information how to data collect by two method (total station and differenicial GPS) and then collect reference point by using pentax total station at eight corner of building for used cooperation RTK method. we know also about cause of error occur at those method and then collect data at three times by two method then calculate error by RMSE method and standard deviation formula and select which method is beset to collect data appropriately depending on result.

3.4 Study design

When we study about these research by using the following procedure first we collect (x, y, z) coordinate data on the selected study area by the two method of (total station and differenicial GPS).

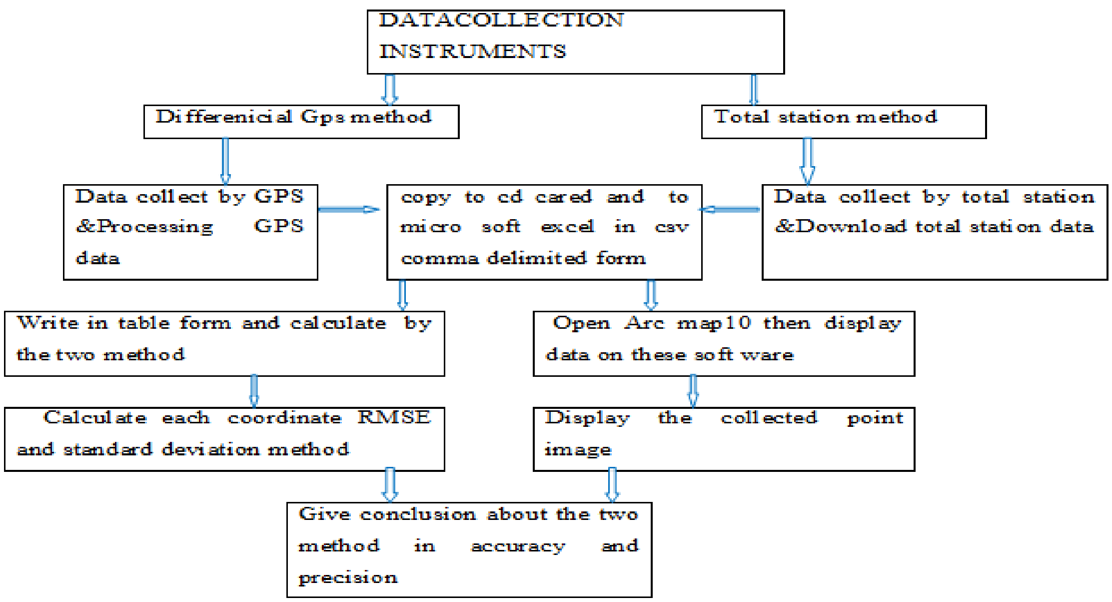

Figure 1 study design

3.5 RECONNAISSANCE SURVEY

Proper field reconnaissance is a prerequisite for survey area. The data of building corner collect by by Total Station method, was used to select the control points of the GPS survey. This point provides required information about the location of buildings. The reconnaissance survey also helped to figure out about the accessible points building corner Due to inadequate direct sky contact signal error occurs and the GPS device cannot work properly in some coordinate of building. In this unavoidable situation we have to proceed by trial and error method by tacking babul and more time at the some point. In that case the way points were fixed up in the accessible points.

3.6 Surveying at field

As much known too many people in the engineering field, the surveying process is the base and or field work, surveying measurements will be taken, whether for fixation of control reference points, setting out of previously determined points onsite or production of maps and quality control. Few examples of such applications include; water pipelines layout, establishment of residential complexes, excavation works, deformation monitoring, etc. This can be done by different instruments and techniques varying in technology, price and application but in this research we collect coordinate of building by using total station and differenicial GPS that used to compression and error determination at known reference point and also record amount of time to take.

3.6.1 Modern surveying methods

Recently, many modern surveying instruments are used in various projects and applications, mainly total stations and differential GPS equipment.GPS receivers wither geodetic precise ones or less accurate navigators, observe continuously rotating satellite signals from sky, and again determine the global coordinates of surveyed points relative to the Global datum. The wide use of the aforementioned instruments comes from their efficiency, or in other words easiness of data sampling, storage and display. This will of course lead to reduction in manpower needed as well as required field and even office work time.

3.7 Practical on the field

After presentation of the different techniques to be adopted in the current research, the theoretical applied part in this research will be introduced, regarding the case study area, and by starting from BM1and BM2 measure the coordinate of the point (x, y, z) at the reference point of building coordinate by using the two method of total station and differenicial GPS.

3.8 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 GPS and TS measurement. Therefore, to accomplish the objectives of this project, data were collected from field measurement. The field measurements were taken using two different surveying instruments: - differenicial Global Positioning System (GPS) and total station (TS).

3.9 Sampling procedure and sample size

How to take sample from the given area? When we collect the data we select some sample coordinate point in the following procedure:

1. Identify which positions (study area) of data to collect.
2. Collect coordinate data by using total station used as reference point or as true value
3. Collect coordinate data by using GPS and total station three time for each.
4. Handling data by memory and paper.
5. The handle data from GPS and total station compare by standard deviation and root mean square method by entering to micro soft excel.
6. Select or conclude the best method which is minimum error stand from the standard or based on reference network.

3.10 Variable

3.10.1 Dependent Variable

Dependent variable to determine the effect of independent variable and perform accuracy data collection due to coordinate of building.

3.10.2 Independent Variable

- Rout main square error method.
- Standard deviation method

3.11 Data collection material

1) Differenicial GPS.
2) Total station with tripod.
3) Paper and pen.
4) Head mat.
5) Prism with reflector
6) Tape

3.12 Error propagation

All surveying observations are subject to errors from varying sources. For example, when observing an angle, the major error sources include instrument placement and leveling, target placement, circle reading, and target pointing. Although great care may be taken in observing the angle, these error sources will render inexact results. To appreciate fully the need for adjustments, surveyors must be able to identify the major observational error sources, know their effects on the measurements, and understand how they can be modeled. In this chapter, emphasis is placed on analyzing the errors in observed horizontal angles and distances.7

3.12.1 Error sources in horizontal angle measurement and coordinate

The total station instrument is used; errors are present in every horizontally observation. Whenever an instrument's circles are read, a small error is introduced into the final angle. Also, in pointing to a target, a small amount of error always occurs. Other major error sources in angle observations include instrument and target setup errors and the instrument leveling error. Each of these sources produces random errors. They may be small or large, depending on the instrument, the operator, and the conditions at the time of the angle observation.

3.12.2 Reading errors

Errors in reading conventional transits and total station depend on the quality of the instrument's optics, the size of the smallest division of the circle, and the operator's abilities. Reading errors also occur with digital instruments, their size being dependent on the sensitivity of the particular electronic angular resolution system. Manufacturers quote the estimated combined pointing and reading precision for an individual direction measured face I (direct) and face II (reversed) with their instruments in terms of standard deviations. Typical values range from 1 for the more precise instruments to 10 for the less expensive ones. These errors are random, and their effects on an angle depend on the observation method and the number of repeated observations.

3.12.3 Observed the point by Repetition Method

When observing any point by repetition using a repeating instrument The coordinate of a point is turned a number of times, and finally, thicken cumulative is read and divided by the number of repetitions, to determine the average value. In this method, a reading error exists in just two positions, regardless of the number of repetitions. For this procedure, the average of coordinate of (x, y, z) point is computed as follow (C. D. Ghilani and P. R. Wolf © 2006)

Coordinate (x, y, z) = [(x1+x2+xn) +(y1+y2+yn)+(z1+z2+zn)]/n

3.12.4 Target centering errors

Whenever a target is set over a station, there will be some error due to faulty centering. This can be attributed to environmental conditions, optical plummet errors, quality of the optics, plumb bob centering error, personal abilities, and so on. When care is taken, the instrument is usually within 0.001 to 0.01 ft of the true station location. Although these sources produce a constant centering error for any particular angle, it will appear as random in the adjustment of a network involving many stations since targets and instruments will center differently over a point. This error will also be noticed in resurveys of the same points. An estimate of the effect of this error in an angle observation can be made by analyzing its contribution to a single direction.

3.12.5 Instrument centering errors

Every time an instrument is centered over a point, there is some error in its position with respect to the true station location. This error is dependent on the quality of the instrument and the state of adjustment of its optical plummet, the quality of the tripod, and the skill of surveyor.

3.12.6 Collimation error

Collimation axis error (line of sight error) affects the horizontal angle to be deviated and resulting in poor accuracy measurement. This axial error is caused when the line of sight (see Fig 4) is not perpendicular to the tilting axis look at point c. It affects all horizontal circle readings and increases with steep sightings, but this effect can be corrected by taking average of two face measurement in two rounds. For single face measurements, an on-board calibration function is used to determine collimation errors, the deviation between the actual line of sight and a line perpendicular to the tilting axis.

3.12.7 Tilting axis error

Vertical axis error (tilting axis error) errors occur when the titling axis of the total station is not perpendicular to its vertical axis. This has no effect on sightings taken when the telescope is horizontal, but introduces errors into horizontal circle readings when the telescope is tilted, especially for steep sightings.

3.12.8 Reflector reading Error

When that reflector is held non vertical (water level) always causes the reading to be too high, this error will appear random in a leveling network, due to its presence in all records are contain error. Thus, the reflector reading error should be modeled when computing the standard error in total station measurement.

3.13 Measurement accuracy

Accuracy Field observations and the resulting measurement are never exact. Any observation can contain various types of errors. Often some of these errors are known and can be eliminated or at least reduced by applying appropriate corrections. However, even after all known errors are eliminated, a measurement will still be in error by some unknown value. To minimize the effect of errors and maximize the accuracy of the final result, the surveyor has to use most care in making the observations. However, a measurement is never exact, regardless of the precision of the observations.

Accuracy is the degree of conformity with a standard or accepted value. Accuracy relates to the quality of the result. The standards used to determine accuracy can be:

– An exact known value, such as the sum of the three interior angles of a plane triangle is 180°.

– A value of a conventional unit as defined by a physical representation thereof, such as the international meter.

– A survey determined or established by superior methods and deemed sufficiently near the ideal or true value to be held constant for the control of detail survey.

The accuracy of a field survey depends directly upon the precision of the survey. Therefore, all measurements and results should be quoted in terms that are commensurate with the precision.

3.14 Precision

Precision is the ability to repeat the same measurement. It is a measure of the uniformity or reproducibility of the result. Precision is different from accuracy in that it relates repeatability of the measurements made. In short a measurement is precise if it obtains similar results with repeated measurements, while accuracy is the closeness to the established value.

3.15 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. RMS was computed using the following formula:

$$\text{RMS (I)} = \frac{\sqrt{\sum_{i}^{n} (L-li)^{\wedge}2}}{\text{n}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad \text{Eq 3.1}$$

Where: L is the established (true) value, $li$is individual measurement and n is the number of measurements.

- Standard deviation is a measure of variations of the repeated measurement, i.e. of the precision of each individual observation. It can be computed from the mean values of the individual measurement and the individual measurement. Standard deviation is it calculated on the excel from FX function computed using the following formula.

SD (I) ==$\frac{\sqrt{\sum_{i}^{n} (L-li)^2}}{n-1}$ Where L= $\sum_{i=1}^{n}$ li/n ……………… Eq 3.2

Where: li is individual measurement, L is mean value of the measurements and n is number of measurements. Generally when the amount of its value increase error also large and we can also determine error by the formula of true value minus (-) measured value.

3.16 Detail survey

Once the reference network and the targets for detail measurement were established, the next step was taking the detail survey. RTK measurement was taken on the reference network to compare the result with total station measurement, and measurements from total station on the building were taken and the results were compared. In order to evaluate the precision of the measurements, all control points and targets points were measured three times. During all measurements the time required was recorded for comparison.

- **Total station**

In order to determine and compare accuracy, precision and time expenditure of the this method, on the building for its corner were surveyed three times with the total station.And time expenditure was also recorded both for field measurement and processing.

- GPS RTK (Real Time Kinematics) the RTK method was performed to compare accuracy of the network with total station measurements.RTK was used to measure the 8 coordinate points the times with 3D quality. This 3D quality describes the accuracy of the GPS measurement. Depending on the satellite availability and other sources of errors that affect the GPS measurement, the magnitude of the 3D quality might be small or large.

CHAPTER FOUR

4 RESULTAND DISCUSSIONS

4.1 Adjustment

Adjustment is an improvement of the measurement, since measurements are not free from errors. Improvements to observations and coordinates for new points are calculated with various quality measures such as standard deviation, RMSE.etc. But we use the two methods to correct the error in these researches.

4.2 Reference (true value) 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 GPS and TS measurement. The reference net work that collect by total station that used to as true value of that point to compare the result of RTK measurement for RMS formula the reference value (true value that used only for GPS of RMS b/s it collect by total station.

Table 1 references network

Point	Reference net work		
	X	Y	Z
A	671060.389	1115826.43	1549.705
B	671061.143	1115830.184	1549.805
C	671065.407	1115828.907	1549.797
D	671071.197	1115847.633	1549.791
E	671069.887	1115850.385	1550.224
F	671071.41	1115862.613	1549.593
G	671061.403	1115865.737	1549.18
H	671050.674	1115829.416	1549.409

4.3 Determination of precision and accuracy of RTK

On the reference network, RTK measurements were taken in order to compare with the total station measurements. Using RTK method, all control points were surveyed 3 times so as to evaluate the precision of the measurements. To compute the precision of the repeated measurement of the reference network, standard deviation formula Eq. (3.2) has been used. Then, RMS of the RTK measurements were also computed using Eq. (3.1) in order to evaluate how much the measurements were close to the established value (true value used as reference value).

According to the work by Ehsani et al, (2004), the base station and four reference points were established over the highest point in the survey area Corrected GPS signals are transmitted in real time from a base receiver at a known location to one or more rover receivers. Results from RTK GPS method, a horizontal coordinate accuracy of 1 cm has been achieved by compensating for atmospheric delay, orbital errors and other variables in GPS geometry. Comparing this thesis with the above work, 8 mm horizontal coordinate accuracy achieved using the same method (RTK).

- To evaluate how much RTK measurements were close to the established value, RMS of the RTK measurements were computed (see Table 2). This RMS indicates the accuracy of the RTK measurements of the reference network. Accuracy of the horizontal coordinates ranges between maximum - mm - cm (at point) and minimum cm (point -). This result can be compared with the work of Ehsani et al, (2004), in which, a horizontal accuracy of 1 cm achieved by compensating for atmospheric delay, orbital errors and other variables in GPS geometry. By comparing the accuracy of horizontal coordinates, they are close to each other. The thesis results are quite reasonable considering the errors attributed from satellite blocking, centering error and so on.

Table 2 Total station mean

Point	Total station mean		
	X mean	Y mean	Z mean
b1c1	671060.3893	1115826.43	1549.71
b1c2	671061.1477	1115830.187	1549.805
b1c3	671065.405	1115828.909	1549.794667
b1c4	671071.194	1115847.643	1549.789333
b1c5	671069.87	1115850.506	1550.230667
b1c6	671071.41	1115862.624	1549.595

b1c7	671061.4163	1115865.736	1549.18
B1c8	671050.6707	1115829.412	1549.413333

Table 3 The difference b/n total station and RTK mean

Point	mean TS			mean RTK			TS-RTK mean		
	X	Y	Z	X	Y	Z			
A	671060.3893	1115826.43	1549.71						
B	671061.1477	1115830.187	1549.805						
C	671065.405	1115828.909	1549.794667						
D	671071.194	1115847.643	1549.789333						
E	671069.87	1115850.506	1550.230667						
F	671071.41	1115862.624	1549.595						
G	671061.4163	1115865.736	1549.180						
H	671050.6707	1115829.412	1549.413333						

In order to check if there were significant differences between total station and RTK results, the difference between the total station and the RTK measurements were computed. The difference was computed using the mean values of the measurements.

Table 4 show standard deviation of total station

Point	TS			St D TS		
	X	Y	Z	X	Y	Z
A	671060.3893	1115826.43	1549.71	0.000577	0.000	0.005
B	671061.1477	1115830.187	1549.805	0.008083	0.005774	0
C	671065.405	1115828.909	1549.794667	0.005292	0.003464	0.005859
D	671071.194	1115847.643	1549.789333	0.005196	0.010017	0.002082
E	671069.87	1115850.506	1550.230667	0.015394804	0.073221126	0.011547
F	671071.41	1115862.624	1549.595	0.000	0.010599	0.003464

G	671061.4163	1115865.736	1549.18	0.011547	0.009019	0

The largest value at measurement of total station standard deviation 7.32 millimeter at point E in vertical direction and 1.53 millimeter in horizontal direction and smallest value is 0 at point A, B, F, G.

Table 5 Comparison of standard deviations between TS and RTK

Point	TS			RTK			St DTS- St D RTK		
	St D X	St D Y	St D Z	St D x	St D y	St D z	St D x	St D y	St D z
A	0.000577	0	0.005						
B	0.008083	0.005774	0						
C	0.005292	0.003464	0.005859						
D	0.005196	0.010017	0.002082						
E	0.015394804	0.07322112	0.011547						
F	0	0.010599	0.003464						
G	0.011547	0.009019	0						

In addition, the standard deviation of the difference between total station and RTK measurements were calculated using (Eq. 3.2) and compared the result with their coordinate differences. Table 6 presents the standard deviation of the difference between total station and RTK. The result shows maximum standard deviation difference of -mm horizontally and - cm vertically. Here the RMS of the total station was not computed because there was no reference value for it b/c of the reference value collect by total station.

4.4 Comparison of Time Expenditure

In order to compare the cost (time expenditure) of the methods applied, the time has been used to record times from setup up instrument to the tack the measurements. The time needed to measure the required tasks without considering the delayed time due to some problems. For the convenient of comparison, time expenditure was classified in to time needed for total station versus GPS. The required time does not include the time for transportation of instruments from store to the field and vice versa, and delayed time due to some problems such as: battery problem, incorrect reading, and any other problem etc is not consider for time expenditure.

Table 6 time compare between total station GPS

Measurement steps	Total station	GPS
	Time expenditure in (minute)	
Tripod Setup	3(3 time set)=9	4
Centering &bubble	4(3 time)=12	3
Tap measurement	1(3 time)=3	…….
Recording &targating	3(13 time)=39	……….
Rover set up and centering	……..	………7
Base set up	………	………5
Total work take	63	19

- Generally we take time expenditure of total station and differenicial GPS from starting of setup up to recording and station change but we do not consider time of material travel from lab to field (study area) and vice versa.Generaly more amount of time is take at measurement of total station compared to differenicial GPS from the above table.

In order to compare the cost (time expenditure) by using both survey instruments, effective time has been recorded throughout the measurement in sample. Effective time refers to the time needed to measure the required tasks without taking considering the delayed time due to unforeseen problems.

CHAPTER FIVE

5 CONCLUSIONS AND RECOMMONDATION

5.1 Conclusion

This research paper will help to Survey at Buildings corner for the purpose of research work was to evaluate and compare accuracy, precision and time expenditure of two surveying methods (TS, GPS). The comparison was made between TS versus GPS RTK on the reference network and in Assosa University. To accomplish the objectives of these is RTK method was performed to compare the result with that of total station. Finally, by using those result we can conclude or identified the baste method for any survey measurement and also we can determine cause of the two measurement error from those method In every task of the measurement, time expended was recorded and compared (see Table 5.7) also we can identify the method of time and man power saving and measuring the same target points with the total station, comparison has been made between the extracted coordinates of the façade and the coordinates measured by the total station.

5.3 Recommendations

The obtained results from this thesis will hopefully improve the knowledge about accuracy, precision and time consumption of the two methods used (TS, GPS). One can differentiate which instrument should be used for which specific application depending on the presented results. For further improvement of accuracy, the following recommendations are forwarded:

- ✓ Total station (pentax) should be calibrated at some time intervals to gate accurate result. Since there was problem in to level and tilt view occur and the three lag of tripod that have no the some result and other on the total station couldn't be leveled at the same time. So, once calibrated the instrument, it will improve the level of accuracy.
- ✓ It can be achieved better accuracy by calibrating those instruments before the measurementto tacke.
- ✓ The time must be select that means the day is free from humidity and any cloud condition for accurate data collect by GPS.
- ✓ During the data collect by total station the comparison of bench mark and any turning point must be approach to zero for accurate data.

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