Chapter 1
Introduction

No doubt that surveying practice has been enlarged in the last few years because much modern technologies have been introduced. So, the areas of applications have been enlarged and a lot of new applications have been evolved.

GPS (Global Positioning System) has been established by the United states Department of Defense starting from 1978 as a mean of navigation (Hofmann-Wellenhof,2001) , from that date GPS has been improved more and more in different applications of surveying .

The use of GPS receivers became popular in many fields. GPS now plays an important role in the surveying practice because it has a wide range of applications , these applications are enlarged day after day , especially in cadastral surveying , net leveling , topographic survey , geodetic control networks , geoid determination , GIS data capture , roads , setting out , . . . , etc.

Compared with classical surveying, there are many advantages make surveyors prefer to use GPS in their works because:

- Line of sight is not required.
- It can be used day and night.
- It gives 3-dimensional results.
- It is faster compared with traditional survey.
- It gives high precision.

In all organizations whether they are private or public, the most important target is the accuracy of the final product. So, it must be taken into consideration during the work cycle.

The cycle of surveying work requires a very big effort in planning , observations , editing , calculations , processing , mapping and production of the final product which may be drawings , reports , list of coordinates or all of them .

Till this product is finished a very expensive instruments are used , a lot of money and time are spent and a big effort is done . So, the question now is "what about the accuracy of the final product ? " , "does it satisfy the expected results?" and if not ," what can be done ?". The observations may be repeated and that means a lost of more effort , money and time . So , the factors which may affecting the accuracy obtained by using GPS must be studied carefully .

Different accuracies can be obtained from GPS to serve in different fields of applications. GPS could be used in navigation, point positioning, and different modes by processing the code. GPS could be used in relative surveying positioning by processing the carriers (phase observations), (Saad and El Tokhy, 2001).

GPS observations now have different techniques for observing and processing data. According to the required accuracy, the suitable technique can be selected to satisfy that accuracy. For example, the technique of observations and processing used for ground control points should be different than that technique used for topographic

survey and cadastral survey. Also, it should be different from that used for cadastral survey or setting out.

Among these techniques there is " The Real Time Kinematic Technique " which now has a wide range of applications especially in grid leveling , topographic survey , cadastral survey , setting out and roads because it has many advantages such as :

- There is no need for post processing.
- The corrected coordinates is obtained at once in the field.
- The final accuracy and standard deviations can be noticed in real time in the field.
- It is more fast and easy to use.
- It is the only technique can be used in setting out, in the real time.

The RTK (Real-Time Kinematic) technique is the most suitable GPS surveying technique for cadastral mapping , and it has many advantages over the tacheometric surveying using the total station. **(**Shaker and El Sagheer, 2002a).

The dream of many geodesists is the millimeter accuracy for short baselines in extremely short time of observations (Hofmann and Remondi, 1988). So, the main target of this thesis is to study carefully the main factors which effecting on the accuracy obtained by this technique in order to get "Accurate Position Determination Using GPS Real Time Kinematic Technique " .

1.1 Statement of the Problem

In recent years there is large number of GPS applications each of them has its own requirements such as equipments to be used, standards, accuracies, field procedures and logistics to be performed.

There are different GPS observation techniques. Among these techniques there are the static technique and the real time kinematic technique.

Each kind of these two techniques has its advantages and disadvantages. The static technique is more accurate to be used in observing ground control points but it requires a long occupation time for the rover to stay on the point. Another disadvantage is that the observations must be processed first in the office to have corrected coordinates. So, the static observation technique requires much effort, much time and high cost to obtain accurate results.

RTK observation technique is less accurate compared with the static technique but it has the advantage that there is no need for post processing because the corrected coordinates is obtained at once in the field. So, it can be used in setting out projects. Also, the short occupation time of this technique which increases the production rate is a big advantage to decrease the cost of any surveying project.

The question now is that "could RTK accuracy obtained be improved to reach or to nearly reach the accuracy obtained by the static observation technique? ".

To answer this question each factor that affects the RTK results must be studied carefully .So, The target of this research is to study carefully the geometrical factors which may affect the accuracy of the RTK results and give each factor of them some restrictions in order to get an accuracy comparable or nearly comparable with that obtained by the static observation technique but in a short time at once in the field.

Many researches were dealt with the comparisons between different GPS observations techniques but this search deals with how to improve the real time kinematics technique accuracy to use this technology in the right way.

To achieve this target the main geometrical factors which affect the RTK accuracy must be studied carefully to determine its influence on the accuracy obtained by the RTK measurements.

The main factors of the study will be :

- The influence of the cut off angle and the satellites altitudes.
- The influence of the number of base stations.
- The influence of the inter visibility between the base and the rover.
- The influence of the data transmission frequency between the base station and the rover.
- The influence of the number of observations (number of Epochs).
- The influence of the number of satellites.
- The influence of the distance between the base and the rover.
- The influence of the azimuths of the base lines.

To study these factors actual observations will be made in the field on two sample areas of about 26 points as will be seen in chapter 4.

Then, the results will be analyzed carefully to determine the influence of each geometrical factor on the RTK observation technique in order to get "Accurate Position Determination Using GPS Real Time Kinematic Technique ".

1.2 The Thesis Objectives

The objectives of this thesis are:

- To study carefully the geometrical factors which may affect the accuracy obtained from real time kinematic observation technique.
- To give each factor of them the required restrictions in order to get the required accuracy.
- To give the user the working instructions required to be followed when using the real time kinematic observation technique in order to use this technology in the right way.

1.3 The Thesis Structure

The thesis is divided into five chapters as following:

Chapter 1 is an introduction to the thesis with a description for the statement of problem and the main target of this research.

Chapter 2 is a basic brief introduction to the global positioning system including a historical background for NAVSTAR GPS, the GPS segments, the navigation signals, the signal structures, code and carrier phase tracking, the basic concept of position calculations and the expected GPS error sources.

Chapter 3 covers the differential GPS observation techniques with concentration on the real time kinematic technique including the correction data transmission , the RTK range , the RTK accuracy , the data links considerations, the GNSS improvements, the real time kinematic technique improvement and the RTK receivers new technology improvement.

Chapter 4 includes the numerical experiments conducted to study the effect of the geometrical factors affecting the real time kinematic observation technique accuracy with a brief explanation for each factor studied.

Chapter 5 is the final summary and conclusions of the study and recommendations for both using RTK observation technique for accurate positioning and future studies.