APG4005F Assignment 3 - Free Network Adjustment

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07/05/2015

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1 Introduction

The aim of this assignment is to conduct an Epoch deformation analysis using fictitious data with a Free Network least squares adjustment.

2 Background

2.1 Classification of Deformation Analysis

There are three main classifications of deformation analysis monitoring methods, Permanent, Semi-permanent and Epoch. There are advantages and disadvantages of all three methods. The main advantages of the permanent and Semi-permanent methods are that they are continuous and offer a very high precision. These two methods make use of a multitude of sensors, such as capacitive, strain, inductance and electro-optical sensors. These sensors are able to produce data in real time which is useful for situations in which immediate data is required in order to, for example, raise an alarm. Some of the disadvantages of these two methods of deformation analysis is that the senors are expensive, and require regular calibration. Epoch monitoring involves geodetic and/or photogramerric techniques to capture data, this is beneficial in that relative and/or absolute positions of many points can be obtained, as apposed to just relative positions in the case of the Permanent and Semi-permanent methods mentioned above. Another advantage of Epoch monitoring is that it is much more cost effective.

2.2 Network Classifications

Typically, when constructing a network for Epoch deformation analysis, a free or minimum constrained network is used, preferably free. In a free network adjustment, no parameter is held fixed, and as a result, precision estimates for all points are provided in the variance-covariance matrices. The effect of holding no parameters fixed is that the shape of the network is defined only by the observations. One of the main advantages of not holding any parameters fixed is that the shape of the network is not affected by erros in the coordinates of the points defining the datum (because the network is not tied to the datum and is allowed to 'float'). Free networks are especially useful in cases where precise surveys are connected to existing point coordinates of lower precisions. A caveat of the free network adjustment is that because the datum is not defined (no points are fixed) a singular normal equation matrix will occur (a rank defect occurs in the normal equation matrix). As singular matrices have a determinant of zero (because one of the eigen values is zero) the normal equation matrix cannot be inversed, and so a solution vector 'x' cannot be obtained. In order to negate the singular normal equation matrix, special mathematical treatment based on the determination of a generalized inverse is applied. To remove the singularity in the normal equation matrix, a set of pseudo-observation equations are added to to the normal equation matrix in such a way that these equations remove the singularity and do not affect the result vector ‘x’.

2.3 Concepts of deformation analysis using geodetic method

2.3.1 Points selection

Points representing the feature to be monitored are selected. The placement of deformation control points must adhere to two criteria: The network configuration must follow the principles of conventional geodetic network design, and the selected points must be representative of the feature in question and points should be suitably placed so as to effectively detect and model any deformation.

2.3.2 Network

A network pre-analyisis based on the least squares adjustment theory should be undertaken. Then, a conventional network of appropriate accuracy should be executed in at least two epochs. In terms of coordinate system to use, Local systems are adequate and preferable, as larger scale coordinate systems are usually of a poorer precision.

2.3.3 Deformation Models

One of a variety of available deformation analysis techniques based on statistical testing is used to detect if point deformations have occurred. Often, a second method is employed to confirm the first analysis.

2.3.4 Inspection

The quantities and directions of deformations are determined.

3 Problem Statement

The aim of this assignment was to conduct an epoch based, deformation analysis using a free network adjustment with an appropriate deformation analysis tequinique.

4 Method

Data for a free network adjustment was obtained after performing a network pre-analysis. Four control points were used to observe to various points of intereset. Two epochs were observed, in the second epoch, points of intereset were artificailly displaced in order to repersent a deformation of those points.

A free network adjustment was then carried out on the xy and the z values independantly.

The X-method of deformation analysis was to be employed in order to model the deformation. The X-method relies on the comparason of point coordinates for the various epochs. The basis of the comparason is the assumption that any deformations in a point field will result in shifts of points which are then reflected in a change of the xy coordinates of the displaced points.

This method like many other analysis methods attempts to answer three questions: 1. Have points shifted, 2. Which points have shifted, 3. What form does the deformation have.

Another popular deformation modelling technique is the l-method. The l-methor or the invarient functions method compares those quantities of the various epoch networks which are invarient to a change of the reference system. Distances and angles will remain unchanged with a change of the datum.

5 Conclusion

In designing a deformation analysis survey, it is important to decide upon the most effective type of deformation analysis to undertake, whether it be permanent or epoch based. It is also very important to select points which are representitive of the area of a feature which is suspect to deform. Assistance from specialists of other fields such as civil engineers should always be seeked so as to ensure an effective deformation survey.