

## **PROCEDURE FOR DEFORMATION DETECTION USING STARNET**

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### **Abstract**

The main steps in the deformation detection via geodetic methods are the least square estimation (LSE) of each epoch, and the deformation detection between epochs. This research focuses on the development of an interface programs called CONVERT, to integrate STARNET V6 (a commercial software) and our in-house software (DEFORM99 and GPSAD 2000), for deformation detection between two epoch (for 2D and 3D applications respectively). In this research, STARNET V6 is used first for LSE of each epoch due to its powerful adjustment capabilities. Next, CONVERT reads the special files created by STARNET, and create the appropriate input files for DEFORM99 and GPSAD 2000. An example is included to show the possibility of using output from STARNET for deformations detection applications.

### **1. Introduction**

The commonly adopted methods for monitoring deformation by geodetic methods are based on the repeated observation of a survey monitoring network at difference epochs (Caspary, 1987), followed by two-step analysis (i.e. independent least squares estimation (LSE) or adjustment of single epoch, and deformation detection between epochs). The detection of deformation uses two-epoch analysis, an absolute monitoring network and a static model to compare the coordinate between the epochs (Halim, 1995).

Surveyors and practitioners usually rely on commercial software, such as STARNET (a powerful adjustment commercial software). However, there is very limited number of commercial software for deformation detection. This research focuses on the development of an interface program called CONVERT (Figure 1), to integrate STARNET V6 (a commercial LSE software) and our in-house deformation detection software (DEFORM99 and GPSAD 2000) for 2D and 3D applications respectively.

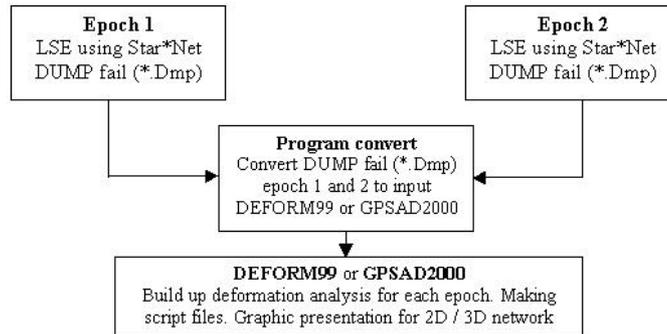


Figure 1- Linking STARNET and GPSAD2000/DEFORM99

## 2. STARNET

STARNET V6 is a powerful windows-based software package for LSE of 2D and 3D survey networks (Starplus, 2000). It employs a rigorous simultaneous least squares adjustment using the variation of coordinates method. Data input includes angles, bearings, azimuths, coordinate differences, directions, distances, elevation differences, zenith angles, etc. For LSE, all these data can be independently or globally weighted.

Approximate coordinate can be entered manually or computed automatically. STARNET V6 performs LSE or adjustment of network, data checking, blunder detection and pre analysis. For deformation detection applications, STARNET V6 provides setting for generating the variance covariance matrix information in a special dump (\*.dmp) file.

## 3. DEFORM99

Program DEFORM99 (Halim & Ong, 2001) comprises of 4 main module for 2D applications (Figure 2): LSE, deformation detection, preparing script file, and graphics presentation (linking with AutoCAD).



Figure 2- Program DEFORM99

## 4. GPSAD2000

GPSAD2000 is a windows based software system specially developed for 3D applications, and consists of 3 module: GPS baseline adjustment via LSE, deformation detection and visualization analysis (Figure 3). GPSAD2000 employs 3 types of LSE solutions based on the selected datum, i.e. minimum constraint, minimum trace (free network) and partial minimum trace. For deformation detection, both GPSAD2000 and DEFORM99 use the method of congruency testing, S-transformation and single point test (Halim & Bong, 2000).



Figure 3- Program GPSAD 2000

## 5. CONVERT

CONVERT is an interface program for linking STARNET V6 and DEFORM99/GPSAD2000 in one environment (Figure 4). This program extracts and converts variance covariance matrix (and other relevant information) in the \*.dmp file into a suitable input format (\*.def file) for DEFORM99 and GPSAD2000. Example of the \*.def file is shown in Figure 5.

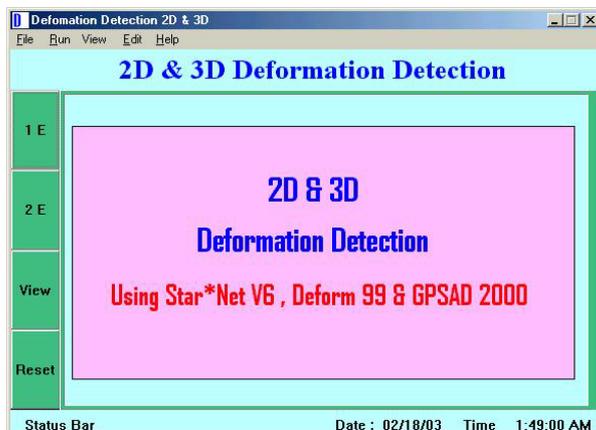


Figure 4- Program CONVERT

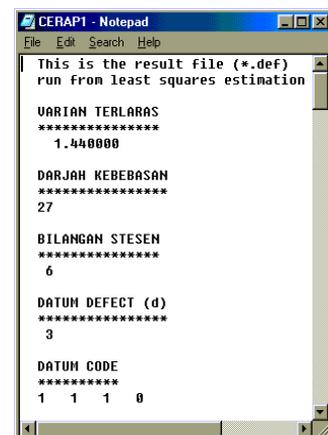


Figure 5- Def file



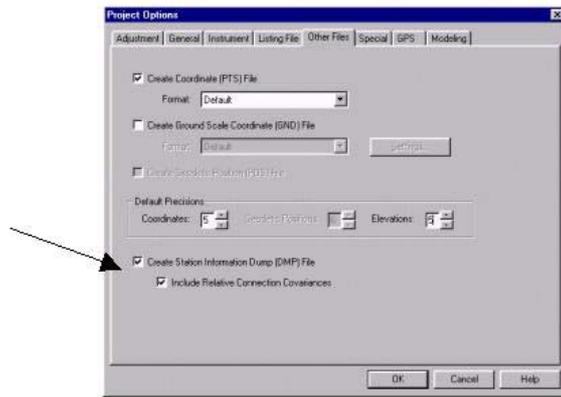


Figure 7- Other files setting

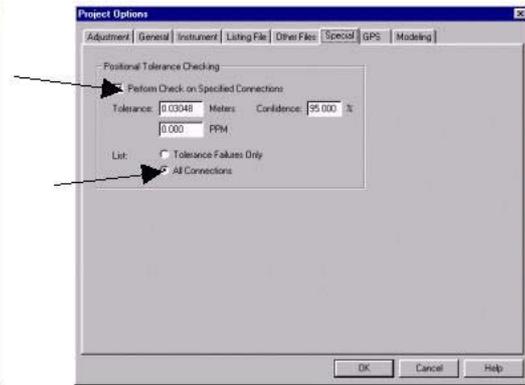


Figure 8- Special setting

**Step 2.**

Conversion of **.dmp files into input files (\*.def files)** using CONVERT (Figure 9).

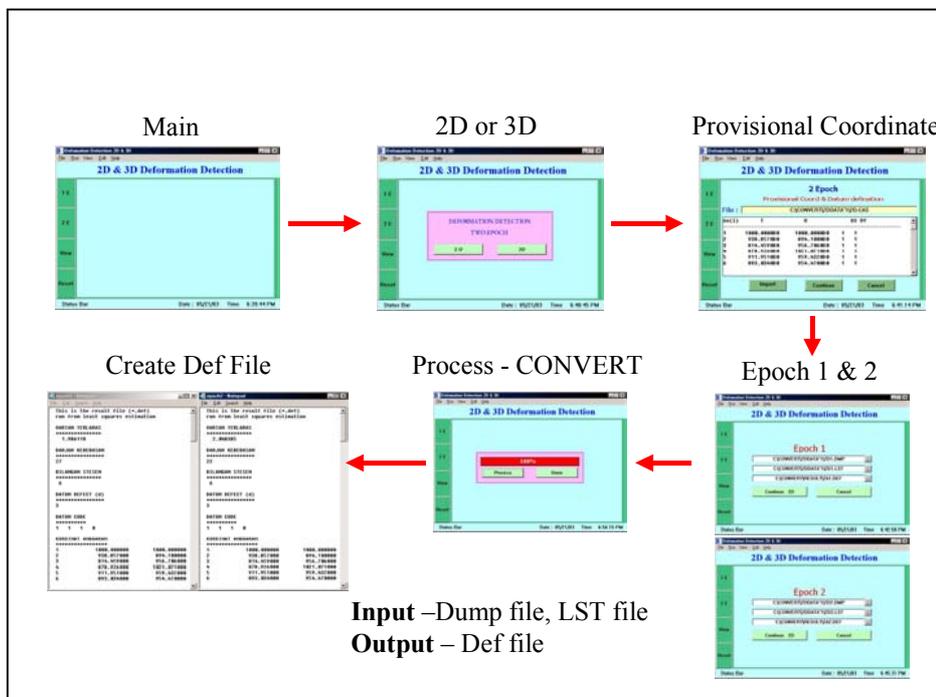


Figure 9- Procedure using CONVERT

**Step 3.**

Deformation detection using DEFORM99 and GPSAD 2000 (Figure 10 and Figure 11).

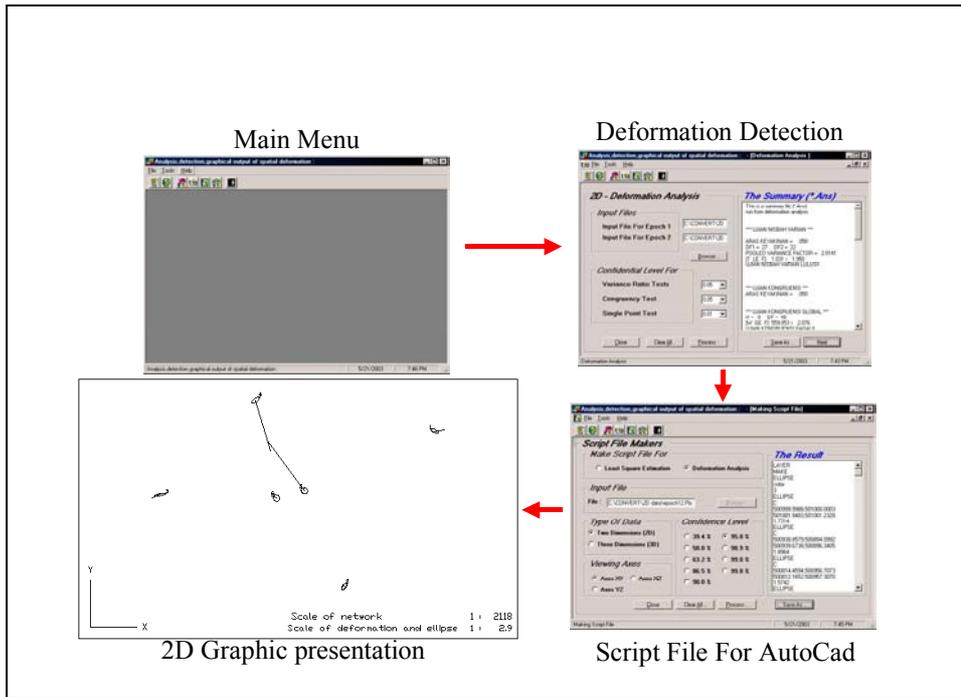


Figure 10- Procedure using DEFORM99

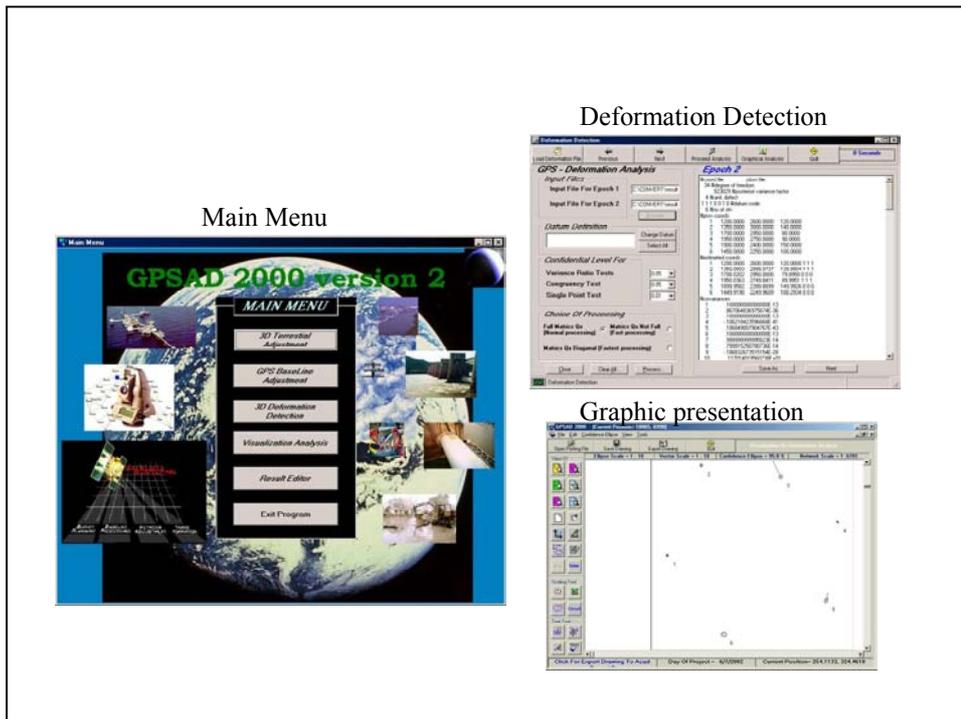


Figure 11- Procedure using GPSAD2000

## 7. Results

Figure 12 shows examples of 2D and 3D deformation detection. Details on the data input, processing, output and interpretation are given in Figure 13.

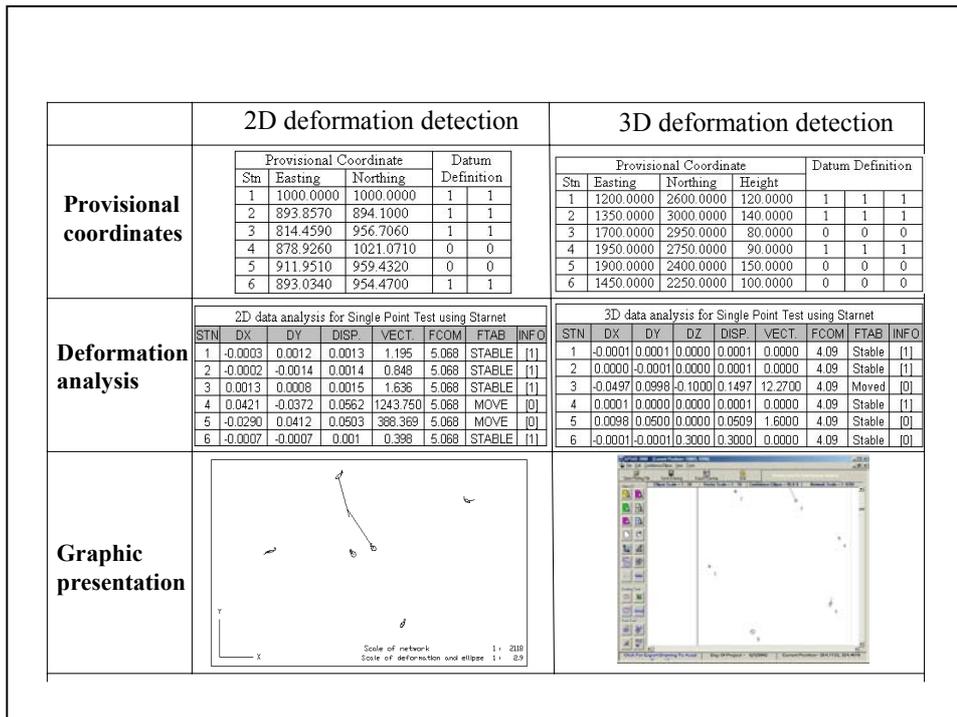


Figure 12- Examples of deformation detection

	2D deformation detection	3D deformation detection
Data input	•Angle & Horizontal Distance	•Angle ,Slope Distance & height diff
Processing	<ul style="list-style-type: none"> <li>•Using STARNET for LSE</li> <li>•Program DEFORM99 for deformation detection</li> <li>•Using partial minimum trace as initial datum definition</li> </ul>	<ul style="list-style-type: none"> <li>•Using STARNET for LSE</li> <li>•Program GPSAD2000 for deformation detection</li> <li>•Using partial minimum trace as initial datum definition</li> </ul>
Output	<ul style="list-style-type: none"> <li>•Graphic presentation in AutoCAD script format (*.Scr)</li> <li>•Linking with AutoCAD to view graphic</li> </ul>	<ul style="list-style-type: none"> <li>•Graphic presentation (built-in)</li> <li>•Export to Autocad *.Dxf format</li> <li>•Save graphic as picture (Gif, Bitmap &amp; Meta file)</li> </ul>
Interpretation	Total Station = 6 Number of Datum Stations /stable = 4 Number of Datum Stations /moved = 0 Number of non-datum stns/stable = 0 Number of non-datum stns/moved = 2	Total Station = 6 Number of Datum Stations/stable = 3 Number of Datum Stations/moved = 0 Number of non-datum stns/stable = 2 Number of non-datum stns/moved = 1

Figure 13- Summary of analysis

## 8. Conclusions

This study focuses on the applications of STARNET, a powerful and popular windows-based commercial LSE software, for 2D and 3D deformation detection. STARNET

provides special setting for generating the \*.dmp files, which contain the necessary information (especially variance covariance matrix) for deformation detection purposes.

Consequently, an interface program called CONVERT was developed, for linking STARNET and our in-house deformation detection software (GPSAD2000 and DEFORM99). It is hoped that surveyors might be beneficial from the integration of STARNET with other software for deformation surveying applications.

## **References**

Caspary, W. F. (1987). Concept of network and deformation analysis. Monograph, School of Surveying, University of New South Wales, Australia.

Halim Setan (1995). Design and Implementation of Computer Programs for Analysis and Detection of Spatial Deformation. Buletin Ukur Jld 6, No.2, pp 84-98, September 1995.

Halim Setan & Ong Boon Sheng (2001). Pembangunan perisian DEFORM99 bagi perhitungan dan pemaparan grafik untuk pengesanan deformasi 2D. Geoinformation Science Journal. Volume 1, Number 1.

Halim Setan & Bong Chin Nyet (2001). Development of a software system for least squares estimation, deformation detection and visualization analysis. Presented at the 10th International Symposium on Deformation measurement, USA, 19-22 March, 2001.

Starplus Software, Inc. (2000). STARNET V6 least squares Survey Adjustment Program. Reference Manual.