Using Virtual Reference Stations "VRS" in Positioning

A Thesis
Submitted to the Faculty of Engineering
Ain Shams University for the Fulfillment
Of the Requirements of M. Sc. Degree
In Civil Engineering - Surveying

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Statement

This Thesis is submitted to Ain Shams University, Faculty of Engineering for the degree of M. Sc. in Civil Engineering.

The work included in this thesis was carried out by the author from 2010 to 2016 and no part of the thesis has been submitted for a degree or a qualification at any other University or Institution.

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

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Abstract

To reach centimeters or millimeters levels accuracy of positioning, this requires using of precise dual-frequency carrier phase observations. Furthermore, these observations are usually processed using (DGPS) technique, such as real time kinematic (RTK) or post-processing (PP) where both methods have many variations based on the same concept.

The virtual reference station (VRS) technique helps satisfying this requirement using a network of reference stations connected to each other or to a control center. In contrast, GNSS network of many reference stations often make use of multiple reference stations as the reference station transmitting the corrections.

Hence, the main objective of the current research is to study the multi-reference station approach in general, especially the VRS approach versus the classical survey, showing how this new approach can help effectively in survey work.

A lot of data were used from the Egyptian CORS network for post processing, stations locations, stations setup, correcting the internal and external loops in the network and connecting the network with the IGS 2008; On the other hand, a real time data were used in Dubai by the (DVRS) network to examine the network accuracy and reliability.

A field test was done on both networks in (PP) and (RTK) modes, showing the 2D and 3D accuraciesare up to mm in the Egyptian CORS with (PP) technique while the accuracy for DVRS is from 10 to 12mm in 2D coordinates and from 18 to 22mm in 3D coordinates.

Another test was done on the Egyptian VRS to show the influence of observation time on the coordinates accuracy, the results showed that after 15minutes the accuracy is acceptable – less than 10mm for (PP) and after 30 minutes its stable at almost 8 to 10mm for baselines up to 35km.

For showing the differences in using single base station and multi-reference station network from accuracy side, a field test was done in Dubai on the (DVRS), using sets of points measured by both single base and the network, it showed that the accuracy is almost the same. On the other hand, the (VRS) has better performance concerning the resulted standard deviation of the obtained coordinates.

Acknowledgement

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Table of Contents

List of Abbreviations

AC – Alternating Current

ADSL – Asymmetric Digital Subscriber Line

CMR - Compact Measurement Record

CORS - Continuously Operating Reference Station

D/A - Digital to Analog

DGNS - Doppler GPS Navigation System

DGNSS - Differential Global Navigation Satellite System

DGPS - Differential Global Positioning System

DVRS - Dubai Virtual Reference Station

E - East

EGNOS - European Geostationary Navigation Overlay Service

ESA – Egyptian Survey Authority

EUREF – European Reference Frame

EVRS – Egyptian Virtual Reference Station Network

FKP – Flachen Korrectur Parameter (in Germany) = network area corrections

GDOP - Geometric Dilution of Precision