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Mathematical Model, Software Design, Implementation and Validation of a General Plate and RTCM Transformation Con cept for Mobile GIS Applications with Android Smartphones

Introduction

Global spatial reference data over time have proven to be more efficient and reliable. This was achieved by making use of receivers with accuracy of few millimetres. RTK networks are rapidly growing as the preferred solution for GNSS data. The use of RTK network sometimes requires the surveyed coordinate to be transformed from a global reference frame to a local reference frame. In Some cases, the transformation and height of the observed coordinate are needed in real time without input from the user.

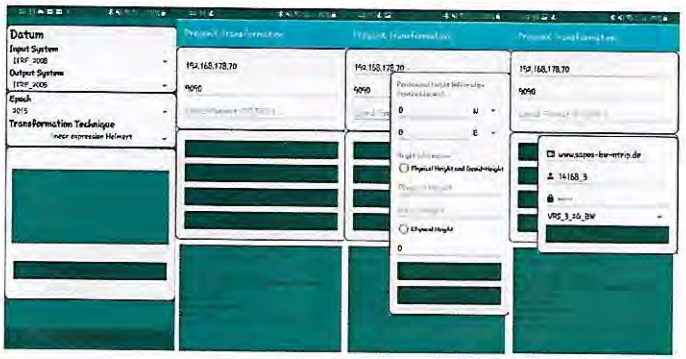
Objective

The objective of the research work is to add datum transformation to the NAVKA Smartphone RTK to transform ITRF20xx.20yy.mm to frozen plates. Also, to implement RTCM 3.x transformation Client for the NAVKA smartphone RTK to transform from frozen plates to regional horizontal and vertical systems. Finally, Practical Tests and Validation using PPP and DGNSS (sapos).

Implementation

The app implementation was done using the Android Studio IDE and Java, cpp. For the transformation phase from ITRF20xx.20yy.mm to frozen plates, the app carries out the transformation by first querying the database to obtain the 7 transformation parameter. When the parameters are obtained, the application then computes the transformed coordinates using either of the four transformation technique supported by the RTCM 3.x transformation. A client feature was added to the NAVKA smartphone app. Using the credentials provided by the user and the position data (rover), the client connect, sends (NMEA), reads and finally decodes the messages sent by the server.

The content of the messages sent by the server are then used to transform from frozen plates to regional horizontal and vertical systems using Helmert transformation technique.



Overview of the implemented graphical user interface

$$\begin{bmatrix} X_T \\ Y_T \\ Z_T \end{bmatrix} = M * \begin{bmatrix} 1 & +R_z & -R_y \\ -R_z & 1 & +R_x \\ +R_y & -R_x & 1 \end{bmatrix} * \begin{bmatrix} X_s \\ Y_s \\ Z_s \end{bmatrix} + \begin{bmatrix} dX \\ dY \\ dZ \end{bmatrix} \qquad \begin{bmatrix} X_T \\ Y_T \\ Z_T \end{bmatrix} = \begin{bmatrix} dX \\ dY \\ dZ \end{bmatrix} + M * \mathbf{R} * \begin{bmatrix} X_S \\ Y_S \\ Z_S \end{bmatrix}$$

$$\varphi_T = \varphi_S + d\varphi \qquad \lambda_T = \lambda_S + d\lambda \qquad h_T = h_S + dh$$

$$\begin{bmatrix} X_T \\ Y_T \\ Z_T \end{bmatrix} = M * \begin{bmatrix} 1 & +R_Z & -R_Y \\ -R_Z & 1 & +R_X \\ +R_Y & -R_X & 1 \end{bmatrix} * \begin{bmatrix} X_S & -X_P \\ Y_S & -Y_P \\ Z_S & -Z_P \end{bmatrix} + \begin{bmatrix} X_P \\ Y_P \\ Z_P \end{bmatrix} + \begin{bmatrix} dX \\ dY \\ dZ \end{bmatrix}$$

Transformation techniques used by RTCM 3.x

Evaluation

The NAVKA Smartphone RTK testing was done Using RTKLIB Version 2.4.3 with fixed setup. The application was tested in two GNSS solutions services and positioning modes (DGNSS, PPP). The accuracy of the datum transformation computation can be said to be good however the accuracy of the computed coordinate is highly dependent on the accuracy of the GNSS position obtained by RTKlib. It can be noted that sometimes the RTCM solutions sent by SAPOS does not contain transformation messages. The reason for this is that if the checksum does not return an integer value, no RTCM message will obtained from SAPOS.

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