GEODETIC NETWORK ADJUSTMENT

THROUGH ROBUST PARAMETER ESTIMATION

BY

JOSEPH LANGAT AWANGE

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ABSTRACT

The classical estimation procedures, such as least squares approach, used to estimate parameters in geodetic network adjustment, take into consideration several assumptions about normality and independence of observational errors, distribution models, and prior distribution for certain parameters. In the event that the assumptions do not hold, owing to the presence of gross errors, the classical procedures loose efficiency drastically.

To circumvent the difficulty of estimating under such circumstances, robust estimation procedures that can accommodate gross errors have been put forward. Robust estimation procedures are supposed to proceed safely despite the presence of gross errors and yield estimates that are largely not affected by the gross errors.

The present study considers four robust estimation techniques as applied in the estimation of geodetic parameters. The procedures have been referred to as; iterative weighting approach, location step with modified residuals, location step with modified weights, and combined approach.

In the iterative weighting approach, observational weights are considered as functions of both variances and residuals, where the weights are derived in an iterative procedure. The location step with modified residuals is based on the minimisation of the residuals in a winsorized version instead of minimising as usual the sum of the squares of the residuals. The location step with modified weights considers the weights as functions of the winsorized residuals with the weights thus obtained iteratively. The combined approach adopts the estimate of the modified residuals approach as the initial values for the modified weights approach.

The techniques are used to estimate geodetic network parameters when the observations are considered to be gross error free and when they are considered to be contaminated with gross errors. Through the analysis of the results with each technique, the effectiveness of estimation with each of the techniques when there are gross errors could be established.

To test the validity of the models under study, a simulated test network that consisted of 19 points, 42 distances and 84 directions has been considered. In the test network outliers were simulated both in distances and directions, and the network adjusted on the basis of free-network solution, first with gross error free observations and then, with the observations considered to have gross errors.

The results indicate that the robust estimation models, in general result in much more efficient estimates than ordinary least squares when observations are contaminated with gross errors. The iterative weighting approach performed extremely well and was most robust with respect to gross error contaminated observations. The performance of the other robust estimation models, in the order of robustness were; the combined approach, modified weights approach, and the modified residual approach.