Lagrangian-Based Least Squares Criterion in Electro-Optical Distance Measurement (EDM) Instrument Calibration

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SUMMARY

Geomatics instruments frequently encounter continuous and barbarous use in highway construction sites. To measure with high precision, Electro-Optical Distance Measurement (EDM), inherent in Total Station instruments, have to fulfil certain requirements. Whether the EDM is old or new, its constant should be capable of automatically correcting the deviation between the mechanical and electrical centres when measuring distance. This calls for EDM calibration in order to control systematic errors in distance measurement. The least squares method minimizes the sum of squares of weighted disparities between observations to obtain a unique estimates from redundant measurements. As such, this method is applied in analyzing geomatics engineering data. In this contribution, the Lagrangian-based least squares criterion in Electro-Optical Distance Measurement (EDM) instrument calibration is assessed. Distance measurements by tape and EDM collected on a 440-meter (from 0+000.00 to 0+0440.00 meters) stretch are used to evaluate the level of accuracy of Nikon Nivo Total Station. The Lagrangian approach is derived and implemented to compute the residual vectors, a posteriori variance factor and the correlation between the two sets of distance observations. In addition, the paper also establishes the total uncertainty of the measured distance using the distance precision provided in manufacturer's literature for the EDM. Using the proposed approach, the study obtains substantial accuracy from the distances determined by the EDM. The achieved level of accuracy is also found to be within the acceptable tolerances for highway engineering projects in Malawi. As such, geomatics engineers may adopt the method in calibrating EDM instruments.