Forum

A Step-by-Step Strategy for Gross-Error Detection

In their paper, "A Step-by-Step Strategy for Gross-Error Detection," *Photogrammetric Engineering and Remote Sensing*, June 1984, pp. 713-718, El-Hakim and Ziemann discuss the following four types of gross errors:

> *Gross error type A*—very large blunders in image coordinates.
>
> *Gross error type B*—very large blunders in coordinates of control points.
>
> *Gross error type C*—errors in either the image or control coordinates but of smaller magnitudes than types A and B.
>
> *Gross error type D*—these are mainly observation errors of magnitudes larger than the random range---.

The *Manual of Photogrammetry*, 4th Edition (ASP, 1980, p. 69) considers the types of measurement error to be

- blunder—mistakes
- constant errors—having same sign and magnitude
- systematic errors—having a definite pattern
- random errors—very small and of any sign

Many other authors, such as Bomford (1971) and Mikhail (1976), use similar definitions for the errors of measurement. In my earlier paper (Rosenfield, 1968), I adapted these usual definitions for use with adjustment techniques:

- random errors—can be treated by methods of probability theory.
- accidental errors—can be detected and removed by editing of the data.
- blunders—cause the adjustment of the data to fail to converge.
- systematic errors—occurrence, size, and direction are regulated by a certain functionally expressable law.

Considering the extensive background on this subject matter, it is surprising that the authors have not chosen to use accepted designations for the errors of measurement.

I was pleased to see that the authors based their gross-error detection strategy on transformation, strip and block adjustment, bundle block adjustment, and rigorous statistical testing since these advanced photogrammetric algorithms are based upon the collinearity equations. The same thoughts are expressed in the epilog section of my earlier paper. However, El-Hakim and Ziemann's strategy does not seem to utilize a sequential algorithm to eliminate the influence of the erroneous data, which would eliminate the need for repetitive adjustments. If the various strip, block, and bundle adjustments need to be performed before detection of the error, and again during and after elimination of the erroneous data, then the presented algorithm is computationally inefficient. My earlier paper used the Creusen sequential algorithm for testing the condition equation effects of one data element at a time. The epilog section suggested that a more advanced sequential algorithm could be utilized. At that time Mikhail (1967, 1973) was working on such an algorithm, which has long since been documented (Mikhail, 1976, Chapter 13).

I feel that I must chastise our journal at this point. It is incumbent upon the paper referees to be aware of the literature in the field, and in this case much prior literature has been ignored. The conventional nomenclature for the theory of errors in measuring science, although well known in the fields of geodesy, photogrammetry, and surveying, have not been utilized. The use of sequential methods in adjustment computations is also well known in these fields and has been documented in prior papers and textbooks. Thus, a computationally inefficient algorithm, although not erroneous, has been accepted for publication without editorial comment.

References

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Response

We welcome Mr. Rosenfield's comments and would like to make the following comments:

The four gross error types A to D were introduced to divide "blunders" or gross errors into groups related to the procedures used for their detection. The four error types, therefore, do not cover constant, systematic, and random errors. Constant and systematic errors can be reduced by the introduction of additional parameters into the mathematical model; however, the treatment of these errors was not within the scope of our paper.

It might be of interest to compare the effectiveness and computational efficiency of our procedure with that suggested by Mr. Rosenfield. As indicated in the paper, polynominal strip and block adjustment and bundle adjustment are entered only after elimination of the "gross errors type A" which are determined by linear conformal transformation of common points in different photographs. This first step has proven to be very effective and accounted for the location of the majority of the gross errors for the two blocks discussed in the paper. The polynominal strip adjustments were, for the majority of the strips, carried out only once, and the result was modified only by rotations, translation, and scale change if a blunder affected control point had been used. The polynominal block adjustment served to identify point numbering irregularities between different strips; again, it was not carried out more than twice for either block. Finally, the bundle adjustment was carried out only a very few times. The procedure was chosen based on past experience, and especially the initial stages have proven in the past to be very effective in locating gross errors. We are not willing to claim a most efficient use of computer time but doubt that efficient use of computer time alone can be a meaningful means for judging the effectiveness of an interactive procedure to locate and eliminate gross errors.

Finally, it is worth pointing out that the procedure proved to be more effective than most others used in the comparative test carried out jointly by the working group "Identification and Elimination of Gross and Systematic Errors of the International Society for Photogrammetry and Remote Sensing" and by the European Photogrammetric research organization (OEEPE).

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