A Proposal for GIS Geometrical Database Fusion

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Within the activites carried out recently at the Centre for Spatial Information Systems (CESIS, University of Udine, Italy) in the field of GIS, great effort has been devoted to the problem of data quality control.

To this regard, a method for gathering together different geometrical layers of a GIS is here proposed. Common referentiation of several layers to an absolute system can be performed with an approach similar to photogrammetric block adjustment: a certain number of control points must be fixed and a sufficient number of tie points are chosen for the same cartographic elements reproduced on the different layers.

The simultaneous adjustment allows to determine the correlation existing between the data layers, and at the same time makes the computation procedure more robust and reliable than single transformations.

Particular emphasis is given to the correct weighting of the functional models relating to each transformation. To this regard, local approximate best invariant quadratic unbiased estimators of variance are proposed.

The data quality of the mapping obtained from the transformation adjustment is validated on the base of the comparison of its contents with the results of alternative and more accurate survey methods, such as GPS measurements. Such comparison is performed for each layer and by means of a statistical hypothesis test. The test can be done by two possible approaches: the classical parametric theory, based on the normal distribution, and non-parametric distribution-free procedures.

The choice between the two must be based on a careful analysis of the form of distribution of adjustment residuals. In case the normality is stated, the well known t-test can be applied. It turns out, however, that normality is frequently rejected, due to the presence of systematic effects of various kinds. In this case the Wilcoxon test can be adopted.

The proposed quality assessment method permits to optimize the testing procedure, in terms of the number of control points required to satisfy a certain sensitivity of the test. This is obtained by the consideration of the power function of the test. This is of great economical advantage, since a control sample of minimal size proves to be sufficient.

In the non-parametric case of the Wilcoxon test, it is quite interesting to use the Bootstrap to the estimation of certain parameters for the computation of the power function.

The proposed procedure is applied to some numerical examples.