

OEEPE Seminar Report

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The OEEPE Seminar on Automatic Orientation of Aerial Images on Database Information was held on Oct.8-9, 1998 at Aalborg, Denmark. The two-day seminar was co-organised by the corresponding OEEPE Working Group, Danish Society for Photogrammetry and Surveying and the Laboratory for Geoinformatics at Aalborg University.

The objective of this seminar was to bring together the professionals in both research and production and explore the optimal approach for automatic exterior orientation based on existing database information, which, among others, includes DTM and orthoimage, and a variety of geocoded vector data such as traffic networks, buildings, land use boundaries and manholes. About 30 participants from 8 countries attended this event. Representatives from industrial firms, national and regional mapping agencies reported on the current status of orthoimage production and updating. Test results on the OEEPE test data, which was distributed to about 50 volunteer participants in April 1998, were presented by participants from research institutes and universities. An invited speech was given by H.Wiman (Royal Institute of Technology, Sweden) on matching techniques for images as well as maps. As a post-conference technical activity, participants visited the Laboratory for Geoinformatics and Laboratory for Image Progressing at Aalborg University.

Orthoimagery Production

The seminar opened with presentations from national and regional mapping agencies. The article from M.Knabenschuh (Surveying and Mapping Agency of Northrhine-Westfalia, Germany) addressed the demands on automatic orthoimage production and map revision. A conclusion was drawn, after reviewing the history of official orthoimage production, that requirements on orthoimages are transiting from black-white to colour in digital form, and the updating cycle has shorten to 5 years. One-third of the exterior orientation tasks are done through aerial triangulation and the other two-thirds are undertaken by spatial resection based on given control points, which are identified manually. In order to achieve full automation of exterior orientation, the software package AMOR (Automatic Model-based ORientation, Institute for Photogrammetry, Bonn University, Germany) will be installed, which uses spatial objects as control. The creation of database for control points and objects is being conducted. The current methodology and specification need to adapt to colour orthoimage production.

J.Erkkilä from Finish National Land Survey categorised the applications of orthoimages in Finland for cadastral, topographic as well as for land parcel identification. The revision cycle varies from 4 years (for land parcel identification) to 5 -10 years (for topographic databases). Similar to other agencies, daily productivity at his agency is about 9 images and the user demands are transiting to colour and false colour products. Aerial triangulation is used to obtain orientation parameters based on manually measured control points.

C.Kragh representing Kampsax Geoplan presented the status of orthoimagery production in Denmark. The demands on orthoimages are changing from topographic applications to statistical applications, from black-and-white to colour products.

Image Orientation

Representatives from research institutes and universities reported their proposals and results on the two independent test data sets provided by OEEPE Working Group.

Test A: Orientation Based on Vector Data

Test A aims at automatic exterior orientation by using geographical features. One panchromatic stereopair at scale 1:5,000 was provided along with geocoded data which consists of point features such as manholes, drain gratings, trigonometric points; linear features such as roads, land use boundary, property boundary; as well as building models.

T.Läbe (Bonn University) presented the test results from the AMOR module. Evenly distributed buildings and roads from the supplied vector data were selected as control objects. An additional check was performed to ensure that only roads with a sufficient number of edge directions were chosen. Spatial resection was performed for two images respectively. Experience showed that manual improvement of approximate flight altitude and direction was necessary to initiate the correct calculation at upper levels of the image pyramid. A recommendation was made that available vector data should not only cover the overlapping part of the stereo model but also the whole image. In order to overcome the possible occlusion and generalisation of vector data, he proposed to complete relative orientation of the stereopair and thereafter the search for control features would be assisted by imposing epipolar geometry.

Test results using solely drain gratings as control points were reported by R.Jedryczka from Olsztyn University of Agriculture and Technology, Poland. This approach started with automatic relative orientation and then semi-automatic initial absolute orientation for the reconstructed stereo model. Re-projecting database objects onto the stereopair helped the operator to obtain initial measurements of the drain gratings, which were refined by precise image correlation afterwards. Measurements with higher residuals in planimetry were detected visually and removed from the final absolute orientation calculation.

Work from B.M.Pedersen (Aalborg University) incorporated both roads, manholes and drain gratings. The essential idea of this method was to match the conjugate points on a raster image and a vector map. In order to do so, the vector data was first rasterised to form an object template. Matching was conducted between image templates and object templates at all levels of the pyramids. An algorithm was designed to determine the road crossings so that the area based template matching could be carried out for road features. Sub-pixel positions of best matching were obtained by fitting the correlation coefficients with a quadratic polynomial. Robust adjustment of Match-T package (Inpho, Germany) was used to process all matching results and calculate the orientation parameters. Comparison with the results obtained from manual manholes measurements showed the difference was 0.005gon (for orientation angles) and 7cm (for camera positions). Experience was gained that robust

adjustment could handle observations with high blunder contamination. It was suggested that relative orientation should be conducted at the beginning of the process.

Theory of line photogrammetry was implemented by M.Karjalainen and R.Kuittinen from Finish Geodetic Institute to perform exterior orientation for parcel map updating purposes. Linear features in the database were re-projected onto the images and measured interactively on the screen. A generalised bundle adjustment algorithm was developed to calculate the exterior orientation parameters. Theoretical studies showed that the precision of spatial resection remained stable when about 100 linear features were involved in calculation. The program used PHODIS (ZEISS, Germany) libraries to handle image data.

Test B: Orientation Based on Orthoimage and DTM

Test B aims at automatic exterior orientation by using existing orthoimage and raster DTM data. One colour aerial image at scale 1:27,000 was provided along with DTM and four 2500*3750 orthoimages with pixel size 0.8m.

A unique solution was presented by Z.Paszotta (Olsztyn University of Agriculture and Technology). The determination of exterior orientation was formulated as a non-linear optimisation problem. The target function, which was a function of orientation parameters, consisted of two parts, the colour value difference and similarity measure between aerial image and orthoimage windows. These two components were balanced via reasonably chosen weight factors. Monte Carlo stochastic method and gradient method were applied to solve this minimisation problem. In order to start the calculation, both methods need to know approximate locations of conjugate image points and approximate orientation parameters. New orthoimages was generated by using the derived orientation parameters. Visual checks indicated that accuracy of better than 1 pixel (0.8m) was reached.

J.Höhle presented the proposal of Aalborg University. It derives 5*5 well distributed templates in the image and determines their ground coordinates by precisely matching with the orthoimage. Correlation coefficients are used as the matching measure and fitted to reach subpixel accuracy. Spatial resection is conducted after the elevation is obtained by interpolating the given DTM data. This method is proposed when using road crossings and other distinct geographical features.

The solution presented by J.Shan (University of Gävle, Sweden) started with point feature extraction in nine 512*512 patches in both aerial and ortho images. Feature correspondence was then performed by cross correlation in a bounded search window. A consistency check based on simple geometric transformation detected the wrong correspondences. Least squares matching was used to refine the results of cross-correlation. A large amount of feature points (1000-2000) were selected for spatial resection where robust estimation was used to further ensure the quality. Theoretical analysis of covariance matrix indicated the resection accuracy was within 0.003 deg. and 0.3m. Co-ordinates of check points were determined in an adjustment procedure integrating elevation interpolation and collinear equation calculation. Accuracy for check points was estimated as better than one pixel (0.8m) based on independent resection and mono-intersection calculation with 97 manual measurements. The stand-alone program was developed with Java and therefore could be used on the Internet.

All participants in Test A and B have submitted the exterior orientation parameters, co-ordinates of 25 check points, which will then be analysed and summarised by the Working Group organiser.

Current and Future Work

The OEEPE tests and two-day seminar raised interest from both industrial sectors, mapping agencies, and academic institutions. It turned out to be a successful event with fruitful discussions and novel as well as effective solutions, some of which were very unique and promising. They are expected to be elaborated and incorporated into practical production for orthoimage and map updating.

A questionnaire regarding to the degree of automation, quality of results, stability of the software, user-interface, time spent etc. was submitted to participants for completion. The Working Group will analyse and summarise the test results based on the details submitted by the test participants.

The proceedings, including general report and analysis of the test results, articles from individual participants, is scheduled to appear in 1999 in the OEEPE publication series.

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