Image analysis for topographic mapping

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Abstract

Image analysis can be defined as the automatic derivation of an explicit and meaningful description of the object scene depicted in the images. For this purpose, individual objects must be recognized and described. This recognition needs prior knowledge of objects in terms of models, which must be made available to the machine. Alternatively, they can also be learnt in a first step of the process itself.

For topographic mapping from aerial and satellite imagery, the larger the scale of the images to be analysed and the more details are required, the more important is geometric information. For smaller resolutions, radiometric and spectral attributes dominate, which explains the good results of multi-spectral classification for satellite images of coarser resolution.

The set up of the object models is a major problem of image analysis. At present, it is still not clear, which elements of an object and scene description need to be taken into account. Recently, more and more statistical methods are used in knowledge acquisition and representation. Presently, these attempts are still provisional, however it is obvious that an efficient automatic generation of models is a decisive prerequisite for the success of image analysis altogether.

Another possibility for introducing a priori knowledge is based on the assumption that images are normally analysed for a certain purpose, pre-defined at least in its main features. In GIS, for example, the available information is described in object catalogues, which contain relevant information for formulating the object models for image analysis. Available GIS data may also be used as part of the knowledge base.

In recent years, important progress was made in image analysis, even though a breakthrough in direction of practical applications has not yet been achieved. Under certain conditions single topographic objects like roads in open terrain, buildings and vegetation can be successfully extracted automatically. The present status of image analysis can be summarized as follows :

- simultaneous use of multiple images, combined with early transition to the three dimensional object space,
- rich modular object modelling encompassing geometric, radiometric, and spectral information,
- simultaneous use of multiple image resolutions and degrees of detail in object modelling in terms of multiscale analysis,
- simultaneous interpretation of different data sources, such as single images and image sequences with geometric surface descriptions and two dimensional maps,
- modelling of context and complete scenes instead of single object classes,
- investigations regarding formulation and use of uncertain knowledge, for example based on graphical models to enable automatic evaluation of the obtained results in terms of self-diagnosis,
- investigations into automatic production of knowledge bases using machine learning.

The paper will present the state-of-the-art in this domain, illustrated by a number of examples.