SEMANTIC OBJECT-BASED IMAGE DECOMPOSITION FOR AUTOMATED GIS DATABASE POPULATION

Cosmin Mihai, IrisVanhamel, Mohamed Jabloun, Thomas Geerinck, Hichem Sahli*

Vrije Universiteit Brussel, 2 Pleinlaan, 1050-Brussels, Belgium
{cmihai, iuvanham, mjabloun, tgeerinc, hsahli}@etro.vub.ac.be

Automated generation of maps from remotely sensed images remains an unsolved problem in the quest for bringing together image analysis and GIS technologies. This paper proposes a framework for an automatic scene interpretation system with the objective of populating/updating a GIS database. The proposed approach exploits semantic contextual information, combining scene and application domain knowledge and their mutual support.

The scene decomposition process is based on an initial rough classification into a set of basic classes: Vegetation, Water, Impervious, Soil, Shadow and Other realized via Vegetation Indices (VI). These can be further refined by the application of specialized detectors. Currently, our efforts focus on the refinement of man-made structures, however, the framework can detail the description of any basic class, provided the presence of the necessary fine-tuning tools.

The refinement of the man-made structures consists of the delineation of roads and paths networks and buildings from the potential container classes defined in the initial classification step: Impervious (for roads and buildings) and Soil (for paths). In addition to these classes describing the materials of the interest objects we also consider the Shadow class which may contain shaded portions of the objects of interest as well as the Other class which may contain image objects slightly deviating from the definition of the class (e.g. a car on a road may be labeled as a different object, thus creating a gap in the region delimiting the interest object). By masking all the regions with different labels than the selected ones we reduce the computational costs and in the same time increase the accuracy of the subsequent detection algorithms.

For roads and paths extraction we have developed a model-based approach for the identification of linear structures, which follows certain assumptions concerning their geometric and radiometric properties [1]. During a local analysis step, the detection of elongated structures is performed by applying a series of morphological filters. The main axis of the extracted elongated structures is determined by applying the watershed transformation on the response of the morphological filtering. The response values along the watershed lines, together with information about orientation, is then used as an input to a line-following algorithm that produces a set of line segments. During a global analysis step, the produced line segments, together with an additional set of segments

* Corresponding author

that correspond to all possible connections between them, are organized as a graph. The nodes of the graph are associated with an observation field and a dedicated Markov Random Field that describes the geometrical properties of the linear structures of interest. Using a binary set of interpretation labels, the final result of optimal connected configurations (optimal graph labeling) is then extracted based on a maximum a posteriori probability criterion. The detected road networks are also masked out for further simplification of the image content.

For the delineation of buildings, the proposed approach is intended for very high resolution remotely sensed images, where buildings sizes are large enough to allow us to detect any 3D evidence such side walls and cast shadows. We have investigated the possibility of identifying building rooftops from a single remotely sensed image, without the use of digital terrain models or stereo vision. Our approach is based on an image interpretation model, which combines both 2-D and 3-D contextual information of the imaged scene [2]. The building rooftop hypotheses are extracted using a contour-based grouping hierarchy derived from the principles of perceptual organization. We use levels of increasing abstraction to successively bridge the gap between raw image data and the 3-D objects of interest. A subsequent hypothesis verification step is performed with a MRF-based labeling scheme for contour grouping which takes into consideration both geometrical similarities and color region attributes. The highest level of the hierarchy consists of the hypothesized rooftops.

The current framework allows for further map refinement by providing very simple means to integrate other specialized detectors and by making available basic semantic information. While still far from being the general solution for the problem of automated map creation from remotely sensed images, the current approach proposes a valid answer to automated semantics extraction and its usage for geographical information delineation.

[1] A. del Toro-Almenares, C. Mihai, I. Vanhamel, and H. Sahli, “Graph cuts approach to MRF based linear feature extraction in satellite images”, *Lecture Notes in Computer Science: Progress in Pattern Recognition, Image Analysis and Applications*, pp. 4756:162-171, November 2007.

[2] A. Katartzis, H. Sahli, E. Nyssen, and J. Cornelis, “Detection of buildings from a single airborne image using a Markov random field model”, *IEEE International Geoscience and Remote Sensing Symposium (IGARSS 2001)*, Sydney, Australia, pp. 2832-2834, 2001.