OBJECT MODEL AND KNOWLEDGE DATABASE FOR AUTOMATED OBJECT-BASED ANALYSIS OF REMOTE SENSING IMAGERY

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1. INTRODUCTION

Challenges connected with current remote sensing imagery include the complex information content provided by high resolution sensor systems as well as a corresponding amount of digital data that requires efficient handling. In order to cope with these challenges research has been carried out to develop novel methods for treatment of this kind of data and imagery. A set of methods comprised under the term object-based image analysis aims to integrate contextual information into both the processes of extracting real-world objects from image data as well as their subsequent subsumption into classes of land cover or land use. Besides on knowledge extraction research furthermore focuses on representing, retaining and re-applying extracted knowledge with the help of formalization methods and database systems. As one result of this research, this paper presents IMALYS, a software prototype to eventually provide automated object-oriented classification procedures for remote sensing data.

2. CURRENTLY IMPLEMENTED OBJECT MODEL

The analysis methodology applied by IMALYS utilizes an object model that resembles a multi-level abstraction approach starting with the original imagery as foundation and aiming at the extraction and classification of real-world objects at the top. Using intensity and contrast information, IMALYS groups image pixels to discrete and statistically homogeneous, yet towards their neighbors heterogeneous, regions. This segmentation is implemented as a combination of region-growing and watershed algorithms and its result forms a first abstraction level of the object model. Homogeneous regions, or cells as they are referred to in regard to IMALYS, can be considered image objects, however they don't necessarily represent real-world objects yet. To prepare a sufficient set of input data for later classification, IMALYS allows to derive a variety of standard and user-defined attributes and features to be associated with the segmented regions. Provided with a set of reference data complying with the intended classification scheme, IMALYS further analyzes the data in two ways that in combination allow the description of complex cell compounds: (1) Neighboring pairs of cells are related to each other according to the set of derived attributes allowing for the identification of typical feature value combinations for the currently considered class. (2) The spatial proximity of each cell is examined to assess the relative frequency of occurrence of certain feature values in order to derive typical context characteristics for the currently considered class. Using the results of both processes a fuzzy probability to be part of a certain class is associated with each cell. This result can be considered the second abstraction level of the IMALYS object model. Finally, IMALYS uses the derived probability and a measure for typical object size as input for an optimized classification process. According to the provided classification scheme, the resulting third level of abstraction corresponds with real-world objects or classes.

3. KNOWLEDGE DATABASE DEVELOPMENT

Besides the classification result knowledge extracted by the described process also includes the characteristics of feature values and feature combinations that were found to be typical for the considered classes after performing neighborship and spatial proximity analysis. To retain this knowledge and to prepare its re-application on similar imagery and reference areas, a knowledge database is developed and implemented. Crucial tasks in this regard include (1) the design of a suitable database structure able to hold such information; (2) the application of formalization procedures to transform extracted knowledge in database-ready form and (3) the development of algorithms that allow for the integration of new knowledge, i.e. learning algorithms.

4. CONCLUSION

IMALYS provides object-based image analysis capabilities by applying a multi-level abstraction, including segmentation of original imagery into statistically homogeneous regions or cells, analysis of neighboring pairs and spatial context and optimized classification. This works well for single scenes. To retain knowledge extracted and in order to re-apply this knowledge for other imagery, a suitable knowledge database is currently under development. With its help IMALYS will eventually make automated classification procedures available.