PhD title: Beyond multi-layer MRF models for change detection in high resolution remote sensing images

Research team: Ayin (equipe de recherche INRIA)

Context: Ayin research team located at INRIA-SAM is dedicated to hierarchical and stochastic models for 2 types of applications: remote sensing and skin care imaging. This PhD will be conducted in collaboration with the Dept. of image processing and computer graphics of Szeged University in Hungary.

PhD topic: Change detection refer to the problem of identifying regions in a series of images taken at various time intervals. Such problems often arise in remote sensing. For example, when we want to extract the accurate silhouettes of moving objects or object-groups in images taken by moving airborne vehicles in consecutive moments (e.g. traffic monitoring). Main challenges are camera motion, noise and the parallax artifacts caused by the static objects having considerable height (buildings, trees, walls, etc.) from the difference image. Another prominent application is the detection of changes in land coverage (e.g. vegetation, agricultural areas, buildings) using high resolution satellite images. In contrast to the previous example, here the images are taken in a much larger time interval, hence a major challenge is how to separate normal changes (e.g. the effect of seasonal changes of background vegetation) from real changes caused by agricultural/industrial activities.

Change detection is typically solved in two steps: first a coarse (but robust) image registration is performed, then the aligned input image pair is segmented into changed (foreground) objects and background. It is clear, however, that these steps cannot be separated as registration has a crucial impact on the extraction of changed image regions as well as an accurate registration would require the knowledge of changes.

The goal of this research work is to develop efficient probabilistic methods for the above type of change detection problems in remote sensing by taking a novel approach which simultaneously register and segment the changed regions. Our previous work on multi-layer MRF models [TIP2009] already demonstrated that various image features need to be considered for a reliable detection of moving objects. This is particularly true when changes over a longer time period has to be detected as the background could also have significant changes which needs a careful modeling. Therefore we will go beyond the simple Markov random field multi-layer models by simultaneously modeling geometric alignment as well as various visual features of the background and foreground regions. Furthermore, the resulting probabilistic model should be computationally efficient (e.g. its energy function should be graph-representable) and its parameters should be estimated from the input images.

[TIP 2009]Detection of Object Motion Regions in Aerial Image Pairs with a Multi-Layer Markovian Model. C. Benedek, T. Sziranyi, Z. Kato and J. Zerubia. IEEE Trans. Image Processing, 18(10): pages 2303-2315, October 2009.

Key words: Change detection, high resolution remote sensing images, MRF, graph

Profile of the candidate: Very good knowledge of image processing, good knowledge of probability (in particular Markov random fields) and/or graph theory, basic knowledge of remote sensing, fluent in English.

Duration: 3 years

Place of work: INRIA-SAM near Antibes, Nice and Cannes in France with a few travels to Hungary

Contact person:

Josiane.Zerubia@inria.fr

Web-page of the team: Ayin web site:
https://team.inria.fr/ayin/

Josiane Zerubia personal web page:
http://www-sop.inria.fr/members/Josiane.Zerubia/index-eng.html

Zoltan Kato personal web page:
http://www.inf.u-szeged.hu/~kato/