SEAMFRAME will capitalise on previous research in the development of environmental modelling frameworks. Moreover, it will support a 'declarative' approach to modelling (Muetzelfeldt and Massheder, 2003). A clear-cut separation between model representation (equations) and model manipulation (data processing, integration routines) will allow the effective re-use of the model in different contexts. The model equations will be semantically denoted, by means of Semantic Web technologies such as RDF and Ontologies. This will open the model structure to automated processing, leading to the possibility of searching models according to their specifications --- and model linking and composition will be greatly facilitated. Finally, another distinctive feature of SEAMFRAME will be the component-oriented approach of its software architecture. Declarative models will be deployed as software components, which can be manipulated by tools such as calibrators, simulators, optimisation routines, which are themselves software components. The use of introspection (Rahman et al. 2004) will allow tools to adapt to the published interface of models, thus granting the required flexibility and extensibility of the framework.

Thirty research institutions from thirteen European countries, including several new member states, are involved in the project. These institutions bring together a vast amount of knowledge and expertise from economic, environmental, agronomic, social and information technology disciplines. The project also includes co-operation with an African and an American research institute. The total budget is 15 million Euros. In 18 months the first prototype should be available and in four years the system should be fully operational. The project is coordinated from Wageningen University (The Netherlands), while the development of SEAMFRAME is coordinated by the Swiss institute IDSIA, part of USI (University of Lugano) and SUPSI (the University of Applied Sciences of Southern Switzerland).

Link:
SEAMLESS website:
http://www.seamless-ip.org

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Image Processing for Forest Monitoring

by Josiane Zerubia and Paul-Henry Cournede

Aerial and satellite imagery have a key role to play in forestry management. The increasing availability of data and their high spatial resolution, which is now submetric, allow automatic tools to be developed that can analyse and monitor forests by accurately evaluating the vegetation resources. The Ariana research group at INRIA Sophia Antipolis, with its strong experience in remote-sensing image analysis and feature extraction, is working on this topic as part of the joint research effort Mode de Vie.

Digitized aerial photographs and satellite images of forests represent convenient data for developing computerized assessments of forestry resources. Such automatic tools are useful for a number of reasons, including the help with which they provide forest managers in classifying species. Such work is currently done by specialists, using difficult image analysis combined with ground verifications. Some tools already exist for this purpose, and use texture information and classification based on parameters such as covariance matrices. However, few take advantage of high data resolution. Nowadays, it is possible to study forests on the scale of individual trees, by resolving the extraction of tree crowns. This is one of the aims of the Ariana research group, which in the last year has adapted its knowledge in stochastic geometry (object processes) to forest-resource evaluation. This will allow the automatic assessment of economically and environmentally important parameters such as the number of tree crowns, the distribution of their diameters or the stem density.

Our approach consists in modelling the forestry images as realizations of a marked point process of trees. This stochastic framework aims at finding the best configuration of an unknown number of geometrical objects in the image, with respect to a probability density defined a priori. This density takes into account both the data, in order to fit the objects to the feature we want to extract, and the interactions between these objects, to favour or penalize some arrangements. In the case of tree-crown extraction, we modelled the trees as ellipses, defined by the position of their centre, their orientation, and their major and minor axes. After simulation, we obtain a collection of objects and have access to several statistics such as the number of trees in the stand, their position and their diameter. If different species coexist, we can add a mark to the objects to describe their type, and obtain a classification during the extraction. Some tests have been performed on digitized aerial photographs of stands of poplars, courtesy of the French Forest Inventory (IFN). These photographs are taken in the infrared, which enhances the chlorophyll matter of vegetation. In future investigations, we will be studying texture parameters in order to distinguish different species during the simulation, and lower-level information to obtain a pre-segmentation of the image before the extraction process.

Another application relevant to forest monitoring has been developed by Ariana in collaboration with Alcatel

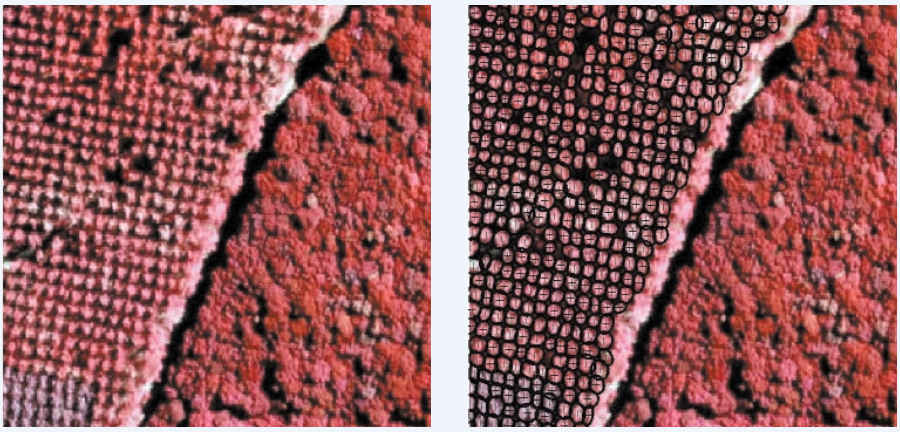

Figure 1: (left) In the original image (courtesy of IFN), the plantation of poplars on the left-hand side can be isolated thanks to a Gabor filter; (right) the result of the extraction process by stochastic geometry (Guillaume Perrin).

Space, and addresses forest-fire detection on satellite images, using the random fields theory. It consists in modelling the image as a realization of a Gaussian field, in order to extract rare events like potential fires that could grow and imply serious damage. For this purpose, the thermal infrared channel (TIR) is selected, since fires show up as peaks of intensity at these wavelengths.

Of further interest is the involvement of Ariana in the ARC joint research effort Mode de Vie, in collaboration with MAS Laboratory (Ecole Centrale Paris), the Digiplante research group (INRIA Rocquencourt, CIRAD), and LIAMA (Sino-French Laboratory of Informatics and Automation, Academy of Sciences, Beijing, China). The purpose of this joint action is to link the assessment of forestry resources with the dynamical models of plant growth developed in Digiplante and LIAMA. The ultimate target would be to develop a complete tool for vegetation monitoring, which could both evaluate the present biomass and predict its evolution.

Links :
http://www.inria.fr/ariana

http://www.inria.fr/recherche/equipes/digiplante.en.html

http://www.mas.ecp.fr

http://liama.ia.ac.cn

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GreenLab: A Dynamical Model of Plant Growth for Environmental Applications

by Paul-Henry Cournède and Philippe de Reffye

Some of the most critical issues for sustainable development and the protection of the environment concern the rationalization of agriculture and forest exploitation. For this purpose, a research project at INRIA, DigiPlant, aims at developing both mathematical models of plant growth and related computing tools. Over the years, an important Sino-European collaboration has emerged, involving research institutes and universities, mathematicians and biologists.

The cultivated areas of Europe, including agricultural land and exploitation forests, have a strong impact on global environmental conditions. Erosion, resource impoverishment due to over-exploitation, and pollution by fertilizers or pesticides are crucial problems that agronomy and forestry hope to solve through harmonious cultivation modes and exploitation strategies. For this purpose, they must take into account production needs on one hand and the environment on the other; that is to say, both quantitative and qualitative criteria. In this context, mathematical models of plant growth describing interactions between the architecture of the plant and its physiological functioning have a key role to play. They allow the exchanges (of water, carbon, minerals etc) between plants and their natural environment to be quantified.

GreenLab is just such a functional-structural model, and is the result of a long dialogue between botanists, physiologists and mathematicians. Derived from the AMAP model developed in the 1990s at CIRAD, GreenLab's new formulation was introduced at LIAMA (Beijing) in 2000. Today, the model is studied and improved upon through the DigiPlant project, which is run by a joint team of researchers from INRIA, CIRAD and Ecole Centrale Paris, and hosted by INRIA. Some very close partnerships exist with LIAMA, China Agriculture University, Wageningen University, Orsay University and INRA.

A number of choices have been made in order to simplify biological knowledge and write the dynamical equations of growth. Organogenetic growth cycles are defined, and an automaton describing the evolution of the buds determines the plant architecture. The botanical concept of physiological age, defining a typology