

Biomedical Imaging and Vision Computing INEB Research Group

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The activities of the BMI-VIC - Biomedical Imaging and Vision Computing group are organized in the following main fields: A - Image Analysis in Medicine and Biology and B - Vision Computing and Biomedical Modelling. The principal tasks and activities developed recently in each one of these fields are described below.

A. Image Analysis in Medicine and Biology

In this field, applications in Medicine and Biology were addressed, namely:

- X-ray chest analysis - several tasks were developed for the analysis of x-ray chest images: a) some of the achievements of the project are the development of two automatic procedures for locating suspicious nodular areas in x-ray radiographs; one of the approaches is based on a new filter (sliding-band filter); the other approach is a classification system for distinguishing nodular and non-nodular image regions based on a multiclassifier system of image features derived from the responses of a multi-scale and multi-orientation filter bank; b) an automated method for extracting the lung region from volumetric X-ray CT images based on material decomposition, by modeling the human thorax as a composition of different materials; the segmentation involves three main steps: patient segmentation and decomposition, large airways extraction and lung parenchyma decomposition, and lung region of interest segmentation. Two PhD theses are being developed under this topic.
- Analysis of biological images - image analysis techniques were developed for gel images, and in particular for Thin-Layer Chromatography images, aiming at automatic band separation and characterization; the image analysis results are a set of features that are the input of a classifier aiming at Lysosomal Storage Disorder classification; two different approaches were developed for solving this classification problem, one based on a hierarchical classifier and another that uses a multiclassifier system. One PhD thesis is being developed under this topic.
- Extraction of 3D surfaces from ultrasonic image sequences - aiming to derive an automatic segmentation method of ultrasonic images of the carotid artery, with or without plaque, and subsequently, use this information to reconstruct a 3D surface of the carotid wall and plaque boundaries. So far, several segmentation techniques have been implemented and tested, including active contour models, anisotropic diffusion models and some experiments with texture-based segmentation, using Gabor filters. An algorithm based on multiphase thresholding and region-based geometric active contour was already conceived to automatically segment the carotid lumen from the rest of the image. One PhD thesis is being developed under this topic.
- Analysis of Retinal Images - the main objective is the automated analysis of retinal images, aiming at the detection of normal and abnormal structures. A method for the detection of the retinal vascular network was developed and evaluated in two publicly available image databases; the results show that the method outperforms the most recently published algorithms for retinal vessel segmentation. Two MSc theses are being developed under this topic.
- Optimization methods in image segmentation - spectral methods for image segmentation were developed; methods for evaluating the performance of different segmentation approaches were implemented and their effectiveness has been compared. One PhD thesis is being developed under this topic.

B. Vision Computing and Biomedical Modelling

In this area we developed a system for 3D visualization of human movement and muscle activation. The data was captured from image sequences of the lower limbs. The human model is based on skeleton/polygonal mesh pairs and it is animated using forward kinematics. The movement of the model adapts to motion data previously captured. For the description and implementation of the movement the CAL3D library was used. In order to develop a realistic 3D model of the human body, data from the Make::Human project was used together with the 3D modeling software Blender. It is also possible to import electromyographic data, in order to represent the level of muscular contraction during the movement. The test application was developed on a walk movement, although the system can be used for other types of movement.

The members of the BMI-VIC group are involved in a new project in high performance computing that was launched in 2005. The main goal of the project is to make available image analysis and processing algorithms for high speed and/or high volume 2D and 3D data. An Application Toolkit, named BioGrid, is being developed as a general purpose grid access tool that provides a parallel and distributed programming environment; it provides an efficient web-based user interface that allows users to develop, run and visualize parallel/distributed applications running on heterogeneous computing resources connected by networks. Two execution models will be available: streaming and data parallel mode.

Members of the BMI-VIC group

The group has one Professor (A. Campilho, co-ordinator of the group) and five Assistant Professors (Ana Maria Mendonça, Jorge Alves Silva, António Monteiro, Miguel Correia, Jorge Barbosa) of the Faculty of Engineering, University of Porto. They are supervising or co-supervising the following students:

- PhD Students: António Sousa, Carlos Vinhais, Fernando Monteiro, Rui Rocha, Luís Alves, Carlos Pereira and Carolina Vila-Chã.
- MSc students: Marta Oliveira, Raquel Guerra, Sandra Dias, Maria Laura Sousa, Celso Silva, Miguel Cunha, José Cruz, Ruben Freire, António Ferreira, Demétrio Matos, Vânia Lima, and Ana Alves.
- Research trainees: João Bateira, and Mafalda Sousa.

Five recent publications

- Barbosa J, Tavares J, Padilha AJ, Optimizing dense linear algebra algorithms on heterogeneous machines, Algorithms and Tools for Parallel Computing on Heterogeneous Clusters, Nova Science Publisher, N.Y., pp 17-31, 2006.
- Vinhais C, Campilho A, Genetic Model-Based Segmentation of Chest X-Ray Images Using Free Form Deformations, Image Analysis and Recognition, LNCS 3656; pp 958-965, 2005.
- Rocha R, Campilho A, Silva J, Segmentation of Ultrasonic Images of the Carotid; Image Analysis and Recognition, LNCS 3656; pp 949-957, 2005.
- Sousa AV, Mendonça AM, Campilho A, Aguiar R, Sá-Miranda C, Feature Extraction for Classification of Thin-Layer Chromatography Images, Image Analysis and Recognition, LNCS 3656; pp 974-981, 2005.
- Correia M, Campilho A, A Pipelined Real-time Optical Flow Algorithm, Image Analysis and Recognition, LNCS 3212; pp. 372-380, 2004.