Título: SOFT COMPUTING AND MACHINE LEARNING FOR IMAGE SEGMENTATION BY DEFORMABLE MODELS

Nombre: Bova, Nicola

Universidad: Universidad de Oviedo

Departamento: Informática

Fecha de lectura: 11/11/2013

Programa de doctorado: Ingeniería Informática

Dirección:

- **Codirector:** Oscar Ibáñez Panizo
- **Codirector:** OSCAR CORDÓN GARCÍA

Tribunal:

- **presidente:** LUCIANO SÁNCHEZ RAMOS
- **secretario:** Petia Radeva Ivanova
- **vocal:** Stefano Cagnoni

Descriptores:

- INFORMATICA
- VISION ARTIFICIAL
- INTELIGENCIA ARTIFICIAL

El fichero de tesis ya ha sido incorporado al sistema

- 2013bovansoftc.pdf

Localización: BIBLIOTECA CENTRAL DE LA UNIVERSIDAD DE OVIEDO

Resumen: Among computer vision processes, Image Segmentation (IS) is a key task. It subdivides an image into its constituent regions or objects sharing certain visual characteristics. Among IS techniques, Deformable Models (DMs) are promising approaches that tackle the problem by exploiting constraints derived from the image data together with specific a priori knowledge. Generally, DMs are curves that detect features of interest in images by means of the minimization of an energy function. The function is defined such that its global minimum corresponds to the ideal DM position. Therefore, the model adjustment process is tackled as a numerical optimization problem.

Regardless the extensive and successful use of DMs, these SI techniques are still affected by several issues. At first, some DMs have difficulties in managing advanced topological changes and common optimization methods can lead to inaccuracies, that is, local optima in the sense of optimization. Besides, it is possible that DMs in general present problems related to the the way they are adjusted. In fact, since the global minimum of the energy function should correspond to the ideal segmentation result, the proper definition of this function is critical

to get a good outcome of the segmentation process. However, expressing this correlation with a robust mathematical formulation is often a daunting task, especially when applied to different IS scenarios. These reasons greatly reduce the applicability of DM in IS.

In this dissertation we aim at providing solutions to the DM problems discussed so far. To do so, we improve DM-based IS techniques by applying methods from both the Evolutionary Algorithms (EAs) and Machine Learning (ML) fields. While the former constitutes a class of efficient, bio-inspired optimization methods used to provide solutions to computationally intractable problems, the latter concerns the study of algorithms that can learn models from data.

On the one hand, we focus on a specific DM, Topological Active Nets (TANs). A TAN is a DM integrating region-based and boundary-based segmentation capabilities. It is defined by a set of interrelated nodes arranged as a deformable mesh. Despite their promising features, TANs have experienced a limited adoption due to limitations regarding difficulties in managing topological changes and the employed local search-based optimization method, which can lead to local optima of the optimization function. The latter issue has been addressed by embedding TANs in a EA-based global search framework, able to consider multiple alternatives in the segmentation process. However, while previous EA-based proposals were effective in avoiding local minima, they failed to design proper evolutionary operators able to effectively combine nets, thus negating the main advantage of a global search approach. To solve these issues, we introduce an extended version of the TAN model by providing a solution to the problems of the original model. Then, we tackle the tendency of the TAN to get stuck in local minima of the energy function by embedding the DM in a novel EA-based global search framework.

On the other hand, we propose an accurate, flexible, and general purpose system for automatic IS employing ML techniques to perform a direct guidance of the DM contour. We provide an implementation of the proposed system designed as the interaction of a specific set of components. They were chosen aiming at providing accurate results in different medical IS scenarios.

The proposed methods were compared with state-of-the-art IS techniques. They were competitive or even outperformed them on various image datasets.

The work carried out resulted in two JCR journal articles and two conference papers. A third JCR journal article will be submitted in the near future.