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Editorial

Special Issue on Fuzzy Logic for Image Processing

Laura Caponetti * and Giovanna Castellano *

Computer Science Department, University of Bari Aldo Moro, 70125 Bari, Italy
* Correspondence: laura.caponetti@uniba.it (L.C.); giovanna.castellano@uniba.it (G.C.)

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The increasing availability of huge image collections in different application fields, such as medical diagnosis, remote sensing, transmission and encoding, machine/robot vision, and video processing, microscopic imaging has pressed the need, in the last few last years, for the development of efficient techniques capable of managing and processing large collection of image data. In particular, techniques suitable for analysis, indexing and the retrieval of image data are of fundamental importance today. Classical image processing methods often face great difficulties while dealing with images containing noise and distortions. Under such conditions, fuzzy logic techniques turn out to be effective to address challenging real-world image processing problems that are often characterized by vagueness and uncertainty. The present Special Issue on Fuzzy Logic for Image Processing is intended to show the potential and the practical impacts of fuzzy logic techniques in challenging applications involving tasks required to understand, represent, and process digital images.

The Special Issue received several submissions, all of which went through a rigorous peer-review process. After the review process, six papers have been selected on the basis of the review ratings and comments. These selected papers range over main applications of fuzzy logic in image processing, including image classification, image segmentation and edge detection.

Classification of scenes, regions or objects within images is a fundamental task in many fields, especially related to image retrieval and remote sensing. In particular, scene classification in remote sensing images is an active research topic in the field of aerial and satellite image analysis, which aims to is to categorize images into a discrete set of meaningful classes according to the region types on the Earth's surface. The first paper entitled "Land Cover Classification from Multispectral Data Using Computational Intelligence Tools: A Comparative Study" [1] addresses the problem of image fusion in land cover classification from multispectral satellite images. The authors propose a fuzzy fusion approach to fuse remote sensing spectral images into a higher level image of land cover distribution. When compared against other computational intelligence methods, this fuzzy approach demonstrates its suitability for spatio-temporal image fusion.

Another essential and crucial task in image processing is segmentation, which consists of identifying homogeneous regions of interest in images for facilitating their characterization and further processing. Particularly, image segmentation is of fundamental importance in the field of medical imaging. For example, in Magnetic Resonance (MR) brain image analysis, segmentation is commonly used for detecting, measuring and analyzing the main anatomical structures of the brain and eventually identifying pathological regions. Among image segmentation methods, clustering-based approaches received a great interest in the domain of medical imaging and several fuzzy clustering algorithms have been proposed and accepted as effective tools for image segmentation. In our featured paper entitled "MR Brain Image Segmentation: A Framework to Compare Different Clustering Techniques" [2] we present a framework for image segmentation that includes different fuzzy clustering methods to perform the segmentation of MR images and enables easy comparison of different segmentation results by providing a quantitative evaluation using an entropy-based measure as well as other measures commonly used to evaluate segmentation results. In the paper "Automated Prostate Gland Segmentation Based on an Unsupervised Fuzzy C-Means Clustering Technique Using Multispectral

T1w and T2w MR Imaging" [3] the authors present an application of fuzzy clustering for MR image segmentation in the field of prostate imaging which is still a critical and challenging issue in the diagnosis, therapy, and staging of prostate cancer. The authors propose the application of the Fuzzy C-Means clustering algorithm for prostate image segmentation and automatic gland volume calculation. The proposed method exploits a flexible fuzzy model to integrate different MRI sequences and is able to achieve accurate and reliable segmentation results. Another medical imaging field that can benefit from automatic image segmentation is dermoscopy where the main goal is to detect eventual lesions to be analyzed for melanoma diagnosis. In the paper "Fuzzy Color Clustering for Melanoma Diagnosis in Dermoscopy Images" [4] the authors present a fuzzy logic-based color histogram analysis technique for discriminating benign skin lesions from malignant melanomas in dermoscopy images. The authors show how a fuzzy logic-based description of lesion colors can offer relevance to clinical descriptions of malignant melanoma.

The Special Issue gives also an insight about type-2 fuzzy logic, which is quite a recent area in fuzzy logic coming from an extension of the concepts of traditional type-1 fuzzy logic. The extension from type-1 to type-2 fuzzy sets enables a better modeling of uncertainty in images, which in turn helps to better manage imprecision or noise in real-world systems. The paper entitled "Edge Detection Method Based on General Type-2 Fuzzy Logic Applied to Color Images" [5] shows how general type-2 fuzzy logic can be successfully applied to low-level image processing tasks, such as edge detection in color images. The authors show that the proposed method based on a general type-2 fuzzy system outperforms the other methods because of its ability to handle the intrinsic uncertainty in the edge detection problem. In the review paper "Review of Recent Type-2 Fuzzy Image Processing Applications" [6], a representative and concise review of type-2 fuzzy logic applications in image segmentation, image filtering, image classification and edge detection is presented. The authors envision that, in the future, the number of works using type-2 fuzzy logic in image processing will increase, as even more complex real-world applications would require this kind of higher type models.

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