

Special Section on Nonlinear and Model-Based Image Analysis

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The idea of this special section arose from the NMBIA98 workshop, organized by Steve Marshall in Glasgow in July 1998 as a spin-off of the European ESPRIT long-term research project, Nonlinear Model-Based Analysis and Description of Images for Multimedia Applications—Noblesse. The subject covered is wide; the six papers published in this special section in fact touch different themes such as nonlinear signal estimation, filter design theory, motion compensation, color image processing, noise suppression, multimodal (audio/video) signal processing, data fusion, and segmentation.

The first paper is entitled “Two-stage binary filters,” by Sarca, Dougherty, and Astola and it is concerned with the optimal design of such filters. The filters form a mapping through binary logic from one data set to another. This is carried out by designing the filter as an optimal estimator of a signal from a corrupted version in noise. The development of this type of filter is valuable in the case of document image processing. Many existing methods employ ad hoc filtering approaches or use standard median and weighted median filters regardless of their optimality or effect on image structure. This paper uses a gradient-based algorithm for filter design through its application to three types of two-stage filters. The filters may be trained to specific train-

ing sets in order to be optimal for particular types of images such as text or line drawings.

The two following contributions also deal with noisy image data. The problem of mixed noise removal from images is addressed in the paper “Adaptive de-noising and lossy compression of images in transform domain,” by Egiazarian, Astola, Helsingius, and Kosmanen. A combined filter is proposed: a first stage removes impulse-like noise, and a second stage deals with white noise. The impulse removal technique has the peculiar property of being decision based; hence, it operates without damaging the high-frequency content of the signal. The second stage is a locally adaptive operator working in a transformed domain. An important characteristic of the proposed method is that it is also able to improve the visual quality of decompressed images, reducing blocking and ringing artifacts.

Giaccone, Jones, Minelly, and Curley present effective solutions for the suppression of noise in color digital film sequences in their contribution, “Motion-compensated multi-channel noise reduction of color film sequences.” They exploit the structured nature of this type of imagery and the correlations among different color planes and along time. An LMS adaptation technique is used, together with motion estimation; in fact, the latter is a

key element in the presented method, and a large part of the paper is devoted to the evaluation and segmentation of the motion fields. The method is particularly suitable when the scene content can be represented as a set of nonrigid objects in the foreground, with a rigidly moving background.

Motion estimation is used in a different context in the following paper. Lloret, Lopez, Serrat, and Villanueva, in “Creaseness-based CT and MR registration: comparison with the mutual information method,” introduce an algorithm for image registration, taking the problem of medical CT and MR images as a test bed. Rigid transformations are determined; in this way, only bone structures such as the skull are considered, and errors due to the deformation of soft tissues are avoided. A creaseness operator is devised to extract ridges and valleys in the image in a well-posed manner; with the creaseness images a hierarchical structure is built, which permits the fast extraction of the registration parameters. The proposed algorithm has been favorably compared to the mutual information method.

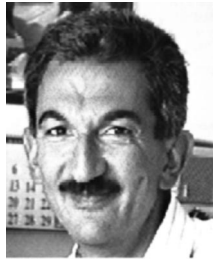
The above-mentioned paper deals with bimodal imaging; the following one is also devoted to bimodal signals, which in this case are audio and video. In the paper “Processing of audio and visual speech for telecommunication systems,” Shah and Marshall study the

relationship between visual and audio information in verbal communication, presenting a way in which the interdependency between image and speech signals can be exploited. This paper concentrates on the correlation between the shape of the mouth and the phoneme which is being uttered; a basic system is presented which, given the vocal information, determines a proper mouth shape. This study finds important applications in multimedia communication systems; for example, the compression factor of a bimodal signal can be increased, or the problem of audio/video synchronization in videophone channels can be solved.

Finally, the paper "Activity driven nonlinear diffusion for color image watershed segmentation" considers the problem of region identification in color images and is authored by De Smet, Pires, Vleeschauwer, and Bruyland. Watershed approaches are now widely accepted for image segmentation tasks but the ideal method to extend their application to color and other multivalued signals is still unclear. It is expected that the segmentation should be closely aligned with the perceptual impressions of how the image should be partitioned. The metric used should therefore correspond closely with the human eye's response to the various colors in the image. The authors consider a number of different color repre-

sentation spaces. They also include a nonlinear diffusion process to clean the image prior to segmentation.

It is our hope that the readers will find these papers beneficial and interesting; we take this occasion to thank all the authors for their contributions. Our gratitude also goes to Ed Dougherty for his helpful comments, and to Karolyn Labes and Rita Rogers for their efficient administration of the various processes. Special thanks is due to the anonymous reviewers for their competent and constructive comments; in fact, each paper was examined by at least two reviewers, first in its original and then in its revised version.



Giovanni Ramponi received his electronic engineering degree (summa cum laude) in 1981; since 1992 he has held the position of associate professor of electronics at the Department of Electronics of the University of Trieste. His research interests include nonlinear digital signal processing, enhancement and feature extraction in images and image sequences, and image compression. He has published more than 90 papers in international journals and conference proceedings. Prof. Ramponi is an associate editor of the *Journal of Electronic*

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Stephen Marshall received a first class honors degree in electrical and electronic engineering from the University of Nottingham in 1979 and his PhD in image processing from University of

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