Progress in Image Analysis and Processing

Proceedings of the 5th International Conference on Image Analysis and Processing

Progress in Image Analysis and Processing

Positano, Italy 20 – 22 September 1989

Edited by

V. Cantoni
Pavia University, Italy

L.P. Cordella
Naples University, Italy

S. Levialdi
Rome University, Italy

G. Sanniti di Baja
National Research Council
Arco Felice-Naples, Italy

World Scientific
Singapore • New Jersey • London • Hong Kong

Published by
World Scientific Publishing Co. Pte. Ltd.,
P O Box 128, Farrer Road, Singapore 9128
USA office: 687 Hartwell Street, Teaneck, NJ 07666
UK office: 73 Lynton Mead, Totteridge, London N20 8DH

Library of Congress Cataloging-in-Publication data is available.

PROGRESS IN IMAGE ANALYSIS AND PROCESSING

ISBN 981-02-0061-7

Printed in Singapore by JBW Printers & Binders Pte. Ltd.

Progress in Image Analysis and Processing

PREFACE

This volume contains the papers presented at the 5th International Conference on Image Analysis and Processing, held in Positano (Italy) on September 20-22, 1989. The Conference was organized by IAPR (Italian Chapter), Istituto di Cibernetica del CNR, and Dipartimento di Informatica e Sistemistica dell'Universita' di Napoli.

The Conference drew some 150 attendees, coming from several countries. Both theoretical and applicative aspects of image processing were discussed, and the most recent results achieved by leading academic and industrial research groups were presented. The 106 papers included in this book have been personally discussed at the Conference by one of the authors. In particular, Robert P.W. Duin, Herbert Freeman, George Nagy, Denis Rutovitz, Hanan Samet, and Piero Zamperoni were invited to talk on important topics of current interest in the field.

Papers have been grouped into six chapters, respectively dealing with 2-D Image Processing, Image Coding and Representation, Image Description and Recognition, 3-D Image Processing and Analysis, IP Systems and Applications, and Special Algorithms and Architectures.

We believe that this book could be considered as a valuable and updated reference source for the Image Processing community, since it illustrates advanced concepts and new frontiers for applications.

We are greatly indebted to the sponsoring institutions and firms, because it is thanks to their financial support that the Conference was realized. We also are indebted to all the colleagues and friends of Naples and in particular to Carlo Arcelli, whose generous efforts strongly contributed to the success of the Conference. Finally, we thank Sorrento Congressi International, who efficiently took care of the Conference Secretariat.

Virginio Cantoni (Pavia University)
Luigi P. Cordella (Naples University)
Stefano Levialdi (Rome University)
Gabriella Sanniti di Baja (National Research Council, Naples)

SPONSORING INSTITUTIONS

The 5th International Conference on Image Analysis and Processing has been financially supported by:

CNR - Comitati Nazionali
CNR - Gruppo Nazionale di Cibernetica e Biofisica
CNR - Centro di Studi su Calcolatori Ibridi
CNR - Istituto di Cibernetica
Dipartimento di Fisica-Universita' di Milano
Dip. di Informatica e Sistemistica-Universita' di Napoli
Istituto di Scienze dell'Informazione-Universita' di Bari
AERITALIA
Centro Ricerche FIAT
Italdata S.p.A.
Olivetti DOR
Raggruppamento Selenia-ELSAG
SAI-Direzione II Zona Napoli
Siemens Data S.p.A.
Azienda di Soggiorno-Positano
Azienda di Soggiorno-Sorrento e Sant'Agnello
Camera di Commercio-Napoli
Ente Provinciale per il Turismo-Salerno

CONTENTS

Preface v

Sponsoring institutions vi

2-D IMAGE PROCESSING

Model-based selective image enhancement by means of adaptive rank order filtering (Invited lecture) 3
P. Zamperoni

Radiometric reference segmentation in thermal images 18
P. G. Bison, E. Grinzato, G. M. Cortelazzo and G. A. Mian

A color image segmentation process suitable for real time implementation 23
L. Borghesi and R. Toscano

Experimenting with region and multiple source segmentation 31
F. Burbello

A method for representing and computing immediate texture discrimination in natural images 36
E. Catanzariti, M. G. Di Cerbo and R. Menna

A segmentation method using Voronoï diagrams in a split and merge environment 44
J. M. Chassery and M. Melkemi

Image analysis applied to arts paintings in a multisource environment 49
J. M. Chassery, M. Melkemi, H. T. Hu, Y. Chryssoulakis and A. Alexopoulou

A second-order differential operator for multispectral edge detection 54
A. Cumani

Comparison of morphological operators for grey tones images 59
V. Di Gesù and M. Tripiciano

Towards unsupervised texture segmentation using Gabor spectral decomposition 65
J. M. H. du Buf

A comparison of dictionary-based relaxation methods 73
E. R. Hancock and J. Kittler

An iterative multispectral image segmentation algorithm 78
J. Kittler and B. H. Ang

Discrete approaches for digital images and patterns of transformations 86
Z. C. Li, C. Y. Suen, T. D. Bui, Y. Y. Tang and Q. L. Gu

Diagnostic analysis of degradation on ancient buildings using textures 94
M. G. Mancini and A. Marcelli

Segmentation of texture regions using points of sharp intensity change 99
A. Perry

Region detection in gray-level images 106
P. Puliti, G. Tascini and P. Zingaretti

Threshold logic and mathematical morphology 111
R. van den Boomgaard

How do variations in resolution influence on gray tone spatial dependence matrix method's capability to classify stochastic textures? 119
A. Visa

A knowledge based approach to image segmentation 124
S. Vitulano, A. Grimaldi and X. L. Feng

IMAGE CODING AND REPRESENTATION

Connected component labeling for arbitrary binary image representations (Invited lecture) 131
M. B. Dillencourt, H. Samet and M. Tamminen

Recent results in adaptive image coding 147
G. Armano, D. D. Giusto and G. Vernazza

A dynamic combinatorial Hough transform 152
D. Ben-Tzvi, V. F. Leavers and M. B. Sandler

An application of binary arithmetic code to colour images 160
A. Bozzoli, M. Dell' Erba and G. Tadini

Some guidelines for the use and manipulation of colors in visual communication 165
A. Della Ventura and R. Schettini

A useful image representation 170
S. Di Zenzo and A. Morelli

Hardware implementation of a connectivity preserving shrinking algorithm 179
P. C. K. Kwok

Skeletons from snakes 186
F. Leymarie and M. D. Levine

Compress images based on fractal dimension 194
J. Ma and A. Vepsalainen

Image representation in nonuniform systems 199
N. Peterfreund and Y. Y. Zeevi

Contour processing distance transforms 204
I. Ragnemalm

Extended neighborhoods in the hexagonal grid: a parallel algorithm to get a line pattern with limited cardinality 213
G. Sanniti di Baja and O. Talamo

Application of Delaunay triangulation in image coding 222
Z. Y. Lu

IMAGE DESCRIPTION AND RECOGNITION

Efficient processing of 2-D images (Invited lecture) 229
D. Rutovitz

Feature extraction from biological images 254
L. Abramo and E. Ardizzone

2D recognition of partially overlapped objects using photometric approach 259
G. Attolico, L. Caponetti, G. Muscillo and E. Stella

A strategy based on fuzzy set theory for similarity judgement between structures 267
E. Binaghi, A. Della Ventura, A. Rampini and R. Schettini

Using skeletons for OCR 275
G. Boccignone, A. Chianese, L. P. Cordella and A. Marcelli

Pictorial entity indexing by shape descriptions 283
G. Bordogna, P. Carrara, I. Gagliardi, D. Merelli, P. Mussio, F. Naldi, M. Padula and M. Protti

Description-based indexing of ECG 291
P. Bottoni, M. Cigada, A. De Giuli, B. Di Cristofaro and P. Mussio

A structural description method for OCR 296
A. Chianese, L. P. Cordella, M. De Santo and M. Vento

A heuristic matcher of ARG graphs for object recognition 301
A. Chianese, M. De Santo and M. Vento

An application-independent knowledge-based framework for complex image recognition 309
S. Dellepiane, C. Regazzoni, S. B. Serpico and G. Vernazza

Linear features extraction in remotely sensed images using a skeletonization approach 317
G. Farella and A. Mori

The local form – a new method for contour segmentation 322
S. Frydrychowicz

Ambiguous patterns: investigation on their properties 327
S. Impedovo, M. Castellano, G. Dimauro and G. Pirlo

Region organization in two-dimensional shapes 332
Y. Ito, K. Abe and C. Arcelli

Isolation and identification of abutting and overlapping objects in binary images 340
O. Kübler, F. Klein, R. Ogniewicz and U. Kienholz

Tools for shape complexity evaluation and associated decomposition processes 348
A. Montanvert and D. Adelh

A similarity retrieval method for line drawing image databases 357
K. Tanabe and J. Ohya

The application of dynamic programming to object identification 365
M. Varga, A. Sleigh and R. Series

3-D IMAGE PROCESSING AND ANALYSIS

Development of a trainable machine-vision inspection system (Invited lecture) 375
H. Freeman

Object recognition based on hypothesis generation and verification strategy 389
K. Arakawa and H. Kaneko

3-D scene reconstruction from multiple 2-D views 394
E. Ardizzone, M. A. Palazzo and F. Sorbello

Binocular motion and structure from monocular motion and structure 399
J. L. Barron, A. D. Jepson and J. K. Tsotsos

Reconstructing three-dimensional shapes through Euler operators 407
E. Bruzzone, L. De Floriani and E. Puppo

Object recognition using inexact matching of 3-D graphs 415
J. Buurman and R. P. W. Duin

Identification of 3-D surface primitives using structured light 420
C. Cassolino and F. Mangili

Automatic tailoring of vision systems 425
U. Cei and P. Cordini

Surface recovering by local shading analysis 430
M. T. Chiaradia, A. Distante, R. Mugnuolo and E. Stella

Visibility characteristics of grey-scale images 435
L. De Floriani, G. Nagy and P. Jeanne

Group-theoretic analysis of local flow characteristics while visually tracking a textured surface 443
R. Eagleson and T. Caelli

On computing stable surface descriptions from range data 451
F. P. Ferrie and J. Lagarde

Detection of local symmetries in multi-dimensional images 459
O. Hansen and J. Bigün

Digitized images and patterns of perspective transformations 465
Z. C. Li, C. Y. Suen, T. D. Bui, Q. L. Gu and Y. Y. Tang

3-D surface characterization 470
S. Losito, M. Iannotta, G. Pasquariello and G. Sylos Labini

Matching overlapping objects in 3-D scene to model-base under a heuristic search strategy 478
S. W. Lu

Computing optical flow with medianess 483
J. Ma

3D scene modeling based on a generic model 493
T. Shakunaga

LOAS: automatic site localisation and orientation using a 3D model 501
P. Thevenoux, B. Zavidovique and G. Stamon

IP SYSTEMS AND APPLICATIONS

Document analysis and optical character recognition
(Invited lecture) 511
G. Nagy

DIMES: Diagnostic imaging in mammography using expert systems 530
K. Ahmad, P. Mosconi, L. Lombardi, J. Price and P. Horton

Applications of signature analysis by computer and the consequence
of its possible misuse 535
M. Ammar

Towards an evaluation of an experimental OCR system
by means of a complex document 543
G. Boccignone, L. Freina, S. Mogliotti and M. R. Spada

An image interpretation management system 551
P. Bottoni, P. Mussio, M. Protti and A. Rossello

Automatic method for cloud analysis from monochromatic satellite pictures 556
G. Brunet and J. Devars

A new technique to measure the performances of an imaging system 563
E. Bussoletti, G. Longo, L. Errico and C. Fusco

An image processing system based on object oriented design 570
V. Cappellini and A. Del Bimbo

Automatic visual inspection of textured textiles 575
P. Dewaele, L. Van Gool, P. Wambacq and A. Oosterlinck

Pictorial information retrieval with uncertain knowledge 583
V. Di Gesù, M. C. Maccarone, D. Ponz,
D. Tegolo and M. Tripiciano

A thin lines based approach to PCB visual inspection 590
L. Esposito, M. Frucci and A. Marcelli

Digital integration and analysis of multiple images for mineral resource mapping 595
A. G. Fabbri

Segmentation of 3D magnetic resonance data 602
G. Gerig and R. Kikinis

Decision making process in a signature verification system 610
S. Impedovo, M. Castellano, G. Dimauro and G. Pirlo

Recent developments of the optical character reading systems 615
S. Impedovo, L. Ottaviano and S. Occhinegro

The RESEDA Project – a knowledge based approach to extracting environmental information from remote sensor data 623
W. F. Riekert

Computer identification and matching of circuit diagrams with PC boards 629
J. T. Tou and K. C. Fan

Hybrid processing of images for territory monitoring 637
A. M. Visin, M. Carosella, M. Busillo and L. Campanelli

SPECIAL ALGORITHMS AND ARCHITECTURES

Massively parallel architectures for cellular logic image processing (Invited lecture) 643
R. P. W Duin and E. R. Komen

Geometry constraints and limited memory for the generalized-Hough transform 658
M. G. Albanesi and M. Ferretti

Global transforms in real time with the Functional Low Level Image Processor (FLLIP) 666
E. Allart and B. Zavidovique

Parallel implementation of a skeletonising algorithm on a MIMD multiprocessor system 671
A. Anzalone, C. Arcelli, A. Machì, G. Sanniti di Baja and O. Talamo

Study of workload partitioning on a PRAM_CREW multiprocessor system performing low_mid level image processing tasks 679
A. Anzalone, G. Gugliotta and A. Machì

Fast parallel algorithms for image thresholding 686
G. Bongiovanni, A. Giustiniani, S. Levialdi and E. Nulli Gabbiani

Using resolution pyramids to efficiently store distance transforms of arbitrary size 691
G. Borgefors

Real-time processing architectures in ground surveillance systems 699
S. Bottalico, F. de Stefani and F. Imelio

Stereo vision in multi-resolution 706
V. Cantoni, A. Griffini and L. Lombardi

The medial axis transform on a pyramid architecture 714
L. Cinque, C. Guerra and S. Levialdi

Parallel implementation of a region merging algorithm on a pyramid machine 721
Ph. Clermont, A. Mérigot, J. C. Roussel and B. Zavidovique

Object recognition strategy in a multi-resolution system 729
G. Cova, A. Griffini and L. Lombardi

A dataflow image processing system TIP-4 734
Y. Fujita, M. Iwashita and T. Temma

A multigranularity massively parallel architecture for image understanding 742
A. Giordano, E. I. Noviello, C. Sanges and R. Vaccaro

Neural network models of perceptual alternation of ambiguous patterns 751
F. Masulli, M. Riani and E. Simonotto

Designing a VLSI processing element chip for pyramid computer SPHINX 759
Y. Ni, A. Merigot and F. Devos

Architectures for image coding using adaptive vector quantization 767
S. Panchanathan and M. Goldberg

Systolic algorithms for VLSI geometry checking 775
N. Petkov

String processing algorithms and architectures for digital curves analysis 783
F. Sloboda and J. Priecel

2-D IMAGE PROCESSING

Model-based selective image enhancement by means of adaptive rank order filtering

P. Zamperoni
Institut für Nachrichtentechnik
Technische Universität Braunschweig, FRG

Abstract

This paper proposes some new locally adaptive rank-order operators for image enhancement. The rank of the grey value constituting the operator's output depends upon the degree of match between an unimpaired image model and the local image data. The image model can be described i) by means of template local histograms; ii) by its coordinates in an adequate feature space. In many cases these features can be extracted after rank-ordering the grey values in the processing window.

1 Adaptive image filtering on the basis of local histograms

The local histogram of the grey value or of other more elaborate features of an image, measured over an $L \times L$ – pixel processing window, has been considered by many authors as a valuable source of information [1),2),3)]. This information may regard structural features, describing coarsely the shape of the grey value function's "ridges and valleys", as well as fine detail, commonly called texture. The local grey value histogram alone can be a questionable image descriptor if the problem under study involves to consider all the possible local patterns having the same histogram, which can be of course very manifold; however, it can be very useful if the task is just to discriminate among a less varied pattern set, as for instance between an impaired pattern and its unimpaired original.
Computing the local histogram over a processing window is equivalent to rank-order the $U = L^2$ grey values $P_1 \dots P_U$ by means of a sorting algorithm. In rank-order filters, which are widely used in signal processing, the output is a linear combination of the ordered grey values $P_{(1)}, P_{(2)}, \dots P_{(U)}$, with $P_{(1)} \leq P_{(2)} \dots \leq P_{(U)}$, using constant weights $a_1, a_2 \dots a_U$ [3),5)]. Rank-order filters, as for instance trimmed-mean filters [4)], have proved to provide robust one-dimensional signal estimators, because suitable sets of weights can be determined for different types of noise. This technique, which has been successfully employed also in the two-dimensional case of image restoration, can be schematically described by **Fig. 1**, where the block S represents a weighted sum. In the image enhancement approach, which is object of the present work, the filter output is given by the N-th ordered input grey value, with $1 \leq N \leq U$; in other words, the block S of fig. 1 acts as a selector, being $a_N = 1$ and $a_i = 0$ for $i \neq N$. The rank N is adaptively