VISUAL FORM

Analysis and Recognition

VISUAL FORM

Analysis and Recognition

Edited by
Carlo Arcelli

*Istituto di Cibernetica
Consiglio Nazionale delle Ricerche
Naples, Italy*

Luigi P. Cordella

*Dipartimento di Informatica e Sistemistica
Università di Napoli Federico II
Naples, Italy*

and
Gabriella Sanniti di Baja

*Istituto di Cibernetica
Consiglio Nazionale delle Ricerche
Naples, Italy*

SPRINGER SCIENCE+BUSINESS MEDIA, LLC

Library of Congress Cataloging in Publication Data

Visual form: analysis and recognition / edited by Carlo Arcelli, Luigi P. Cordella, and Gabriella Sanniti di Baja.

p. cm.

"Proceedings of the International Workshop on Visual Form, held May 27-30, 1991, in Capri, Italy"—T.p. verso.

Includes bibliographical references and index.

1. Computer vision—Congresses. 2. Pattern recognition systems—Congresses. I. Arcelli, Carlo. II. Cordella, Luigi P. III. Sanniti di Baja, Gabriella. IV. International Workshop on Visual Form (1991: Capri, Italy)

TA1632.V558 1992

92-853

621.39'9—dc20

CIP

Proceedings of the International Workshop on Visual Form,
held May 27-30, 1991, in Capri, Italy

ISBN 978-1-4899-0717-2

ISBN 978-1-4899-0715-8 (eBook)

DOI 10.1007/978-1-4899-0715-8

© Springer Science+Business Media New York 1992

Originally published by Plenum Press, New York in 1992

Softcover reprint of the hardcover 1st edition 1992

All rights reserved

No part of this book may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording, or otherwise, without written permission from the Publisher

PREFACE

This book contains the papers presented at the International Workshop on Visual Form, held in Capri (Italy) on May 27-30, 1991. The workshop, sponsored by the International Association for Pattern Recognition (IAPR), has been jointly organized by the Dipartimento di Informatica e Sistemistica of the University of Naples and the Istituto di Cibernetica of the National Research Council of Italy, and has focussed on Shape.

Shape is a distinctive feature of most patterns, so that recognition can often be attained through shape discrimination. The organizers of the workshop shared the general feeling manifested by researchers, that it was time for holding a meeting exclusively devoted to a feature so crucial for both human and machine perception. During this meeting, problems and prospects in the field of 2D and 3D shape analysis could be discussed extensively, so as to provide an effective, updated picture of the current research activity in which shape plays a central role. Indeed, many highly qualified researchers in the field positively reacted to the Call for Papers.

The papers included in the book deal with shape in the areas of representation, decomposition, description and recognition, and supply valuable hints for both the theoretical and the applied levels. Acceptance of each contributed paper has been approved by at least two referees belonging to an international committee. Invited talks have been given by experts, outstanding for their notable contributions in the field.

We are indebted to the invited speakers, L.S. Davis, J.O. Eklundh, R.M. Haralick, T.S. Huang, M.D. Levine, M. Leyton, T. Pavlidis, A. Rosenfeld, H. Samet, L.G. Shapiro, J.I. Toriwaki, and L. Uhr, whose scientific contribution, presence and enthusiasm have proved determinant for the success of the meeting.

We hope this book may provide an insight into Shape, and we also hope it may remind participants in the workshop of the days spent in a beautiful setting and stimulating from both the scientific and the human perspectives.

Carlo Arcelli
Luigi P. Cordella
Gabiella Sanniti di Baja

ACKNOWLEDGEMENTS

The International Workshop on Visual Form has been financially supported by the following organizations:

Bull HN Sud
Centro Ricerche FIAT
CNR - Comitati Nazionali
CNR - GNCB
CNR - GNIM
CNR - Istituto di Cibernetica
CIRAI
ELSAG S.p.A.
IBM Semea
Italtel
Olivetti Systems & Networks
Università degli Studi di Napoli Federico II

The help of Mr. Salvatore Piantedosi in the preparation of this book is also gratefully acknowledged.

CONTENTS

Thinning of Gray-Scale Images with Combined Sequential and Parallel Conditions for Pixel Removal	1
K. Abe, F. Mizutani, and C. Wang	
Shape Decomposition Using Structured Light Vision	11
M.J. Aldon and O. Strauss	
Reversible Skeletonization by (5,7,11)-Erosion	21
C. Arcelli and M. Frucci	
Perception of 3-D Objects by a Robotic Stereo Eye-in-Hand Vision System.....	29
M.A. Arlotti and M. Notturmo Granieri	
Motion and Structure in Rigid Multi-Surfaced Stationary Environments Using Time-Varying Image Velocity: Linear Solutions	39
J.L. Barron	
Parallel Simulated Annealing for Shape Detection	47
A. Berna, G. Bongiovanni, P. Crescenzi, and C. Guerra	
Filling and Analysing Concavities of Digital Patterns Parallelwise	57
G. Borgefors and G. Sanniti di Baja	
Shape from Occluding Contours: a Regularization Method.....	67
C. Braccini, P. Cicconi, A.A. Grattarola, and S. Zappatore	
Towards Representation of 3D Shape: Global Surface Parametrization	79
Ch. Brechbühler, G. Gerig, and O. Kübler	
Differential Invariants of Planar Curves and Recognizing Partially Occluded Shapes	89
A.M. Bruckstein and A.N. Netravali	
Three-Dimensional Surface Reconstruction Using Delaunay Triangulation in the Image Plane.....	99
E. Bruzzone, G. Garibotto, and F. Mangili	
Multidimensional Indexing for Recognizing Visual Shapes	109
A. Califano and R. Mohan	
Circular Shape Detection in Remote Sensing Multispectral Images.....	119
V. Cappellini, S. Fini, E. Harrigan, and A. Mecocci	

Orthogonal Zig-Zag: an Efficient Method for Extracting Straight Lines from Engineering Drawings.....	127
I. Chai and D. Dori	
Massively Parallel Processing of Image Contours.....	137
L.T. Chen, L.S. Davis, and C.P. Kruskal	
Classifying Character Shapes.....	155
A. Chianese, L.P. Cordella, M. De Santo, and M. Vento	
Detecting Digital Straight Line Segments in $O(N^2)$	165
L. da Fontoura Costa and M.B. Sandler	
Computing Egomotion and Shape from Image Motion Using Collinear Points.....	175
N. da Vitoria Lobo and J.K. Tsotsos	
Extraction and Representation of Shape Features for CAD/CAM Applications	187
L. De Floriani and E. Puppo	
3-D Object Recognition from Single Perspective Views	197
A. Del Bimbo, P. Nesi, and R. Consales	
Search and Replace of 2-D Objects in Digital Images	205
A. Della Ventura, P. Ongaro, and R. Schettini	
Primitive-Based Shape Modeling and Recognition	213
S.J. Dickinson, A. Rosenfeld, and A.P. Pentland	
Qualitative Shape - Some Computational Aspects	231
J.O. Eklundh, T. Lindeberg, and H. Winroth	
Fast Thinning Algorithms for Large Binary Images.....	249
C. Evers	
3D Object Recognition by Integration of Associative and Symbolic Techniques	259
G. Foresti, V. Murino, C.S. Regazzoni, and R. Zunino	
A New Approach to Affine Transform Invariant Shape Matching.....	267
S. Frydrychowicz	
Model-Based Morphology: Simple and Complex Shapes	275
R.M. Haralick	
Human Face Motion Analysis.....	287
T.S. Huang and S.C. Reddy	
A Computational Model of Mathematical Morphology.....	293
A. Imiya and T. Nakamura	
Determining the Symmetry of Polyhedra	303
X.Y. Jiang and H. Bunke	
Depth Data Segmentation Using Robust Estimation in a Hierarchical Data Structure	313
G.A. Jones, J. Princen, J. Illingworth, and J. Kittler	
Shape Recognition Under Affine Distortions.....	323
P. Kempenaers, L. Van Gool, and A. Oosterlinck	

Entropy Scale-Space.....	333
B.B. Kimia, A. Tannenbaum, and S.W. Zucker	
A New Contour Generation Thinning Algorithm.....	345
P.C.K. Kwok	
The Visual Hull and Its Computation in 2-D	355
A. Laurentini	
Shape Description Using Geons as 3D Primitives.....	363
M.D. Levine, R. Bergevin, and Q.L. Nguyen	
Shape and Causal-History	379
M. Leyton.	
Shape Representation and Recovery Using Deformable Superquadrics	389
D. Metaxas and D. Terzopoulos	
From Voxels to Curvature Features	399
O. Monga, N. Ayache, and P.T. Sander	
The Dimensions of Shape and Form	409
G. Nagy	
Shape Classification by Using Associative Memories.....	421
G. Parodi, G. Vernazza, and R. Zunino	
Applications of Splines to Shape Description	431
T. Pavlidis	
3D Medial Surfaces and 3D Skeletons	443
F. Rolland, J.M. Chassery, and A. Montanvert	
A Review of Hierarchical Representations of Shape and Some Applications	451
H. Samet	
Estimating Curvature by Kalman Filters	469
P.T. Sander	
View-Class Representation and Matching of 3D Objects	479
L.G. Shapiro	
Occlusions and Perspective in an Image Sequence	495
A. Shmuel and M. Werman	
Detecting Round Regions.....	507
A. Sirjani and G.R. Cross	
On Symmetric Forms of Discrete Sets of Points and Digital Curves	517
F. Sloboda	
Extraction of Surface Orientation Using Gray Level Difference Statistics	527
M. Terauchi, H. Matsushima, T. Tsuji, and K. Ito	
Shape Splitting from Medial Lines Using the 3-4 Chamfer Distance.....	537
E. Thiel and A. Montanvert	
Distance Transformation and Skeleton for Shape Feature Analysis.....	547
J. Toriwaki, T. Saitoh, and M. Okada	

Forms Structure Form at Ever "Higher" and "Lower" Levels 565
L. Uhr

Human Perception of Affine Equivalent Polygons 583
P. Vanden Bossche, N. Segers, J. Wagemans, and G. d'Ydewalle

3-D Pose Estimation by an Improved Kohonen-Net 593
B. Wirtz and Ch. Maggioni

On the Recognition of Articulated Objects (Generalizing the
Generalized Hough Transform)..... 603
H.J. Wolfson

Analysis of Straight Homogeneous Generalized Cylinders
Under Perspective Projection..... 613
K.C. Wong, J. Kittler, and J. Illingworth

Invariants and Pose Determination 623
X. Yu, T.D. Bui, and A. Krzyżak

Characteristic Pattern Based on Mathematical Morphology..... 633
D. Zhao

Contributors 641

Index..... 643