The Handbook of Medical Image Perception and Techniques

This state-of-the-art book reviews key issues and methods in medical image perception research through associated techniques, illustrations, and examples. Written by key figures in the field, the book covers a range of topics including the history of medical image perception research, the basics of vision and cognition, and dedicated application areas, especially those concerned with the interface between the clinician and the display of medical image data. It summarizes many of the basic techniques used to conduct and analyze medical image perception and observer performance research, allowing readers to understand basic research techniques so they can adopt them for use in their own studies.

Written for both newcomers to the field and experienced researchers, this book provides a broad overview of medical image perception, and will serve as a reference volume for years to come.

EHSAN SAMEI is a Professor of Radiology, Biomedical Engineering, and Physics at Duke University, where he serves as the Director of the Carl E. Ravin Advanced Imaging Laboratories (RAI Labs) and the Director of Graduate Studies for Medical Physics. His current research interests include medical image formation, analysis, display, and perception, with particular focus on quantitative and molecular imaging.

ELIZABETH KRUPINSKI is a Professor at the University of Arizona in the Departments of Radiology, Psychology, and Public Health. She is the Associate Director of Evaluation and Assessment for the Arizona Telemedicine Program, President of the Medical Image Perception Society, and serves on the Editorial Boards of a number of journals in both radiology and telemedicine.

THE HANDBOOK OF MEDICAL IMAGE PERCEPTION AND TECHNIQUES

Edited by
EHSAN SAMEI
Duke University Medical Center

ELIZABETH KRUPINSKI
University of Arizona

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, São Paulo, Delhi

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521513920

First published 2010

Printed in the United States of America

A catalog record for this publication is available from the British Library

ISBN 978-0-521-51392-0 Hardback

Dedicated to M^5
(Maija, Mina, Mateen, Mitra, and Maryam),
without whose love, understanding, and sacrifice
this project would have not been possible,
and to my mentors, Mike Flynn and Perry Sprawls,
who set examples before me of dedication, ingenuity, and professionalism.
E.S.

Dedicated to my parents Carole and Joseph Krupinski
who instilled in me the appreciation of life-long learning and hard work,
to my medical image perception mentors and friends Harold Kundel, MD, and Calvin Nodine, PhD,
and to my husband Michel Rogulski, PhD,
who supports and stands by me every day.
E.K.

CONTENTS

CONTRIBUTORS

CRAIG K. ABBEY
Department of Psychology
Building 429, Room 205a
University of California, Santa Barbara
Santa Barbara, CA 93106–9660
USA

EUGENIO ALBERDI
Centre for Software Reliability
City University
Northampton Square
London EC1V 0HB
UK

PETER AYTON
Department of Psychology
City University
Northampton Square
London EC1V 0HB
UK

ARTHUR BURGESS
Radiology Department
Brigham & Women's Hospital
308–1012 Pakington St.
Victoria, BC V8V3A1
CANADA

ROBERT CALDWELL
Department of Radiology
University of Iowa
3170 Medical Lab
Iowa City, IA 52242
USA

DEV CHAKRABORTY
Department of Radiology
University of Pittsburgh
3520 Forbes Avenue Parkvale Building
Pittsburgh, PA 15261
USA

WEIJIE CHEN
Center for Devices and Radiological Health
US Food and Drug Administration
10903 New Hampshire Avenue
Silver Spring, MD 20993–0002
USA

MIGUEL P. ECKSTEIN
Department of Psychology
Psychology East (Building 251), Room 3806
University of California, Santa Barbara
Santa Barbara, CA 93106–9660
USA

EDMUND FRANKEN
Department of Radiology
University of Iowa
3890 JPP
Iowa City, IA 52242
USA

MATTHEW FREEDMAN
Lombardi Building, S150
Box 20057–1465
3800 Reservoir Road NW
Washington, DC 20057–1465
USA

MARYELLEN GIGER
Department of Radiology
University of Chicago
5841 S. Maryland Avenue MC 2026
Chicago, IL 60637
USA

STEPHEN HILLIS
VA Iowa City Health Care System
CRIISP (152)
601 Highway 6 West
Iowa City, IA 52246–2208
USA

WALTER HUDA
Radiology
Medical University of South Carolina
169 Ashley Avenue
PO Box 250322
Charleston, SC 29425
USA

YULEI JIANG
Department of Radiology
University of Chicago
5841 S. Maryland Avenue MC 2026
Chicago, IL 60637
USA

ELIZABETH KRUPINSKI
Department of Radiology Research
University of Arizona
1609 N. Warren Building 211 Rm 112
Tucson, AZ 85724
USA

HAROLD KUNDEL
Department of Radiology
University of Pennsylvania
3400 Spruce St.
Philadelphia, PA 19104
USA

MATTHEW KUPINSKI
University of Arizona
Optical Sciences
1630 East University Boulevard
Tucson, AZ 85721
USA

XIANG LI
Duke University Medical Center
2424 Erwin Road
Suite 302 (DUMC) Box 2731
Durham, NC 27705
USA

DAVID MANNING
School of Medical Imaging Sciences
St Martin's College
Lancaster
Lancashire
LA1 3JD
UK

CLAUDIA MELLO-THOMS
University of Pittsburgh
Department of Radiology and
Training Program of Biomedical Informatics
3362 Fifth Avenue
Pittsburgh, PA 15213
USA

CALVIN NODINE
Department of Radiology
University of Pennsylvania
3400 Spruce St.
Philadelphia, PA 19104
USA

KENT OGDEN
Radiology Department
SUNY Upstate Medical University
750 E. Adams St.
Syracuse, NY 13210
USA

TERESA OSICKA
ISIS Center
Georgetown University
2115 Wisconsin Avenue NW,
Washington, DC 20057
USA

MARIA PETROU
Communications and Signal Processing Research Group
Department of Electrical and Electronic Engineering
Imperial College
South Kensington Campus
London SW7 2AZ
UK

ANDREY POVYAKALO
Centre for Software Reliability
City University
Northampton Square
London EC1V 0HB
UK

HANS ROEHRIG
Department of Radiology Research
University of Arizona
1609 N. Warren Building 211 Rm 112
Tucson, AZ 85724
USA

EHSAN SAMEI
Departments of Radiology, Physics, and Biomedical Engineering
Duke University
2424 Erwin Rd, Suite 302
Durham, NC 27710
USA

ROBERT SAUNDERS
Department of Radiology
Duke University
2424 Erwin Rd, Suite 302
Durham, NC 27710
USA

KEVIN SCHARTZ
Department of Radiology
University of Iowa
3170 Medical Lab
Iowa City, IA 52242
USA

JEFFREY H. SIEWERDSEN
Department of Biomedical Engineering
Johns Hopkins University
Baltimore, MD 21205
USA

LORENZO STRINGINI
Centre for Software Reliability
City University
Northampton Square
London EC1V 0HB
UK

RONALD SUMMERS
Radiology and Imaging Sciences Department
National Institutes of Health
Building 10 Room 1C660
10 Center Drive MSC 1182
Bethesda, MD 20892–1182
USA

GEORGIA TOURASSI
Department of Radiology
Duke University
2424 Erwin Rd, Suite 302
Durham, NC 27710
USA

MICHAEL J. ULISSEY
Director of Breast Imaging
Parkland Hospital
The University of Texas Southwestern Medical Center at Dallas
5323 Harry Hines Blvd.
Dallas, TX 75390–8896
USA

RICHARD VANMETTER
252 Walnut St. NW
Washington, DC 20012–2157
USA

ROBERT WAGNER
FDA/CDRH
HFZ-140
Silver Springs, MD 20993
USA

MARGARITA ZULEY
University of Pittsburgh
Director of Breast Imaging
Magee Womens Hospital
300 Halket St.
Pittsburgh, PA 15213
USA

CARL ZYLAK
Henry Ford Health System
Department of Radiology
2799 W. Garnd Blvd.
Detroit, MI 48202
USA