COLOR THEORY AND MODELING FOR COMPUTER GRAPHICS, VISUALIZATION, AND MULTIMEDIA APPLICATIONS

THE KLUWER INTERNATIONAL SERIES
IN ENGINEERING AND COMPUTER SCIENCE

COLOR THEORY AND MODELING FOR COMPUTER GRAPHICS, VISUALIZATION, AND MULTIMEDIA APPLICATIONS

by

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KLUWER ACADEMIC PUBLISHERS
Boston / Dordrecht / London

Distributors for North America:
Kluwer Academic Publishers
101 Philip Drive
Assinippi Park
Norwell, Massachusetts 02061 USA

Distributors for all other countries:
Kluwer Academic Publishers Group
Distribution Centre
Post Office Box 322
3300 AH Dordrecht, THE NETHERLANDS

Library of Congress Cataloging-in-Publication Data

A C.I.P. Catalogue record for this book is available
from the Library of Congress.

The publisher offers discounts on this book when ordered in bulk quantities. For more information contact: Sales Department, Kluwer Academic Publishers, 101 Philip Drive, Assinippi Park, Norwell, MA 02061

Printed on acid-free paper.

Printed in the United States of America

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PREFACE

Imagine a world in which the colors you see do not necessarily represent the correct ones. Imagine, when you approach a traffic light, you cannot tell what color the light is. Imagine the colors of traffic lights changing from one block to the next one. Could you?

If you can't, just go to your computer. In the world of visual computing, you cannot be sure what the colors will be. Even today. And today, the awareness of computer professionals to color has grown orders of magnitude.

When I got introduced to some interesting color problems in medical imaging back in 1984 (and thus reintroduced to color, which I had researched and explored in the seventies), it seemed like nobody really bothered; there were very few publications that attempted to understand the relationship between color and the computer.

Within a few years, that number grew significantly. Finally, people were beginning to realize that, just as colors play such an important role in our day-to-day life, they are important on our computer displays. And, thus, color should be studied, and the appropriate usage on computer displays should be explored, understood, and *practiced.* I cannot say we have reached that stage, yet, but I am glad to report that progress has been made.

This book is the result of over a dozen years of research, teaching, consulting, and advising, first at the Medical Image Processing Group, Department of Radiology, the University of Pennsylvania, and then here at the Institute for Visualization and Perception Research and the Graphics Research Laboratory at the University of Massachusetts Lowell.

I started putting the material presented here together the first time for a half-day color tutorial I taught at the IEEE Visualization '91 conference in San Diego. The success of that tutorial suggested that it should be expanded from a half-day to a full-day course, and that inviting other color experts to contribute their expertise would strengthen it. As a result, I invited Philip Robertson (then of CSIRO, Canberra, Australia, and now with Canon Research in Sydney) and Bernice Rogowitz (IBM Research, Yorktown Heights, NY) to join me. We took our "show" to SIGGRAPH '92 in Chicago, and again to IEEE Visualization '92 in Boston. Phil's and Bernice's contributions to the tutorial, and thereby to this book, were numerous and significant. I am grateful to them for lending me their vast knowledge and experience.

Since then I have taught a similar tutorial at several other conferences, and have used parts of this material in my visualization tutorials, as well as in my computer graphics and visualization courses here at Lowell.

Over the years, many people have asked me for advice about their color graphics applications. At some point, I got convinced that many others, who haven't had the opportunity to take the tutorial, and who couldn't ask me questions, could use some of the material presented here. Thus came the idea for of this book.

The goal of this book is not to teach you everything you need to know about color; numerous publications are available to do that. It is not even to teach you everything you need to know about color computer graphics; no, there aren't numerous publication available to do that. The goal of this book is to convince you that it is important to pay attention to color (if you are not convinced yet); to give you the basic fundamentals of color vision in general, and as related to visual computing in particular; to make you aware of the repercussions of your color choices; and to stimulate you to further explore this topics. One not-so-hidden agenda: I'd like to encourage students to pick color as their doctoral research topic.

To help us accomplish these goals, we have established a World-Wide Web (`http://www.cs.uml.edu/~haim/ColorCenter`) site, where you can find all the color images, more information, examples, tools, and links to other related sites. As all good Web sites should be (forever), this site is under construction, and will hopefully remain so. What you will find on the Web site are all the color figures in the book, additional example images, recommended color scales, some useful software tools, an extended, annotated bibliography, and links to other relevant sites.

We would like you to visit the site, and take advantage of what is available there. To make the most of it, we suggest the use of an automatic monitor (such as URL-minder at `http://www.netmind.com/URL-minder/URL-minder.html`) to alert you to changes in the site.

We would also appreciate your comments, suggestions, contributions, and critique.

This book would not have materialized if not for many people who have helped me, directly or indirectly, make it happen.

More than fifteen years ago, my colleague and friend Yair Censor influenced to a large degree the direction of my academic career. Gabor Herman, my doctoral dissertation advisor, colleague, and friend, made significant contributions to the material presented in this book. Ron Pickett found me at a job I did not enjoy, and together with Georges Grinstein and Stu Smith, brought me over to Umass Lowell, where I have had a wonderful time ever since. Giam Pecelli, our previous Department Chair, and Jim Canning, our current Chair, have both provided me enormous support here; they, together with the rest of the Computer Science Department faculty, have made it so wonderful to work here.

Many extremely capable and dedicated students have worked over the years on projects, the results of which can be found in this book and on the Web site: Kerry Shetline wrote the first versions of MCMTRANS and MCMIDS (and suffered through my notorious bug-finding ability). Nupur Kapoor and Bogdan Pytlik implemented the first version of the color icon. David Gonthier developed the new version of the color icon, and incorporated it in NewExvis, our visualization environment. He was helped by Jude Fatyol, Omar Hoda, and Lisa Masterman. Rob Erbacher developed the parallel implementation of the color icon and the GLHS color model. Krishnan Seetharaman added three-dimensional spaceball navigation to the GLHS color model, and made numerous other contributions, too numerous to list them all. Alex Gee, Pat Hoffman, J.P. Lee, Dave Pinkney, and Marjan Trutschl, have all helped make life at IVPR as pleasant as it is, in many different ways, but mostly in their eagerness to do whatever is necessary, whenever it is necessary. When one is blessed with having so many wonderful students, it is inevitable to forget someone; my apologies to those I have not mentioned: your contributions have been as important and as appreciated.

My family in Israel, Colombia, and here in the US, all deserve my thanks for all they have given me over the years.

Finally, no thanks could be enough to Ea, Merav, and Shir, with whom I should be spending this weekend, instead of in front of my computer, writing this. It's wonderful to have you!

Lowell, Massachusetts *Haim Levkowitz*
January 1997