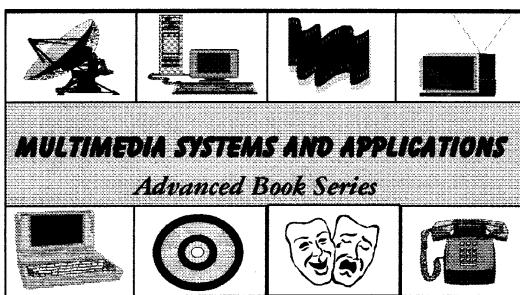

**VIDEO AND IMAGE PROCESSING
IN MULTIMEDIA SYSTEMS**

**THE KLUWER INTERNATIONAL SERIES
IN ENGINEERING AND COMPUTER SCIENCE**

MULTIMEDIA SYSTEMS AND APPLICATIONS

Consulting Editor

Borko Furht
Florida Atlantic University



VIDEO AND IMAGE PROCESSING IN MULTIMEDIA SYSTEMS

by

Borko Furht
*Florida Atlantic University
Boca Raton, Florida, USA*

Stephen W. Smoliar
HongJiang Zhang
*Institute of Systems Science
National University of Singapore*



SPRINGER SCIENCE+BUSINESS MEDIA, LLC

Library of Congress Cataloging-in-Publication Data

Furht, Borivoje.

Video and image processing in multimedia systems / Borko Furht,
Stephen W. Smoliar, HongJiang Zhang.

p. cm. -- (The Kluwer international series in engineering and
computer science)

Includes bibliographical references and index.

ISBN 978-1-4613-5960-9 ISBN 978-1-4615-2277-5 (eBook)

DOI 10.1007/978-1-4615-2277-5

1. Multimedia systems. 2. Video compression. 3. Image
processing--Digital techniques. I. Smoliar, Stephen W. II. Zhang.
HongJiang. III. Title. IV. Series.

QA76.575.F87 1995

006.6--dc20

95-30423

CIP

Copyright © 1995 by Springer Science+Business Media New York
Originally published by Kluwer Academic Publishers in 1995
Softcover reprint of the hardcover 1st edition 1995

All rights reserved. No part of this publication may be reproduced, stored in
a retrieval system or transmitted in any form or by any means, mechanical,
photo-copying, recording, or otherwise, without the prior written permission of
the publisher, Springer Science+Business Media, LLC.

Printed on acid-free paper.

Dedication

To Sandra, Linda, and XueFeng
with our heart-felt thanks for all their understanding and patience.

CONTENTS

Part I INTRODUCTION TO MULTIMEDIA	1
1 BASIC CONCEPTS	3
1.1 Definition of Multimedia	3
1.2 Multimedia Workstations	7
1.3 Distributed Multimedia System Architectures	22
1.4 About the Book	29
2 MULTIMEDIA NETWORKING AND SYNCHRONIZATION	33
2.1 Multimedia Networking	33
2.2 Multimedia Synchronization	46
3 OVERVIEW OF MULTIMEDIA APPLICATIONS	59
3.1 Multimedia Conferencing	59
3.2 Video-On-Demand Applications	65
3.3 Research directions	80
REFERENCES	83
Part II MULTIMEDIA COMPRESSION TECHNIQUES AND STANDARDS	91
4 INTRODUCTION TO MULTIMEDIA COMPRESSION	93
4.1 Storage Requirements for Multimedia Applications	93

viii VIDEO AND IMAGE PROCESSING IN MULTIMEDIA SYSTEMS

4.2 Classification of Compression Techniques	96
4.3 Image Concepts and Structures	98
5 JPEG ALGORITHM FOR FULL-COLOR STILL IMAGE COMPRESSION	103
5.1 JPEG Codec	103
5.2 Compression Measures	112
5.3 Sequential JPEG Encoding Examples	114
5.4 JPEG Compression of Color Images	119
5.5 Progressive JPEG Compression	123
5.6 Sequential Lossless JPEG Compression	130
5.7 Hierarchical JPEG Compression	130
6 PX64 COMPRESSION ALGORITHM FOR VIDEO TELECOMMUNICATIONS	135
6.1 CCITT Video Format	135
6.2 Px64 Encoder and Decoder	137
7 MPEG COMPRESSION FOR MOTION-INTENSIVE APPLICATIONS	143
7.1 MPEG Video Encoder and Decoder	145
7.2 Audio Encoder and Decoder	158
7.3 MPEG Data Stream	161
7.4 MPEG Experimental Results	162
8 OTHER MULTIMEDIA COMPRESSION TECHNIQUES	169
8.1 Digital Video Interactive (DVI) Technology	169
8.2 Fractal Image Compression	172
8.3 Subband Image and Video Coding	177
8.4 Wavelet-Based Compression	183
9 IMPLEMENTATIONS OF COMPRESSION ALGORITHMS	185
9.1 Software JPEG Systems	187
9.2 Compression Chips	189

9.3 Video Compression Software	198
9.4 General-Purpose Processors' Support for MPEG Decoding	202
10 APPLICATIONS OF COMPRESSION SYSTEMS	
10.1 JPEG Applications	205
10.2 Video Compression Applications	207
REFERENCES	213
Part III IMAGE AND VIDEO INDEXING AND RETRIEVAL TECHNIQUES	223
11 CONTENT-BASED IMAGE RETRIEVAL	225
11.1 Introduction	225
11.2 Image Features for Content-Based Retrieval	229
11.3 Indexing Schemes	251
11.4 A User Interface for Formulating Queries and Browsing Results	263
11.5 Performance Evaluation	266
11.6 Image Retrieval in Practice	267
12 CONTENT-BASED VIDEO INDEXING AND RETRIEVAL	271
12.1 Introduction	271
12.2 Partitioning Techniques for Full-Motion Video	273
12.3 Representation and Classification of Camera Shots	290
12.4 Indexing and Retrieval	298
12.5 Interactive Tools	312
12.6 Audio	319
12.7 Video Retrieval in Practice	319
13 VIDEO PROCESSING USING COMPRESSED DATA	323
13.1 Techniques for Video Parsing	323
13.2 Experimental Data	332

14 A CASE STUDY IN VIDEO PARSING: TELEVISION NEWS	335
14.1 Introduction	335
14.2 News Video Parsing Algorithms	337
14.3 Experimental Evaluation of Parsing Algorithms	344
14.4 News Video Indexing and Retrieval	347
14.5 Modeling Other Domains of Content	353
REFERENCES	357
INDEX	371

Acknowledgments

Many of the images in this book have been reproduced with the kind permission of many publishers and other sources. We would like to thank to the IEEE for allowing us to reproduce Figures 2.11, and 2.13-17 from *IEEE MultiMedia* and Figures 1.12-13, 3.6-8, and 3.10-13 from *IEEE Computer*. We should acknowledge that many figures in Chapters 5,6 and 7 will be appearing in two survey papers on multimedia compression techniques and standards published in the *Journal of Real-Time Imaging* (Academic Press, 1995). Figures 8.5-6 were reproduced from *Byte*, and Figures 8.7-10 were reproduced with permission of Kluwer Academic Publishers.

We are particularly thankful to a number of companies for providing information on their products and systems, and allowing us to use their figures and results in Chapters 9 and 10. These companies include: AT&T, Autograph International, Hewlett-Packard, IBM, Integrated Information Technology, Intel, LSI Logic, New Media Graphics, Optivision, Siemens, Sun, Production Catalysts, Telephoto, and Texas Instruments.

We are also particularly indebted to Springer-Verlag for allowing us to reproduce the following Figures which have appeared in issues of *Multimedia Systems*: Figures 12.1-6, Figures 14.1-7, and Figures 14.9-10. In addition, Figure 14.8 will be appearing in the Springer-Verlag volume *Advances in Digital Libraries*. Similarly, all the Figures in Chapter 13 have been taken from the Kluwer journal *Multimedia Tools and Applications*; and Figure 14.11 has been reproduced with permission from the IEEE. The Cunningham Dance Foundation has been particularly generous allowing their material to be used as test data; and Figures 12.7, 12.10, and 12.11 have been reproduced with their permission. Finally, Figure 11.9 was reproduced with the permission of the Television Corporation of Singapore (formerly the Singapore Broadcasting Corporation).

The results reported in Part II could not be produced without contributions from many graduate students working in the Multimedia Laboratory at Florida Atlantic University (FAU), funded by US National Science Foundation. Ray Westwater, Mark Kessler, Jan Alexander, Mauricio Cuervo, Lou Horowitz, and Henry Pensulina have developed the sequential JPEG algorithm and provided results and images presented in Part II. Shen Huang and Zhong-Gang Li have performed and provided results for progressive JPEG compression, while Peter Monnes has analyzed JPEG performance. Srikanth Chitturi has ported and analyzed performance of the Berkeley software MPEG decoder. Keith Morea has implemented fractal image compression and provided related results, while Pa-

vani Chilamakuri and Dana Hawthorne have evaluated subband coding versus JPEG and MPEG techniques and have provided those results.

The research reported in Part III could not have been carried out without the support granted by the National Science and Technology Board of Singapore to the Institute of Systems Science (ISS). We also wish to thank Juzar Motiwalla, Director of ISS, for all the encouragement he has given to the members of the Video Classification Project during the time this work was conducted. The researchers at ISS are also particularly indebted to Professor Louis Pau, who has served in an advisory capacity since the commencement of this effort and has provided no end of helpful suggestions. In addition the authors wish to acknowledge the many contributing members of the ISS team, including Chien Yong Low, Jian Hua Wu, Atreyi Kankanhalli, You Hong Tan, and Siew Lian Koh.

Special thanks for typing, formatting, and finalizing the book goes to Donna Rubinoff from FAU, whose expertise and dedication were invaluable in the completion of this work.