

# Digital Image Processing Gonzalez Solution Manual 3rd Edition

Digital Image Processing and Analysis  
 Methods and Solutions  
 Soft Computing Methods for Practical Environment Solutions: Techniques and Studies  
 Digital Image Processing Using MATLAB  
 Digital Image Processing  
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## JADON MARKS

**Digital Image Processing and Analysis** Packt Publishing Ltd

Solutions to problems in the field of digital image processing generally require extensive experimental work involving software simulation and testing with large sets of sample images. Although algorithm development typically is based on theoretical underpinnings, the actual implementation of these algorithms almost always requires parameter estimation and, frequently, algorithm revision and comparison of candidate solutions. Thus, selection of a flexible, comprehensive, and well-documented software development environment is a key factor that has important implications in the cost, development time, and portability of image processing solutions. In spite of its importance, surprisingly little has been written on this aspect of the field in the form of textbook material dealing with both theoretical principles and software implementation of digital image processing concepts. This book was written for just this purpose. Its main objective

is to provide a foundation for implementing image processing algorithms using modern software tools. A complementary objective was to prepare a book that is self-contained and easily readable by individuals with a basic background in digital image processing, mathematical analysis, and computer programming, all at a level typical of that found in a junior/senior curriculum in a technical discipline. Rudimentary knowledge of MATLAB also is desirable. To achieve these objectives, we felt that two key ingredients were needed. The first was to select image processing material that is representative of material covered in a formal course of instruction in this field. The second was to select software tools that are well supported and documented, and which have a wide range of applications in the "real" world. To meet the first objective, most of the theoretical concepts in the following chapters were selected from *Digital Image Processing* by Gonzalez and Woods, which has been the choice introductory textbook used by educators all over the world for over two decades. The software tools selected are from the MATLAB Image Processing Toolbox (IPT), which similarly occupies a position of eminence in both education and industrial applications. A basic strategy followed in the preparation of the book was to provide a seamless integration of well-established theoretical concepts and their implementation using state-of-the-art software

tools. The book is organized along the same lines as *Digital Image Processing*. In this way, the reader has easy access to a more detailed treatment of all the image processing concepts discussed here, as well as an up-to-date set of references for further reading. Following this approach made it possible to present theoretical material in a succinct manner and thus we were able to maintain a focus on the software implementation aspects of image processing problem solutions. Because it works in the MATLAB computing environment, the Image Processing Toolbox offers some significant advantages, not only in the breadth of its computational tools, but also because it is supported under most operating systems in use today. A unique feature of this book is its emphasis on showing how to develop new code to enhance existing MATLAB and IPT functionality. This is an important feature in an area such as image processing, which, as noted earlier, is characterized by the need for extensive algorithm development and experimental work. After an introduction to the fundamentals of MATLAB functions and programming, the book proceeds to address the mainstream areas of image processing. The major areas covered include intensity transformations, linear and nonlinear spatial filtering, filtering in the frequency domain, image restoration and registration, color image processing, wavelets, image data compression,

morphological image processing, image segmentation, region and boundary representation and description, and object recognition. This material is complemented by numerous illustrations of how to solve image processing problems using MATLAB and IPT functions. In cases where a function did not exist, a new function was written and documented as part of the instructional focus of the book. Over 60 new functions are included in the following chapters. These functions increase the scope of IPT by approximately 35 percent and also serve the important purpose of further illustrating how to implement new image processing software solutions. The material is presented in textbook format, not as a software manual. Although the book is self-contained, we have established a companion Web site (see Section 1.5) designed to provide support in a number of areas. For students following a formal course of study or individuals embarked on a program of self study, the site contains tutorials and reviews on background material, as well as projects and image databases, including all images in the book. For instructors, the site contains classroom presentation materials that include PowerPoint slides of all the images and graphics used in the book. Individuals already familiar with image processing and IPT fundamentals will find the site a useful place for up-to-date references, new implementation techniques, and a host of other support material not easily found elsewhere. All purchasers of the book are eligible to download executable files of all the new functions developed in the text. As is true of most writing efforts of this nature, progress continues after work on the manuscript stops. For this reason, we devoted significant effort to the selection of material that we believe is fundamental, and whose value is likely to remain applicable in a rapidly evolving body of knowledge. We trust that readers of the book will benefit from this effort and thus find the material timely and useful in their work.

*Methods and Solutions* BoD – Books on Demand

This textbook presents the fundamental concepts and methods for understanding and working with images and video in an unique, easy-to-read style which ensures the material is accessible to a wide audience. Exploring more than just the basics of image processing, the text provides a specific focus on the practical design and implementation of real systems for processing video data. Features: includes more than 100 exercises, as well as C-code snippets of the key algorithms; covers topics on image acquisition, color images, point processing, neighborhood processing, morphology, BLOB analysis, segmentation in video, tracking, geometric transformation, and visual effects; requires only a minimal understanding of mathematics; presents two chapters dedicated to applications; provides a guide to defining suitable values for parameters in video and image processing systems, and to conversion between the RGB color representation and the HIS, HSV and YUV/YCbCr color representations.

**Soft Computing Methods for Practical Environment Solutions: Techniques and Studies** CRC Press

A comprehensive digital image processing book that reflects new trends in this field such as document image compression and data compression standards. The book includes a complete rewrite of image data compression, a new chapter on image analysis, and a new section on image morphology.

**Digital Image Processing Using MATLAB** CRC Press

This revised and expanded new edition of an internationally successful classic presents an accessible introduction to the key methods in digital image processing for both practitioners and teachers. Emphasis is placed on practical application, presenting precise algorithmic descriptions in an unusually high level of detail, while highlighting direct connections between the mathematical foundations and concrete implementation. The text is supported by practical examples and carefully constructed chapter-ending exercises drawn from the authors' years of teaching experience, including easily adaptable Java code and completely worked out examples. Source code, test images and additional instructor materials are also provided at an associated website. Digital Image Processing is the definitive textbook for students, researchers, and professionals in search of critical analysis and modern implementations of the most important algorithms in the field, and is also eminently suitable for self-study.

*Digital Image Processing* Prentice Hall

This is an introductory to intermediate level text on the science of image processing, which employs the Matlab programming language to illustrate some of the elementary, key concepts in modern image processing and pattern recognition. The approach taken is essentially practical and the book offers a framework within which the concepts can be understood by a series of well chosen examples, exercises and computer experiments, drawing on specific examples from within science, medicine and engineering. Clearly divided into eleven distinct chapters, the book begins

with a fast-start introduction to image processing to enhance the accessibility of later topics.

Subsequent chapters offer increasingly advanced discussion of topics involving more challenging concepts, with the final chapter looking at the application of automated image classification (with Matlab examples). Matlab is frequently used in the book as a tool for demonstrations, conducting experiments and for solving problems, as it is both ideally suited to this role and is widely available. Prior experience of Matlab is not required and those without access to Matlab can still benefit from the independent presentation of topics and numerous examples. Features a companion website [www.wiley.com/go/solomon/fundamentals](http://www.wiley.com/go/solomon/fundamentals) containing a Matlab fast-start primer, further exercises, examples, instructor resources and accessibility to all files corresponding to the examples and exercises within the book itself. Includes numerous examples, graded exercises and computer experiments to support both students and instructors alike.

*Intelligent Data Security Solutions for e-Health Applications* Academic Press

UP-TO-DATE, TECHNICALLY ACCURATE COVERAGE OF ESSENTIAL TOPICS IN IMAGE AND VIDEO

PROCESSING This is the first book to combine image and video processing with a practical MATLAB®-oriented approach in order to demonstrate the most important image and video techniques and algorithms. Utilizing minimal math, the contents are presented in a clear, objective manner, emphasizing and encouraging experimentation. The book has been organized into two parts. Part I: Image Processing begins with an overview of the field, then introduces the fundamental concepts, notation, and terminology associated with image representation and basic image processing operations. Next, it discusses MATLAB® and its Image Processing Toolbox with the start of a series of chapters with hands-on activities and step-by-step tutorials. These chapters cover image acquisition and digitization; arithmetic, logic, and geometric operations; point-based, histogram-based, and neighborhood-based image enhancement techniques; the Fourier Transform and relevant frequency-domain image filtering techniques; image restoration; mathematical morphology; edge detection techniques; image segmentation; image compression and coding; and feature extraction and representation. Part II: Video Processing presents the main concepts and terminology associated with analog video signals and systems, as well as digital video formats and standards. It then describes the technically involved problem of standards conversion, discusses motion estimation and compensation techniques, shows how video sequences can be filtered, and concludes with an example of a solution to object detection and tracking in video sequences using MATLAB®. Extra features of this book include: More than 30 MATLAB® tutorials, which consist of step-by-step guides to exploring image and video processing techniques using MATLAB® Chapters supported by figures, examples, illustrative problems, and exercises Useful websites and an extensive list of bibliographical references This accessible text is ideal for upper-level undergraduate and graduate students in digital image and video processing courses, as well as for engineers, researchers, software developers, practitioners, and anyone who wishes to learn about these increasingly popular topics on their own.

*Instructor's Manual for Digital Image Processing* Bookboon

Whether for computer evaluation of otherworldly terrain or the latest high definition 3D blockbuster, digital image processing involves the acquisition, analysis, and processing of visual information by computer and requires a unique skill set that has yet to be defined a single text. Until now. Taking an applications-oriented, engineering approach, Digital Image Processing and Analysis provides the tools for developing and advancing computer and human vision applications and brings image processing and analysis together into a unified framework. Providing information and background in a logical, as-needed fashion, the author presents topics as they become necessary for understanding the practical imaging model under study. He offers a conceptual presentation of the material for a solid understanding of complex topics and discusses the theory and foundations of digital image processing and the algorithm development needed to advance the field. With liberal use of color through-out and more materials on the processing of color images than the previous edition, this book provides supplementary exercises, a new chapter on applications, and two major new tools that allow for batch processing, the analysis of imaging algorithms, and the overall research and development of imaging applications. It includes two new software tools, the Computer Vision and Image Processing Algorithm Test and Analysis Tool (CVIP-ATAT) and the CVIP Feature Extraction and Pattern Classification Tool (CVIP-FEPC). Divided into five major sections, this book provides the concepts and models required to analyze digital images and develop computer vision and human consumption applications as well as all the necessary information to use the CVIPtools environment for algorithm development, making it an ideal reference tool for this fast growing field.

**Digital Image Forensics** John Wiley & Sons

This textbook is the third of three volumes which provide a modern, algorithmic introduction to digital image processing, designed to be used both by learners desiring a firm foundation on which to build, and practitioners in search of critical analysis and concrete implementations of the most important techniques. This volume builds upon the introductory material presented in the first two volumes with additional key concepts and methods in image processing. Features: practical examples and carefully constructed chapter-ending exercises; real implementations, concise mathematical notation, and precise algorithmic descriptions designed for programmers and practitioners; easily adaptable Java code and completely worked-out examples for easy inclusion in existing applications; uses ImageJ; provides a supplementary website with the complete Java source code, test images, and corrections; additional presentation tools for instructors including a complete set of figures, tables, and mathematical elements.

*Fundamentals of Digital Image Processing* Tata McGraw-Hill Education

"This book presents the latest developments in computer vision methods applicable to various problems in multimedia computing, including new ideas, as well as problems in computer vision and multimedia computing"--Provided by publisher.

**Digital Image Processing** IGI Global

This textbook provides an accessible general introduction to the essential topics in computer vision. Classroom-tested programming exercises and review questions are also supplied at the end of each chapter. Features: provides an introduction to the basic notation and mathematical concepts for describing an image and the key concepts for mapping an image into an image; explains the topologic and geometric basics for analysing image regions and distributions of image values and discusses identifying patterns in an image; introduces optic flow for representing dense motion and various topics in sparse motion analysis; describes special approaches for image binarization and segmentation of still images or video frames; examines the basic components of a computer vision system; reviews different techniques for vision-based 3D shape reconstruction; includes a discussion of stereo matchers and the phase-congruency model for image features; presents an introduction into classification and learning.

**Image Processing Masterclass with Python** John Wiley & Sons

The two first CEAS (Council of European Aerospace Societies) Specialist Conferences on Guidance, Navigation and Control (CEAS EuroGNC) were held in Munich, Germany in 2011 and in Delft, The Netherlands in 2013. ONERA The French Aerospace Lab, ISAE (Institut Supérieur de l'Aéronautique et de l'Espace) and ENAC (Ecole Nationale de l'Aviation Civile) accepted the challenge of jointly organizing the 3rd edition. The conference aims at promoting new advances in aerospace GNC theory and technologies for enhancing safety, survivability, efficiency, performance, autonomy and intelligence of aerospace systems. It represents a unique forum for communication and information exchange between specialists in the fields of GNC systems design and operation, including air traffic management. This book contains the forty best papers and gives an interesting snapshot of the latest advances over the following topics: I Control theory, analysis, and design I Novel navigation, estimation, and tracking methods I Aircraft, spacecraft, missile and UAV guidance, navigation, and control I Flight testing and experimental results I Intelligent control in aerospace applications I Aerospace robotics and unmanned/autonomous systems I Sensor systems for guidance, navigation and control I Guidance, navigation, and control concepts in air traffic control systems For the 3rd CEAS Specialist Conference on Guidance, Navigation and Control the International Program Committee conducted a formal review process. Each paper was reviewed in compliance with standard journal practice by at least two independent and anonymous reviewers. The papers published in this book were selected from the conference proceedings based on the results and recommendations from the reviewers.

*Introduction to Video and Image Processing* Springer

55% new material in the latest edition of this "must-have for students and practitioners of image & video processing! This Handbook is intended to serve as the basic reference point on image and video processing, in the field, in the research laboratory, and in the classroom. Each chapter has been written by carefully selected, distinguished experts specializing in that topic and carefully reviewed by the Editor, Al Bovik, ensuring that the greatest depth of understanding be communicated to the reader. Coverage includes introductory, intermediate and advanced topics and as such, this book serves equally well as classroom textbook as reference resource. • Provides practicing engineers and students with a highly accessible resource for learning and using image/video processing theory and algorithms • Includes a new chapter on image processing

education, which should prove invaluable for those developing or modifying their curricula • Covers the various image and video processing standards that exist and are emerging, driving today's explosive industry • Offers an understanding of what images are, how they are modeled, and gives an introduction to how they are perceived • Introduces the necessary, practical background to allow engineering students to acquire and process their own digital image or video data • Culminates with a diverse set of applications chapters, covered in sufficient depth to serve as extensible models to the reader's own potential applications About the Editor... Al Bovik is the Cullen Trust for Higher Education Endowed Professor at The University of Texas at Austin, where he is the Director of the Laboratory for Image and Video Engineering (LIVE). He has published over 400 technical articles in the general area of image and video processing and holds two U.S. patents. Dr. Bovik was Distinguished Lecturer of the IEEE Signal Processing Society (2000), received the IEEE Signal Processing Society Meritorious Service Award (1998), the IEEE Third Millennium Medal (2000), and twice was a two-time Honorable Mention winner of the international Pattern Recognition Society Award. He is a Fellow of the IEEE, was Editor-in-Chief, of the IEEE Transactions on Image Processing (1996-2002), has served on and continues to serve on many other professional boards and panels, and was the Founding General Chairman of the IEEE International Conference on Image Processing which was held in Austin, Texas in 1994. \* No other resource for image and video processing contains the same breadth of up-to-date coverage \* Each chapter written by one or several of the top experts working in that area \* Includes all essential mathematics, techniques, and algorithms for every type of image and video processing used by electrical engineers, computer scientists, internet developers, bioengineers, and scientists in various, image-intensive disciplines

#### **An Algorithmic Introduction Using Java** Springer

This book constitutes the thoroughly refereed proceedings of the 17th International Conference on Transport Systems Telematics, TST 2017, held in Katowice-Ustrón, Poland, in April 2017. The 40 papers presented in this volume were carefully reviewed and selected from 128 submissions. They present and organize the knowledge from within the field of intelligent transportation systems, the specific solutions applied in it and their influence on improving efficiency of transport systems. *Computer Vision for Multimedia Applications: Methods and Solutions* Springer Science & Business Media

Over 50 problems solved with classical algorithms + ML / DL models KEY FEATURES ● Problem-driven approach to practice image processing. ● Practical usage of popular Python libraries: Numpy, Scipy, scikit-image, PIL and SimpleITK. ● End-to-end demonstration of popular facial image processing challenges using MTCNN and Microsoft's Cognitive Vision APIs. DESCRIPTION This book starts with basic Image Processing and manipulation problems and demonstrates how to solve them with popular Python libraries and modules. It then concentrates on problems based on Geometric image transformations and problems to be solved with Image hashing. Next, the book focuses on solving problems based on Sampling, Convolution, Discrete Fourier transform, Frequency domain filtering and image restoration with deconvolution. It also aims at solving Image enhancement problems using different algorithms such as spatial filters and create a super resolution image using SRGAN. Finally, it explores popular facial image processing problems and solves them with Machine learning and Deep learning models using popular python ML / DL libraries. WHAT YOU WILL LEARN ● Develop strong grip on the fundamentals of Image Processing and Image Manipulation. ● Solve popular Image Processing problems using Machine Learning and Deep Learning models. ● Working knowledge on Python libraries including numpy, scipy and scikit-image. ● Use popular Python Machine Learning packages such as scikit-learn, Keras and pytorch. ● Live implementation of Facial Image Processing techniques such as Face Detection / Recognition / Parsing dlib and MTCNN. WHO THIS BOOK IS FOR This book is designed specially for computer vision users, machine learning engineers, image processing experts who are looking for solving modern image processing/computer vision challenges. TABLE OF CONTENTS 1. Chapter 1: Basic Image & Video Processing 2. Chapter 2: More Image Transformation and Manipulation 3. Chapter 3: Sampling, Convolution and Discrete Fourier Transform 4. Chapter 4: Discrete Cosine / Wavelet Transform and Deconvolution 5. Chapter 5: Image Enhancement 6. Chapter 6: More Image

#### Enhancement 7. Chapter 7: Facel Image Processing

##### *Digital Image Processing* Prentice Hall

Sustaining ecosystems to deliver what people need and value, while mitigating and adapting to global climate change and extreme event impacts, presents a complex set of environmental, economic, and social challenges in ensuring resilient and sustainable food production. The Climate Smart Landscape (CSL) approach has emerged as an integrated management strategy to address the increasing pressures on agricultural production, ecosystem conservation, rural livelihoods, climate change mitigation and adaptation. Deploying cheaper, more accurate, and efficient technology enables the harnessing of big data for use in solving sustainability challenges. With improved integrated analytical frameworks, statistical approaches, spatially- explicit models and indices, the CSL approach can be further developed and applied for more resilient, productive, and sustainable ecosystems. This eBook brings together original research, review, hypothesis, theory, and technology report articles, involving 87 authors from 9 countries across Asia, Europe, and North America. These articles present new methodological and technological innovation, findings, and insights across four themes: (1) landscape productivity and crop suitability, (2) variable crop requirements for water and nutrients, (3) crop health status, phenology, and phenotyping, and (4) crop disease assessment and prediction under integrated pest management (IPM).

##### *Concepts, Algorithms, and Scientific Applications* IGI Global

The book consists of 21 chapters which present interesting applications implemented using the LabVIEW environment, belonging to several distinct fields such as engineering, fault diagnosis, medicine, remote access laboratory, internet communications, chemistry, physics, etc. The virtual instruments designed and implemented in LabVIEW provide the advantages of being more intuitive, of reducing the implementation time and of being portable. The audience for this book includes PhD students, researchers, engineers and professionals who are interested in finding out new tools developed using LabVIEW. Some chapters present interesting ideas and very detailed solutions which offer the immediate possibility of making fast innovations and of generating better products for the market. The effort made by all the scientists who contributed to editing this book was significant and as a result new and viable applications were presented.

#### **Digital Image Processing for Medical Applications** Springer

Meant for students and practicing engineers, this book provides a clear, comprehensive and up-to-date introduction to Digital Image Processing in a pragmatic style. An illustrative approach, practical examples and MATLAB applications given in the book help in bringing the theory to life.

##### *Fundamentals of Digital Image Processing* Academic Press

Photographic imagery has come a long way from the pinhole cameras of the nineteenth century. Digital imagery, and its applications, develops in tandem with contemporary society's sophisticated literacy of this subtle medium. This book examines the ways in which digital images have become ever more ubiquitous as legal and medical evidence, just as they have become our primary source of news and have replaced paper-based financial documentation. Crucially, the contributions also analyze the very profound problems which have arisen alongside the digital image, issues of veracity and progeny that demand systematic and detailed response: It looks real, but is it? What camera captured it? Has it been doctored or subtly altered? Attempting to provide answers to these slippery issues, the book covers how digital images are created, processed and stored before moving on to set out the latest techniques for forensically examining images, and finally addressing practical issues such as courtroom admissibility. In an environment where even novice users can alter digital media, this authoritative publication will do much so stabilize public trust in these real, yet vastly flexible, images of the world around us.

##### *Mathematical and Computational Solutions for Archaeology* CRC Press

This book is an essential guide to the implementation of image processing and computer vision techniques, with tutorial introductions and sample code in Matlab. Algorithms are presented and fully explained to enable complete understanding of the methods and techniques demonstrated. As one reviewer noted, "The main strength of the proposed book is the exemplar code of the algorithms." Fully updated with the latest developments in feature extraction, including expanded

tutorials and new techniques, this new edition contains extensive new material on Haar wavelets, Viola-Jones, bilateral filtering, SURF, PCA-SIFT, moving object detection and tracking, development of symmetry operators, LBP texture analysis, Adaboost, and a new appendix on color models. Coverage of distance measures, feature detectors, wavelets, level sets and texture tutorials has been extended. Named a 2012 Notable Computer Book for Computing Methodologies by Computing Reviews Essential reading for engineers and students working in this cutting-edge field Ideal module text and background reference for courses in image processing and computer vision The only currently available text to concentrate on feature extraction with working implementation and worked through derivation

*Handbook of Image and Video Processing* Digital Image Processing Digital Image Processing has been the leading textbook in its field for more than 20 years. As was the case with the 1977 and 1987 editions by Gonzalez and Wintz, and the 1992 edition by Gonzalez and Woods, the present edition was prepared with students and instructors in mind. 771e material is timely, highly readable, and illustrated with numerous examples of practical significance. All mainstream areas of image processing are covered, including a totally revised introduction and discussion of image fundamentals, image enhancement in the spatial and frequency domains, restoration, color image processing, wavelets, image compression, morphology, segmentation, and image description. Coverage concludes with a discussion of the fundamentals of object recognition. Although the book is completely self-contained, a Companion Website (see inside front cover) provides additional support in the form of review material, answers to selected problems, laboratory project suggestions. and a score of other features. A supplementary instructor's manual is available to instructors who have adopted the book for classroom use. New Features \*New chapters on wavelets, image morphology, and color image Digital Image Processing Introduce your students to image processing with the industry's most prized text For 40 years, Image Processing has been the foundational text for the study of digital image processing. The book is suited for students at the college senior and first-year graduate level with prior background in mathematical analysis, vectors, matrices, probability, statistics, linear systems, and computer programming. As in all earlier editions, the focus of this edition of the book is on fundamentals. The 4th Edition, which celebrates the book's 40th anniversary, is based on an extensive survey of faculty, students, and independent readers in 150 institutions from 30 countries. Their feedback led to expanded or new coverage of topics such as deep learning and deep neural networks, including convolutional neural nets, the scale-invariant feature transform (SIFT), maximally-stable extremal regions (MSERs), graph cuts, k-means clustering and superpixels, active contours (snakes and level sets), and exact histogram matching. Major improvements were made in reorganizing the material on image transforms into a more cohesive presentation, and in the discussion of spatial kernels and spatial filtering. Major revisions and additions were made to examples and homework exercises throughout the book. For the first time, we added MATLAB projects at the end of every chapter, and compiled support packages for you and your teacher containing, solutions, image databases, and sample code. The support materials for this title can be found at

[www.ImageProcessingPlace.com](http://www.ImageProcessingPlace.com) Digital Image Processing Digital Image Processing has been the leading textbook in its field for more than 20 years. As was the case with the 1977 and 1987 editions by Gonzalez and Wintz, and the 1992 edition by Gonzalez and Woods, the present edition was prepared with students and instructors in mind. 771e material is timely, highly readable, and illustrated with numerous examples of practical significance. All mainstream areas of image processing are covered, including a totally revised introduction and discussion of image fundamentals, image enhancement in the spatial and frequency domains, restoration, color image processing, wavelets, image compression, morphology, segmentation, and image description. Coverage concludes with a discussion of the fundamentals of object recognition. Although the book is completely self-contained, a Companion Website (see inside front cover) provides additional support in the form of review material, answers to selected problems, laboratory project suggestions. and a score of other features. A supplementary instructor's manual is available to instructors who have adopted the book for classroom use. New Features \*New chapters on wavelets, image morphology, and color image