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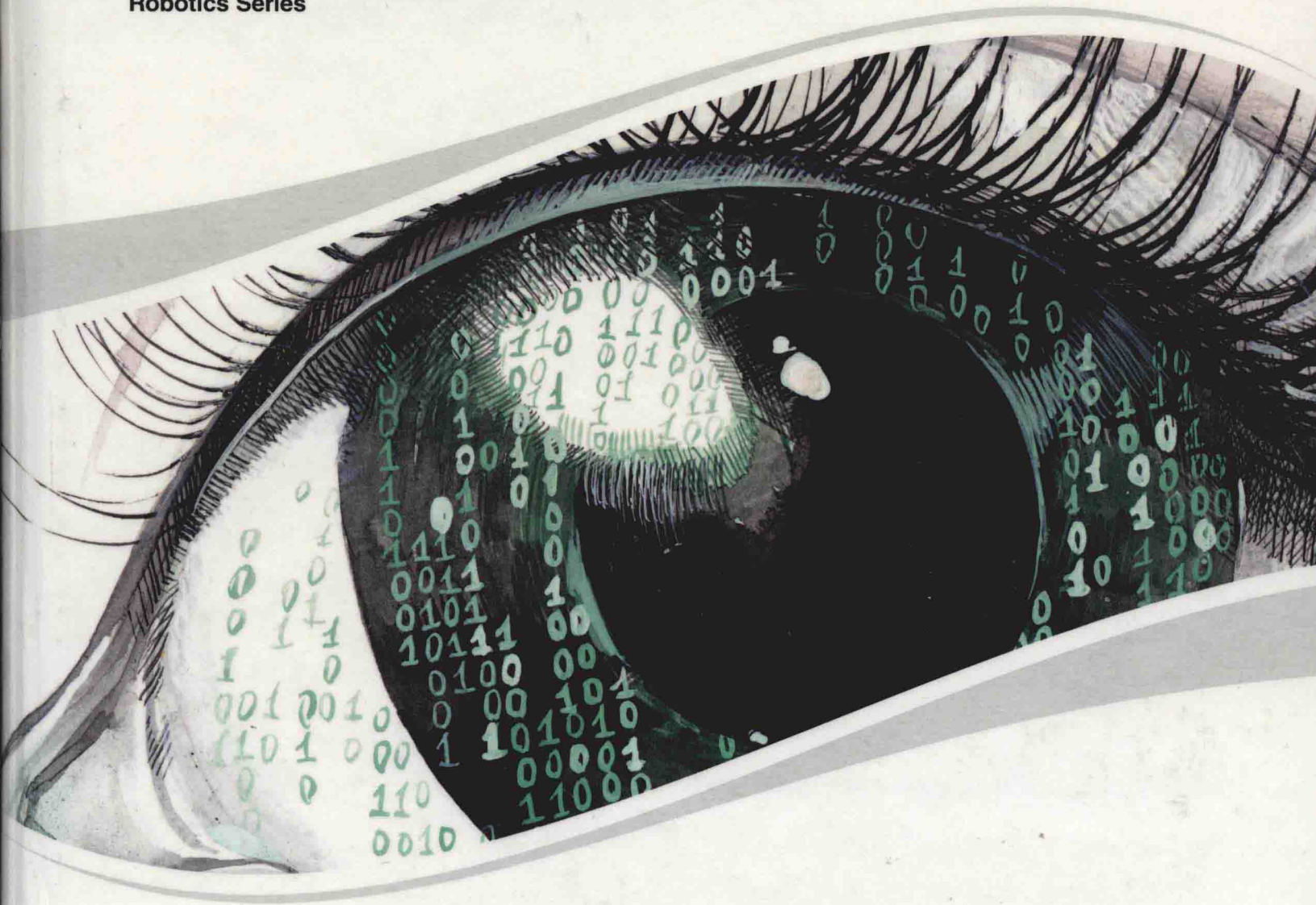

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Research Developments in Computer Vision and Image Processing:

Methodologies and Applications

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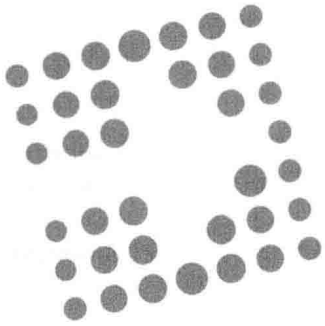

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Preface

Image processing is a rapidly growing field that deals with the manipulation of an image for the purpose of either extracting information from the image or producing an alternative representation of the image. Image analysis includes modelling and analysis of the original image itself (i.e. from image space analysis to different methods to represent the image). The various tools of image analysis include spectral analysis, wavelets, statistics, level-sets, and Partial Differential Equations (PDEs). On the other hand, image processing is to modify the original image to improve the quality or extract information from the given image, for example, image restoration, compression, segmentation, shape, and texture analysis. There are two dual fields that are directly connected to image processing in contemporary computer science. These are computer vision, which is related to the construction of the 3D world from the observed 2D images, and computer graphics, which pursues the opposite direction in designing suitable 2D scene images to simulate our 3D world. Image processing can be considered the crucial middle way connecting the vision and graphics fields. This book incorporates the contents related to the latest research trends in emerging core areas and applications of computer vision and image processing.

The book will serve as a research reference book in the area of computer vision and image processing that provides useful cutting edge research information to the students, researchers, scientists, engineers, and other related professionals in the said area. This book provides the latest research trends and concepts to develop new methodologies and applications in the areas of image representation and reconstruction and medical applications.

The image representation and reconstruction section of the book contains recent research developments in the field of general image processing and computer vision. The various topics include various important topics such as image representation, 3D reconstruction, wavelet-based image processing, a survey on computational model of visual attention, a review on image restoration, image enhancement and restoration techniques for underwater images, and computer vision-based techniques for surface defect detection in apples.

The Medical Application section reports various important research developments in the field of medical image processing and its applications. The various important topics in this section include design and development of a Computer-Aided Diagnostics (CAD) tools for breast cancer detection from digital mammograms, cancer detection from microscopic biopsy images, cancer/disease detection from microarray gene expression data, digital watermarking techniques in telemedicine, blood cell analysis, research developments in the field of medical image reconstruction, and electrical impedance tomography.

SCHOLARLY VALUE, POTENTIAL CONTRIBUTION/IMPACT, AND PURPOSE

At present most of the books available in the field of image processing and computer vision are tuned to a very specific limited research field. This book intends to serve the purpose of a large audience working in related or allied areas including students, researchers, professors, practicing engineers, application developers, radiologists, etc. Also, this book will be helpful for new as well as experienced researchers to familiarise themselves with the new research areas and their possible applications in the field of image processing and computer vision. This book incorporates the methodologies to develop algorithms for related problems and new research trends. In addition, this book also incorporates chapters related to new challenging application areas of image processing and computer vision. Emphasis has been given to develop each and every chapter incorporating a latest literature review, methods and models, implementation, experimental results, performance analysis, conclusion, future work, and latest relevant references.

POTENTIAL USES/INTENDED AUDIENCE

- Interdisciplinary engineering students at final year UG level, PG level, and doctoral research students.
- Faculty members/trainers/professors.
- Research scientists.
- Medical professionals and radiologists.
- Practicing engineers and software application developers.

ORGANIZATION OF THE BOOK

This edited book titled *Recent Advances in Computer Vision and Image Processing: Methodologies and Applications* provides an overview, recent research developments in the field of computer vision and image processing, and related applications. This book contains 17 chapters divided into two sections, namely Section 1: Image Representation and Reconstruction and Section 2: Medical Applications. Section 1 contains 7 chapters from Chapter 1 to Chapter 7, and Section 2 contains 10 chapters from Chapter 8 to Chapter 17.

Section 1: Image Representation and Reconstruction

Chapter 1: Image Representation Using a Sparsely Sampled Codebook for Super-Resolution

This chapter presents a Super-Resolution (SR) method using a vector quantization codebook and filter dictionary wherein the idea of compressive sensing is used to represent a sparsely sampled signal under the assumption that a combination of a small number of code words can represent an image patch. A method for resolution enhancement has been proposed using an alternative l_1 norm minimization, where an iterative reweighted l_1 norm minimization is used for optimization followed by an additional de-blurring step to globally enhance the image quality. Results obtained show the efficacy of the proposed scheme.

Chapter 2: 3D Reconstruction Using Multiple View Stereo and a Brief Introduction to Kinect

This chapter presents the 3D sparse and dense reconstruction approaches using multiple view stereo. The basic properties of the projective geometry and the camera models are introduced to understand the preliminaries about the subject. Methods for point correspondences among images are discussed for multi-view reconstruction. An introduction to Microsoft Kinect, which captures 3D information in real time, and methods to enhance the Kinect point cloud using vision framework are discussed.

Chapter 3: An Introduction to Wavelet-Based Image Processing and Its Applications

This chapter discusses the fundamental concepts of wavelet transforms and its applications to image processing and computer vision. The inherent properties of wavelets that make it useful in image denoising, edge detection, image compression, compressed sensing, and illumination normalization are discussed.

Chapter 4: Computational Models of Visual Attention – A Survey

Computational modeling of neuro-psychological phenomenon has potential to enrich many computer vision tasks. This chapter provides a survey for computational models of visual attention showing the latest research developments in this field. It also discusses various aspects related to computational modeling of attention such as choice of features and evaluation of these models.

Chapter 5: A Brief Review on Recent Trends in Image Restoration

This chapter presents a brief review of image restoration methods. The latest developments in this field and the performance metrics of evaluation are discussed. The concept behind the metric selection for the assessment and evaluation is introduced along with the need for shifting the dependence of the research community towards the newly proposed metrics.

Chapter 6: Image Enhancement and Restoration Methods for Underwater Images

Underwater imaging is one of the challenging tasks in the field of image processing and computer vision. This chapter provides an overview of state-of-the-art image enhancement and restoration techniques for underwater images. Further, a method for the restoration and enhancement of underwater images is proposed. Results show that the proposed method increases better image visualization of objects captured in an underwater environment.

Chapter 7: Computer Vision-Based Techniques for Surface Defect Detection of Apples

In this chapter, review of the recent computer vision-based techniques for automatic inspection of quality of the fruits and in particular automatic inspection of quality of apples based on surface defects is presented. Further, a method using grow-cut and multi-threshold-based segmentation technique is proposed to estimate the defects on the surface of an apple. The obtained results show the efficacy of the proposed method.

Section 2: Medical Applications

Chapter 8: Image Analysis and Understanding Techniques for Breast Cancer Detection from Digital Mammograms

This chapter discusses the steps involved in the design and development of a CAD tool for early breast cancer detection from mammograms. Detailed overviews of the various methods developed in recent years for each of the design stages for the CAD tool are provided. Further, the design of a new CAD tool using fuzzy c-means segmentation, hybrid features, genetic algorithm-based feature selection method, and support vector machine-based classification are proposed. Results obtained show the efficacy of the proposed methodology.

Chapter 9: Denoising, Clustering, Classification, and Representation of Microarray Data for Disease Diagnostics

The microarray data gives a single snapshot of the gene activity profile of a cell at any given time, which is typically used to compare the relative abundance of specific disease causing genes in different pathogenic conditions. Microarray data helps to elucidate the various genes involved in the disease and may also be used for diagnosis/prognosis. In spite of its huge potential, microarray data interpretation and use is limited by its error-prone nature, the sheer size of the data, and the subjectivity of the analysis. This chapter describes the use of established methodologies algorithms for eliminating error, classification, clustering, differential data analysis, and representation of microarray data.

Chapter 10: Detection of Cancer from Microscopic Biopsy Images Using Image Processing Tools

This chapter discusses the methodologies for the design and development of an automatic cancer diagnosis system based on microscopic biopsy images using image-processing tools. The proposed tool can be used to detect the cancer and its type in its early stage for complete treatment and cure. This system may help pathologists to improve the accuracy and efficiency to detect malignancy and to minimize the inter-observer variation. In addition, the tool may help us to analyze the image cell by using classification and clustering algorithms by staining characteristics of the cells.

Chapter 11: Digital Image Watermarking – Impact on Medical Imaging Applications in Telemedicine

The technology of telemedicine makes patient diagnosis possible for physicians located at a remote site. This technology involves electronic transmission of medical images over the Internet, thus raising the need for ensuring security and privacy of such information. Digital watermarking is a widely used technique for the authentication and protection of multimedia data. This chapter investigates the impact of digital watermarking and its effect on the accuracy of disease diagnosis, specifically diagnosis of malarial infection caused by *Plasmodium vivax* parasite. A computer-aided automatic diagnostic model is proposed. The experimental results show that although general (lossy) digital watermarking reduces the diagnostic accuracy, it can be improved with the use of *reversible* (lossless) watermarking. In fact, the adverse effect(s) of watermarking on the diagnostic accuracy can be completely mitigated through the use of reversible watermarking.

Chapter 12: Biomedical Watermarking – An Emerging and Secure Tool for Data Security and Better Tele-Diagnosis in Modern Health Care System

This chapter describes the need of data security and content protection in modern health care systems. A review of existing watermarking techniques is presented. Some new types of data hiding techniques using biomedical watermarking techniques in both spatial and frequency domain, which would help keep the authenticity and secure the contents of the hidden biomedical information for accurate tele-diagnosis, are discussed. These techniques use multiple copies of the same information that is to be hidden in the cover image. Some new types of embedding and recovery processes are also employed for better results and success of the different proposed schemes. The Modified Bit Replacement (MBR) embedding process and the Bit Majority Algorithm (BMA) technique for recovery of the hidden information are the newer approaches which are also described here.

Chapter 13: Electrical Impedance Tomography (EIT) – A Harmless Medical Imaging Modality

This chapter presents a brief review on the available medical imaging modalities and focuses on the need of an alternating method. Further, the concepts of Electrical Impedance Tomography (EIT)-based medical imaging, which is a harmless medical imaging modality is discussed with its physical and mathematical aspects, potentials, and challenges.

Chapter 14: Research and Developments in Medical Image Reconstruction Methods and Its Applications

This chapter presents the review and opinions of the authors on the research and developments in the field of medical image reconstruction techniques, Computed Tomography (CT), challenges, and the impact of future technology developments in CT, computed tomography metrology in industrial research and development, technology and clinical performance of different CT-scanner generations used for cardiac imaging, such as Electron Beam CT (EBCT), single-slice CT, and Multi-Detector row CT (MDCT) with 4, 16, and 64 simultaneously acquired slices. The limitations of current CT-scanners are identified, potential for improvements are indicated, and alternative system concepts such as CT with area detectors and Dual Source CT (DSCT), recent technology with a focus on generation and detection of x-rays, as well as image reconstruction are discussed. Furthermore, the chapter includes aspects of applications, dose exposure in computed tomography, and a brief overview on special CT developments.

Chapter 15: Automatic MRI Brain Image Segmentation Using Gravitational Search-Based Clustering Technique

In this chapter, an automatic MRI brain image segmentation framework using gravitational search-based clustering technique is proposed. The proposed framework consists of a two stage segmentation procedure. First, non-brain tissues are removed from the brain tissues using a modified skull-stripping algorithm. In the second step, the automatic gravitational search-based clustering technique is used to extract the brain tissues from the skull stripped image. The proposed algorithm is applied on four simulated T1-weighted MRI brain images. Experimental results reveal that the proposed algorithm outperforms the existing techniques in terms of the structure similarity measure.

Chapter 16: Survey of Medical Image Compression Techniques and Comparative Analysis

This chapter presents a survey of medical image compression techniques and discusses the need for medical image compression, different approaches to image compression, and wavelet-based lossy-lossless compression techniques. The comparative analyses of some existing recent image compression techniques are also presented.

Chapter 17: Analysis of Blood Cell Smears Using Stationary Wavelet Transform and Harris Corner Detection

Blood cell smears contain a lot of information about the state of human health. This chapter proposes a fuzzy c-means segmentation-based method for the evaluation of blood cells of humans by counting the presence of Red Blood Cells (RBCs) and recognizing White Blood Cell (WBC) types using Harris corner detection. An algorithm for the detection of RBCs is proposed, and the results obtained from the proposed automated system are compared with manual results of expert ophthalmologists' hand-drawn ground-truths. The proposed system detects RBCs successfully with accuracy of 82.37%.

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Section 1

Image Representation and Reconstruction

Table of Contents