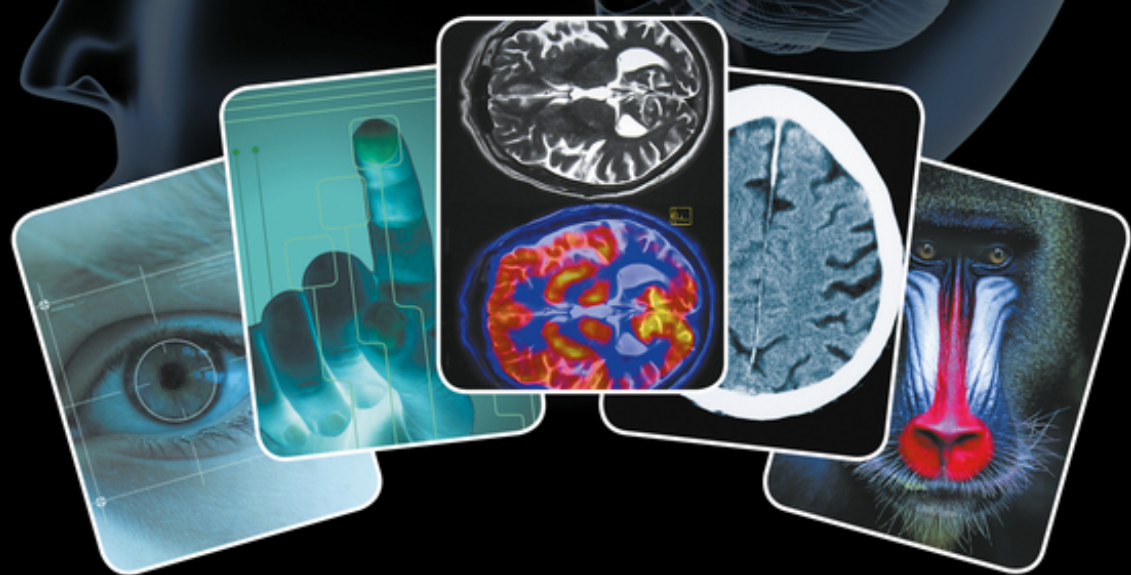


HYBRID INTELLIGENCE FOR IMAGE ANALYSIS AND UNDERSTANDING



**SIDDHARTHA BHATTACHARYYA
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Dedication

Dedicated to my parents, the late Ajit Kumar Bhattacharyya and the late Hashi Bhattacharyya; my beloved wife, Rashni; my elder sisters, Tamali, Sheuli, and Barnali; my cousin sisters, Sutapa, Mousumi, and Soma; and all my students, who have made this journey enjoyable.

Dr. Siddhartha Bhattacharyya

Dedicated to all my students.

Dr. Indrajit Pan

Dedicated to my respected teachers.

Dr. Anirban Mukherjee

Dedicated to my parents, the late Arun Kanti Dutta and Mrs. Bandana Dutta.

Dr. Paramartha Dutta

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Dr Dutta has guided three scholars who already had been awarded their PhD. Presently, he is supervising six scholars for their PhD program. Dr Dutta has served as editor of special volumes of several international journals published by publishers of international repute such as Springer. Dr Dutta, as investigator, could implement successfully projects funded by AICTE, DST of the Government of India.

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Foreword

Image analysis and understanding have been daunting tasks in computer vision given the high level of uncertainty involved therein. At the same time, a proper analysis of images plays a key role in many real-life applications. Examples of applications include image processing, image mining, image inpainting, video surveillance, and intelligent transportation systems, to name a few. Albeit there exists a plethora of classical techniques for addressing the problem of image analysis, which include filtering, hierarchical morphologic algorithms, 2D histograms, mean shift clustering, and graph-based segmentation, most of these techniques often fall short owing to their incapability in handling inherent real-life uncertainties. In past decades, researchers have been able to address different types of uncertainties prevalent in real-world images, thanks to the evolving state of the art of intelligent tools and techniques such as convolutional neural networks (CNNs) and deep learning. In this direction, computational intelligence techniques deserve special mention owing to their flexibility, application-free usability, and adaptability. Of late, hybridization of different computational intelligence techniques has come up with promising avenues in that these are more robust and offer more efficient solutions in real time.

This book aims to introduce the readers with the basics of image analysis and understanding, with recourse to image thresholding, image segmentation, and image and multimedia data analysis. The book also focuses on the foundations of hybrid intelligence as it applies to image analysis and understanding. As a sequel to this, different state-of-the-art hybrid intelligent techniques for addressing the problem of image analysis will be illustrated to enlighten the readers of upcoming research trends.

As an example of the recent trends in image analysis and understanding, albeit aging mitigates the glamor in human beings, wrinkles in face images can often be used for estimation of age progression in human beings. This can be further utilized for tracing unknown or missing persons. Images exhibit varied uncertainty and ambiguity of information, and hence understanding an image scene is far from being a general procedure. The situation becomes even graver when the images become corrupt with noise artifacts.

In this book, the editors have attempted to deliver some of the recent trends in hybrid intelligence as it applies to image analysis and understanding. The book contains 17 well-versed chapters illustrating diversified areas of application of image analysis using hybrid intelligence. These include multilevel image segmentation, character recognition, image analysis, video image processing, hyperspectral image analysis, and medical image analysis.

The first chapter deals with multilevel image segmentation. The authors propose a modified genetic algorithm (MfGA) to generate the optimized class levels of the multilevel images, and those class levels are employed as the initial input in the fuzzy c-means (FCM) algorithm. A performance comparison is depicted between the MfGA-based FCM algorithm, the conventional genetic algorithm (GA)-based FCM algorithm, and the well-known FCM algorithm with the help of three real-life multilevel grayscale images. The comparison revealed the superiority of the proposed method over the other two image segmentation algorithms.

Chapters 2 to 5 address the issue of character recognition and soft biometrics. Chapter 2 shows pros and cons of an entropy-based FCM clustering technique to classify huge training data for English character recognition. In chapter 3, the authors propose a two-stage word-level script identification technique for eight handwritten popular scripts, namely, Bangla, Devanagari, Gurumukhi, Oriya, Malayalam, Telugu, Urdu, and Roman. Firstly, discrete wavelet transform (DWT) is applied on the input word images to extract the most representative information, whereas in the second stage, radon transform (RT) is applied to the output of the first stage to compute a set of 48 statistical features from each word image. Chapter 4 presents a skin color region segmentation method based on K-means clustering and Mahalanobis distance for static hand gesture recognition. The final chapter in this group deals with soft-biometrics prediction. There, three prediction systems are developed using a support vector machine (SVM) classifier associated to various gradient and textural features. Since different features yield different aspects of characterization, the authors investigate classifier combination in order to improve the prediction accuracy. As a matter of fact, the fuzzy integral is used to produce a robust soft-biometrics prediction.

Chapters 6 and 7 focus on image analysis applications. More specifically, in chapter 6, the authors draw an analogy and comparison between the working principle of CNNs and the human brain. In chapter 7, the authors propose a framework for human action recognition that is trained using evolutionary algorithms and deep learning. A CNN classifier designed to recognize human actions from action bank features is initialized by evolutionary algorithms and trained using back-propagation algorithms.

Chapter 8 is targeted to video image processing applications. The authors propose a technique using Haar-like simple features to describe object models in chapter 8. This technique is applied with Adaboost classifier for object detection on the video records. The tracking method is described and illustrated by fusing global and local features.

Chapter 9 deals with a GIS-based application. The proposed GIS-anchored system extends a helping hand toward common and innocent people and exposes the trails for releasing themselves from the clutches of criminals. The chief intent of the proposed work is to not only check out the hot-spot areas (the crime-prone areas), but also give a glance to the flourishing of criminal activities in future. The process of determination of hot-spots is carried out by associating rank (an integer value) to each ward/block on the digitized map. The process of hooking up rank to a specific region is carried out on the basis of criminal activity at that particular region.

Chapters 10 and 11 deal with hyperspectral image analysis. Chapter 10 covers the hyperspectral data analysis and processing algorithms organized into three topics: spectral unmixing, classification, and target identification. In chapter 11, the authors deal with the band selection problem. They use the fuzzy k -nearest neighbors (KNN)