

Hybrid Soft Computing for Image Segmentation

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Editors

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 Springer

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*To my parents, the late Ajit Kumar
Bhattacharyya and the late Hashi
Bhattacharyya, my beloved wife, Rashni,
my maternal uncle, Mr. Arabinda Kumar
Banerjee, and my maternal aunt,
Mrs. Maya Banerjee*

Siddhartha Bhattacharyya

*To my parents, the late Arun Kanti Dutta and
Mrs. Bandana Dutta*

Paramartha Dutta

*To my parents, Mr. Satya Narayan De and
Mrs. Tapasi De, my wife, Mrs. Debolina
Ghosh, my son, Mr. Aishik De, and my sister,
Mrs. Soumi De*

Sourav De

*To my wife, Antonija Klepac, and my
children, Laura Klepac, Viktor Klepac,
Oliver Klepac and Gabrijel Klepac*

Goran Klepac

Foreword

Imparting intelligence has become the focus of various computational paradigms. Thanks to the evolving soft computing and artificial intelligent methodologies, scientists have been able to explain and understand real-life processes and practices, which formerly remained unexplored by dint of their underlying imprecision, uncertainties and redundancies, as well as the unavailability of appropriate methods for describing the inexactness, incompleteness, and vagueness of information representation.

Image segmentation is no exception in this regard, when it comes to the manifestation of uncertainty and imprecision in varied forms. The situation becomes more severe when images become corrupt with noise artifacts. Adding to it, the time complexity involved in processing images exhibiting the different color gamuts is also a challenging thoroughfare. A plethora of literature exists involving the classical domains for coping with the complex task of image segmentation, particularly for handling uncertainty and imprecision prevalent in image processing. Soft computing has been applied to deal with these unanswered uncertainties to a great and appreciable extent. However, as we know that the notable soft computing methodologies often fall short of deriving a robust solution to the problem of image segmentation.

The present treatise is targeted at introducing to the readers the evolving hybrid soft computing paradigm, which is a confluence of the existing soft computing tools and techniques aimed at achieving more efficient and robust solutions to uncertain real-life problems with a special regard to image segmentation. An in-depth analysis of the different facets of the hybrid soft computing models has been discussed. Illustrative examples (with case studies) of the applications of the hybrid soft computing techniques for the purpose of handling uncertainty in image segmentation has been presented for the sake of understanding of the subject under consideration.

The edited volume comprises a total of 12 well-versed chapters focused on the varied aspects of image segmentation using the hybrid soft computing paradigms.

Chapter “[Hybrid Swarms Optimization Based Image Segmentation](#)” explores the application of an admixture of Firefly Algorithm (FA) and Social Spider Optimization (SSO) for handling multilevel thresholding in image segmentation. The authors have shown the superiority of their proposed technique in terms of lower time complexity.

Chapter “[Grayscale Image Segmentation Using Multilevel Thresholding and Nature-Inspired Algorithms](#)” deals with another hybridization approach named GSA-GA, which is a fusion of Gravitational Search Algorithm (GSA) and Genetic Algorithm (GA). The authors demonstrate the usage of the hybrid algorithm on multilevel image thresholding.

The objective of Chapter “[A Novel Hybrid CS-BFO Algorithm for Optimal Multilevel Image Thresholding Using Edge Magnitude Information](#)” is to use the optimal edge magnitude information of an image to obtain multilevel threshold values on the basis of the Gray-Level Co-occurrence Matrix (GLCM) of the image. Here, the authors have used a novel hybrid algorithm comprising cuckoo search and bacterial foraging optimization in the form of CS-BFO algorithm for obtaining the optimal threshold values.

In Chapter “[REFII Model and Fuzzy Logic as a Tool for Image Classification Based on Image Example](#)”, the author demonstrates the effectiveness of REFII model coupled with fuzzy logic on image classification tasks.

Chapter “[Microscopic Image Segmentation Using Hybrid Technique for Dengue Prediction](#)” offers a hybrid methodology capable of providing an automated platelet counting system for the efficient, easy, and fast detection of dengue infection. This is achieved by segmentation of platelets from microscopic images of a blood smear.

Chapter “[Extraction of Knowledge Rules for the Retrieval of Mesoscale Oceanic Structures in Ocean Satellite Images](#)” focuses on the extraction of the rules for the oceanic structures of mesoscale dimension, where the imaging modality used are ocean satellite images.

Chapter “[Hybrid Uncertainty Based Techniques for Segmentation of Satellite Imagery and Applications](#)” presents an approach to establish the effectiveness of hybridization of soft computing techniques for achieving segmentation of satellite image applications.

Chapter “[Improved Human Skin Segmentation Using Fuzzy Fusion Based on Optimized Thresholds by Genetic Algorithms](#)” uses genetic algorithm for obtaining the optimal thresholding of images. These optimal thresholds, in turn, are used with fuzzy in fusion for segmentation of human skin image information.

In Chapter “[Uncertainty Based Spatial Data Clustering Algorithms for Image Segmentation](#)”, the authors have discussed about various clustering approaches used in image segmentation. In addition, they have established the efficiency of hybridization in overcoming the limitations in crisp as well as fuzzy-based clustering techniques.

The authors of Chapter “[Coronary Artery Segmentation and Width Estimation Using Gabor Filters and Evolutionary Computation Techniques](#)” have shown the efficacy of hybridization of Gabor filtering with evolutionary approach for

achieving the very important task of estimation of the width of coronary artery after its appropriate segmentation.

In Chapter “[Hybrid Intelligent Techniques for Segmentation of Breast Thermograms](#)”, the authors use hybridization techniques to identify and classify affected regions (out of abnormal growth) due to breast carcinoma.

Finally, Chapter “[Modeling of High-Dimensional Data for Applications of Image Segmentation in Image Retrieval and Recognition Tasks](#)” illustrates a hybridization approach in the form of Probabilistic Features Combination (PCF) method for multidimensional data modeling, extrapolation, and interpolation using the set of high-dimensional feature vectors.

The design of different hybrid soft computing algorithms might evolve over the years, and more and more efficient algorithms are likely to come. But one issue must be mentioned at this point. This book will be one of the stepping-stones in the forward direction enticing the readers to develop and apply indigenous and robust hybrid soft computing algorithms for image segmentation.

I herewith would like to invite the readers to enjoy the book and take most of its benefits. One could join the team of hybrid soft computing algorithm designers and bring new insights into this developing and challenging enterprise.

Finland
July 2016

Xiao-Zhi Gao

Preface

The field of image segmentation has assumed paramount importance in the computer vision research community given the vast amount of uncertainty involved therein. Proper segmentation of real-life images plays a key role in many real-life applications. Traditional applications include image processing, image mining, video surveillance, intelligent transportation systems, to name a few.

With the shortcomings and limitations of classical platforms of computation, particularly for handling uncertainty and imprecision prevalent in the challenging thoroughfare of image processing, soft computing as an alternative along with extended computation paradigm has been making its presence felt. Accordingly, a phenomenal growth of research initiative in this field is being witnessed. Soft computing techniques include (i) the elements of fuzzy mathematics, primarily used for handling various real-life problems engrossed with uncertainty, (ii) the ingredients of artificial neural networks, usually applied for cognition, learning and subsequent recognition by machine inducing thereby the flavor of intelligence in a machine through the process of its learning and (iii) components of evolutionary computation mainly used for search, exploration, efficient exploitation of contextual information and knowledge useful for optimization.

There has been ample research reporting based on such soft computing techniques applied effectively to solve various real-life problems. The spectrum of applications is practically all pervading. These techniques individually have their points of strength as well as of limitation. On the several real-life contexts, it is being observed that they play supplementary role to one another. Naturally, this has given rise to a serious research initiative for exploring avenues of hybridization of the above-mentioned soft computing techniques. Present day research initiative finds more orientation towards hybridization as an alternative to individual soft computing methods. Moreover, it is observed that hybrid approaches in the form of neuro-fuzzy, fuzzy genetic, rough-neuro, rough-fuzzy, neuro-fuzzy-genetic, neuro-fuzzy-rough, quantum neuro-fuzzy architectures usually offer more robust and intelligent solutions. Interestingly the scope of such hybridization is gradually being found all encompassing.

In this backdrop, the editors, in the present scope, became motivated to invite people from research community to share their latest findings. As a result, the present edited volume may be viewed as a formidable platform particularly aimed at accommodating problems pertaining to image segmentation. There are 12 chapters reported with each representing a self-contained and complete individual contribution.

In the chapter entitled “[Hybrid Swarms Optimization Based Image Segmentation](#)”, Mohamed Abd El Aziz, Ahmed A. Ewees, Aboul Ella Hassanien have demonstrated as to how an efficient admixture of Firefly Algorithm (FA) and Social Spider Optimization (SSO) could achieve multilevel thresholding in image segmentation. The authors could justify their finding in terms of less CPU time consumption.

The chapter entitled “[Grayscale Image Segmentation Using Multilevel Thresholding and Nature-Inspired Algorithms](#)” by Genyun Sun, Aizhu Zhang and Zhenjie Wang demonstrates how an effective hybridization, namely GSA-GA, of Gravitational Search Algorithm (GSA) with Genetic Algorithm (GA) could be used for achieving multilevel image thresholding. The authors also substantiated results through extensive numerical means.

The focal point of the chapter entitled “[A Novel Hybrid CS-BFO Algorithm for Optimal Multilevel Image Thresholding Using Edge Magnitude Information](#)” is utilization of optimal edge magnitude information (second-order statistics) of an image to obtain multilevel threshold values on the basis of the Gray-Level Co-occurrence Matrix (GLCM) of the image. Sanjay Agrawal, Leena Samantaray, and Rutuparna Panda use a novel hybrid cuckoo search bacterial foraging optimization (CS-BFO) algorithm, which plays a very crucial role for obtaining optimal threshold values.

The chapter entitled “[REFII Model and Fuzzy Logic as a Tool for Image Classification Based on Image Example](#)” by Goran Klepac is a very informative article where he tries to establish the effectiveness of REFII model coupled with fuzzy logic for the purpose of image classification.

In the chapter entitled “[Microscopic Image Segmentation Using Hybrid Technique for Dengue Prediction](#)”, Pramit Ghosh, Ratnadeep Dey, Kaushiki Roy, Debotosh Bhattacharjee and Mita Nashipuri take up an important practical problem. They offer a hybrid methodology capable of providing an automated platelet counting system for efficient, easy, and fast detection of dengue infection as well as treatment through segmentation of platelets from microscopic images of a blood smear.

The chapter entitled “[Extraction of Knowledge Rules for the Retrieval of Mesoscale Oceanic Structures in Ocean Satellite Images](#)” deals with rule extraction for the oceanic structures of mesoscale dimension where the imaging modality is ocean satellite. The authors Eva Vidal-Fernández, Jesús M. Almendros-Jiménez, José A. Piedra, and Manuel Cantón also propose a comprehensive tool for this.

B.K. Tripathy and P. Swarnalatha, in the chapter entitled “[Hybrid Uncertainty Based Techniques for Segmentation of Satellite Imagery and Applications](#)”, try to establish the effectiveness of hybridization in comparison to the earlier techniques,

both classical and fuzzy, towards achieving segmentation of satellite image applications

In the chapter entitled “[Improved Human Skin Segmentation Using Fuzzy Fusion based on Optimized Thresholds by Genetic Algorithms](#)” Anderson Santos, Jônatas Paiva, Claudio Toledo, and Helio Pedrini consider genetic algorithm for ensuring optimal thresholding. These thresholds, in turn, are used in fuzzy fusion for achieving segmentation of human skin image information.

Chapter “[Uncertainty Based Spatial Data Clustering Algorithms for Image Segmentation](#)” happens to be of enormous importance from the survey point of view. It will be particularly useful for young researchers. The authors Deepthi P. Huddegaddi and B.K. Tripathy in this work discuss the pros and cons of various clustering approaches used in image segmentation and try to establish as to how hybridization is capable in overcoming the limitations inherent in crisp as well as fuzzy-based clustering techniques.

Fernando Cervantes-Sanchez, Ivan Cruz-Aceves, and Arturo Hernandez-Aguirre in their Chapter “[Coronary Artery Segmentation and Width Estimation Using Gabor Filters and Evolutionary Computation Techniques](#)” try to establish as to how effective it could be to hybridize Gabor filtering with evolutionary approach for achieving the very important task of estimation of the width of coronary artery after its appropriate segmentation.

In Chapter “[Segmentation and Analysis of Breast Thermograms for Abnormality Prediction Using Hybrid Intelligent Techniques](#)”, Sourav Pramanik, Mrinal Kanti Bhowmik, Debotosh Bhattacharjee, and Mita Nasipuri through their contribution entitled “[Segmentation and Analysis of Breast Thermograms for Abnormality Prediction Using Hybrid Intelligent Techniques](#)” try to demonstrate and thereby establish the effectiveness of thermal imaging modality and technique towards the identification of abnormal growth, possibly due to breast carcinoma, by classifying the affected region.

Dariusz Jakóbczak in Chapter “[Modeling of High-Dimensional Data for Applications of Image Segmentation in Image Retrieval and Recognition Tasks](#)” offers a hybridized approach called Probabilistic Features Combination (PCF) method for multidimensional data modeling, extrapolation, and interpolation using the set of high-dimensional feature vectors.

The editors of the present treatise aimed to bring out some of the latest findings in the field of hybrid soft computing applied to proper segmentation of images. Their mission has met success with a number of quality chapters reported. The editors want to make use of this opportunity to express their sincere gratitude to the authors of the chapters for extending their wholehearted support in sharing some of their latest findings. Without their significant contribution, this volume could not have fulfilled its mission. The editors also extend their heartiest congratulations to the specific team members who took the trouble to make the present endeavor a success, not to mention Springer for providing the editors with an opportunity to work with them. The editors would also like to take this opportunity to extend their heartfelt thanks to Mr. Ronan Nugent, Senior Editor, Springer, for his constructive support during the tenure of the book project. The editors feel encouraged to make

further efforts to explore and address other areas of research significance in the days to come. The editors would also like to thank, in anticipation, graduate students and researchers in computer science, electronics communication engineering, electrical engineering, and information technology who will read this as a reference book and as an advanced textbook for their active feedback; their suggestions will be of utmost academic importance to the editors.

Kolkata, India
Santiniketan, India
Cooch Behar, India
Zagreb, Croatia
July 2016

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