Preface

Segmentation is targeted to partition an image into distinct regions comprising pixels having similar attributes. In the context of image analysis and interpretation, these partitioned regions should strongly relate to depicted objects or features of interest. Faithful segmentation of an image scene is the first step from low-level image processing transforming a multilevel or colour image into one or more other images to high-level image description in terms of features, objects, and scenes. The success of image analysis depends on reliability of segmentation, but an accurate partitioning of an image is generally a very challenging problem.

Segmentation techniques are either contextual or non-contextual. The non-contextual techniques take no account of spatial relationships between features in an image and group pixels together on the basis of some global attributes, viz. grey level or colour. On the other hand, the contextual techniques group together pixels with similar grey levels and close spatial locations. A plethora of classical techniques are available in the literature for faithful segmentation of images. However, each of these techniques suffers from several drawbacks affected by the inherent uncertainties in images. The soft computing paradigm is very capable of handling the uncertainties prevalent in the image segmentation problem faced by the computer vision research community. However, the existing soft computing methodologies applied for the segmentation of multilevel and colour images are jeopardised in several respects. The most notable among them is the selection of the class levels/transition levels of the different segments/classes. Researches in this direction are aimed at finding suitable solutions to these problems.

An effort has been made in this book to remove the aforementioned shortcomings of these soft computing methodologies involving neural network architectures, with special reference to the neighbourhood topology-based multilayer self-organising neural network (MLSONN) architecture through an optimization of the class levels/transition levels of the segments/classes. The book takes recourse to seven well-written chapters targeted in this direction.

Chapter 1 introduces to the audience the basics of image segmentation with reference to the classical approaches, the soft computing counterparts and the hybrid approaches. The chapter also discusses the different soft computing paradigms in brief like neural network, fuzzy sets and fuzzy logic, genetic algorithms and the classical differential evolutionary algorithm. Then it throws light on the role of single- and multi-objective optimization on image segmentation.

A brief review of the recent trends in image segmentation is illustrated in Chap. 2. The chapter starts with a discussion of the classical approaches of image segmentation. As a sequel, the chapter elaborates the different soft computing paradigm based image segmentation approaches in detail.

As earlier stated the main objective of the book is to remove the limitation of the existing soft computing paradigm as far as image segmentation is concerned. The initial steps in this direction are centred on the standard multilevel sigmoidal (MUSIG) activation function of the MLSONN architecture. This results in an induction of the data heterogeneity in the area of clustering/segmentation with the help of the conventional self-organising neural network. The MUSIG activation function uses equal and fixed class responses, assuming the homogeneity of image information content. Chapter 3 introduces a genetic algorithm based optimised MUSIG (OptiMUSIG) activation function, which enables the network architecture to incorporate the underneath image content for the segmentation of the multilevel greyscale images.

Suitable extensions to the OptiMUSIG activation function with the help of the MLSONN architecture for the purpose of segmentation of true colour images have been proposed by resorting to a parallel version of the activation function in Chap. 4. The genetic algorithm based parallel version of optimised MUSIG (ParaOptiMUSIG) activation function is generated with the optimised class boundaries for the colour components and is able to segment colour images efficiently with the help of the parallel self-organising neural network (PSONN) architecture.

Thirdly, in order to overcome the flaws of single objective based optimization procedures multi-objective based optimization procedures have been invested to solve the problem of image segmentation. A multi-objective based OptiMUSIG activation function has been presented in Chap. 5 to segment the multilevel grey-scale images. This refining procedure reduces the possibility of the non-effectiveness of a particular solution in the field of other objective functions. Not only restricted in this, a NSGA II based OptiMUSIG activation function is also presented to segment the multilevel gray scale images.

In attempt to put forward the aforementioned approaches together, a multi-objective genetic algorithm based ParaOptiMUSIG activation function, which obviates the shortcomings of the single objective based ParaOptiMUSIG activation function, is proposed in Chap. 6 to segment colour images. Similar to the NSGA II based OptiMUSIG activation function, a NSGA II based ParaOptiMUSIG activation function is also presented for the segmentation of true colour images.

A segmentation procedure with a predefined number of classes cannot assure good results. Good segmented output may be derived by increasing or decreasing the number of classes if the exact number of classes in that test image/dataset is unknown. This is when no *a priori* knowledge regarding the information distribution, the number of classes and the information about the class responses are supplied at the preliminary stage. In this direction a genetic algorithm based clustering algorithm is presented in Chap. 7 to perform automatic clustering/segmentation. The effectiveness of a cluster/segment is validated by a proposed fuzzy intercluster hostility index. The proposed segmentation process starts from a large number of classes and finds out the exact number of classes in the test image/dataset.

The experimental findings of each of the chapter reveal that the hybrid soft computing paradigms resorted to yield superior performance as compared to the soft computing counterpart devoid of any hybridization. This substantiates the fact that proper hybridization of the soft computing tools and techniques always leads to more effective and robust solutions since the constituent soft computing elements in the hybrid system always complement each other.

The authors have tried to bring together some notable contributions in the field of hybrid soft computing paradigm for the application of multilevel image and data segmentation. The authors feel that these contributions will open up research interests among the computer vision fraternity to evolve more robust, time-efficient and fail-safe hybrid intelligent systems. The authors believe that this book will serve the graduate students and researchers in computer science, electronics communication engineering, electrical engineering, and information technology as a reference book and as an advanced textbook for some parts of the curriculum. Last but not the least, the authors would like to take this opportunity to extend their heartfelt thanks to the editors of the Springer book series Computational Intelligence Methods and Applications, and to Mr. Ronan Nugent, Senior Editor, Springer-Verlag for his constructive support during the tenure of the book project.

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