Preface

The aim of this book is to provide a common platform for the researchers from diverse backgrounds to present their theoretical and applied research findings in artificial intelligence and pattern recognition. This book may prove to be a building block for enhancing/developing intelligent systems as it highlights the core concepts as well as applicability in real world problems.

The need of intelligent machines in day to day activities such as medical diagnostics, biometric security systems, image processing, et cetera, motivates the researchers to develop and explore new techniques, algorithms, and their applications. The techniques of pattern recognition are evolving rapidly and boosting the research areas mentioned above. Also, the advances in fuzzy logic, neural networks and other decision making techniques have contributed immensely in the development of artificial intelligence and its usage. Most of the methods used in intelligent systems apply pattern recognition in artificial intelligence based systems and vice-versa. For instance, medical diagnostic systems, which are traditionally an AI task, get enhanced and provide better results using pattern recognition methods. Similarly, biometric imagery, feature recognition, document image analysis, and other pattern recognition tasks perform well with the induction of artificial intelligence techniques. This book provides a common platform to artificial intelligence and pattern recognition researchers to disseminate new ideas and techniques.

This book is organized in self-contained chapters to provide greatest reading flexibility. In response to the call for papers, the book received around 100 abstracts. Based on the suitability, the editors invited full chapters from 67 researchers of various disciplines (Pattern Analysis and Recognition, Image Processing, Artificial Intelligence and Soft Computing) and from 19 different countries. All submitted chapters have been reviewed on a double-blind review basis, by at least three reviewers. After an evaluation process by the EBM members, 32 chapters were selected. Acceptance was based on relevance, technical soundness, originality, and clarity of presentation.

This book is organized as follows:

Chapter 1: The recent advances in robotics and related technologies have placed more challenges and stricter requirements to the issue of recognizing objects in a scene. In such applications, robots must be equipped with a sense of location and direction with a view to the efficient accomplishment of navigation or demanding pick and place tasks. In addition, spatial information is required in surveillance processes where recognized targets are located in the working space of the robot. Furthermore, accurate perception of depth is mandatory in driver assistance applications. This chapter presents several recently proposed methods capable of first recognizing objects and then providing their spatial information in cluttered environments.

Chapter 2: This chapter describes a multi-linear discriminant method of constructing and quantifying statistically significant changes on human identity photographs. The approach is based on a general mul-

tivariate two-stage linear framework that addresses the small sample size problem in high-dimensional spaces. Starting with a 2D data set of frontal face images, the authors determine a most characteristic direction of change by organizing the data according to the patterns of interest. These experiments on publicly available face image sets show that the multi-linear approach does produce visually plausible results for gender, facial expression and aging facial changes in a simple and efficient way.

Chapter 3: This chapter focuses on the usage of image orthogonal moments as discrimination features in pattern recognition applications and discusses their main properties. Initially, the ability of the moments to carry information of an image with minimum redundancy is studied, while their capability to enclose distinctive information that uniquely describes the image's content is also examined. Along these directions, the computational formulas of the most representative moment families will be defined analytically and the form of the corresponding moment invariants in each case will be derived. Appropriate experiments have taken place in order to investigate the description capabilities of each moment family, by applying them in several benchmark problems.

Chapter 4: Triangulation is a fundamental problem in computer vision that consists of estimating the 3D position of a point of the scene from the estimates of its image projections on some cameras and from the estimates of the projection matrices of these cameras. This chapter addresses multiple view L2 triangulation, i.e. triangulation for vision systems with a generic number of cameras where the sought 3D point is searched by minimizing the L2 norm of the image reprojection error. The authors consider the standard case where estimates of all the image points are available, and consider also the case where some of such estimates are not available for example due to occlusions.

Chapter 5: Camera calibration is a process that allows to fully understand how the camera forms the image. It is necessary especially when 3D information of the scene must be known. Calibration can be performed using a 1D pattern (points on a straight line). This kind of pattern has the advantage of being "visible" simultaneously even by cameras in opposite positions from each other. This makes the technique suitable for calibration of multiple cameras. Unfortunately, the calibration with 1D patterns often leads to poorly accurate results. In this work, the methods of single and multi-camera calibration are analyzed. It is shown that, in some cases, the accuracy of this type of algorithm can be significantly improved by simply performing a normalization of coordinates of the input points. Experiments on synthetic and real images are used to analyze the accuracy of the discussed methods.

Chapter 6: Nonparametric snake algorithms for object segmentation have been proposed to overcome the drawback of conventional snake algorithms: the dependency on several parameters. In this chapter, a new object segmentation algorithm for video, based on a nonparametric snake model with motion prediction, is proposed. Object contour is initialized by using the mean absolute difference of intensity between input and previous frames. And in order to convert initial object contours into more exact object contours, the gradient vector flow snake is used. Finally object contour is predicted using a Kalman filter in successive frames. The proposed object segmentation method for video can provide more detailed and improved object segmentation results than the conventional methods. Various experimental results show the effectiveness of the proposed method in terms of the pixel-based quality measure and the computation time.

Chapter 7: The analysis of face images is used for various purposes such as facial expression classification, gender determination, age estimation, emotion assessment, face recognition, et cetera. The research community of face image analysis has developed many techniques for face recognition; one of the successful techniques is based on subspace analysis. In the first part of the chapter, the authors present discussion of earliest face recognition techniques, which are considered as mile stones in the

roadmap of subspace based face recognition techniques. The second part presents one of the efficient interval-valued subspace techniques, namely, symbolic Kernel Fisher Discriminant analysis (Symbolic KFD), in which the interval type features are extracted in contrast to classical subspace based techniques where single valued features are used for face representation and recognition.

Chapter 8: The authors introduce an approach to recognize objects with multi-configurations using the shape space theory. Firstly, two sets of landmarks are obtained from two objects in two-dimensional images. Secondly, the landmarks represented as two points are projected into a pre-shape space. Then, a series of new intermediate data have been obtained from data models in the pre-shape space. Finally, object recognition has been achieved in the shape space with the shape space theory.

Chapter 9: In this chapter, the authors propose and implement an improved iris recognition method based on image enhancement and heuristics. They make major improvements in the iris segmentation phase. In particular, the authors implement the raised to power operation for more accurate detection of the pupil region. Additionally, with their technique they are able to considerably reduce the candidate limbic boundary search space; this leads to a significant increase in the accuracy and speed of the segmentation. Furthermore, the authors selectively detect the limbic circle having center within close range of the pupil center. The effectiveness of the proposed method is evaluated on a grand challenge, large scale database: the Iris Challenge Evaluation (ICE) dataset.

Chapter 10: This chapter focuses on the studies relating to the analysis of endoscopic images of lower esophagus for abnormal region detection and identification of cancerous growth. Several color image segmentation techniques have been developed for automatic detection of cancerous regions in endoscopic images, which assists the physician for faster, proper diagnosis and treatment of the disease. These segmentation methods are evaluated for comparing their performances in different color spaces, namely, RGB, HSI, YC_bC_r, HSV, and CIE Lab. The segmented images are expected to assist the medical expert in drawing the biopsy samples precisely from the detected pathological legions. Further, various methods have been proposed for segmentation and classification of squamous cell carcinoma (SCC) from color microscopic images of esophagus tissue during pathological investigation.

Chapter 11: Recognizing faces that are partially visible is a challenging task. Most of the solutions to the problem focus on reconstruction or restoration of the occluded part before attempting to recognize the face. In the current chapter, the authors discuss various approaches to face recognition, challenges in face recognition of occluded images, and approaches to solve the problem. The authors propose an adaptive system that accepts the localized region of occlusion and recognizes the face adaptively. The chapter demonstrates through case studies that the proposed scheme recognizes the partially occluded faces as accurately as the un-occluded faces and in some cases outperforms the recognition using un-occluded face images.

Chapter 12: Research and development of new human computer interaction (HCI) techniques that enhance the flexibility and reliability for the user are important. Research on new methods of computer control has focused on three types of body functions: speech, bioelectrical activity, and use of mechanical sensors. Speech operated systems have the advantage that these provide the user with flexibility. Such systems have the potential for making computer control effortless and natural. This chapter summarizes research conducted to investigate the use of facial muscle activity for a reliable interface to identify voiceless speech based commands without any audio signals. System performance and reliability have been tested to study inter-subject and inter-day variations and impact of the native language of the speaker.

Chapter 13: An accurate Content Based Image Retrieval (CBIR) system is essential for the correct retrieval of desired images from the underlying database. Rotation invariance is very important for

accurate Content Based Image Retrieval (CBIR). In this chapter, rotation invariance in Content Based Image Retrieval (CBIR) system is achieved by extracting Fourier features from images on which Dual Tree Complex Wavelets Transform (DT-CWT) has been applied. Before applying DT-CWT, the Fourier feature set is reduced by exploiting the symmetry property of Fourier transform. For an N x N image, feature set has been reduced from $N^2/2$ features to $N^2/4$ features. This reduction in feature set increases the speed of the system. Hence, this chapter proposes a method which makes the Content Based Image Retrieval (CBIR) system faster without comprising accuracy and rotation invariance.

Chapter 14: Devnagari script is the most widely used script in India and its Optical Character Recognition (OCR) poses many challenges. Handwritten script has many variations, and existing methods used are discussed. The authors have also collected a database on which the techniques are tested. The techniques are based on structural methods as opposite to statistical methods. There are some special properties of Devnagari script like the topline, curves, and various types of connections that have been exploited in the methods discussed in this chapter.

Chapter 15: Reliable corner detection is an important task in pattern recognition applications. In this chapter an approach based on fuzzy-rules to detect corners even under imprecise information is presented. The uncertainties arising due to various types of imaging defects such as blurring, illumination change, noise, et cetera. Fuzzy systems are well known for efficient handling of impreciseness. In order to handle the incompleteness arising due to imperfection of data, it is reasonable to model corner properties by a fuzzy rule-based system. The robustness of the proposed algorithm is compared with well known conventional detectors.

Chapter 16: Eye detection is an important initial step in an automatic face recognition system. Though numerous eye detection methods have been proposed, many problems still exist, especially in the detection accuracy and efficiency under challenging image conditions. The authors present a novel eye detection method using color information, Haar features, and a new efficient Support Vector Machine (eSVM) in this chapter . In particular, this eye detection method consists of two stages: the eye candidate selection and validation. The selection stage picks up eye candidates over an image through color information, while the validation stage applies 2D Haar wavelet and the eSVM to detect the center of the eye among these candidates. The eSVM is defined on fewer support vectors than the standard SVM, which can achieve faster detection speed and higher or comparable detection accuracy.

Chapter 17: This chapter proposes new approaches to emotion recognition from facial expression and electroencephalogram signals. Subjects are excited with selective audio-visual stimulus, responsible for arousal of specific emotions. Manifestation of emotion which appears in facial expression and EEG are recorded. Subsequently the recorded information is analyzed for extraction of features, and a support vector machine classifier is used to classify the extracted features into emotion classes. An alternative scheme for emotion recognition directly from the electroencephalogram signals using Duffing Oscillator is also presented.

Chapter 18: In this chapter, the authors elaborate on the facial image segmentation and the detection of eyes and lips using two neural networks. The first neural network is applied to segment skin-colors and the second to detect facial features. As for input vectors, for the second network the authors apply speed-up robust features (SURF) that are not subject to scale and brightness variations. The authors carried out the detection of eyes and lips on two well-known facial feature databases, Caltech. and PICS.

Chapter 19: This chapter presents a new method for binary classification that classifies input data into two regions separated by axis-aligned rectangular boundaries. Given the number of rectangular regions to use, this algorithm automatically finds the best boundaries that are determined concurrently.

The formulation of the optimization problem involves minimizing the sum of minimum functions. To solve this problem, the author introduces underestimate of the minimum function with piecewise linear and convex envelope, which results in mixed integer and linear programming. The author shows several results of the algorithm and compares the effects of each term in the objective function.

Chapter 20: In recent times there is an urgent need for a simple yet robust system to identify natural hand actions and gestures for controlling prostheses and other computer assisted devices. Surface Electromyogram (sEMG) is a non-invasive measure of the muscle activities but is not reliable because there are multiple simultaneously active muscles. This research first establishes the conditions for the applicability of Independent Component Analysis (ICA) pattern recognition techniques for sEMG. Shortcomings related to order and magnitude ambiguity have been identified and a mitigation strategy has been developed by using a set of unmixing matrix and neural network weight matrix corresponding to the specific user. The experimental results demonstrate a marked improvement in the accuracy. The other advantages of this system are that it is suitable for real time operations and it is easy to train by a lay user.

Chapter 21: This chapter describes a system of fuzzy methods designed to solve a broad range of problems in multiple-criteria evaluation, and also their software implementation, FuzzME. A feature common to all the presented methods is the type of evaluation, well suited to the paradigm of fuzzy set theory. All evaluations take on the form of fuzzy numbers, expressing the extent to which goals of evaluation are fulfilled. The system of fuzzy methods is conceived to allow for different types of interaction among criteria of evaluation. Under no interaction, the fuzzy weighted average, fuzzy OWA operator, or WOWA operator are used to aggregate partial evaluations (depending on the evaluator's requirements regarding type of evaluation). If interactions appear as redundancy or complementarity, the fuzzified discrete Choquet integral is the appropriate aggregation operator. Under more complex interactions, the aggregation function is defined through an expertly set base of fuzzy rules.

Chapter 22: In this chapter, the authors have realized Interval Type-2 Fuzzy Logic Systems (IT2 FLSs) with the average of two Type-1 Fuzzy Logic Systems (T1 FLSs). The authors have presented two case studies by applying this realization methodology on (i) an arbitrary system, where an IT2 FLS is considered, in which its footprint of uncertainty (FOU) is expressed using Principal T1 FS+FOU approach, and the second (ii) the Mackey-Glass time-series forecasting. In the second case study, T1 FLS is evolved using Particle Swarm Optimization (PSO) algorithm for the Mackey-Glass time-series data with added noise, and is then upgraded to IT2 FLS by adding FOU. Further, four experiments are conducted in this case study for four different noise levels.

Chapter 23: There are available metrics for predicting fault prone classes, which may help software organizations for planning and performing testing activities. This may be possible due to proper allocation of resources on fault prone parts of the design and code of the software. Hence, importance and usefulness of such metrics is understandable, but empirical validation of these metrics is always a great challenge. Random Forest (RF) algorithm has been successfully applied for solving regression and classification problems in many applications. In this work, the authors predict faulty classes/modules using object oriented metrics and static code metrics. This chapter evaluates the capability of RF algorithm and compares its performance with nine statistical and machine learning methods in predicting fault prone software classes. The authors applied RF on six case studies based on open source, commercial software and NASA data sets.

Chapter 24: Artificial neural networks form a class of soft computing tools, which are made up of interconnected computational primitives for the analysis of numeric data. These are inspired by the

functional behavior of the human nervous system comprising millions of nerve cells or neurons. Different artificial neural network architectures have been evolved over the years based on the storage, transmission, and processing characteristics of the human nervous system.

Chapter 25: This chapter presents a new optimization method for clustering fuzzy data to generate Type-2 fuzzy system models. For this purpose, first, a new distance measure for calculating the (dis) similarity between fuzzy data is proposed. Then, based on the proposed distance measure, Fuzzy c-Mean (FCM) clustering algorithm is modified. Next, Xie-Beni cluster validity index is modified to be able to valuate Type-2 fuzzy clustering approach. In this index, all operations are fuzzy and the minimization method is fuzzy ranking with Hamming distance.

Chapter 26: Artificial Neural Network (ANN) is a non-parametric statistical tool which can be used for a host of pattern classification and prediction problems. It has excelled in diverse areas of application ranging from character recognition to financial problems. One of these areas, which have ample of scope of application of the ANN, is wireless communication. Especially, in segments like Multi-Input Multi-Output (MIMO) wireless channels ANNs have seldom been used for problems like channel estimation. Very few reported work exists in this regard. This work is related to the application of ANN for estimation of a MIMO channel of a wireless communication set-up. As Orthogonal Frequency Division Multiplexing (OFDM) is becoming an option to tackle increased demands of higher data rates by the modern generation mobile communication networks, a MIMO-OFDM system assisted by an ANN based channel estimation can offer better quality of service and higher spectral efficiency.

Chapter 27: This chapter presents a novel 3D approach for patient scheduling (3D-PS) using multi-agents. Here the 3Ds refers to the Distributed, Dynamic and Decentralized nature of the patient scheduling. As in many other scheduling problems, in the hospital domain, a major problem is the efficient allocation of resources to the patients. The resources here mean the doctor, diagnosing equipments, lab tests, et cetera. Commonly, patient scheduling is performed manually by human schedulers with no automated support. Human scheduling is not efficient, because the nature of the problem is very complex; it is inherently distributed, dynamic, and decentralized. Since agents are known to represent distributed environment well and also being capable of handling dynamism, an agent based approach is chosen. The objectives are to reduce patient waiting times, minimize the patient stay in the hospital, and to improve resource utilization in hospitals.

Chapter 28: The decision making process of the Emergency Medical Rescue Services (EMRS) operations centre during disasters involves a significant amount of uncertainty. Decisions need to be made quickly, and no mistakes are tolerable, particularly in the case of disasters resulting in a large number of injured people. A multiphase linguistic fuzzy model is introduced to assist the operator during the initial phase of the medical disaster response. Based on uncertain input data, estimating the severity of the disaster, the number of injured people, and the amount of forces and resources needed to successfully deal with the situation is possible. The need for reinforcements is also considered. Fuzzy numbers, linguistic variables and fuzzy rule bases are applied to deal with the uncertainty.

Chapter 29: In this study, the fuzzy causal map inference mechanisms are analyzed for decision making tasks and a comparative analysis is performed to handle with the uncertainty in the problem of pulmonary risk prediction. Fuzzy Cognitive Mapping (FCM) is a causal graphical representation including nodes, determining the most relevant factors of a complex system, and links between these nodes determining the relationships between those factors. It represents knowledge in a symbolic manner and relates states, processes, policies, events, values, and inputs in an analogous manner. In the proposed work, a modi-

fied inference mechanism for FCM approach, which handles uncertainty and missing data, is presented and compared with the common fuzzy causal graph reasoning process for a medical diagnosis problem.

Chapter 30: Electronic Marketplaces (EMs) enable entities to negotiate and trade products. Usually, intelligent agents assume the responsibility of representing buyers or sellers in EMs. However, uncertainty about the characteristics and intentions of the negotiating entities is present in these scenarios. Fuzzy Logic (FL) theory presents a lot of advantages when used in environments where entities have limited or no knowledge about their peers. Hence, entities can rely on a FL knowledge base that determines the appropriate action on every possible state. FL can be used in offers, trust, or time constraints definition or when an agent should decide during the negotiation process. The autonomic nature of agents in combination with FL leads to more efficient systems. In this chapter, the authors provide a critical review on the adoption of FL in marketplace systems and present their proposal for the buyer side.

Chapter 31: In today's competitive markets, prediction of financial variables has become a critical issue. Especially in stock market analysis where a wrong prediction may result in a big loss in terms of time and money, having a robust prediction is a crucial issue. To model the chaotic, noisy, and evolving behavior of stock market data, new powerful methods should be developed. Soft Computing methods have shown a great confidence in such environments where there are many uncertain factors. Also it has been observed through many experiments that the hybridization of different soft computing techniques such as fuzzy logic, neural networks, and meta-heuristics usually results in better results than simply using one method. This chapter presents an adaptive neuro-fuzzy inference system (ANFIS), trained by the particle swarm optimization (PSO) algorithm for stock price prediction. Instead of previous works that have emphasized on gradient base or least square (LS) methods for training the neural network, four different strategies of PSO are implemented.

Chapter 32: This chapter provides a prototype design of a hand tremor compensator/controller to reduce the effect of the tremor to an external device/ apparatus, such as a magnetic pen for the patients suffering from Parkinson and similar diseases. It would also be effective for busy surgeons suffering from hand tremor due to muscle fatigue. Main emphasis in this chapter is given on the prediction of the tremor signal from the discrete samples of electromyogram data and tremor. The predicted signal is inverted in sign and added to the main tremor signal through a specially designed magnetic actuator carrying the external device, such as a magnetically driven pen or surgical instrument. Two different prediction algorithms, one based on neural nets and the other based on Kalman Filter have been designed, tested, and validated for the proposed application.

Vijay Kumar Mago
Simon Fraser University, Canada

Nitin Bhatia
DAV College, India