Preface

Advanced techniques in image processing have led to many inventions and provide valuable support especially in medical fields to identify and analyze the diseases. Biomedical imaging is an essential part of early diagnosis, detection and treatment for assorted diseases, as it is considered as the first step for proper management of medical pathological conditions. Therefore, the role of medical signal/ image processing augments the ability to improve the visibility of significant features in a medical image which facilitate the diagnosis process and remove/ reduce unwanted information. Thus, the need for powerful instruments for detecting, sorting, transmitting, analyzing, and displaying images becomes a must. Miscellaneous modalities such has Echo Cardiograph, Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and X-ray are encompassed various paradigms dedicated to diagnosing the diseases. These instruments greatly support biologists, medical scientists, biochemists, and physicians as they produce the required signals and images ambulated to extract the required features. Non-invasive diagnostic imaging schemes for patients' pathological condition diagnosis is increasingly developed due to the promising results and follows up in several clinical trials for treatment. The accuracy of the diagnosis depends on the experience and knowledge of physicians. In such scenario, the need for quantitative measures for details such as shape and size of tissue can assist physicians for better intuitive understanding of tissue and its pathologies. Computer aided diagnosis (CAD) tool incorporating methods for segmentation, texture analysis and area computation can increase the accuracy of the diagnosis by providing quantitative analysis of the image.

The basic processes such as filtering, enhancement, clustering, classification, and combining images different modalities, can assist scanning, diagnosis, research, and treatment. Thus, pattern recognition techniques play a crucial role. Automated image processing facilities accurate detection with less computational time. Often this involves identifying structures such as a tumor or lesions.

Clustering and classification are the foremost subdivisions of pattern recognition techniques. Using these techniques, samples can be classified according to a precise property by measurements indirectly related to the property of interest. Numerous computational and cognitive applications, especially medical imaging requires objects to be grouped into disjoint sets and classification for further processing. Clustering is a statistical technique by which objects of similar nature are grouped together. Similarity means that the objects have similar shape, dimensions, magnitude, direction (vectors) and color. Clustering achieved its importance as it is the preprocessing step in numerous procedures. Thus, there is an increasing necessity to simplify the process and its mathematical interpretations. Afterward, the classification rule can be used to predict the property in samples that are not part of the original training set. Moreover, there is a significant increase in the use of registration, retrieval and registration based retrieval of medical images in healthcare.

Consequently, there is an urgent need for edited wide collection of the major techniques of clustering and classification in the biomedical field. It compacts with methods and approaches that involve clustering, classification and pattern recognition. Additionally, these methods are use to support computer-aided diagnosis systems. Also, it will specify the principals of pattern recognition and medical image applications.

OBJECTIVE OF THE BOOK

This book elaborates the foremost techniques of classification and clustering. It deals, principally, with methods and approaches that involve medical signals/image and signal analysis, image retrieval, biomedical images feature extraction, etc. and their algorithms. As well as, it includes miscellaneous techniques of various modalities in medical imaging techniques and the computer-aided diagnosis (CAD) systems. This book endeavors to endow with significant frameworks and the most recent empirical research findings in the area. It is written for professionals who desire to improve their understanding and developing automated systems for medical imaging classification and clustering. Progressions of this field will assist to intensify interdisciplinary discovery in medical image processing, CAD systems, medical device improvements, aid doctors and physicians in diagnosis, early detection of diseases.

ORGANIZATION OF THE BOOK

The book consists of and introductory chapter followed by sixteen chapters that are organized in six sections as shown below. The first two chapters focus on the concept and applications for the medical image processing with more focus on the classification and clustering. The second section, consists of Chapters 3 and 4, relates to the filtering and thresholding for medical image quality improvement. The third section of the book encloses two chapters that introduced the classification and clustering of Magnetic Resonance Imaging. The fourth section contains two chapters concerning medical image database retrieval. From Chapter 9 till Chapter 13, the fifth section introduces several medical imaging applications based classification. The last three chapters are included in section 6, which focuses on wireless systems for healthcare.

Introduction Chapter: Includes the main concept of image analysis and processing in the medical domain is introduced, with referring to the different non-invasive automated medical image modalities. The authors elaborated the classification and clustering various applications in the biomedical area. The intention is to state the biomedical image classification and clustering in its context.

Section 1: Introduction to Classification and Clustering

This section elaborates the fundamental concepts of the image processing in the biomedical domain with various applications. The intention is to state the biomedical image classification and clustering in its context. Since, the classification process has several techniques that support various. Thus, the aim is to emphasize the role of the classifier selection on the classification accuracy and performance.

Table 1. Organization of the book

Section 1: Introduction to Classification and Clustering				
Chapter 1 Bag-of-Features in Microscopic Images Classification	**Chapter 2** An overview of Machine Learning in Medical Image Analysis: Trends in health informatics			
Section 2: Filtering and Thresholding for Medical Image Quality Improvement				
Chapter 3 The Combination of Adaptive Filters to Improve the Quality of Medical Images in New Wavelet Domain	**Chapter 4** Intensity – based classification and related methods in brain MR images			
Section 3: Classification and Clustering of Magnetic Resonance Imaging				
Chapter 5 GPU based Level Set Method for MRI Brain Tumor Segmentation Using Modified Probabilistic Clustering	**Chapter 6** Classification of Magnetic Resonance image and segmentation of brain tissues for tumor detection			
Section 4: Medical Image Retrieval				
Chapter 7 Analysais and Comparaison of Developed 2D Medical Image Database Design Using Registration Scheme, Retrieval Scheme and Bag-of-Visual-Words	**Chapter 8** Multimodal indexing and information retrieval system based on mammographic image analysis: Gabor model in digital Learning			
Section 5: Assortment of Medical Imaging Applications Based Classification				
Chapter 9 Effect of Slow and Fast Music on the Autonomic Nervous System and Cardiac Health: A Preliminary Investigation	**Chapter 10** Development of Ultrasound Imaging CAD Tool for Assessment of Pathologies in Supraspinatus Tendon	**Chapter 11** New Imaging and Computational Technology as a guide for CatheterAblation of Incessant Tachyarrhythmias	**Chapter 12** An Optimized Graph Based Metagenomic Gene Classification Approach: Metagenomic Gene Analysis	**Chapter 13** Classification of Surface Electromyogram Signals Acquired from the Forearm of a Healthy Volunteer
Section 6: Wireless Systems for Healthcare				
Chapter 14 Development of a Surface EMG Based Control System for Controlling Assistive Devices: A Study on Robotic Vehicle	**Chapter 15** Development of Bluetooth, Xbee and Wi-Fi Based Wireless Control Systems for Controlling Electric-Powered Robotic Vehicle Wheelchair Prototype	**Chapter 16** Wireless Body Area Networks Combined with Mobile Cloud Computing in Healthcare: A Survey		

Chapter 1: This chapter included an overview on several classification techniques employed in microscopic image classification to guide the reader to advanced aspects concerning image classification approaches. Additionally, an applied examplewasintroduced to classify different Albino rats' samples captured using light microscope taken from three different organs, namely hippocampus, renal and pancreas. The Bag-of-Features (BoF) technique was used for features extraction and selection, which then classified using the multiclass linear support vector machine classifier. The proposed classifier realized 94.33% average classification accuracy for the three classes. For binary classification of the hippocampus and pancreas sets, the attained average accuracy was 100%.

Chapter 2: Health informatics is a relatively new area which deals to mining large amounts of data to gain useful insights. The authors provided an overview of machine learning applications. Medical imaging problems using machine learning are the main concern of this chapter. Some of the common challenges in health informatics were briefly discussed.

Section 2: Filtering and Thresholding for Medical Image Quality Improvement

Improving the quality of the medical images is an essential issue for accurate further image analysis and processing such as classification and clustering. The incorporated noise during medical images acquisition using various modalities degrades the human interpretation and the automated analysis of the images. This section presented filtering and thresholding approaches that considered starting points for other sophisticated methods such as segmentation, classification and clustering.

Chapter 3: The chapter discussed the effect of noise and blur which reduces the image quality and influences the medical diagnosis process. The authors explored new wavelets generation to provide the basic framework for the adaptive techniques development to improve the medical imagesquality. Medical images decomposition in non-sub-sampled contourlet domain and the calculation of Bayesian thresholding coefficients combined with Lucy Richard to reconstruct the medical images were proposed. The dataset was collected from several hospitals to test different cases: motion blur combined with Gaussian noise and Gaussian blur combined with Gaussian noise. The experimental results compared the proposed method to other approaches in the wavelet domain and new generation wavelet transform such as ridgelet, curvelet and contourlet domain. The results of the proposed method were superior to those of the other methods. The authors recommended in the medical image domain to carefully select the threshold value to preserve the image information.

Chapter 4: This chapter depicted widespread procedures such as thresholding schemes and clustering algorithms for digital image processing. These schemes represent the initial step for other sophisticated methods such as segmentation and classification. A specific reference was directed to brain magnetic resonance images. The authors proposed a method to classify neurodegenerative diseases such as Alzheimer, Pick's, Huntington's or cerebral calcinosis. The MATLAB code used to solve such problem was listed to assist the reader to identify and choose the best solution for a particular problem.

Section 3: Classification and Clustering of Magnetic Resonance Imaging

Accurate and efficient diagnosis in diminutive time period is a significant issue of brain magnetic resonance imaging (MRI) classification and cluttering. This section outlines the MRI Brain Tumor Segmentation based on various approaches such as Modified Probabilistic Clustering and Kernel weighted clustering.

Chapter 5: The authors proposed a new level set algorithm (LMS) based on probabilistic C- mean objective function which included intensity in-homogeneity in the image and robust to noise. The proposed LSM computational complexity is greatly reduced by using highly parallelizable lattice Boltzmann method (LBM). The LSM is then implemented using a graphics processing units (NVIDIA) to fully take the advantage of the LBM local nature. After carrying out exhaustive results, comparison to Li method in terms of the consumed time proved the superiority of the proposed method.

Chapter 6: Brain tumor is one of the severe diseases that require early diagnosis for successful treatment. Classification and segmentation play a vital role in identifying the disease. In the present chapter, image Pre-processing is elaborated for image quality enhancement the image quality, followed by decomposition using Dual-Tree Complex Wavelet Transform to analysis the image texture. Fea-

tures are extracted using Gray-level co-occurrence matrix, which used in the classification process. Neuro-Fuzzy and Neural Network are employed to categorize the types of the brain tumor into normal, benign and malignant. Finally, tumor regions are detected using Kernel weighted clustering method by segmenting the brain tissues with determining the tumor size.

Section 4: Medical Image Retrieval

With the extensive dissemination of medical images archiving and communication systems in hospitals, the amount of medical imaging data is hastily increased. Effective image retrieval methods are required to manage these complex and huge image databases. This section is concerned with medical image database retrieval.

Chapter 7: This chapter is extensively discussed the registration and retrieval for monomodal images. Retrieval techniques, Bag-of-Visual-Words and registration techniques are considered in an interoperable manner to design a successful computer assisted diagnostic system. The authors aim to disseminate the knowledge of creating the patient database and a basis healthcare setup for the clinical diagnosis. Thus, the goal of this chapter is to provide an overview of various strategies to design a system based on a proposed model. The experiment results are carried out on five types of anatomical (radiology) images. Bag-of-visual-words approach is employed in the retrieval technique for modality images than content based retrieval techniques. The results proved that Affine with B-Spine and Bag-of-visual-words are more appropriate for modality images in registration based retrieval.

Chapter 8: The main objective of this chapter is to design an intelligent application to assist medical professionals in the decision-making on tumor diagnosis based on mammography scanner. A suggested new indexing approach on medical image scanner databases, which joined the texture characteristics analysis process with the descriptive information, is proposed. A characteristics vector is used in the proposed model to represent the morphological processing result on the image texture. The used application context is based on mammographic image analysis (MIAS) in databases. The texture analysis of the image is based on the Gabor wavelets filter. The proposed system included both offline and online processes for each image in MIAS databases. The similarities are built between the image-query and images in MIAS databases using the same Gabors' algorithms implementation. A database of 320 mammographies is conducted in the evaluation step. The results provided a set of criteria in image representations based on the Gabor's Wavelets, semantic attributes and significant ratios in the system recall and precision.

Section 5: Assortment of Medical Imaging Applications Based Classification

Medical images are considered the main component in the patient's health record. They are associated with manipulation, processing and handling by computers. Medical imaging is involved in both diagnosis and therapy. One of the major processes is the automated classification, which plays an implicative role in several applications. This section focuses on a variety of applications based medical image classification using different modalities. Besides, an example for Ultrasound Imaging computer-aided detection development is introduced.

Chapter 9: This chapter studies the effect of slow and fast music on the heart rate variability. The authors calculated the statistical features of the time domain and wavelet transform of the electrocardiogram (ECG) signals. Additionally, the artificial neural network (ANN) was employed for classification, which achieved classification efficiency of more than 80%.The experimental results indicated that slow and fast music affected the sympatho-vagal balance in different proportions. Additionally, the authors concluded that listening to music affects the conduction pathway of the heart.

Chapter 10: This chapter is briefly described the issues and challenges for building the Computer aided diagnosis (CAD) tool. A new CAD tool for supraspinatus tendon diagnosis using ultrasound images is provided. The results proved the intuitive user interface of the new software which is easy, quick and suitable for medical applications.

Chapter 11: This chapter reported the results of the 3D electroanatomical mapping (EAM) system of the atrial tachyarrhythmias (AT) for more than 500 consecutive patients. Patients underwent electroanatomical-mapping systems, which combined electrophysiological and spatial information to provide accurate reconstruction of the whole atria with real-time activation sequence guiding RFA for continuous transmural linear lesions. The mapping discriminated obviously and rapidly between micro-macro-reentrant (>80%) and focal mechanisms. The EAM technology allowed the determination of both mechanism and location of arrhythmia with successful elimination of complex arrhythmogenic substrates.

Chapter 12: This chapter supported the Gene analysis and assembly problem in the field of bioinformatics. Assembly is a computationally very exhaustive process that consumes long time to produce the sequence of a more complex organism. A variety of techniques are used to address the problem. Thus, the authors used graph reduction rule to build a de Bruijn graph. The results found accurate solution of large scale sequencing trims space complexity and generates optimal gene assembly.

Chapter 13: The current chapter introduced the electromyography signal (sEMG) classification recorded from the skin surface above the palmaris longus, flexor carpi radialis and flexor carpi ulnaris muscles by flexing fingers in different combinations and durations. The authors used an in-house developed EMG signal acquisition system. The extracted sEMG signal was processed using Discrete Wavelet Transform (DWT). The extracted features and the wavelet processed signals are used for probable classification using Artificial Neural Network (ANN). The results established 90% classification efficiency using the ANN classifier. The results suggested that the sEMG can be used efficiently for designing efficient control system.

Section 6: Wireless Systems for Healthcare

Recently, wireless control devices design and development become essential to support healthcare applications. This section provides a study on Wireless Control Systems for Controlling Electric-Powered Robotic Vehicle Wheelchair Prototype as well as wireless body area networks combined with mobile cloud computing as applications in the healthcare domain.

Chapter 14: The current study proposed a simple surface EMG based control system for wireless control of the wheelchair movement as well as other rehabilitative devices. The Surface EMG (sEMG) signals are processed in the time domain and using discrete wavelet transforms (DWT). The statistical features of the signals are determined and analyzed, where the features of the squared sEMG signals

envelope are sufficient for high-efficiency classification and control signal generation. A hall-effect sensor based switching mechanism is introduced for controlling the duration of the activation of the device. The control signals are wirelessly transmitted to the robotic vehicle.

Chapter 15: In this chapter, multiple control systems are developed using wireless communication protocols, such as the Bluetooth, Xbee and Wi-Fi. The Xbee and Bluetooth protocols are used to design mechanical switch based control systems. Additionally, an android application based control systems is developed using Bluetooth and Wi-Fi protocols. A robotic vehicle is used as an electric-powered wheelchair prototype. For obstacle and pothole detection, the ultrasonic sensors and infrared sensors are integrated with the robotic vehicle, respectively. L-shaped corridor is used to test the control systems for identifying the suitable wireless communication protocol to powerfully guide the robotic vehicle through a scheduled navigational pathway. Both Xbee and Wi-Fi technology based control systems have the ability to guide the robotic vehicle through the corridor.

Chapter 16: In this chapter, a theoretical study on the combination of wireless body area network (WBAN) and mobile cloud computing (MCC) in healthcare was presented. Cloud computing is used to achieve much more user friendly device that manage the information. The combination of WBAN and the MCC promised better performance to the users immediately. The authors wired the sensor which executed the necessary medical tests and provided the information through devices, such as mobile phones and tablets.

This book is expected to assist researchers, academicians and engineering in healthcare informatics, medical imaging, biology and medical devices design. It addressed innovative conceptual framework for various applications. The book is expected to serve as a reference for the post-graduated students as it offers the requisite knowledge for understanding the classification and clustering along with their applications. This book is based on a research studies carried out by experienced academicians and is expected to shed new insights for researchers; academicians, students and improves understanding of biomedical image classification and clustering concept.

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