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Digital Image Processing for Ophthalmology

*Detection and Modeling of
Retinal Vascular Architecture*

Faraz Oloumi
Rangaraj M. Rangayyan
Anna L. Ellis

***SYNTHESIS LECTURES ON
BIOMEDICAL ENGINEERING***

John D. Enderle, *Series Editor*

Digital Image Processing For Ophthalmology Detection And Modeling Of Retinal Vascular Architecture

Alireza Ghahari, John D. Enderle



Digital Image Processing For Ophthalmology Detection And Modeling Of Retinal Vascular Architecture:

Digital Image Processing for Ophthalmology Faraz Oloumi, Rangaraj M. Rangayyan, Anna L. Ells, 2014-05-01 The monitoring of the effects of retinopathy on the visual system can be assisted by analyzing the vascular architecture of the retina This book presents methods based on Gabor filters to detect blood vessels in fundus images of the retina Forty images of the retina from the Digital Retinal Images for Vessel Extraction DRIVE database were used to evaluate the performance of the methods The results demonstrate high efficiency in the detection of blood vessels with an area under the receiver operating characteristic curve of 0.96 Monitoring the openness of the major temporal arcade MTA could facilitate improved diagnosis and optimized treatment of retinopathy This book presents methods for the detection and modeling of the MTA including the generalized Hough transform to detect parabolic forms Results obtained with 40 images of the DRIVE database compared with hand drawn traces of the MTA indicate a mean distance to the closest point of about 0.24mm This book illustrates applications of the methods mentioned above for the analysis of the effects of proliferative diabetic retinopathy and retinopathy of prematurity on retinal vascular architecture

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Medical Image Analysis and Informatics Paulo Mazzoncini de Azevedo-Marques, Arianna Mencattini, Marcello Salmeri, Rangaraj M. Rangayyan, 2017-11-23 With the development of rapidly increasing medical imaging modalities and their applications the need for computers and computing in image generation processing visualization archival transmission modeling and analysis has grown substantially Computers are being integrated into almost every medical imaging system Medical Image Analysis and Informatics demonstrates how quantitative analysis becomes possible by the application of computational procedures to medical images Furthermore it shows how quantitative and objective analysis facilitated by medical image informatics CBIR and CAD could lead to improved diagnosis by physicians Whereas CAD has become a part of the clinical workflow in the detection of breast cancer with mammograms it is not yet established in other applications CBIR is an alternative and complementary approach for image retrieval based on measures derived from images which could also facilitate CAD This book shows how digital image processing techniques can assist in quantitative analysis of medical images how pattern recognition and classification techniques can facilitate CAD and how CAD systems can assist in achieving efficient diagnosis in designing optimal treatment protocols in analyzing the effects of or response to treatment and in clinical management of various conditions The book affirms that medical imaging medical image analysis medical image informatics CBIR and CAD are proven as well as essential techniques for health care

Spatiotemporal Modeling of Influenza William E. Schiesser, 2022-05-31 This book has a two fold purpose 1 An introduction to the computer based modeling of influenza a continuing major worldwide communicable disease 2 The use of 1 as an illustration of a methodology for the computer based modeling of communicable diseases For the purposes of 1 and 2 a basic influenza model is formulated as a system of partial differential equations PDEs that define the spatiotemporal evolution of four populations susceptibles untreated and treated infecteds and recovered The requirements of a well posed PDE model are considered including the initial and boundary conditions The terms of the PDEs are explained The computer implementation of the model is illustrated with a detailed line by line explanation of a system of routines in R a quality open source scientific computing system that is readily available from the Internet The R routines demonstrate the straightforward numerical solution of a system of nonlinear PDEs by the method of lines MOL an established general algorithm for PDEs The presentation of the PDE modeling methodology is introductory with a minimum of formal mathematics no theorems and proofs and with emphasis on example applications The intent of the book is to assist in the initial understanding and use of PDE mathematical modeling of communicable diseases and the explanation and interpretation of the computed model solutions as illustrated with the influenza model

Models of Horizontal Eye Movements Alireza Ghahari, John D. Enderle, 2022-06-01 There are five different types of eye movements saccades smooth

pursuit vestibular ocular eye movements optokinetic eye movements and vergence eye movements The purpose of this book series is focused primarily on mathematical models of the horizontal saccadic eye movement system and the smooth pursuit system rather than on how visual information is processed In Part 1 early models of saccades and smooth pursuit are presented A number of oculomotor plant models are described here beginning with the Westheimer model published in 1954 and up through our 1995 model involving a 4th order oculomotor plant model In Part 2 a 2009 version of a state of the art model is presented for horizontal saccades that is 3rd order and linear and controlled by a physiologically based time optimal neural network Part 3 describes a model of the saccade system focusing on the neural network It presents a neural network model of biophysical neurons in the midbrain for controlling oculomotor muscles during horizontal human saccades In this book a multiscale model of the saccade system is presented focusing on a multiscale neural network and muscle fiber model Chapter 1 presents a comprehensive model for the control of horizontal saccades using a muscle fiber model for the lateral and medial rectus muscles The importance of this model is that each muscle fiber has a separate neural input This model is robust and accounts for the neural activity for both large and small saccades The muscle fiber model consists of serial sequences of muscle fibers in parallel with other serial sequences of muscle fibers Each muscle fiber is described by a parallel combination of a linear length tension element viscous element and active state tension generator Chapter 2 presents a biophysically realistic neural network model in the midbrain to drive a muscle fiber oculomotor plant during horizontal monkey saccades Neural circuitry including omnipause neuron premotor excitatory and inhibitory burst neurons long lead burst neuron tonic neuron interneuron abducens nucleus and oculomotor nucleus is developed to examine saccade dynamics The time optimal control mechanism demonstrates how the neural commands are encoded in the downstream saccadic pathway by realization of agonist and antagonist controller models Consequently each agonist muscle fiber is stimulated by an agonist neuron while an antagonist muscle fiber is unstimulated by a pause and step from the antagonist neuron It is concluded that the neural network is constrained by a minimum duration of the agonist pulse and that the most dominant factor in determining the saccade magnitude is the number of active neurons for the small saccades For the large saccades however the duration of agonist burst firing significantly affects the control of saccades The proposed saccadic circuitry establishes a complete model of saccade generation since it not only includes the neural circuits at both the premotor and motor stages of the saccade generator but it also uses a time optimal controller to yield the desired saccade magnitude Table of Contents Acknowledgments A New Linear Muscle Fiber Model for Neural Control of Saccades footnotemark A Physiological Neural Controller of a Muscle Fiber Oculomotor Plant in Horizontal Monkey Saccades footnotemark References Authors Biographies

Nanotechnology for Bioengineers Wujie Zhang, 2022-05-31

Nanotechnology is an interdisciplinary field that is rapidly evolving and expanding Significant advancements have been made in nanotechnology related disciplines in the past few decades and continued growth and progression in the field are

anticipated Moreover nanotechnology omnipresent in innovation has been applied to resolve critical challenges in nearly every field especially those related to biological technologies and processes This book used as either a textbook for a short course or a reference book provides state of the art analysis of essential topics in nanotechnology for bioengineers studying and working in biotechnology chemical biochemical pharmaceutical biomedical and other related fields The book topics range from introduction to nanotechnology and nanofabrication to applications of nanotechnology in various biological fields This book not only intends to introduce bioengineers to the amazing world of nanotechnology but also inspires them to use nanotechnology to address some of the world s biggest challenges

Computerized Analysis of Mammographic Images for Detection and Characterization of Breast Cancer Paola Casti,Arianna Mencattini,Marcello Salmeri,Rangaraj M.

Rangayyan,2022-05-31 The identification and interpretation of the signs of breast cancer in mammographic images from screening programs can be very difficult due to the subtle and diversified appearance of breast disease This book presents new image processing and pattern recognition techniques for computer aided detection and diagnosis of breast cancer in its various forms The main goals are 1 the identification of bilateral asymmetry as an early sign of breast disease which is not detectable by other existing approaches and 2 the detection and classification of masses and regions of architectural distortion as benign lesions or malignant tumors in a unified framework that does not require accurate extraction of the contours of the lesions The innovative aspects of the work include the design and validation of landmarking algorithms automatic Tab r masking procedures and various feature descriptors for quantification of similarity and for contour independent classification of mammographic lesions Characterization of breast tissue patterns is achieved by means of multidirectional Gabor filters For the classification tasks pattern recognition strategies including Fisher linear discriminant analysis Bayesian classifiers support vector machines and neural networks are applied using automatic selection of features and cross validation techniques Computer aided detection of bilateral asymmetry resulted in accuracy up to 0.94 with sensitivity and specificity of 1 and 0.88 respectively Computer aided diagnosis of automatically detected lesions provided sensitivity of detection of malignant tumors in the range of 0.70-0.81 at a range of falsely detected tumors of 0.82-3.47 per image The techniques presented in this work are effective in detecting and characterizing various mammographic signs of breast disease

Fast Quantitative Magnetic Resonance Imaging Guido Buonincontri,Joshua Kaggie,Martin Graves,2022-05-31 Among medical imaging modalities magnetic resonance imaging MRI stands out for its excellent soft tissue contrast anatomical detail and high sensitivity for disease detection However as proven by the continuous and vast effort to develop new MRI techniques limitations and open challenges remain The primary source of contrast in MRI images are the various relaxation parameters associated with the nuclear magnetic resonance NMR phenomena upon which MRI is based Although it is possible to quantify these relaxation parameters qMRI they are rarely used in the clinic and radiological interpretation of images is primarily based upon images that are relaxation time weighted The clinical adoption of qMRI is

mainly limited by the long acquisition times required to quantify each relaxation parameter as well as questions around their accuracy and reliability. More specifically, the main limitations of qMRI methods have been the difficulty in dealing with the high inter-parameter correlations and a high sensitivity to MRI system imperfections. Recently, new methods for rapid qMRI have been proposed. The multi-parametric models at the heart of these techniques have the main advantage of accounting for the correlations between the parameters of interest as well as system imperfections. This holistic view on the MR signal makes it possible to regress many individual parameters at once, potentially with a higher accuracy. Novel accurate techniques promise a fast estimation of relevant MRI quantities, including but not limited to longitudinal T1 and transverse T2 relaxation times. Among these emerging methods, MR Fingerprinting, MRF, synthetic MR, syMRI or MAGIC and T1/T2 Shuffling are making their way into the clinical world at a very fast pace. However, the main underlying assumptions and algorithms used are sometimes different from those found in the conventional MRI literature and can be elusive at times. In this book, we take the opportunity to study and describe the main assumptions, theoretical background, and methods that are the basis of these emerging techniques. Quantitative transient state imaging provides an incredible transformative opportunity for MRI. There is huge potential to further extend the physics in conjunction with the underlying physiology toward a better theoretical description of the underlying models, their application, and evaluation to improve the assessment of disease and treatment efficacy.

Exosomes and MicroRNAs in Biomedical Science

Hamed Mirzaei, Neda Rahimian, Hamid Reza Mirzaei, Javid Sadri Nahand, Michael R. Hamblin, 2022-04-21

MicroRNAs (miRNAs) are a member of the family of non-coding RNA molecules and consist of small conserved sequences between 19-25 nucleotides in length that are responsible for regulating many cellular functions by affecting a wide range of messenger RNAs in a sequence-specific manner. Fundamental biological processes like cell proliferation and growth, stress resistance, tumorigenesis, fat metabolism, and neural development have all been shown to be governed by miRNAs. miRNAs carry out the post-transcriptional silencing of gene expression via targeting the 3' untranslated region (UTR) of the complementary mRNA sequence. The dysregulation of the expression levels of various miRNAs is typical of tumor cells and has been associated with tumor progression and poor prognosis. Many miRNAs are up-regulated in cancer, where they can silence tumor suppressor genes such as apoptosis and immune response-associated genes. Therefore, it is possible to profile the expression levels of miRNAs as biomarkers in order to diagnose cancer and noncancerous diseases. Moreover, cancer detection in the early stages is crucial in clinical situations. Characterization of miRNAs in serum, plasma, and other bodily fluids and understanding their stability against RNase degradation is important to assess their suitability as biomarkers and diagnostic tools. Exosomes play an important role in inter-cellular communications, and these nanosized particles have various functions in diverse physiological pathways in normal as well as abnormal cells. Exosomes can carry diverse cargos such as mRNAs, miRNAs, and proteins that transfer information between donor and recipient cells. Furthermore, uptake of exosomes and their cargos may promote or suppress

various molecular and cellular pathways which alter the cellular behavior Many reports have discussed the role of exosomes released from cancer cells on the progression of cancer at various stages Exosomes and their cargos may affect the growth of the tumor metastasis drug resistance immune system function as well as angiogenesis Therefore exosomes have been explored as diagnostic biomarkers in many cancers Moreover exosomes can be used as biological vehicles to deliver different drugs and agents like doxorubicin DOX miRNAs and siRNAs The present book covers the role of exosomes and micro RNAs in the pathogenesis and treatment of various diseases

Adopting the Beat of Appearance: An Emotional Symphony within **Digital Image Processing For Ophthalmology Detection And Modeling Of Retinal Vascular Architecture**

In a world consumed by screens and the ceaseless chatter of fast communication, the melodic beauty and emotional symphony created by the published word often disappear in to the backdrop, eclipsed by the persistent sound and disturbances that permeate our lives. However, situated within the pages of **Digital Image Processing For Ophthalmology Detection And Modeling Of Retinal Vascular Architecture** a stunning literary prize full of natural feelings, lies an immersive symphony waiting to be embraced. Crafted by an elegant musician of language, this fascinating masterpiece conducts viewers on a psychological journey, skillfully unraveling the concealed melodies and profound affect resonating within each carefully constructed phrase. Within the depths of the touching evaluation, we shall investigate the book is main harmonies, analyze its enthralling publishing design, and submit ourselves to the profound resonance that echoes in the depths of readers souls.

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Introduction

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