

# OPTIMIZATION OF LEFT VENTRICULAR MUSCLE FIBER ORIENTATION

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## 1. Introduction

The left ventricle (LV) of the heart is a hollow muscle, that pumps blood through the systemic circulation. The muscular wall resembles a thick-walled truncated ellipsoid, and consists largely of muscle fibers (cells), that are oriented in a complex, but highly organized pattern (figure 1).

It is still a matter of debate whether or not all muscle cells contribute equally to the global performance of the left ventricle. The contribution of the individual cell is determined by the local state of stress and strain in the tissue. In the absence of experimental techniques to determine these quantities with sufficient reliability and spatial resolution, mathematical models have been designed to predict them [1, 4, 5, 8, 9]. In one model, using a measured wall geometry and muscle fiber orientation, an inhomogeneous distribution of stress and strain was found [8]. In other models, it was found that predicted local stresses and strains depend strongly on the choice of the muscle fiber orientation [1, 4, 5, 9]. Within the range of experimental data on the fiber orientation, from the models virtually any spatial distribution of stresses and strains could be predicted, including rather homogeneous distributions.

Starting point for the present study was the hypothesis that, in the real left ventricle, muscle fiber orientation is such, that mechanical load is evenly distributed across the wall. The hypothesis was based on observed changes in left ventricular wall geometry, following changes in mechanical loading of the ventricle [6, 12]. The geometric changes, that originate from the ability of the myocardial cells to adapt structurally to alterations in experienced deformation [10, 16], are expected to restore the original mechanical load.

The aim of this study was 1) to optimize the muscle fiber orientation field in a mathematical model of LV mechanics, such that systolic fiber

# Optimization Of Left Ventricular Muscle Fiber Orientation

**Alejandro F. Frangi, Petia I.  
Radeva, Andres Santos, Monica  
Hernandez**



## **Optimization Of Left Ventricular Muscle Fiber Orientation:**

*Optimization of Left Ventricular Muscle Fiber Orientation* Johannes Matthias Rijcken, 1997      *Multiscale Modeling of the Ventricles* David Urs Josef Keller, 2014-08-22 This work is focused on different aspects within the loop of multiscale modeling On the cellular level effects of adrenergic regulation and the Long QT syndrome have been investigated On the organ level a model for the excitation conduction system was developed and the role of electrophysiological heterogeneities was analyzed On the torso level a dynamic model of a deforming heart was created and the effects of tissue conductivities on the solution of the forward problem were evaluated      **IUTAM Symposium on Synthesis in Bio Solid Mechanics** Pauli

Pedersen, Martin P. Bendsøe, 2006-04-11 This book contains the edited version of invited lectures presented at the IUTAM Symposium Synthesis in Bio Solid Mechanics held at Hotel Frederiksdal Virum Copenhagen Denmark May 24 to May 27 1998 The symposium was attended by 48 scientists from 14 countries Biomechanics has been a very active research area in the last 25 years and covers a very broad class of problems The present symposium concentrated on the solid mechanics main of biomechanics where important problems of synthesis presently are an active and challenging part Characteristics of biomechanical materials are not only the inhomogeneity and anisotropy but also the capability to change in relation to actual use These living materials call for new methods of analysis and also new methods for synthesis By the synthesis in this context is meant design of implants or artificial control of material growth Bone mechanics is closely related to recent work on analysis and design of microstructural anisotropic materials Also recent work in shape design can to some extent be useful in the more complicated problems of biomechanics Here interface problems play an essential role The symposium brought together scientists from mechanics mathematics and medicine      **Functional Imaging and Modeling of the**

**Heart** Alejandro F. Frangi, Petia I. Radeva, Andres Santos, Monica Hernandez, 2005-06-13

The 1st and 2nd International Conferences on Functional Imaging and Modelling of the Heart FIMH were held in Helsinki Finland in November 2001 and in Lyon France in June 2003 These meetings were born through a fruitful scientific collaboration between France and Finland that outreached to other groups and led to the start of this biennial event The FIMH conference was the first attempt to agglutinate researchers from several complementary but often isolated fields cardiac imaging signal and image processing applied mathematics and physics biomedical engineering and computer science cardiology radiology biology and physiology In the first two editions the conference received an enthusiastic acceptance by experts of all these communities FIMH was originally started as a European event and has increasingly attracted more and more people from the US and Asia This edition of FIMH received the largest number of submissions so far with a result of 47 papers being accepted as either oral presentations or posters There were a number of submissions from non EU institutions which confirms the growing interest in this series of meetings All papers were reviewed by up to four reviewers The accepted contributions were organized into 8 oral sessions and 3 poster sessions complemented by a number of invited talks This year we tried to allocate

as many papers as possible as oral presentations to facilitate more active participation and to stimulate multidisciplinary discussions     Functional Imaging and Modeling of the Heart Nicholas Ayache, Hervé Delingette, 2009-05-25 This book constitutes the refereed proceedings of the 5th International Conference on Functional Imaging and Modeling of the Heart FIMH 2009 held in Nice France in June 2009 The 54 revised full papers presented were carefully reviewed and selected from numerous submissions The contributions cover topics such as cardiac imaging and electrophysiology cardiac architecture imaging and analysis cardiac imaging cardiac electrophysiology cardiac motion estimation cardiac mechanics cardiac image analysis cardiac biophysical simulation cardiac research platforms and cardiac anatomical and functional imaging

Cardiac Modeling: Aiming for Optimization of Therapy Javier Saiz, Olaf Doessel, 2020-12-15 This eBook is a collection of articles from a Frontiers Research Topic Frontiers Research Topics are very popular trademarks of the Frontiers Journals Series they are collections of at least ten articles all centered on a particular subject With their unique mix of varied contributions from Original Research to Review Articles Frontiers Research Topics unify the most influential researchers the latest key findings and historical advances in a hot research area Find out more on how to host your own Frontiers Research Topic or contribute to one as an author by contacting the Frontiers Editorial Office frontiersin.org about contact     **Heart Mechanics** El-Sayed H. Ibrahim, 2017-09-19 MRI techniques have been recently introduced for non invasive qualification of regional myocardial mechanics which is not achievable with other imaging modalities Covering more than twenty three years of developments in MRI techniques for accessing heart mechanics this book provides a plethora of techniques and concepts that assist readers choose the best technique for their purpose It reviews research studies and clinical trials that implemented MRI techniques for studying heart mechanics     **Functional Imaging and Modeling of the Heart** , 2005

Functional Imaging and Modeling of the Heart Olivier Bernard, Patrick Clarysse, Nicolas Duchateau, Jacques Ohayon, Magalie Viallon, 2023-06-15 This book constitutes the refereed proceedings of the 12th International Conference on Functional Imaging and Modeling of the Heart held in Lyon France in June 2023 The 72 full papers were carefully reviewed and selected from 80 submissions The focus of the papers is on following topics increased imaging resolutions data explosion sophistication of computational models and advent of AI frameworks while new imaging modalities have emerged e.g combined PET MRI Spectral CT     *Applied Mechanics Reviews* , 1989     **Proceedings of the ... Bioengineering Conference** , 1999     *Latest Advances in Clinical and Pre-Clinical Cardiovascular MRI* Christakis Constantinides, 2014-12-18 This e book series presents readers with information about state of the art developments in clinical and pre clinical cardiovascular magnetic resonance imaging MRI The first volume of the series brings contributions from prominent scientists and the to     Recent Advances on Myocardium Physiology Norio Fukuda, Henk Granzier, Shin'Ichi Ishiwata, Sachio Morimoto, 2021-07-27     **Cardiac Mechano-Electric Coupling and Arrhythmias** Peter Kohl, Frederick Sachs, Michael R. Franz, 2011-08-25 Ranging from stretch activated ion channels to mechanically induced arrhythmias and mechanical

interventions for heart rhythm correction this new edition offers a thoroughly reviewed compendium of chapters written by the top experts in the world on the mechanism and consequences of cardiac mechano electrical coupling **11th Mediterranean Conference on Medical and Biological Engineering and Computing 2007** Tomaz Jarm, Peter Kramar, Anze Zupanic, 2007-10-24 Biomedical engineering today is a well recognized area of research It brings together bright minds from diverse disciplines ranging from engineering physics and computer sciences on one side to biology and medicine on the other side With valuable assistance of members of the International Advisory Committee and Scientific Program Committee the co organizing institutions and societies our sponsors and distinguished invited lecturers we will ensure that the research and development presented at MEDICON 2007 plenary meetings scientific sessions and workshops will truly be relevant and up to date The MEDICON conferences are international events of high scientific standards with long lasting tradition held every third year in one of the Mediterranean countries under the auspices of the International Federation for Medical and Biological Engineering *Oxford Textbook of Advanced Heart Failure and Cardiac Transplantation* Michael J. Domanski, Mandeep R. Mehra, Marc A. Pfeffer, 2016 The Oxford Textbook of Advanced Heart Failure and Cardiac Transplantation is the authoritative text on advanced heart failure and a key resource for clinicians caring for heart failure patients It comes with an online version which allows you to find content quickly and easily with intuitive search options and cross linking and access to downloadable content [Heart Failure: A Companion to Braunwald's Heart Disease E-Book](#) G. Michael Felker, Douglas L. Mann, 2019-02-06 Up to date authoritative and comprehensive Heart Failure 4th Edition provides the clinically relevant information you need to effectively manage and treat patients with this complex cardiovascular problem This fully revised companion to Braunwald's Heart Disease helps you make the most of new drug therapies such as angiotensin receptor neprilysin inhibitors ARNIs recently improved implantable devices and innovative patient management strategies Led by internationally recognized heart failure experts Dr G Michael Felker and Dr Douglas Mann this outstanding reference gives health care providers the knowledge to improve clinical outcomes in heart failure patients Focuses on a clinical approach to treating heart failure resulting from a broad variety of cardiovascular problems Covers the most recent guidelines and protocols including significant new updates to ACC AHA and HFSA guidelines Covers key topics such as biomarkers and precision medicine in heart failure and new data on angiotensin receptor neprilysin inhibitors ARNIs Contains four new chapters Natriuretic Peptides in Heart Failure Amyloidosis as a Cause of Heart Failure HIV and Heart Failure and Neuromodulation in Heart Failure Covers the pathophysiological basis for the development and progression of heart failure Serves as a definitive resource to prepare for the ABIM's Heart Failure board exam 2016 British Medical Association Award First Prize Cardiology 3rd Edition [Cardiovascular Imaging and Image Analysis](#) Ayman El-Baz, Jasjit S. Suri, 2018-10-03 This book covers the state of the art approaches for automated non invasive systems for early cardiovascular disease diagnosis It includes several prominent imaging modalities such as MRI CT

and PET technologies There is a special emphasis placed on automated imaging analysis techniques which are important to biomedical imaging analysis of the cardiovascular system Novel 4D based approach is a unique characteristic of this product This is a comprehensive multi contributed reference work that will detail the latest developments in spatial temporal and functional cardiac imaging The main aim of this book is to help advance scientific research within the broad field of early detection of cardiovascular disease This book focuses on major trends and challenges in this area and it presents work aimed to identify new techniques and their use in biomedical image analysis Key Features Includes state of the art 4D cardiac image analysis Explores the aspect of automated segmentation of cardiac CT and MR images utilizing both 3D and 4D techniques Provides a novel procedure for improving full cardiac strain estimation in 3D image appearance characteristics Includes extensive references at the end of each chapter to enhance further study

**Neuroprosthetics - Theory And Practice** Gurpreet S Dhillon, Kenneth W Horch, 2004-02-20 Neuroprosthetics is an area of intense scientific and clinical interest and rapid progress Since the introduction of the cardiac pacemaker in 1932 we have seen developments that include cochlear prostheses techniques for bladder and bowel control deep brain stimulation and restoration of mobility and respiration to paralyzed individuals The chapters in this book have been contributed by authors who are recognized internationally in their fields The result is a comprehensive and up to date review that will be invaluable to graduate students clinicians and researchers in neuroprosthetics It is broadly divided into three sections Section 1 provides a core of knowledge that forms a foundation for the rest of the book and covers the basics of neuroanatomy and neurophysiology biomaterials and biocompatibility stimulation and recording techniques Section 2 describes current clinical applications of neuroprosthetics Section 3 looks at future developments in the field

*Research Grants Index* National Institutes of Health (U.S.). Division of Research Grants, 1975

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