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RICHARD JOYCE

Neural Tissue Biomechanics CRC Press This book offers a comprehensive and timely overview of the latest developments in the field of biomechanics and extensive knowledge of tissue structure, function, and modeling. Gathering chapters written by authoritative scientists, it reports on a range of continuum and computational models of solids, and related experimental works, for biomechanical applications. It discusses cutting-edge advances such as constitutive modeling and computational simulation of biological tissues and organs under physiological and pathological conditions, and their mechanical characterization. It covers innovative studies on arteries, heart, valvular tissue, and thrombus, brain tumor, muscle, liver, kidney, and stomach, among others. Written in honor of Professor Gerhard A. Holzapfel, the book provides specialized readers with a thorough and timely overview of different types of modeling in biomechanics, and current knowledge about biological structures and function.
Computer Models in Biomechanics World Scientific
Traumatic brain injury (TBI) is a significant cause of death and morbidity in both the civilian and military populations. The major causes of TBI, such as motor vehicle accidents, falls, sports concussions, and ballistic and explosive blast threats for military

personnel, are well established and extensively characterized; however, there remains much to be learned about the specific mechanisms of damage leading to brain injury, especially at the cellular level. In order to understand how cells of the central nervous system (CNS) respond to mechanical insults and stimuli, a combined modeling/experimental approach was adopted. A computational framework was developed to accurately model how cells deform under various macroscopically imposed loading conditions. In addition, in vitro (cell culture) models were established to investigate damage responses to biologically relevant mechanical insults. In order to develop computational models of cell response to mechanical loading, it is essential to have accurate material properties for all cells of interest. In this work, the mechanical responses of neurons and astrocytes were quantified using atomic force microscopy (AFM) at three different loading rates and under relaxation to enable characterization of both the elastic and viscous components of the cell response. AFM data were used to calibrate an eight-parameter rheological model implemented in the framework of a commercial finite element package (Abaqus). Model parameters fit to the measured responses of neurons and astrocytes provide a quantitative measure of homogenized nonlinear viscoelastic properties for each cell type. In order to ensure that the measured responses could be considered representative of cell populations in their physiological environment, cells were also grown and tested on substrates of various stiffness, with the softest substrate mimicking the stiffness of brain tissue. Results of this study showed both the morphology and measured force response of astrocytes to be significantly affected by the stiffness of their substrate, with cells becoming increasingly rounded on soft substrates. Results of simulations suggested that changes in cell morphology were able to account for the observed changes in AFM force response, without significant changes to the cell material properties. In contrast, no significant changes in cell morphology were observed for neurons. These results highlight the importance of growing cells in a biologically relevant environment when studying mechanically mediated responses, such as TBI. To address this requirement, we developed two model systems with CNS cells grown in soft, 3D gels to investigate damage arising from dynamic compressive loading and from a shock pressure wave. These damage protocols, coupled with the single cell computational models, provide a new tool set for characterizing damage mechanisms in CNS cells and for studying TBI in highly controllable in vitro conditions.

Biomechanics and Biological Consequences of Traumatic Brain Injury

Springer

The Computational Biomechanics for Medicine titles provide an opportunity for specialists in computational biomechanics to present their latest methodologiesand advancements. Thisvolumecomprises twelve of the newest approaches and applications of computational biomechanics, from researchers in Australia, New Zealand, USA, France, Spain and Switzerland. Some of the interesting topics discussed are:real-time simulations; growth and remodelling of soft tissues; inverse and meshless solutions; medical image

analysis; and patient-specific solid mechanics simulations. One of the greatest challenges facing the computational engineering community is to extend the success of computational mechanics to fields outside traditional engineering, in particular to biology, the biomedical sciences, and medicine. We hope the research presented within this book series will contribute to overcoming this grand challenge.

Computational Biomechanics for Medicine Springer Nature

Intelligence results from the interaction of the brain, body and environment. The question addressed in this book is, can we measure the contribution of the body and its' interaction with the environment? To answer this, we first present a comprehensive overview of the various ways in which a body reduces the amount of computation that the brain has to perform to solve a task. This chapter will broaden your understanding of how important inconspicuously appearing physical processes and physical properties of the body are with respect to our cognitive abilities. This form of contribution to intelligence is called Morphological Intelligence. The main contribution of this book to the field is a detailed discussion of how Morphological Intelligence can be measured from observations alone. The required mathematical framework is provided so that readers unfamiliar with information theory will be able to understand and apply the measures. Case studies from biomechanics and soft robotics illustrate how the presented quantifications can, for example, be used to measure the contribution of muscle physics to jumping and optimise the shape of a soft robotic hand. To summarise, this monograph presents various examples of how the physical properties of the body and the body's interaction with the environment contribute to intelligence. Furthermore, it treats theoretical and practical aspects of Morphological Intelligence and demonstrates the value in two case studies.

Biomechanics of the Brain Springer Science & Business Media

Nearly 50,000 Americans die from brain injuries annually, with approximately half of all Traumatic Brain Injuries (TBI) being transportation-related. TBI is a critical and ever-evolving safety topic, with equally important components of injury prevention, consequences, and treatment. This book is part of a 3-volume set which presents a comprehensive look at recent head injury research and focuses on injury of the head's contents and features 13 technical papers. These publications are primarily related to injuries to the brain, its surrounding membranes, and its blood supply. Editor Jeffrey A. Pike has selected the most relevant technical papers spanning the early 1990s through the beginning of 2011, including several older papers which provide an essential historical perspective. Each volume in the series also includes a table of references arranged by topic and a new chapter tying together anatomy, injury, and injury mechanism topics. Buy the Set and Save! Head Injury Biomechanics The three-volume set consists of these individual volumes: Head Injury Biomechanics, Volume 1--The Skull Head Injury Biomechanics, Volume 2--The Brain Head Injury Biomechanics, Volume 3--Mitigation

Forensic Biomechanics and Human Injury Springer Nature

Mechanical laws of motion were applied very early for better understanding anthropomorphic action as suggested in

advance by Newton «For from hence are easily deduced the forces of machines, which are compounded of wheels, pullies, levers, cords, and weights, ascending directly or obliquely, and other mechanical powers; as also the force of the tendons to move the bones of animals». In the 19th century E.J. Marey and E. Muybridge introduced chronophotography to scientifically investigate animal and human movements. They opened the field of motion analysis by being the first scientists to correlate ground reaction forces with kinetics. Despite of the apparent simplicity of a given skilled movement, the organization of the underlying neuro-musculo-skeletal system remains unknown. A reason is the redundancy of the motor system: a given action can be realized by different muscle and joint activity patterns, and the same underlying activity may give rise to several movements. After the pioneering work of N. Bernstein in the 60’s on the existence of motor synergies, numerous researchers «walking on the border» of their disciplines tend to discover laws and principles underlying the human motions and how the brain reduces the redundancy of the system. These synergies represent the fundamental building blocks composing complex movements. In robotics, researchers face the same redundancy and complexity challenges as the researchers in life sciences. This book gathers works of roboticists and researchers in biomechanics in order to promote an interdisciplinary research on anthropomorphic systems at large and on humanoid robotics in particular.

Biomechanics of the Primate Skull Base Springer Nature

This book provides an overview of biomedical applications in sports, including reviews of the current state-of-the art methodologies and research areas. Basic principles with specific case studies from different types of sports as well as suggested student activities and homework problems are included. Equipment design and manufacturing, quantitative evaluation methods, and sports medicine are given special focus. Biomechanical Principles and Applications in Sports can be used as a textbook in a sports technology or sports engineering program, and is also ideal for graduate students and researchers in biomedical engineering, physics, and sports physiology. It can also serve as a useful reference for professional athletes and coaches interested in gaining a deeper understanding of biomechanics and exercise physiology to improve athletic performance.

New Developments on Computational Methods and Imaging in Biomechanics and Biomedical Engineering Springer Science & Business Media

Forensic Biomechanics and Human Injury: Criminal and Civil Applications An Engineering Approach provides a concise, comprehensive overview of human anatomy and the biomechanical factors involved in human injury. It describes the methodologies used to compute the various forces, stresses, and energies required to injure the human body.The book cov

Computational Biomechanics for Medicine Springer Nature

This new edition presents an authoritative account of the current state of brain biomechanics research for engineers, scientists and medical professionals. Since the first edition in 2011, this topic has unquestionably entered into the mainstream of

biomechanical research. The book brings together leading scientists in the diverse fields of anatomy, neuroimaging, image-guided neurosurgery, brain injury, solid and fluid mechanics, mathematical modelling and computer simulation to paint an inclusive picture of the rapidly evolving field. Covering topics from brain anatomy and imaging to sophisticated methods of modeling brain injury and neurosurgery (including the most recent applications of biomechanics to treat epilepsy), to the cutting edge methods in analyzing cerebrospinal fluid and blood flow, this book is the comprehensive reference in the field. Experienced researchers as well as students will find this book useful.

Multiscale Biomechanical Modeling of the Brain Oxford University Press

This book contains a collection of papers that were presented at the IUTAM Symposium on “Computer Models in Biomechanics: From Nano to Macro” held at Stanford University, California, USA, from August 29 to September 2, 2011. It contains state-of-the-art papers on: - Protein and Cell Mechanics: coarse-grained model for unfolded proteins, collagen-proteoglycan structural interactions in the cornea, simulations of cell behavior on substrates - Muscle Mechanics: modeling approaches for Ca2+–regulated smooth muscle contraction, smooth muscle modeling using continuum thermodynamical frameworks, cross-bridge model describing the mechanoenergetics of actomyosin interaction, multiscale skeletal muscle modeling - Cardiovascular Mechanics: multiscale modeling of arterial adaptations by incorporating molecular mechanisms, cardiovascular tissue damage, dissection properties of aortic aneurysms, intracranial aneurysms, electromechanics of the heart, hemodynamic alterations associated with arterial remodeling following aortic coarctation, patient-specific surgery planning for the Fontan procedure - Multiphasic Models: solutes in hydrated biological tissues, reformulation of mixture theory-based poroelasticity for interstitial tissue growth, tumor therapies of brain tissue, remodeling of microcirculation in liver lobes, reactions, mass transport and mechanics of tumor growth, water transport modeling in the brain, crack modeling of swelling porous media - Morphogenesis, Biological Tissues and Organs: mechanisms of brain morphogenesis, micromechanical modeling of anterior cruciate ligaments, mechanical characterization of the human liver, in vivo validation of predictive models for bone remodeling and mechanobiology, bridging scales in respiratory mechanics

Mathematical Modelling and Biomechanics of the Brain Springer Nature

This book presents an understanding of biomechanics through chapters analyzing human behavior in sport from a medical perspective. It offers a comprehensive range of principles, methods, techniques, and tools to provide the reader with clear knowledge of the impact of biomechanic processes. The text considers physical, mechanical, and biomechanical aspects and is illustrated by different key application domains such as sports performance, sports science, ergonomy science, gait and human posture, and musculoskeletal disorders in medicine. The first three chapters provide useful tools for measuring, generating, simulating, and processing in biomechanics with the clinical and experimental applications in medicine. The last section describes the

application of biomechanics in sport performance. Engineers, researchers, and students from biomedical engineering and health sciences, as well as industrial professionals, can profit from this compendium of knowledge on biomechanics applied to the human body.

Approximate Analytical Methods for Solving Ordinary Differential Equations BoD – Books on Demand
One of the greatest challenges for mechanists is to extend the success of computational mechanics to fields outside traditional engineering, in particular to biology, biomedical sciences, and medicine. The proposed workshop will provide an opportunity for computational biomechanics specialists to present and exchange opinions on the opportunities of applying their techniques to computer-integrated medicine. These are peer-reviewed proceedings of the workshop affiliated to a major international research conference (Medical Image Computing and Computer Assisted Intervention MICCAI 2010 in Beijing) dedicated to research in the field of medical image computing and computer assisted medical interventions. The list of subjects covered include: medical image analysis, image-guided surgery, surgical simulation, surgical intervention planning, disease prognosis and diagnostics, injury mechanism analysis, implant and prostheses design, medical robotics.

Cell Biomechanics of the Central Nervous System Springer
Damage to the central nervous system resulting from pathological mechanical loading can occur as a result of trauma or disease. Such injuries lead to significant disability and mortality. The peripheral nervous system, while also subject to injury from trauma and disease, also transduces physiological loading to give rise to sensation, and mechanotransduction is also thought to play a role in neural development and growth. This book gives a complete and quantitative description of the fundamental mechanical properties of neural tissues, and their responses to both physiological and pathological loading. This book reviews the methods used to characterize the nonlinear viscoelastic properties of central and peripheral neural tissues, and the mathematical and sophisticated computational models used to describe this behaviour. Mechanisms and models of neural injury from both trauma and disease are reviewed from the molecular to macroscopic scale. The book provides a comprehensive picture of the mechanical and biological response of neural tissues to the full spectrum of mechanical loading to which they are exposed. This book provides a comprehensive reference for professionals involved in pre prevention of injury to the nervous system, whether this arises from trauma or disease.

Biomechanics and Neural Control of Posture and Movement Springer Science & Business Media
In the past decade, few subjects at the intersection of medicine and sports have generated as much public interest as sports-related concussions - especially among youth. Despite growing awareness of sports-related concussions and campaigns to educate athletes, coaches, physicians, and parents of young athletes about concussion recognition and management, confusion and controversy persist in many areas. Currently, diagnosis is based primarily on the symptoms reported by the individual rather than on objective

diagnostic markers, and there is little empirical evidence for the optimal degree and duration of physical rest needed to promote recovery or the best timing and approach for returning to full physical activity. Sports-Related Concussions in Youth: Improving the Science, Changing the Culture reviews the science of sports-related concussions in youth from elementary school through young adulthood, as well as in military personnel and their dependents. This report recommends actions that can be taken by a range of audiences - including research funding agencies, legislatures, state and school superintendents and athletic directors, military organizations, and equipment manufacturers, as well as youth who participate in sports and their parents - to improve what is known about concussions and to reduce their occurrence. Sports-Related Concussions in Youth finds that while some studies provide useful information, much remains unknown about the extent of concussions in youth; how to diagnose, manage, and prevent concussions; and the short- and long-term consequences of concussions as well as repetitive head impacts that do not result in concussion symptoms. The culture of sports negatively influences athletes' self-reporting of concussion symptoms and their adherence to return-to-play guidance. Athletes, their teammates, and, in some cases, coaches and parents may not fully appreciate the health threats posed by concussions. Similarly, military recruits are immersed in a culture that includes devotion to duty and service before self, and the critical nature of concussions may often go unheeded. According to Sports-Related Concussions in Youth, if the youth sports community can adopt the belief that concussions are serious injuries and emphasize care for players with concussions until they are fully recovered, then the culture in which these athletes perform and compete will become much safer. Improving understanding of the extent, causes, effects, and prevention of sports-related concussions is vitally important for the health and well-being of youth athletes. The findings and recommendations in this report set a direction for research to reach this goal.

Computational Biomechanics for Medicine National Academies Press

A multi-disciplinary look at the current state of knowledge regarding motor control and movement—from molecular biology to robotics The last two decades have seen a dramatic increase in the number of sophisticated tools and methodologies for exploring motor control and movement. Multi-unit recordings, molecular neurogenetics, computer simulation, and new scientific approaches for studying how muscles and body anatomy transform motor neuron activity into movement have helped revolutionize the field. Neurobiology of Motor Control brings together contributions from an interdisciplinary group of experts to provide a review of the current state of knowledge about the initiation and execution of movement, as well as the latest methods and tools for investigating them. The book ranges from the findings of basic scientists studying model organisms such as mollusks and Drosophila, to biomedical researchers investigating vertebrate motor production to neuroengineers working to develop robotic and smart prostheses technologies. Following foundational chapters on current molecular biological techniques,

neuronal ensemble recording, and computer simulation, it explores a broad range of related topics, including the evolution of motor systems, directed targeted movements, plasticity and learning, and robotics. Explores motor control and movement in a wide variety of organisms, from simple invertebrates to human beings Offers concise summaries of motor control systems across a variety of animals and movement types Explores an array of tools and methodologies, including electrophysiological techniques, neurogenic and molecular techniques, large ensemble recordings, and computational methods Considers unresolved questions and how current scientific advances may be used to solve them going forward Written specifically to encourage interdisciplinary understanding and collaboration, and offering the most wide-ranging, timely, and comprehensive look at the science of motor control and movement currently available, Neurobiology of Motor Control is a must-read for all who study movement production and the neurobiological basis of movement—from molecular biologists to roboticists.

Natural Biodynamics Springer Science & Business Media

Motor control has established itself as an area of scientific research characterized by a multi-disciplinary approach. Scientists working in the area of control of voluntary movements come from different backgrounds including but not limited to physiology, physics, psychology, mathematics, neurology, physical therapy, computer science, robotics, and engineering. One of the factors slowing progress in the area has been the lack of communication among researchers representing all these disciplines. A major objective of the current book is to overcome this deficiency and to promote cooperation and mutual understanding among researchers addressing different aspects of the complex phenomenon of motor coordination. The book offers a collection of chapters written by the most prominent researchers in the field. Despite the variety of approaches and methods, all the chapters are united by a common goal: To understand how the central nervous system controls and coordinates natural voluntary movements. This book will be appreciated as a major reference by researchers working in all the subfields that form motor control. It can also be used as a supplementary reading book for graduate courses in such fields as kinesiology, physiology, biomechanics, psychology, robotics, and movement disorders.In one concise volume, Motor Control presents the diversity of the research performed to understand human movement. Deftly organized into 6 primary sections, the editors, Dr Frederic Danion and Dr Mark Latash, have invited the who's who of specialists to write on: MotorControl: Control of a Complex; Cortical Mechanisms of Motor Control; Lessons from Biomechanics; Lessons from Motor Learning and Using Tools; Lessons from Studies of Aging and MotorDisorders; and Lessons from RoboticsMotor Control will quickly become the go-to reference for researchers in this growing field. Researchers from mechanics and engineering to psychology and neurophysiology, as well as clinicians working in motor disorders and rehabilitation, will be equally interested in the pages contained herein.

Biomechanical Principles and Applications in Sports Springer

Approximate Analytical Methods for Solving Ordinary Differential Equations (ODEs) is the first book to present all of the available approximate methods for solving ODEs, eliminating the need to wade through multiple books and articles. It covers both well-established techniques and recently developed procedures, including the classical series solution method, diverse perturbation methods, pioneering asymptotic methods, and the latest homotopy methods. The book is suitable not only for mathematicians and engineers but also for biologists, physicists, and economists. It gives a complete description of the methods without going deep into rigorous mathematical aspects. Detailed examples illustrate the application of the methods to solve real-world problems. The authors introduce the classical power series method for solving differential equations before moving on to asymptotic methods. They next show how perturbation methods are used to understand physical phenomena whose mathematical formulation involves a perturbation parameter and explain how the multiple-scale technique solves problems whose solution cannot be completely described on a single timescale. They then describe the Wentzel, Kramers, and Brillown (WKB) method that helps solve both problems that oscillate rapidly and problems that have a sudden change in the behavior of the solution function at a point in the interval. The book concludes with recent nonperturbation methods that provide solutions to a much wider class of problems and recent analytical methods based on the concept of homotopy of topology.

Mechanics of Biological Systems & Micro- and Nanomechanics, Volume 4 Springer

This ground-breaking book brings together researchers from a wide range of disciplines to discuss the control and coordination of processes involved in perceptually guided actions. The research area of motor control has become an increasingly multidisciplinary undertaking. Understanding the acquisition and performance of voluntary movements in biological and artificial systems requires the integration of knowledge from a variety of disciplines from neurophysiology to biomechanics.

Computational Biomechanics for Medicine CRC Press

This book provides a conceptual and computational framework to study how the nervous system exploits the anatomical properties of limbs to produce mechanical function. The study of the neural control of limbs has historically emphasized the use of optimization to find solutions to the muscle redundancy problem. That is, how does the nervous system select a specific muscle coordination pattern when the many muscles of a limb allow for multiple solutions? I revisit this problem from the emerging perspective of neuromechanics that emphasizes finding and implementing families of feasible solutions, instead of a single and unique optimal solution. Those families of feasible solutions emerge naturally from the interactions among the feasible neural commands, anatomy of the limb, and constraints of the task. Such alternative perspective to the neural control of limb function is not only biologically plausible, but sheds light on the most central tenets and debates in the fields of neural control, robotics, rehabilitation, and brain-body co-evolutionary adaptations. This perspective developed from courses I taught to engineers and life scientists at Cornell University and the University of

Southern California, and is made possible by combining fundamental concepts from mechanics, anatomy, mathematics, robotics and neuroscience with advances in the field of computational geometry. Fundamentals of Neuromechanics is intended for neuroscientists, roboticists, engineers, physicians, evolutionary biologists, athletes, and physical and occupational therapists seeking to advance their understanding of neuromechanics. Therefore, the tone is decidedly pedagogical, engaging, integrative, and practical to make it accessible to people coming from a broad spectrum of disciplines. I attempt to tread the line between making the mathematical exposition accessible to life scientists, and convey the wonder and complexity of neuroscience to engineers and computational scientists. While no one approach can hope to definitively resolve the important questions in these related fields, I hope to provide you with the fundamental background and tools to allow you to contribute to the emerging field of neuromechanics.

Neural Tissue Biomechanics Elsevier This book provides a comprehensive overview of the current state of the art of practical applications of neuroprosthesis based on functional electrical stimulation for restoration of motor functions lost by spinal cord injury and discusses the use of brain-computer interfaces for their control. The book covers numerous topics starting with basics about spinal cord injury, electrical stimulation, electrical brain signals and brain-computer interfaces. It continues with an overview of neuroprosthetic solutions for different purposes and non-invasive and invasive brain-computer interface implementations and presents clinical use cases and practical applications of BCIs. Finally, the authors give an outlook on cutting edge research with a high potential for clinical translation in the near future. All authors committed themselves to use easy-to-understand language and to avoid very specific information, focusing instead on the essential aspects. This makes this book an ideal choice not only for researchers and clinicians at all stages of their education interested in the topic of brain-computer interface-controlled neuroprostheses, but also for end users and their caregivers who want to inform themselves about the current technological possibilities to improve paralyzed motor functions.