Preface

Recent scientific advancements in the field of 3D physiological human research have enabled the investigation and simulation of human articulations with increasingly more detail. This progress has been made across several research domains, each focusing on separate aspects of the musculoskeletal system with customized modalities tailored for the relevant scale. As a result, knowledge has diversified while being formulated in heterogeneous terminologies specific to each research domain. However, to understand the place of each individual piece, the puzzle must be fit together. Indeed, the physiology of human movement is hierarchically organized in functional units which collaborate over a wide spectrum of spatiotemporal scales, ranging from the molecular to the organ level. Therefore, the need to converge research efforts into a multidisciplinary approach using multi-scale modalities has been formulated. This is especially relevant in the medical field, where the continuous introduction of new technologies has led to an increasing amount of patient data available to the physicians. Therefore, computer-based solutions are needed to assist in obtaining a comprehensive integration and presentation of medical data to improve diagnosis. This is a necessary step to advance the frontiers of personalized healthcare, which is particularly motivated by the rising burden of musculoskeletal disorders, especially in the increasing population of elderly people.

However, integrative solutions can only be successfully achieved through a mutual dialogue between the multiple disciplines involved. This book aims to increase the awareness of the variety in methodologies and knowledge paradigms providing a reference that will help computer scientists, physicians, biomedical engineers, and physiologists in uncovering potential gaps and opportunities for integration.

Overviews and examples of recent scientific and technological advancements are presented for the relevant domains of cell and tissue engineering, imaging and visualization, simulation of articulations, and medical analysis. Chapter 1 introduces the book with an overview of state-of-the-art techniques to create virtual 3D models of patients for diagnosis and treatment. Chapter 2 gives an overview of current tissue engineering approaches in osteochondral regenerative medicine. This is followed by three chapters describing the advancements of multi-modal medical imaging, deformable model image segmentation, and multi-scale visualization of biomedical data. Chapter 6 gives a general overview of current human musculoskeletal modeling research which is narrowed down to the field of clinical gait analysis in Chap. 7. The advancements in computational approaches is further illustrated by chapters describing examples of joint contact modeling, shoulder joint complex modeling, dynamic hip joint analysis, and coupled biomechanical modeling of the face and oral structures. Finally, the last two chapters present a current state-of-the-art in the development of computer-aided diagnosis tools and an overview of modalities in medical knowledge management.

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