MULTIPHYSICS MODELING AND SIMULATION IN BIOMEDICINE: ADVANCING DIGITAL TWINS FOR MULTIPLE ORGANS

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ABSTRACT

Computational models of physiological processes across multiple organs have demonstrated great potential in advancing our understanding of biomedical phenomena and supporting therapeutic interventions for a wide range of diseases [1, 2, 3, 4]. These models face numerous challenges due to the unique characteristics of each organ, such as the pulsatile nature of blood flow in the cardiovascular system, the intricate mechanical behavior of tissues, and the interaction between various biological systems. The variability between individuals and the presence of pathological conditions call for the careful development and personalization of these models to ensure clinical relevance and accuracy. Recent advancements in machine learning (ML) techniques further enhance the model capabilities, enabling more robust data-driven approaches to simulate complex organ dynamics. ML-based models offer the potential to handle large datasets, automate the personalization process, develop surrogate models, and improve predictions by integrating patient-specific data in real time. These advancements pave the way for the development of comprehensive organ digital twins, supporting diagnostics, treatment planning, and outcome prediction. In this broad context, this minisymposium aims at bringing together recent developments in modeling and simulation techniques for biomedical applications for multiple organ systems. Topics of interest include computational fluid dynamics, fluid-structure interaction models, tissue mechanics, ML-based modeling approaches, high-performance computing, model validation in both healthy and diseased conditions, and algorithms for personalization, data assimilation, and clinical translation. The goal is to foster interdisciplinary discussions that will push the boundaries of biomedical modeling and accelerate its integration into precision medicine.

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