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Electrophysiology of the Heart Using the Mixed Collocation Method to Model Meshfree

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Introduction

Electrophysiology of the heart is a complex field focusing on the electrical properties and activities that drive the heart's function. Understanding the heart's electrophysiology involves exploring how electrical impulses are generated, propagated, and regulated within cardiac tissues. Computational modeling has become an indispensable tool in this field, providing insights into the intricate dynamics of heart electrophysiology. One of the innovative approaches in this realm is using the Mixed Collocation Method (MCM) to model these dynamics meshfree. This method offers significant advantages over traditional mesh-based methods, particularly in dealing with complex geometries and dynamic changes in cardiac tissues [1].

Description

Computational models simulate the electrical activity of the heart, aiding in understanding and predicting heart behavior under normal and pathological conditions. Traditional methods often employ mesh-based approaches, where the heart's geometry is discretized into small, interconnected elements. However, these methods can struggle with complex geometries and dynamic changes in tissue structure, prompting the exploration of meshfree methods. Meshfree methods do not require a predefined mesh to discretize the domain. Instead, they use points scattered throughout the domain, making them highly adaptable to complex geometries and dynamic changes. This flexibility is particularly advantageous in cardiac electrophysiology, where the heart's structure and function can change rapidly, such as during arrhythmias or heart failure [2].

The Mixed Collocation Method is a powerful meshfree approach combining the benefits of collocation methods with mixed formulations to enhance stability and accuracy. In the context of cardiac electrophysiology, MCM can be particularly effective due to the following reasons. Collocation methods approximate the solution of differential equations by satisfying the equations at a set of discrete points. This approach is straightforward and efficient, making it suitable for complex problems like cardiac electrophysiology. Mixed formulations involve multiple fields, such as electric potential and ion concentrations, which are solved simultaneously. This holistic approach enhances the stability and accuracy of the solution [3].

In MCM, the domain's discretization involves placing collocation points throughout the region of interest. Each point is associated with basis functions that approximate the solution. These basis functions can be polynomial, radial basis functions, or other suitable forms, chosen based on the specific requirements of the problem. The collocation process involves substituting the approximate solution into the governing equations and enforcing that these equations are satisfied at each collocation point. This results in a system of algebraic equations, which can be solved using numerical methods [4]. The mixed formulation ensures that all relevant fields, such as electric potential and ion concentrations, are solved simultaneously. Solving the system of algebraic equations typically involves iterative methods, especially given the nonlinear nature of the governing equations in cardiac electrophysiology. Techniques like Newton-Raphson or Krylov subspace methods can be employed to find the solution efficiently. Despite its advantages, MCM can still be computationally intensive, particularly for large-scale simulations involving millions of collocation points. Advances in computational power and numerical algorithms will be crucial in addressing this challenge. Validating computational models is essential to ensure their accuracy and reliability. This involves comparing simulation results with experimental or clinical data, which can be challenging due to the complexity of cardiac electrophysiology. Cardiac electrophysiology spans multiple spatial and temporal scales, from the molecular level of ion channels to the organ level of the whole heart. Integrating these scales into a cohesive model remains a significant challenge but is essential for capturing the full complexity of cardiac function [5].

Conclusion

The Mixed Collocation Method represents a significant advancement in modeling cardiac electrophysiology, offering flexibility, accuracy and efficiency in handling the heart's complex dynamics. By leveraging this meshfree approach, researchers can gain deeper insights into the electrical behavior of the heart, advancing our understanding of normal and pathological conditions. While challenges remain, ongoing developments in computational techniques and validation methods will continue to enhance the capabilities and applications of MCM in cardiac electrophysiology, paving the way for improved diagnostic and therapeutic strategies. Despite its advantages, MCM can still be computationally intensive, particularly for large-scale simulations involving millions of collocation points. Advances in computational power and numerical algorithms will be crucial in addressing this challenge.

Acknowledgement

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Conflict of Interest

None.

References

1. Zhang, Heye, Huajun Ye and Wenhua Huang. "A meshfree method for

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simulating myocardial electrical activity." *Comput Math Methods Med* 2012 (2012): 936243.

2. Legner, D., S. Skatulla, J. MBewu and R. R. Rama, et al. "Studying the influence of hydrogel injections into the infarcted left ventricle using the element-free Galerkin method." *Int j Numer Method Biomed Eng* 30 (2014): 416-429.
3. Costabal, Francisco Sahli, Daniel E. Hurtado and Ellen Kuhl. "Generating Purkinje networks in the human heart." *J Biomech* 49 (2016): 2455-2465.
4. Lopez-Perez, Alejandro, Rafael Sebastian and Jose M. Ferrero. "Three-dimensional cardiac computational modelling: methods, features and applications." *Biomed Eng Online* 14 (2015): 1-31.
5. Niederer, Steven A., Joost Lumens and Natalia A. Trayanova. "Computational models in cardiology." *Nat Rev Cardiol* 16 (2019): 100-111.

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