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Parameter estimation in cardiac biomechanical models based on physics-informed neural networks

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Biophysical models of the cardiac function are becoming increasingly popular due to their ability to predict patient outcomes and optimise treatment plans. However, the development and personalisation of these models is computationally expensive and requires extensive calibration, making them difficult to apply in clinical settings. In this presentation we study the application of a novel methodology [1] integrating physics-informed neural networks [2] with high-resolution three-dimensional nonlinear cardiac biomechanical models to reconstruct displacement fields and estimate patient-specific biophysical properties (s.a. passive stiffness and active contractility). The physics of the problem is represented by a mathematical model based on partial differential equations. Additionally, the learning algorithm incorporates displacement and strain data that can be routinely acquired in clinical settings. Various training methodologies are explored, e.g. different sampling strategies and adaptive weighting schemes for the individual loss terms as well as Fourier features. The presentation includes a series of benchmark tests that demonstrate the accuracy, robustness, and promising potential of this method for the precise and efficient determination of patient-specific physical properties in nonlinear biomechanical models.

REFERENCES

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