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COMPUTATIONAL MECHANICAL MODELING IN THE HUMAN HEART

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Abstract. Medical Imaging has emerged as a powerful non-invasive tool for assessing heart function and pathology. Capable of providing detailed information on anatomy, regional myocardial motion and blood flow, medical imaging provides detailed quantification of the kinematic behaviour of the heart through the cardiac cycle. However, linking these kinematics to kinetics in the heart remains a challenge, typically requiring invasive measurement.

Integration of this source of data with mathematical models has the strong potential to bridge the kinematic to kinetic gap. Computational cardiac models provide a construct for assessing myocardial strain, stress as well as metrics of cardiac work. Additionally, passive and active parameters within these models provide potential quantitative biomarkers of disease.

However, practical use of mathematical modelling and medical imaging introduces two core computational challenges: model parameterization and patient-specific boundary conditions. In this presentation, we will address our recent advancements on both fronts. We present a novel mathematical modelling paradigm for data integration and boundary condition specification using an energy-based regularization. We show that these conditions minimize artefacts stemming from imaging data, while retaining model accuracy. Core to the design of our model are issues of practical identifiability and parameter uniqueness. Here we present a method that exploits features of this new model in order to ensure unique parameterization of both active and passive model components strictly from non-invasive data. We then validate this method through an in silico pipeline, demonstrating accuracy and robustness of the method. These techniques are subsequently applied to patient-specific data, illustrating the effectiveness of this approach *in vivo.*