ABSTRACT OF THESIS/ STRESZCZENIE PRACY PO ANGIELSKU

"Integration of Statistical Data Analysis and Surrogate Modeling for Uncertainty Quantification, Sensitivity Analysis and Inverse Problems involving Fluid-Structure Interaction models"

Local arterial stiffness is a useful marker for early detection of cardiovascular diseases. It is possible to estimate it inversely using non-invasive methods basing on measured arterial displacements. However, before implementing such a methodology clinically, it should be validated and tested in laboratory conditions. To achieve this, a testing rig for measuring arterial displacements was developed, whose reproducibility was assessed using Linear Mixed Effects Models. Basing on the test data, a Fluid-Structure Interaction model was developed, which was meant to be used in the inverse task. Ultimately, its computational overhead was deemed too demanding and a Sparse Gaussian Process Regression-based surrogate model was developed to allow for inverse estimation. The model's performance was tested and it was subsequently used in Uncertainty Quantification and Sensitivity Analysis of the original FSI model. The purpose was twofold: to gain information on the uncertainty present in the FSI model due to input data and to estimate which factors were the most influential. This was achieved making it possible to simplify the surrogate model even further and apply it in inverse estimation of the arterial stiffness based on laboratory phantom displacement data. Resulting arterial stiffness estimates proved to be very accurate. This research demonstrated the potential to apply the whole methodology to human subject test data and possible subsequent implementation of the methodology in clinical diagnostics.

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