

SIEMENS SPECIAL SESSION AT ECC 2023

Date/Time: Wednesday June 14th, 2023

Location: Library Room: L.4.1. Time: 12:40-13:20

Artificial Intelligence in Personalized Medicine: From Medical Image Processing to Real-time Patient-specific Physiological Computations

Abstract:

Physics-based physiological models have shown great promise in being able to noninvasively assess cardiovascular diseases like coronary artery disease, from patient-specific anatomical information, e.g., as obtained from computed tomography scans of the heart and the coronary arteries. We have previously developed a Computational Fluid Dynamics (CFD) based method for performing patient-specific coronary hemodynamic computations. In this talk we'll present the proposed method, which is based on a multi-variable feedback control framework which ensures that the computed mean arterial pressure and the flow distribution matches the patient-specific values. The boundary conditions at hyperemia are derived from the respective rest-state values via a transfer function that models the vasodilation phenomenon. Since CFD models have a high computational demand, we have further developed a machine-learning-based model for computing personalized coronary hemodynamics as an alternative to physics-based approaches.

The anatomical information for performing such analyses is extracted from medical images of the patient. Over the last few years, deep learning-based techniques have revolutionized the field of computer and machine vision and have rapidly entered the field of medical imaging. In addition to the theoretical progress, the convergence of two other factors has contributed to this success: the availability of large amounts of curated data, and the access to high performance computing infrastructure for training and testing the machine-learning algorithms. Thus, the talk will further address the processing of imaging data using artificial intelligence (AI), which is performed at four levels of increasing complexity and wider implications. At the examination level, AI aims at improving, simplifying, and standardizing image acquisition and processing. At the reading and reporting levels, AI focuses on automatic detection and characterization of features and on automatic measurements in the images. At the prediction and prescription levels, AI focuses on risk prediction

and stratification, as opposed to merely detecting, measuring, and quantifying images. The digital twin is presented as a concept of individualized computational modeling of human physiology, with AI-based CT fractional flow reserve modeling as example. Finally, at the cohort and population analysis levels, the focus of AI shifts from clinical decision-making to operational decisions.



About the presenter:

Lucian Mihai Itu is heading the Artificial Intelligence team, within the Image Fusion and Analytics group, at Siemens SRL. He received the Dipl.-Eng. degree in Systems Engineering from the Transylvania University of Brasov in 2009 and the PhD degree in Systems Engineering in 2013 after having collaborated with Siemens Corporate Research, Princeton, USA during the doctoral studies. He has participated in numerous European, National and Industry funded R&D projects. His research interests are: artificial intelligence with focus on machine learning, modeling of the human physiology, and high performance computing. He has published over 60 papers in various international journals and conferences. He is joint author of over 30 international patent applications.