Research topics for graduate students for 2023

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Acceptable course(s)

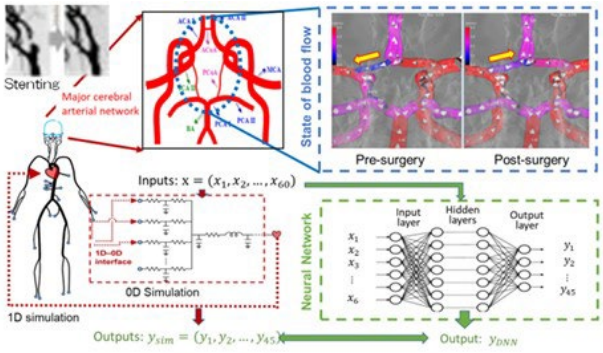
- Master's Degree
- Doctoral Degree

Research Topics

The research topics of Oshima's group cover a wide range of biofluid dynamic studies, particularly computational hemodynamics for cardiovascular diseases such as stroke or cerebral aneurysms[1]. A cutting-edge simulation technique have been developed in a patient-specific manner combined with multi-modal medical information to elucidate the mechanism between cardiovascular diseases and hemodynamics as well as to advance the simulations for clinical applications. The main research areas are described below.

1. New challenges of integrating machine learning and multi-scale patient-specific simulation

The stoke is No.2 cause of death in the world. To avoid the stroke, a patient with a sever stenosis resulted from progression of atherosclerosis is subjected to surgery. The uncertainty quantification has been performed to find a suitable surgery for the patient as shown in the right figure by combing a 1D-0D reduced order simulation with a machine learning technique[2].



2. Parameterization of vascular geometry for hemodynamics

The hemodynamics plays an important role in initiation and progression of cardiovascular diseases, which tend to occur at a preferential location of vasculature. Therefore, the present study develops a method to parametrize vascular geometry and investigates the relationship between vascular geometry and associated fluid dynamics[3].

3. Development of multi-scale simulation method for a DDS (Drug Delivery System)

The drug is transported to a vessel wall through the circulatory system in the macroscopic to the microscopic level. A new simulation technique has been developed to combine various simulations methods such as a finite volume method and dissipative particle dynamics to bridge across the scales and capture the flow physics.

Articles Related to Research Topics

[1] Zhang, H.,et al., Development of a numerical method for patient-specific cerebral circulation using 1D-0D simulation of the entire cardiovascular system with SPECT data", Annals of biomedical engineering, 44, pp. 2351-2363,(2016)

[2] Yuhn, C, Oshima, M., et al,, Uncertainty quantification in cerebral circulation simulation 1 focusing on collateral flow: Surrogate model approach with 2 machine learning PLOS Computational Biology、2022.

[3] Kobayashi, M.,et al., A penalized spline fitting method to optimize geometric parameters of arterial centerlines extracted from medical images, Computerized Medical Imaging and Graphics, 84, p. 101746, (2020)

Lab. Web page: http://www.oshimalab.iis.u-tokyo.ac.jp/english/