Research topics for graduate students for 2024

Professor Marie Oshima

Department of Mechanical Engineering (The Institute of Industrial Science)

Acceptable course(s)

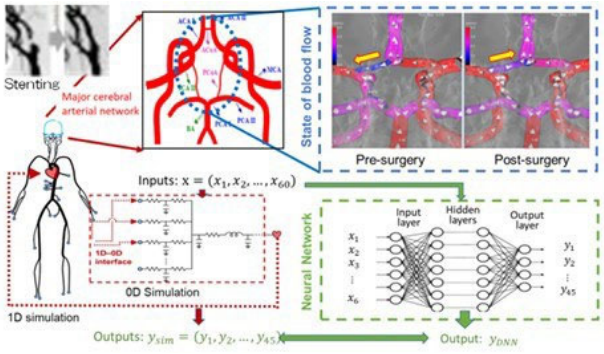
- Master's Degree
- Doctoral Degree

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/