Research topics for graduate students for 2025

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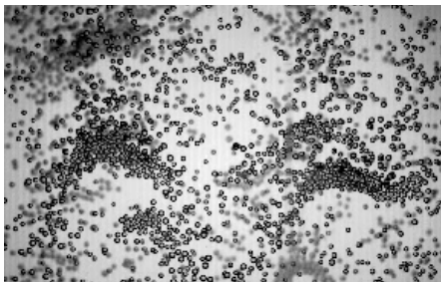
Acceptable course(s)

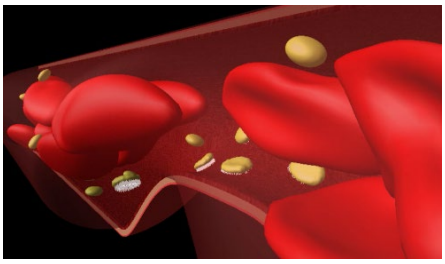
- Master's Degree
- Doctoral Degree

Research Topics

"Fluid Mechanics" is an intriguing subject due to the unpredictable nature of flow behaviors, despite well-defined governing equations. Currently, our focus lies on conducting numerical simulations and experimental investigations into dispersed multiphase flows (bubbly flows, blood cell flows etc.), medical ultrasound, hierarchical integrated simulation of the human body, molecular thermo-fluid mechanics, and multiscale analysis of thermo-fluid phenomena. Our research targets a wide array of issues in mechanics, spanning from environmental and energy concerns to biomedical fields, based on a fluid dynamics perspective. Below are a few examples of our ongoing studies.



Rising Bubble Clusters



Bood Flow Simulation with RBCs

1. **Multiscale Analysis of Bubble Flows** , (Ref. [1] and [2])

Small bubbles can form rising bubble clusters in the flow. These clusters can alter the entire flow structure of turbulence, which can lead the drag reduction of moving ships, effective control of water purification etc. The phenomena contain many interesting multiscale structures.

2. **Blood Flows and Medical Application of Microbubbles** (Ref. [3])

Microbubble-encapsulated vesicles can be a new type of drug delivery agent. Our focus has been on developing a method to capture, manipulate, and disrupt these vesicles within the bloodstream using externally applied ultrasound..

3. **Ultrasound Diagnosis with Machine Learning** (Ref. [4])

Ultrasound diagnostic techniques can be applied not only to visualize internal bodily structures but also to observe dispersed phase distributions within opaque liquids. We are currently engaged in the development of a novel monitoring method that utilizes ultrasound in conjunction with machine learning algorithms.

Articles Related to Research Topics

[1] Takagi, S and Matsumoto, Y., 2010, Surfactant effects of bubble motion and bubbly flows, *Annual Review of Fluid Mechanics*, **43**, pp.615-636.
[2] Shimizu, K., & Takagi, S., 2021, Study on the performance of a 200 m airlift pump for water and highly-viscous shear-thinning slurry. *International Journal of Multiphase* Flow, **142**, 103726.
[3] Ii, S., Shimizu, K., Sugiyama, K., & Takagi, S., 2018, Continuum and stochastic approach for cell adhesion process based on Eulerian fluid-capsule coupling with Lagrangian markers. J. Comput. Phys., **374**, pp.769-786.
[4] Watanabe, Y., Azuma, T., & Takagi, S., 2023, A Deep Neural Networks-Based Sound Speed Reconstruction with Enhanced Generalization by Training on a Natural Image Dataset. *Applied Sciences*, **14**(1), 37.K.

Lab. Web page: http://www.fel.t.u-tokyo.ac.jp/index.html