

Research topics for graduate students for 2023

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Acceptable course(s)

- Master's Degree
- Doctoral Degree



Research Topics

We are working on optimization problems in thermo-fluids engineering for wide applications such as energy, biology, medicine, environment and industrial processes.

1. Optimal control of turbulent transport

We apply optimal control theory to turbulent flows for enhancing heat and mass transfer with least pressure loss [1]. We also develop novel shape/topology optimization algorithms and validate them in experiments [2]. Recently, we also apply machine learning technique for turbulence control [3].

2. Estimation of velocity and scalar fields with limited measurement data

We develop novel algorithms based on advanced optimization and machine learning techniques to estimate the entire flow and scalar fields from limited measurement data [4]. We are also working on scalar source estimation problems[5] and the proposed algorithms are validated in laboratory wind tunnel experiment.

3. Mathematical modeling of vascular network formation and its applications to engineering

Under the close collaborations with biologists and medical doctors, we try to understand the mechanisms of vascular network formation in biological systems and apply the extracted algorithms to engineering designs [6].

4. Optimization of ink-jet printing technology for industrial manufacturing processes

Ink-jet printing has attracted attention as a novel fabrication technique for complex structures and thin films in electric, optical and energy devices and also bio-chemical analyzers. We are developing a new framework to optimize the droplet ejection processes for high precision ink-jet printing and validate its performance in experiments [7].

Articles Related to Research Topics

[1] Yamamoto et al., *J. Fluid Mech.*, Vol. 733, 189-220 (2013) [2] Kametani et al., *J. Therm. Sci. Tech.*, Vol. 15 (2) JTST0016 (2020) [3] Sonoda et al., *J. Fluid Mech.*, Vol. 960, A30 (2023) (<http://arxiv.org/abs/2206.15355>) [4] Suzuki & Hasegawa, *J. Fluid Mech.*, Vol. 830, 760-796 (2017) [5] Cerizza et al., *Flow, Turb. Comb.*, Vol. 97, 1211-1233 (2016) [6] Mirzapour-shafiyi et al., *PLoS Comput. Biol.*, Vol. 17, e1008398 (2021) [7] Wang & Hasegawa, *Physics of Fluids*, Vol. 35, Issue 1, 013318(2023) (<https://arxiv.org/abs/2208.11301>)

[See our web page and YouTube channel for more detailed information on our research activities](#)

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