Karlsruhe Institute of Technology

Institute of Fluid Mechanics

Building 10.23, 6th floor, Kaiserstraße 10, D-76131 Karlsruhe, Germany
http://www.istm.kit.edu

bachelor thesis – numerical

A comparative study of shape optimization methods.

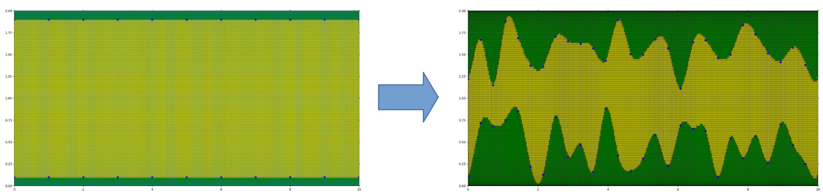
Background

Laminar channel flows are one of the simplest canonical flow configurations in fluid mechanics. However, under the diffusion-dominated laminar flow regime in channels, it is difficult to enhance mixing and hence improve heat transfer. Thus searching for a channel shape that maximizes heat transfer while minimizing momentum loss is a non-trial task. For this we will make use of zero-order/gradientless methods instead of computationally expensive and mathematically rigorous gradient-based methods.

Content of the Thesis

The aim of the thesis will be to use gradientless optimization methods to search for channel flow configurations with arbitrary wall structuring that increase Stanton number St (non-dimensional heat transfer). And this has to be achieved with the least possible drag coefficient C_D (non-dimensional momentum transfer) possible. This is difficult to achieve due to the similarity in the transport mechanism of heat and momentum transfer - known as the Raynolds analogy.

In the first phase, Particle Swarm Optimization (PSO) will be used to explore the high dimensional parameter space marked by the discretized grid. To predict C_D and St, for the channel with arbitrary wall structuring, we will make use of a surrogate machine learning (ML) model instead of using numerical simulations. A ready-to-use trained ML model is available for this purpose. The final goal is to compare and contrast the impact of different gradientless techniques on shape optimization. For this purpose, we will make use of other well-known gradientless techniques, namely Random Walk, Genetic Algorithm and Firefly Algorithm.



flat channel   channel with structured walls

Requirements

Basic knowledge of fluid mechanics

Beneficial Skills

Optimisation techniques
Numerical programming
Python

Start: immediately

Contact:

Dr. Arjun John K

Institute of Fluid Mechanics (ISTM)
Kaiserstraße 10,
Building 10.23,
Room 603
☎ +49 721 608-45880
✉ arjun.kaithakkal@kit.edu