Universität Stuttgart

IWS Department of Hydraulic Engineering and Water Resources Management
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M.Sc. Topic

High-resolution three-dimensional (3d) hydrodynamic modeling with OpenFOAM

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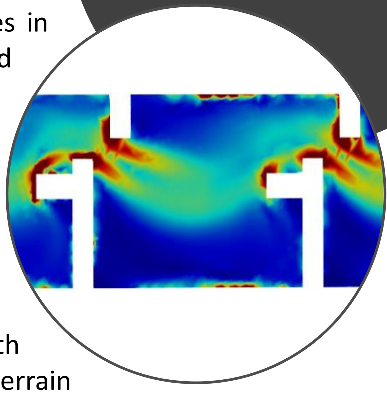
Background

Advancements in computational fluid dynamics (CFD) have made it increasingly feasible to simulate complex hydrodynamic environments in three dimensions. High-resolution 3d models can provide detailed insights into flow patterns, turbulence structures, and interactions with natural or engineered features in rivers and channels. These models enable detailed analysis of spatial and temporal variations in velocity, turbulence, and other flow structures that are critical for engineering applications and ecological assessments



OpenFOAM (Open Field Operation and Manipulation) is an open-source CFD toolbox that enables the simulation of fluid flow problems in complex geometries. Its flexibility and modularity make it especially suited for research applications where customization and precision are required. However, modeling real-world river systems at high resolution comes with challenges such as generating high-quality computational meshes for natural terrain and structures, selecting appropriate turbulence models, calibrating boundary conditions and solver settings, and balancing model detail with acceptable computational cost.

This thesis will focus on developing and optimizing a high-resolution 3d hydrodynamic model using OpenFOAM. The work will emphasize the selection of numerical schemes, solver configurations, mesh resolution strategies, and turbulence models appropriate for natural flow environments.

Thesis Overview

1. Literature review on hydrodynamic numerical simulations and turbulence modeling.
2. Familiarize with OpenFOAM and mesh generation tools, including setting up the simulation environment and learning the workflow.
3. Develop a 3d hydrodynamic model for river or channel segment, including mesh creation, boundary condition setup, and selection of solver parameters.
4. Run simulations at different mesh resolutions and with various turbulence models.
5. Interpret and provide a comprehensive overview of the simulation results.

Required Skills

Accomplished course work in numerical modeling of free-surface water bodies or a specific challenge to gain basic understanding of the topic. Basic programming skills are beneficial but not mandatory.

Apply now!

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The thesis can be written in German or English.

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