Internship Proposal: Open-Source CFD Framework for Hydraulic Systems

Duration: 6 months (Master's Thesis / End of Studies) **Location:** Toulouse, France

1. Context & Company Overview

Positive Aviation is a Toulouse-based aerospace company founded by former Airbus executives. Our flagship program, the **FF72**, aims to transform the ATR 72 regional turboprop into a next-generation amphibious water bomber to combat global wildfires.

By converting existing airframes, we offer a robust, cost-effective alternative to the aging Canadair fleet. Our engineering challenges are unique, combining high-performance aeronautics with complex hydrodynamics, specifically regarding the water scooping and dropping systems.

Our engineering team is currently looking to optimize its simulation capabilities by integrating open-source solutions into our industrial workflow. We are focusing specifically on hydraulic systems, ranging from reservoir filling dynamics to complex duct distribution networks.

2. Project Objective

The main objective of this internship is to design, validate, and document a robust simulation framework using open-source CFD tools (**OpenFOAM** and **Code_Saturne**).

The intern will move beyond simple "one-off" simulations to create a standardized methodology (framework) that our engineering team can use for:

1. **Reservoir Filling:** Modelling multiphase flows (air/water), free surface tracking, sloshing effects, and filling time optimization.

2. **Duct Distribution:** Analysing pressure drops, flow balancing, and turbulence in complex piping networks.

3. Detailed Missions

The intern will be responsible for the following tasks:

Phase 1: State of the Art & Tool Selection

- Literature review on VOF (Volume of Fluid) methods for free-surface flows and RANS turbulence modelling for internal flows.

- Comparative analysis of **OpenFOAM** (e.g., interFoam, simpleFoam) and **Code_Saturne** regarding accuracy, convergence speed, and ease of automation for the specific use cases.

Phase 2: Validation & Benchmarking

- **Case A - Reservoir:** Set up a benchmark simulation for filling a tank. Validate mass conservation and interface sharpness.

- **Case B - Duct Network:** Simulate a representative distribution network to predict head losses. Compare results with empirical charts or existing proprietary software data (if available).

- **Case C – Tank Discharge**: Simulate the tank discharge isolated and/or in a real environment (external wind impact). The simulation may also include vents on top of the tank.

Phase 3: Framework Development (The Core Task)

- **Automation:** Develop scripts (Python/Bash) to automate the workflow:

  - *Pre-processing:* Meshing automation (using **Salome**, **Gmsh**, or **snappyHexMesh**).

  - *Solving:* Automatic selection of numerical schemes and solver settings.

  - *Post-processing:* Automatic extraction of key KPIs (fill time, pressure delta, uniformity index) using **ParaView**.

- Create a "Best Practices Guide" for the team, defining the optimal mesh strategies and Courant number limitations for these specific flow types.

4. Candidate Profile

Education:

- Final year Engineering Student (Master 2 or equivalent) specializing in **Fluid Mechanics**, **Applied Mathematics**, or **Energy Engineering**.

Technical Skills:

- **CFD:** Strong theoretical understanding of Finite Volume Methods, Turbulence Modelling (k-epsilon, k-omega SST), and Multiphase flows.

- **Software:** Experience with OpenFOAM or Code_Saturne, and Paraview.

- **Programming:** Proficiency in **Python** and **Linux/Unix** shell scripting is essential for the framework development aspect.

- **Meshing:** Knowledge of Gmsh, Salome, or snappyHexMesh.

Soft Skills:

- Autonomy and analytical mindset.

- Ability to synthesize complex technical data into clear procedures.

- Good communication skills (English and/or French).

5. What We Offer

- Opportunity to work on a high-impact R&D project with real industrial applications.

- Mentorship from experienced CFD engineers.

- Experience in software industrialization and open-source integration (a highly sought-after skill in the current market).

6. Application

Please send your CV and a cover letter highlighting your experience with CFD and programming to: **yannis.sadoudi@ff72.fr**