HSLU Hochschule Luzern

Technik & Architektur
Mechanical Engineering

Master Thesis Mechanical Engineering

Application of the Fluid Structure Interaction Method for the Investigation of Paragliders

Introduction to Paragliders

his paper, a paraglider of the brand Skywalk GmbH Co. KG is examined. It current sport class model Cayenne6. Sport class paragliders are preferably flown t aced and performance-oriented pilots. Compared to entry-level models, sport cla els have a clearly have a significantly higher aspect ratio and a higher number of cell re 1.1 shows the glider in its serial colour way, lines and risers.

Figure 1.1: Skywalk Cayenne6

owing list is showing the key research objectives of this thesis.

evelopment of a best practice approach for an application of the ructure Interaction method for the study of paragliders
evelop an accessible and comprehensive glider simulation workflow. The scop ovide an interface to the design of paragliders, modeling and execution of th ructure interaction, as well as the final analysis and evaluation of the para sign.

esearch of Material and angle of attack
xamination of the paraglider cloth by means of a tensile test and determinat e material characteristics. Creation of a measuring instrument to determin gle of attack of the paraglider in flight.

pen source based fluid structure interaction, which is integrated iversally usable environment
evelop a method to use the fluid structure analysis free of charge and highly tible with different systems.

Source	Programm	Utility
OpenSource	Docker	Container
	Salome	CAD / Meshing
	OpenFOAM	CFD
	preCICE	Coupling
	calculiX	FEM
	Paraview	Post Processing
	PrePoMax	Pre / Post Processing
Ansys	CFX	CFD
In-House	coupledNumerics	CFD

Table 3.1: Table 2: Engineering Tools

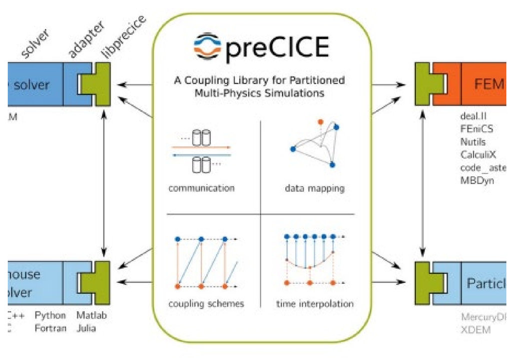


Figure 3.2: preCICE Overview (14)

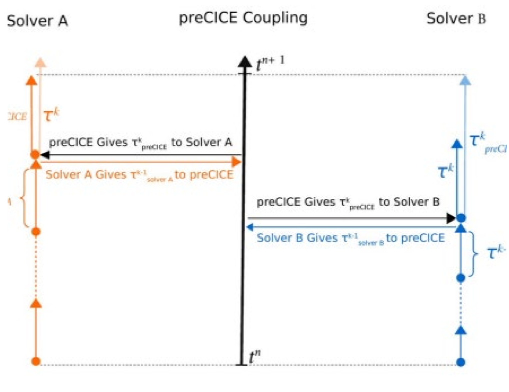


Figure 3.3: preCICE subcycling (14)

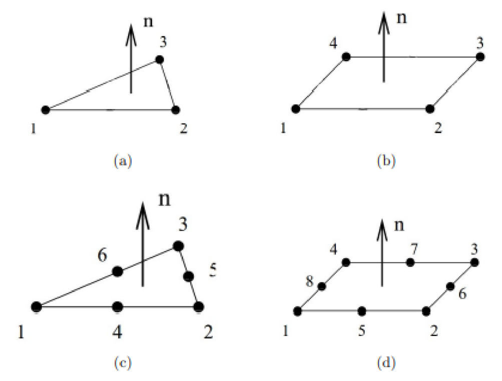


Figure 3.4: Elementtypes (16)

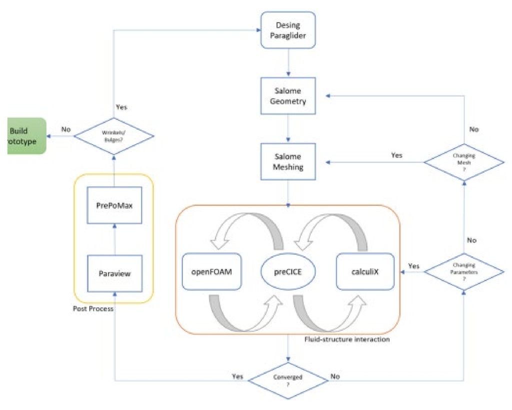


Figure 4.1: Workflow Best practice approach

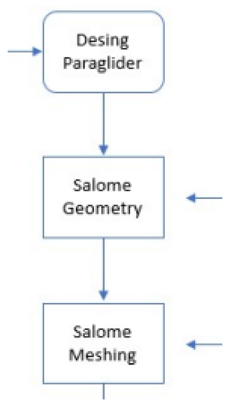


Figure 4.2: Pre process of the Workflow

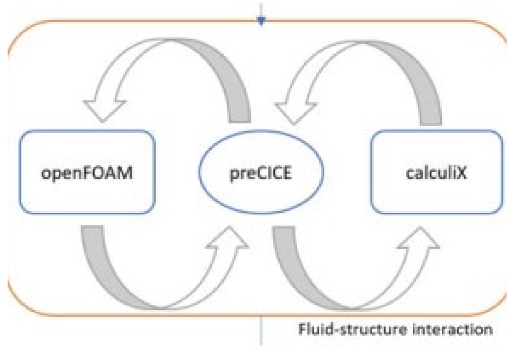


Figure 4.3: Fluid-structure interaction

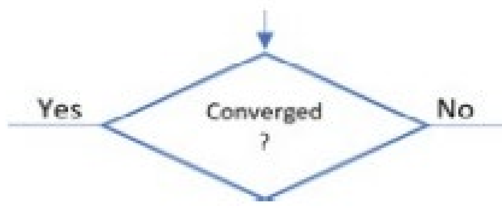


Figure 4.4: Convergence Decisio

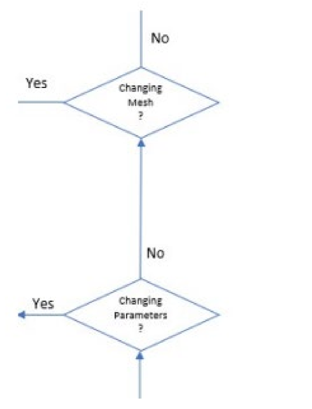


Figure 4.5: Refinement of mesh or geometry

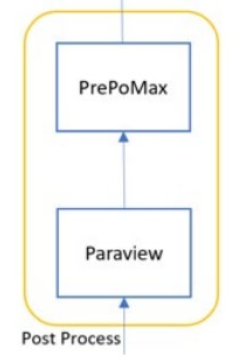
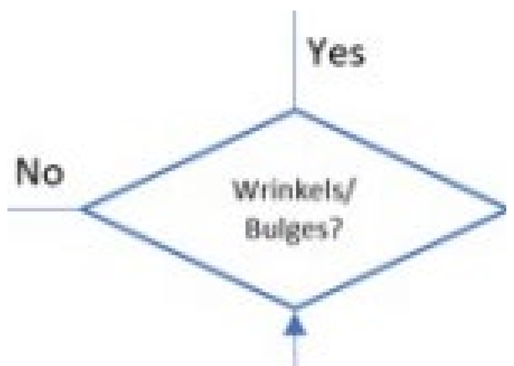
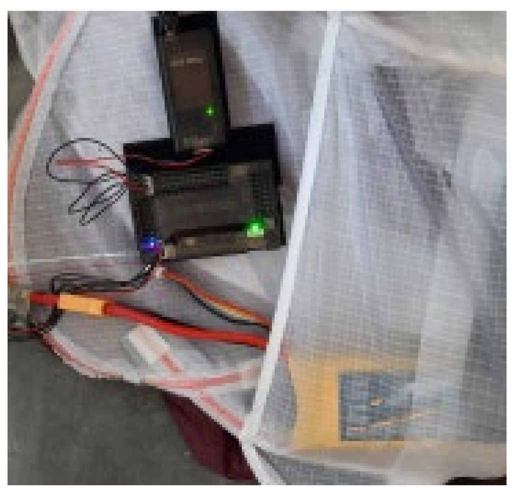


Figure 4.6: Post process of the Workflow

Workflow





Profilechord

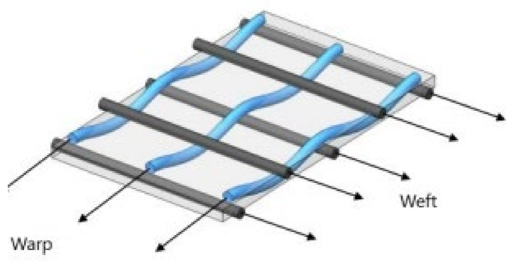
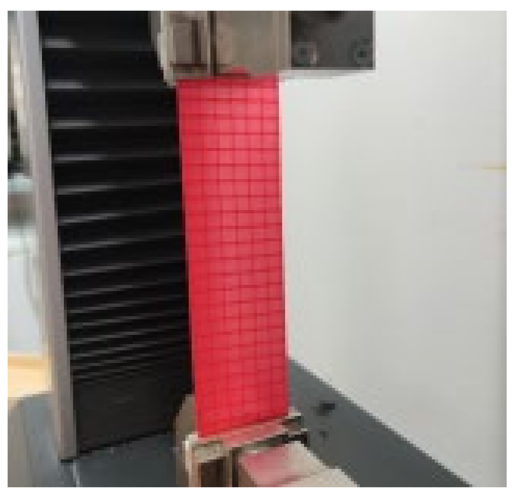
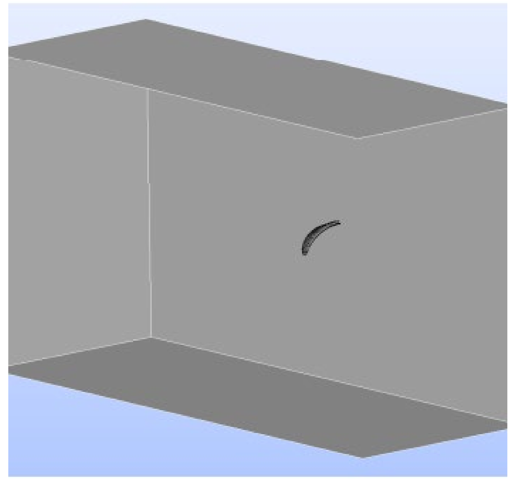


Figure 4.15: Explanation web structure (5)





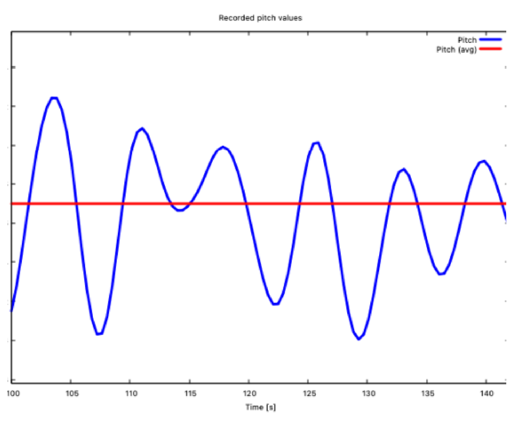


Figure 5.2: Pitch recording interval

Avg. Pitch

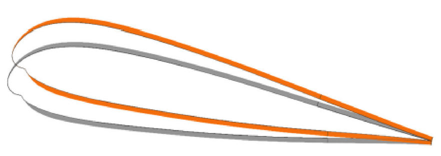


Figure 5.3: Difference AoA

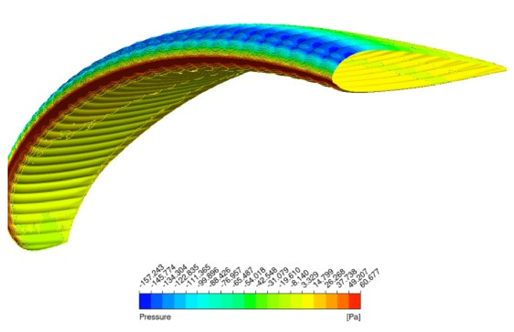


Figure 5.4: Pressure field of new AoA

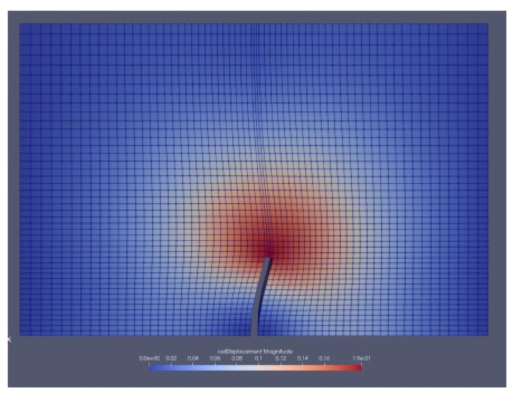


Figure 5.12: Cell displacement

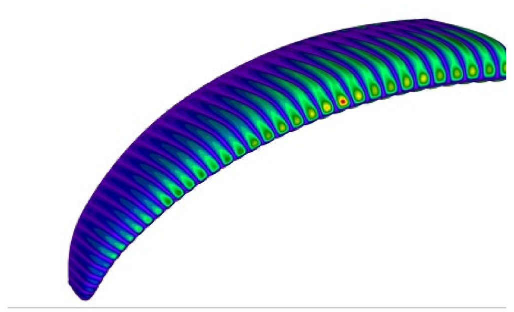


Figure 5.25: Displacement

Figure 5.30: Comparison to a real paraglider

Problemstellung
Develop an accessible and comprehensive glider simulation workflow. The scope is to provide an interface to the design of paragliders, modeling and execution of the fluid structure interaction, as well as the final analysis and evaluation of the paraglider design. Research of Material and angle of attack. Examination of the paraglider cloth by means of a tensile test and determination of the material characteristics. Creation of a measuring instrument to determine the angle of attack of the paraglider in flight. Open source-based fluid structure interaction, which is integrated in a universally usable environment Develop a method to use the fluid structure analysis free of charge and highly compatible with different systems.

Lösungskonzept
The aim of this research is to follow up on the previous specialization project 1 and specialization project 2. Create a open source based workflow for the combination of fluid mechanics and structural mechanics, which are used for fluid structure interaction. After the workflow is successfully established the FSI is used to investigate paragliding airfoils.

Ergebnisse
Results of this work are the successful implementation of a universal and open source based working environment for the use of fluid structure interactions. In addition, tensile tests on the paraglider cloth and test flights to determine the angle of attack were perfor The results of the experiments were successfully integrated into the simulation, which improves the quality of the simulation. Subsequently, the simulations were performed and continuously improved using OpenFOAM and calculiX. This resulted in a fluid structure interaction that was coupled using preCICE. PreCICE was adapted to the fluid structure interaction. A two-way coupling was implemented. As a result of the workflow, the stress curve in the paraglider cloth could be calculated.

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Skywalk GmbH & Co. KG

SKYWALK PARAGLIDERS

MSE MASTER OF SCIENCE IN ENGINEERING

FH Zentralschweiz