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ME 572 – Aerodynamic Design

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Project Proposal

Project Overview

This project proposes to simulate and visual potential flow fields. It will attempt to adapt theoretical potential flows into coding software, most likely MATLAB. The aim of this project is to help visualize different potential flows with different variables and freedom of changing such flows' parameters. Being able to simulate how multiple flows act and affect each other will be an important goal as well.

Background

The potential flows that were covered in ME 57200: Aerodynamic Design set the foundation of most analytical flow analyses. From basic flows such as uniform, source, sink, and vortex flows, we can obtain stream functions and streamlines, which define the flow path of particles affected by such flows. Such derivations can lead to more complex flow patterns. Basic knowledge of potential and stream functions, streamlines, circulation, and topics covered in both ME 572 and ME 556: Advanced Fluid Mechanics would be required.

Problem Statement

Analytical flow analysis can get rather difficult when it comes to looking at more realistic flows. This is where numerical flow analyses, such as CFD (Computational Fluid Dynamics) comes into play. The issue is that most numerical flow analysis programs require a license (can be quite expensive, have limited computational hours, or only accessible through institutions), are not beginner friendly (high learning curve), and usually require to large amounts of processing power (and time). What I find missing is the bridge between theoretical and analytic analysis.

Project goal and objectives

The main goal of this project is to allow a user-friendly MATLAB code able to simulate basic potential flows in 2D. If it can be simulated, it will allow better intuitive connections between the equations and the

visualization. After the basic potential flows can be displayed in MATLAB, multiple flows will be able to be visualized, if the code allows the potential flow functions to satisfy Laplace's Equation, which should make the simulation of multiple flows much easier. Additionally, the simulation should be able to simulate both steady and unsteady potential flow.

Methods

The main software that will be used is MATLAB. Python might be utilized for preliminary calculations if needed. Frequent references to ME 572 and ME 556 notes and online sources will made to advance the project.

Project Plan and expected outcomes

The project plan is to first compile MATLAB code. This code will be an attempt to translate potential flow functions into MATLAB functions or scripts. The display/visualization of such fields will be done simultaneously, but only as an image (steady state). Once the groundwork for the potential flow functions in code format are done, visualization as an animation will be implemented. With the animation available, the unsteady flows may be possible to simulate. Moving on from proper visualization, the transition from 2D to 3D may prove difficult. Either way, it will be built up from the previous 2D functions and visualization methods.

Expected outcomes include images of various simple potential flows with different parameters, animations of multiple complex flow patterns, a 3D animation for 3D potential flow, and a time-evolving (unsteady state) potential flow visualization. No calculation are in the project plan, but can be consider if the addition of such features are along the project plan path and not an entirely different direction.

References

N/A