A Parallel Implementation of Unsteady Simulation of Downstream Wake generated by a flapping flat plate

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Aerodynamics research often draws inspiration from nature, and biomimetic flows are crucial. For instance, analyzing the aerodynamics of flapping bird wings provides valuable insights. Unlike conventional fixed-wing aircraft, birds' flapping wings demonstrate remarkable energy efficiency, especially at their characteristic scale and speed. Leveraging this natural phenomenon, engineers aspire to design aerial vehicles that use flapping wings called ornithopters. This is especially useful for the scale of micro UAVs.

A detailed understanding of the aerodynamics associated with flapping motion is essential to achieve this goal. One critical aspect is capturing the downstream wake generated during motion and assessing its impact on wing load generation. In this context, the presented project simulates the unsteady wake downstream of a vertically oscillating flat plate in a freestream.

This project considers a flat plate oscillating vertically according to a sinusoidal motion kept in a freestream at a certain angle of attack. For a numerical simulation, the body will be discretized into several collocation points, each being the location of a vortex (called the body vortices). At each time step, the motion of the wake vortices will be determined. The effect of these vortices on the force felt by the flat plate will be computed. The structure of the wake and its connection with the experienced loads will be analyzed.

First, a serial code will be written to verify the algorithm's workings. Then, the code will be parallelized using OpenMP. The project will also then compare the performance of the serial and parallel codes through several metrics, such as speedup and efficiency.

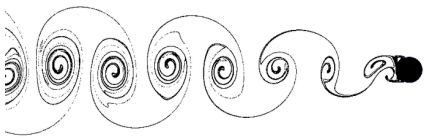

Figure 1: A Reverse Karman Wake structure

Keywords: Aerodynamics, flapping wing, downstream wake