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

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One of the important fields of study in aerodynamics is that of biomimetic flows. An example would be the analysis of the aerodynamics of the flapping wings of birds. Bodies with flapping wings are known to be more energy efficient compared to more common fixed-wing aircraft, especially at the scale and speed typical for a bird. Thus, building an aerial vehicle that can operate using flapping wings instead of fixed wings (called an ornithopter) is desirable. For designing such a vehicle, detailed modelling of the aerodynamics associated with its motion needs to be made. One of the essential aspects of aerodynamics is capturing the downstream wake generated by motion and studying its effect on the load-generation capabilities of the wing.

This project considers a flat plate oscillating vertically according to a sinusoidal motion kept in a freestream. The plate will be kept at a certain angle of attack. For a numerical simulation, we will discretize the body into several collocation points, each being the location of a vortex (called the body vortices). At each time step, one wake vortex will be generated. The interaction between these wake vortices and body vortices will determine the motion of the wake vortices. The effect of these vortices on the force felt by the flat plate will be computed at each time instant. 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.

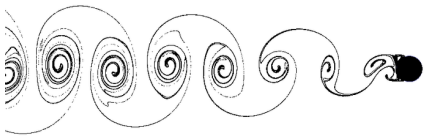

Figure 1: A Reverse Karman Wake structure

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