Unsteady Analysis of the Vorton Wake – Wing Interaction

Paolo Caccavale paolo.caccavale@gmail.com
DIAS - Department of Aerospace Engineering, University of Naples "Federico II"
phone (+39) 081 7682157, Piazzale Tecchio 80, 80125, Naples, Italy
Carlo de Nicola denicola@unina.it
DIAS - Department of Aerospace Engineering, University of Naples "Federico II"

Abstract

Panel methods represent a theoretical procedure widely used in the preliminary industrial design for fluid-dynamics applications. Generally, the flow field is assumed to be unsteady, inviscid and incompressible. The difficulty in the analysis of the interaction among bodies and wakes (e.g.: for vertical axis wind turbines, rotors and propellers, interference of the wing wake with the horizontal plane, flight refueling, etc) is the drawback preventing the even more widespread use of the panel methods. In fact, modelling the wake by means of the classical vortex filaments does not always allow to analyze the phenomena of aerodynamic interference, while it is possible to do it by means of the vorton method.
The vorton wake approach has been introduced into PaMS (Panel Method Solver), a BEM open source method developed at University of Naples. In this paper the improvement of the solution related to the use of vortons for a simple unsteady aerodynamic interference is presented: the effects due to the wake of an oscillating wing on the lift of a downstream wing.

Keywords: *unsteady aerodynamics, panel method, vorton wake, aerodynamic interference*

1. INTRODUCTION

It may be safely said that a not negligible percentage of Computational Fluid Dynamics effort in any aircraft design is still shared by the panel codes since computing economy is of prime consideration in industry, and it would not pay to use more sophisticated and expensive codes for all stages of design effort [7]. Other typical fields of interest are, for example: naval and sail, wind engineering, aeroacoustic, etc.
The PaMS (Panel Method Solver) code [2][3], developed at DIAS Department (University of Naples), is a non-classical unsteady method, based on potential theory, and relies on developing a distribution of source and doublet singularities on wing and body surfaces, and appropriate doublet and vorton singularities to represent the wake [1][6][8][9][10][15][18]. A vorton is a point computational element similar but quite different from classical vortex filaments, vortex rings and doublet lattice usually used to model wakes in the potential methods.
The PaMS code has been developed in order to have satisfactory analysis and design tool, even in presence of moving and deformable surfaces, focusing on a drastic reduction of the costs, in terms of overall time, resources and man power, by using unstructured grid with both quadrilateral and triangular panels, and by introducing a wide variety of boundary and closure conditions to perform a wide variety of fluid dynamic time-dependent calculations and to allow the coupling with many different other code, for pre and post-processing, for aeroelasticity, acoustics, flight dynamics, etc.