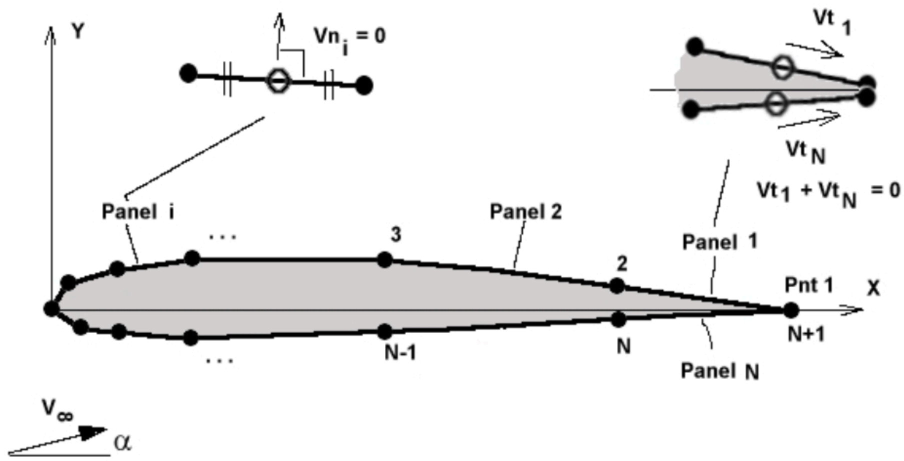
Assignment 1: Inviscid flow over an airfoil



Requirements

- Personal / group task: personal or group (max. 2 persons)
- Minimum / Maximum number of pages: 8 / 12 (excluding Title page)
- Font size: 10 - 12

For the analysis of airfoils it is essential to obtain the pressure distribution. This distribution forms the basis for determination of the lift and pitching moment coefficients. The drag of the airfoil can be determined if also the development of the boundary is calculated. At a later stage we will see that this requires an interaction between the inviscid (potential flow) and viscous (boundary layer) calculation.

To get a better understanding of the capabilities and limitations of a potential flow calculation in this assignment you are requested to write a program that calculates the potential flow over an arbitrary airfoil. The particular program may subsequently be used to analyze some airfoil shapes and determine the effect of camber and thickness.

Tasks

Write a clear and concise program that is able to calculate the pressure distribution, the lift coefficient and the pitching moment of arbitrary airfoils with a sharp (closed) trailing edge. You may use the programming language/environment of your preference (MatLab, Python or Fortran).

The solver should be based on a panel method in which a singularity distribution is placed on the airfoil contour. For the essential details on the contents and procedures applied, please refer to standard textbooks like:

- J. Katz and A. Plotkin, "Low-Speed Aerodynamics" (Cambridge Aerospace Series)
- J.J. Bertin, "Aerodynamics for Engineers"

Once the program has been established perform the following tasks:

- Shortly discuss the flow diagram of your solver. What essential steps are taken to arrive at the lift and the pitching moment coefficient?
- Check the correct working of the program by comparing the calculation results with that found in open literature (for example for a NACA0012 airfoil).
- Perform calculations for:
  a. a thin (t/c = 0.05) and a thick airfoil (t/c = 0.3)
  b. a symmetrical airfoil and a cambered airfoil

  and compare:
    - The pressure distribution (provide C_p versus x/c plots)
    - The lift coefficient, C_l (provide lift polars)
    - The pitching moment coefficient, C_m (provide pitching moment polars).

- Discuss the main difference between a thick and a thin airfoil as well as the difference between the symmetrical and the cambered airfoil.
- Discuss the effect of the panel density by comparing the results of a low (order 10) and a high number of panels (order 50-100). What is the minimum number of panels that you would suggest for a user of your program to obtain acceptable results?
- Add the listing of the program at the end of the report. Make sure you have added comments to explain the various steps.