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Team#2 2 Early 2 Submit Things

Validation of airfoil simulation in Xfoil

UCI Samueli School of Engineering

Summary

- Xfoil, developed by MIT, is a software designed to forecast the lift and drag forces acting on airfoils under conditions of low Reynolds numbers and minimal angles of attack.
- Our team aims to assess the effectiveness and precision of XFoil. If validated, XFoil could swiftly and accurately generate results mirroring actual flow conditions.
- Verification entails comparing XFoil predictions with the forces experienced by a flat plate solved through the Blasius solution.
- Validation will be conducted by contrasting XFoil outputs with data obtained from experiments conducted in the UCI wind tunnel, employing a tangible airfoil model.

Key features

Airfoil selection

Use aerodynamic theories to analyze the most influential factor in the variable we are going to focus on. In our project, lift coefficient and drag coefficient are the significant variables for validation, and they are most related to the degree of camber line of the airfoil. Therefore, our airfoil selection emphaze on varying the camber degree.

Xfoil verification

- Test the precision and accuracy of the result from Xfoil in different panels
- Create a log scale plot to show the error between Joukowsky theoretical value and the simulated value
- Figure out the best panel setting for the Xfoil

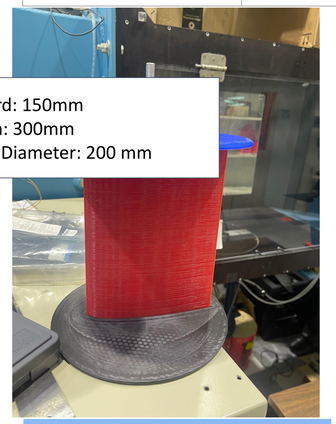
Wind tunnel selection

- Contact professor and graduate students on campus to check the availability of wind tunnel
- Compare the wind tunnel to see which will be more appropriate for our project, considering the following specifications: Size of Test Section, Velocity Range, Angles of Attack, Ease of Mounting, Ambient Conditions, and Accuracy.

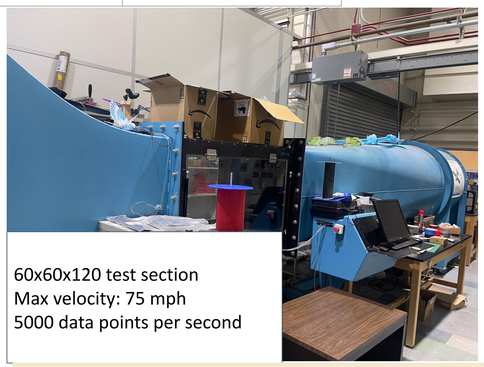
Method

We summarize and understand the data through mean, median, mode, range, variance, standard deviation and graphs.

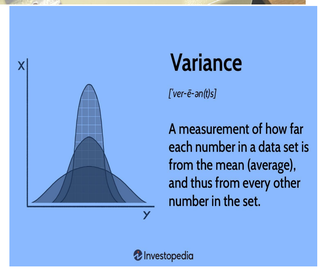
	NACA 0012	NACA 4412
Maximum Camber	0%	4%
Span	300mm	300mm
Chord	15mm	15mm

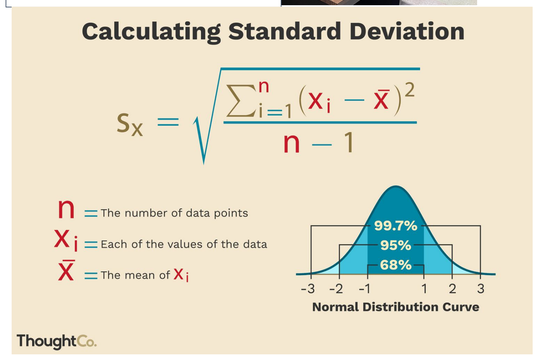


Chord: 150mm
Span: 300mm
Disc Diameter: 200 mm



60x60x120 test section
Max velocity: 75 mph
5000 data points per second



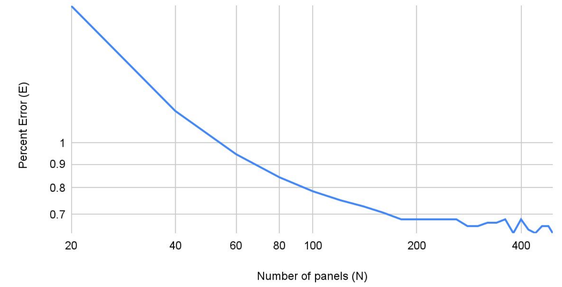


Analysis and conclusion

Through the **cambered Joukowski aerofoil formula** and **symmetrical Joukowski aerofoil formula**, we can find that the lift coefficient varies with different degrees of the camber for cambered airfoil. Furthermore, through the induced drag (dominant drag of airfoil in airflow) coefficient, CDi=CL^2/(pi*AR), we can find that **the drag coefficient is related to the CL**. Thus, the camber factor is basically the dominant factor we need to consider in the project, as we are going to collect the data of lift coefficient and drag coefficient.

Analysis and conclusion (continued)

- Assessment of available wind tunnel leads us to wind tunnels shown.
- Decrease in percent error with an increasing number of panels



Recommendations and Improvements

- Further test the airfoil in wind tunnel with **different Reynolds number** to see whether the data will still be similar to the one from simulation
- Further verify the Xfoil by **collecting other variables** about the performance of airfoil. Compare the two groups of data to see whether Xfoil will work for simulating other factors.

References and Acknowledgements

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- John Anderson, “Modern Compressible Flow: With Historical Perspective”, McGraw Hill, 4th Edition, ISBN-13: 978-1260471441
- G.K. Batchelor, “An Introduction to Fluid Dynamics”,Cambridge University Press, ISBN: 978-0-521-66396-0
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