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Team AntFoil
Validation of XFoil for 2D Airfoils

UCI Samueli School of Engineering

Summary

- XFoil is a program made by MIT to predict the lift and drag forces on airfoils for low Reynolds numbers flow conditions and for low angles of attack
- AntFoil's goal is to verify and validate the usefulness and accuracy of XFoil
- Validation of XFoil would mean that it could be used to quickly and reliably produce results that reflect real flow conditions
- Verification will be confirmed through a comparison to the forces experienced by a flat plate which is solved using the Blasius solution
- Validation will be performed by comparing XFoil to the data gathered in the UCI wind tunnel using a physical airfoil model

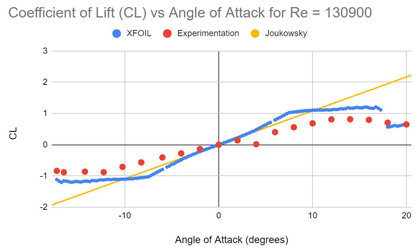
Designing our Experiments

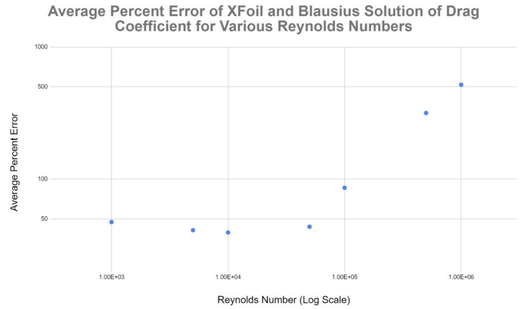
Verification

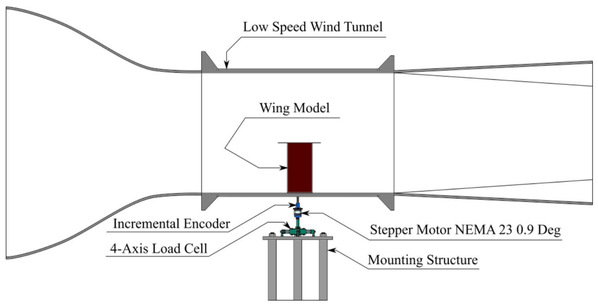
- Use a flat plate to verify XFoil
- Blasius solution gave the results for drag at a given Reynolds number
- XFoil not able to compute a zero thickness geometry, used an approximation with a decreasing thickness ellipse
- Found a value for drag that XFoil converged to for a decreasing thickness ellipse for each Reynolds number

Validation

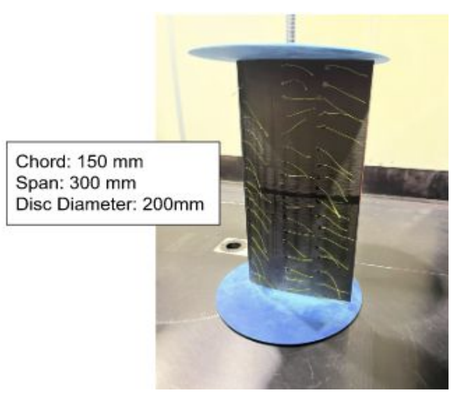
- Used the NACA 0021 airfoil and the Clark y-14 airfoil in the UCI wind tunnel to gather data
- Data was collected at Re = 64500 (15mph) and Re= 130863 (30mph)
- Compared wind tunnel data to XFoil data that was gathered at the same Reynolds numbers
- Comparison between the lift and drag coefficients, varying the angle of attack







	NACA 0012	NACA 2412	NACA 4412	NACA 6412
Maximum Camber	0%	2%	4%	6%
Maximum Percent Error	146.7%	125.7%	72.6%	15.5%
Average Percent Error	43.8%	21.7%	40.5%	10.7%



Results and Conclusion

- From our data, we can not conclude that XFoil is able to verified with our flat plate analysis
  - XFoil still converged to a solution for most tests
  - Possibly due to an error in the values input into the Blasius solution
- Based on the comparison between collected wind tunnel data and predictions from XFOIL analysis, we concluded that we cannot validate the XFOIL software
  - percent errors ranged from 40% to 170%, which is much higher than our 10% error margin

Recommendations and Improvements

- Collect data from online sources with a similar range of Reynolds numbers for comparison
- Test an airfoil with camber to see if there if a difference in accuracy
- Calibrate the wind tunnel load cell to 0 lift at 0 angle of attack for proper measurements
- Attach streamers to the airfoil for a visual identifier of fluid dynamics
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References and Acknowledgments

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