16.930 PS2

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1 Area and Perimeter of a Circle

As before, the code to generate everything is available online at github at `https://github.com/neocpp89/16.930-ps2`.

The tables 1, 2, and 3 look mostly as expected, but the cubic seems to be off. Looking at the difference tables in tables 4, 5, and 6 we see that there is indeed something strange. I believe the calculation of the jacobian or normal must be done incorrectly, but my simple, lower order tests were not able to see the problem.

2 Airfoil

We see from figure 1 that aside from a small blip at $\alpha = -3$, the analytical lift coefficient and the computed coefficient from differentiation the potential are very close together. I expected less drag, but I don't have any real mathematical basis for that assumption (I know that in stokes flow, you don't get drag forces due to time reversibility, so I expected that to happen here). I do see that there is a singularity at the trailing edge, and the pressure coefficient goes crazy there, so there is probably error due to that.

I cut down to range of the scalar plot (shown in figure 2) for $\alpha = 10$ due to the aforementioned singularity at the trailing edge.

Table 1: Here we show the results for the volume integral over the circular mesh.

Order	size = 0.4	size = 0.2	size = 0.1
p = 1	2.99998005	3.120035198	3.135911097
p = 2	3.141104487	3.141581464	3.141591858
p = 3	3.142238786	3.141607559	3.141593714

Table 2: Here we show the results for the surface integral of a divergence over the circular mesh.

Order	size = 0.4	size = 0.2	size = 0.1
p = 1	2.99998005	3.120035198	3.135911097
p = 2	3.141104486	3.141581464	3.141591858
p = 3	3.142238786	3.141607559	3.141593714

Table 3: Here we show the results for the surface integral for the boundary over the circular mesh; again, something seems off with the cubic case.

Order	size = 0.4	size = 0.2	size = 0.1
p = 1	6.211646756	6.272389794	6.280343336
p = 2	6.282703515	6.283174141	6.283184512
p = 3	6.283887563	6.2832004	6.283186372

Table 4: Here we show the difference of the actual result (π) and the volume integral over the circular mesh.

Order	size = 0.4	size = 0.2	size = 0.1
p = 1	0.1416126033	0.02155745523	0.005681557049
p = 2	0.0004881662526	1.118983413e-05	7.952615473e-07
p = 3	-0.0006461324586	-1.490538989e-05	-1.060175449e-06

Table 5: Here we show the difference of the actual result (π) and the surface integral of a divergence over the circular mesh.

Order	size = 0.4	size = 0.2	size = 0.1
p = 1	0.1416126033	0.02155745523	0.005681557049
p = 2	0.00048816714	1.118939987e-05	7.953761627e-07
p = 3	-0.000646132143	-1.490568041e-05	-1.060602533e-06

Table 6: Here we show the difference of the actual result (2π) and the surface integral of the boundary over the circular mesh.

Order	size = 0.4	size = 0.2	size = 0.1
p = 1	0.07153855166	0.01079551292	0.002841971621
p = 2	0.0004817918999	1.11664233e-05	7.950975895e-07
p = 3	-0.0007022559048	-1.509262559e-05	-1.064640536e-06

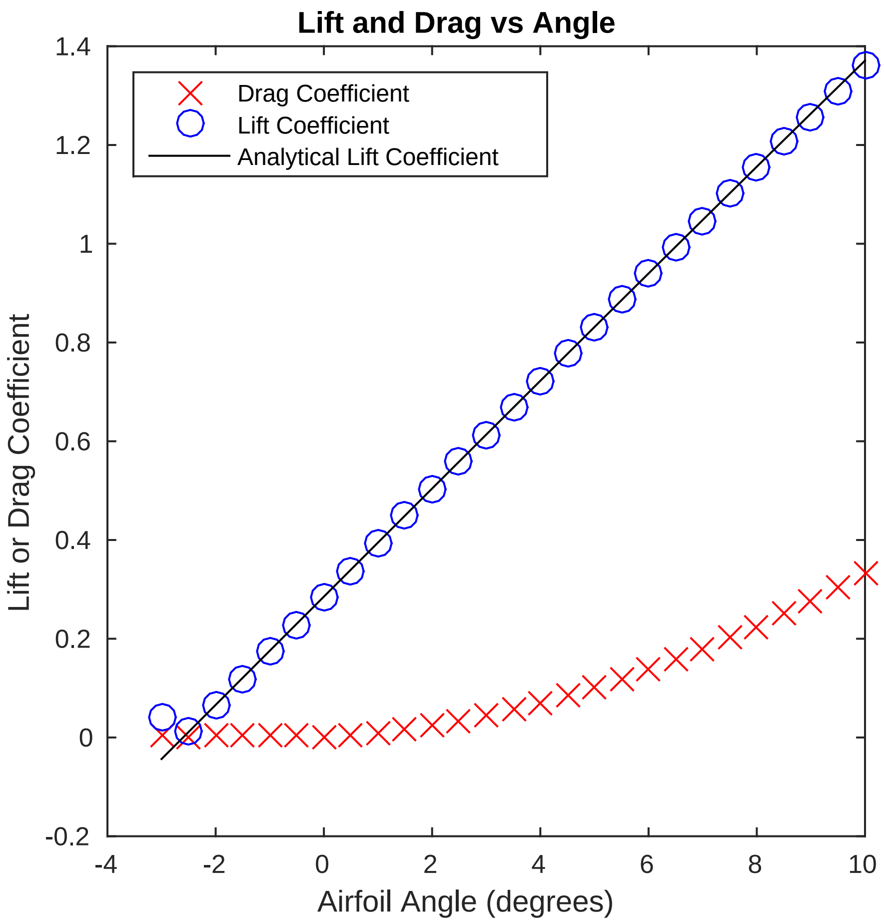

Figure 1: The lift and drag coefficients as a function of angle of attack. The numerics closely match analytical results except the very first data point.

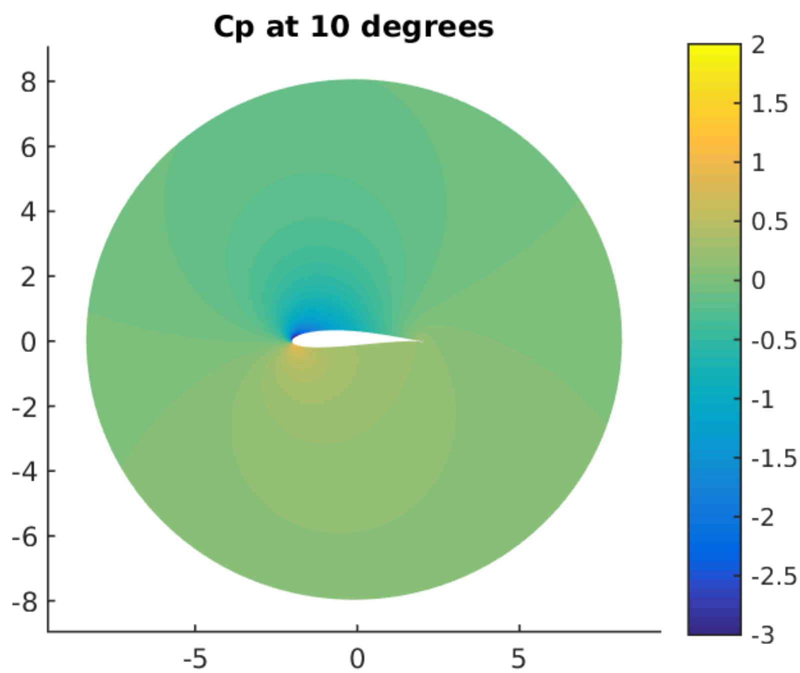

Figure 2: The scalar plot of the pressure coefficient. The range was truncated due to the singularity at the trailing edge.