

AE 625 -Particle Methods in Fluid Flow
Simulation
Assignment 4: Report

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Question3: Velocity vectors around cylinder using Exact Solution

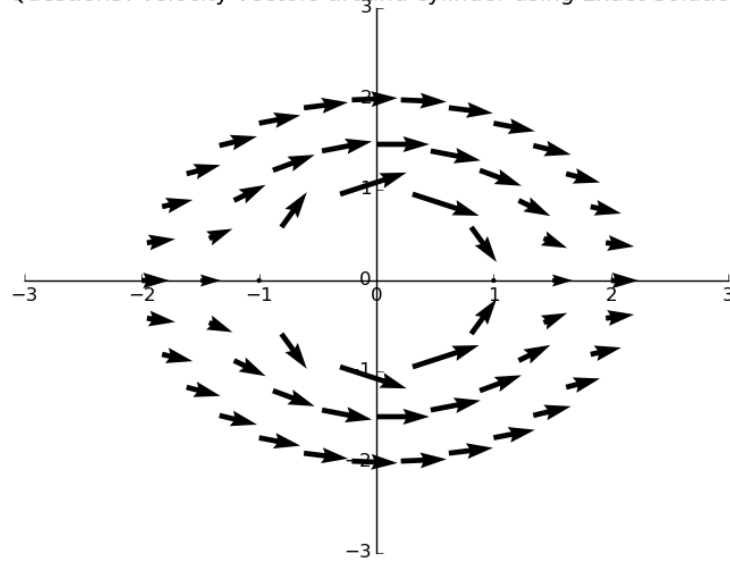


Figure 1: Velocity Distribution around Cylinder from Exact Solution

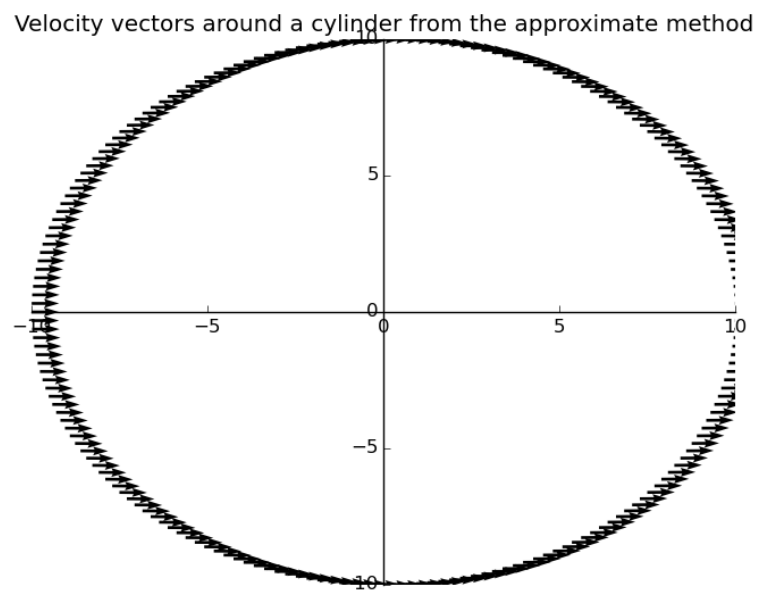


Figure 2: Velocity Distribution around Cylinder from Panel Method Approximation

Velocity vectors around a vortex sheet panel extending from -1,2 to 1,0

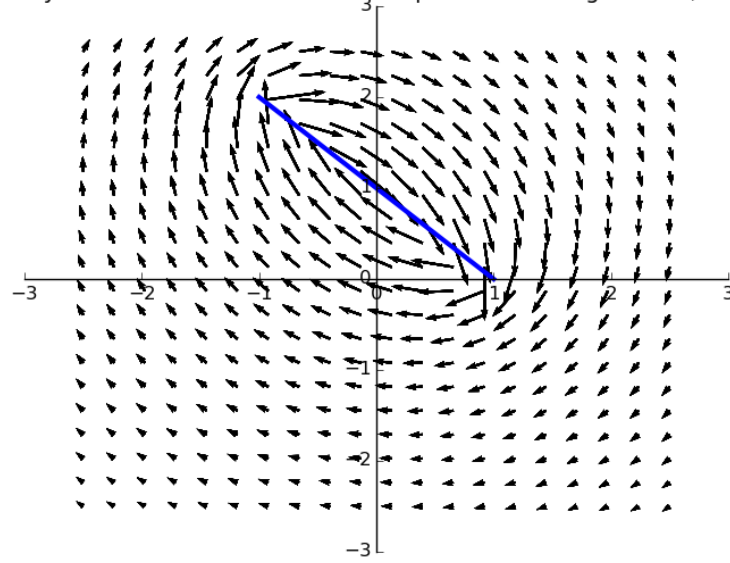


Figure 3: Velocity Distribution around Panel inclined at 45 degrees and length = 2.0

Question3: Using Rk2 to Capture streamlines around cylinder using Exact Soluti

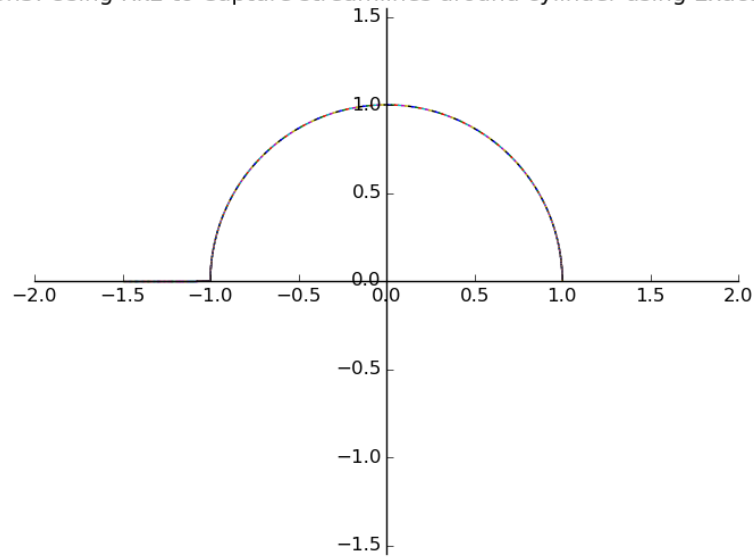


Figure 4: Streamline around Cylinder With Free stream velocity = 1.0

Question1

Consider a ring of points (say 200) at a radius R outside the cylinder (i.e. $R > 1$), vary R and plot the average error in the value of the velocity magnitude with the exact solution.

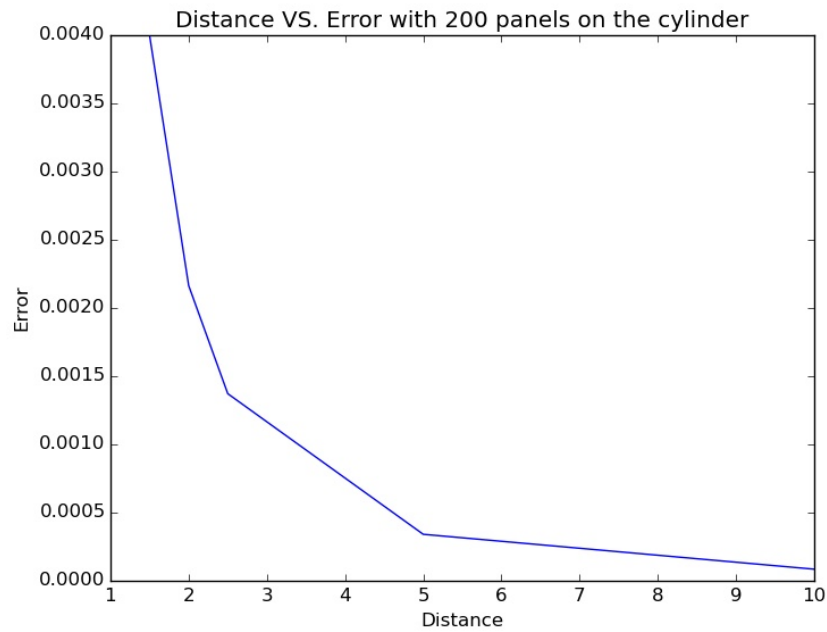


Figure 5: Error(relative average) Vs. Distance assuming 200 panels on the cylinder

Question 2

Do part 1 for different number of panels (say 20 to 100 or more).
Plots obtained for Panels 20,100,500:

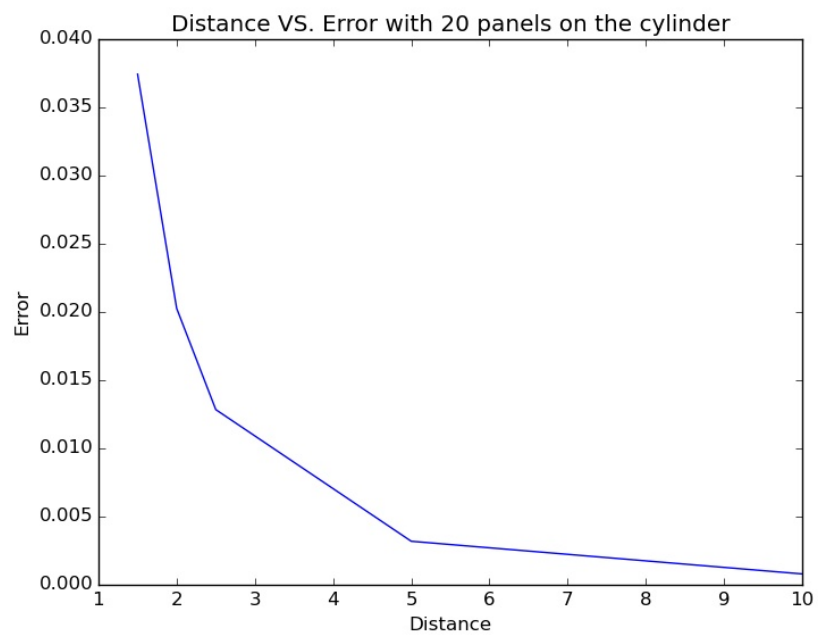


Figure 6: Error(relative average) Vs. Distance assuming 20 panels on the cylinder

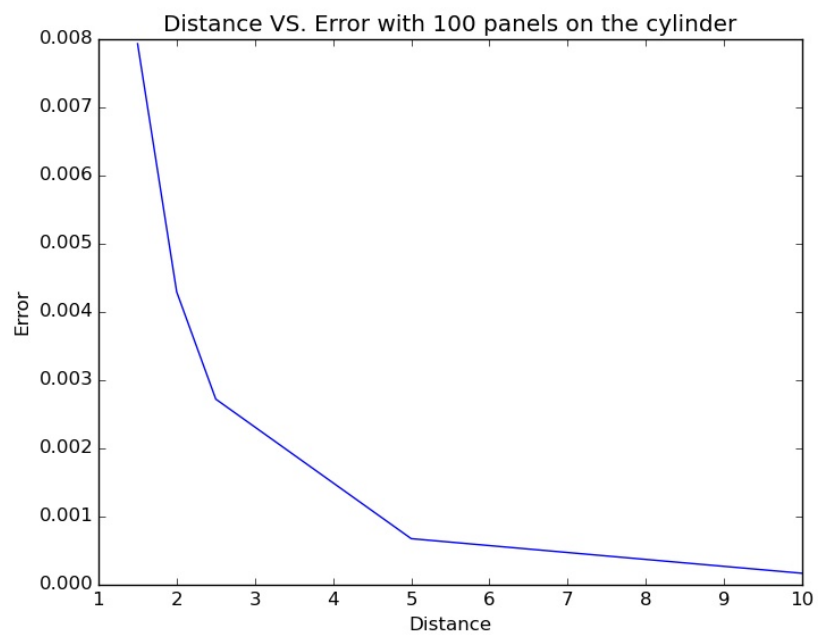


Figure 7: Error(relative average) Vs. Distance assuming 100 panels on the cylinder

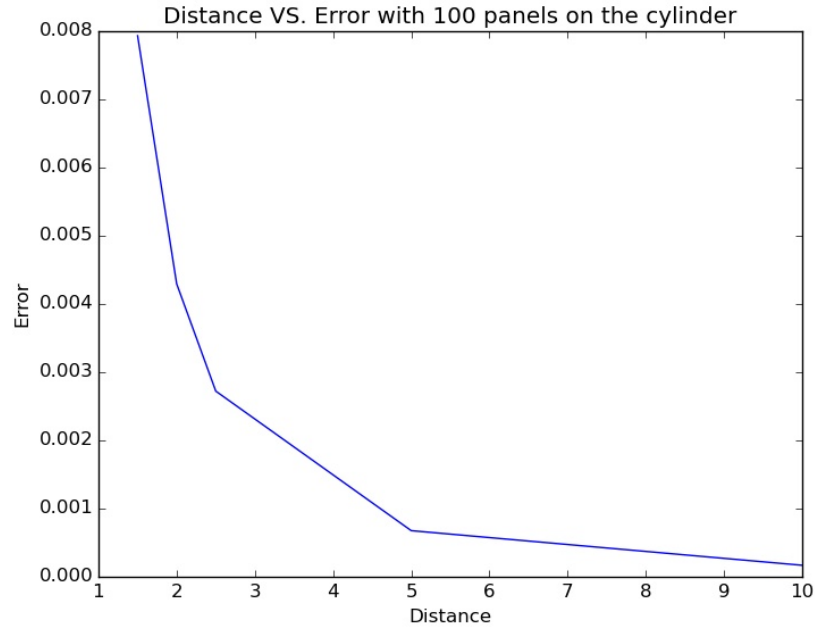


Figure 8: Error(relative average) Vs. Distance assuming 500 panels on the cylinder

Thus, it is clear that error decreases as the distance from the cylinder increases, since the effect of boundary condition decreases. Error also decreases as the number of panels increases.

Question 3

Consider the path of a single point vortex of strength 2π placed at a radius 1.5 units from the center of the cylinder of unit radius (without any free-stream). Integrate its path using the RK2 scheme. Also solve the same using the method of images and ensure that the paths are similar. Calculate the error.

stion3: Using Rk2 to capture movement of vortex around cylinder using Panel M

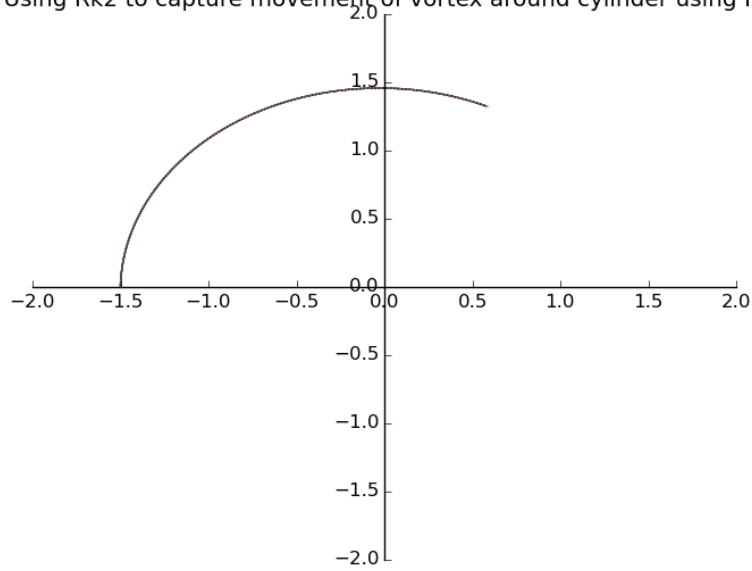


Figure 9: Path Traced by Vortex kept at (0,1.5) using Panel approximation solution in 5 sec

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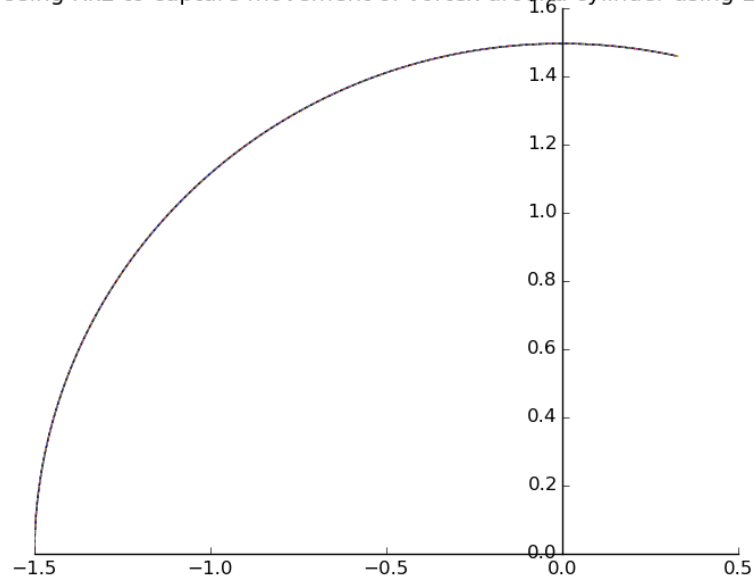


Figure 10: Path Traced by Vortex kept at (0,1.5) using exact solution in 5 sec

Absolute Error in the final position the vortex after 5 sec = 0.292746493
Error Increases as the time increases.