Name(s)

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Project Number

S1424

Project Title

Simulating Incompressible Fluid Flow with the Navier-Stokes Equation

Abstract

Objectives/Goals
The objective was to determine how accurite my fluid simulator was.

Methods/Materials
The simulation method was a staggered grid finite difference approximation of the two dimensional incompressible Navier Stokes Equations. To test the method's accuracy I simulated fluid flow around circles of varying size. I programed the whole program in java from scratch.

Results
The simulation produced results that looked like water in general but did not agree with past experiments numerically. The frequency did decrease with cylinder size as expected but it was almost exactly ten times
more than it should be. Also, the frequency decreased about half as much, proportionally, as expected for the higher diameters. All the simulations converged to a stable frequency after less than ten vortices.

Conclusions/Discussion
This experiment showed definitively that my simulator was too inaccurate for anything but possibly computer graphics. However, he cause of the inaccuracy is still uncertain. A question for future exploration is wether the error approches zero as the grid resolution approches infinity and the time step approches zero. If so, than the approximation method needs to be improved and possibly greater computing power must be used. If not, than there is probably a bug in the program or something fundamentally wrong with the math.

Summary Statement

My project was an attempt to make an incompressible two-diminutional fluid simulator that agreed with the literature.

Help Received

I had some discussions with my science teacher on related subjects such as boundary layers on hypersonic aircraft.