Reynolds Number Flow Around a Flying Saucer Micro Air Vehicle

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Introduction: Today Unmanned Air Vehicles (UAV) are a reality, nonetheless the tendency of these devices is to decrease their size in order to produce stealthy and undetectable vehicles. Our hypothesis are: that our device flies in very large spaces and speed developed by the vehicle is very low.

Figure 1. Prototype analyzed

Computational Methods: In order to achieve our goal, we performed two simpler analyses which consisted on the simulation of a flow around a cylinder in 2D and around a sphere in 3D for different Reynolds number. These analyzes were performed in order to compare the results to those found in the literature.

The equations solved for this work were the *mass conservation equation* and the Navier-Stokes equation for the three simulations.

$$\nabla \cdot V = 0$$

$$\rho\left(\frac{\partial V}{\partial t} + V \cdot \nabla V\right) = -\nabla P + \eta \nabla^2 V + \rho F$$

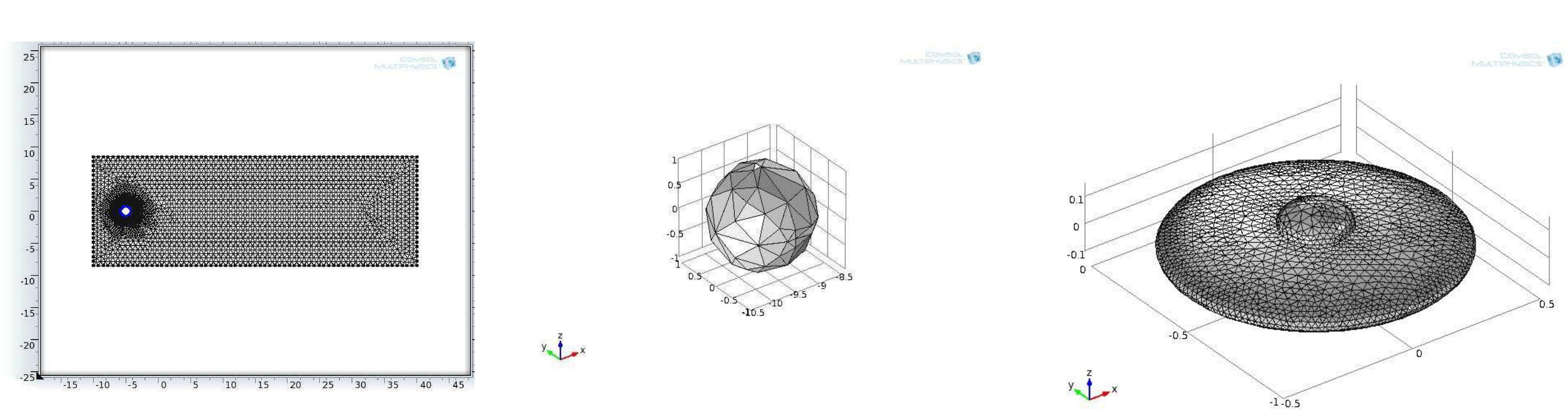

Figure 2. Grid elements for the three analyses

Results: The results obtained were the drag (C_D) and lift coefficients for different range of the Reynolds (Re_D) number in the various simulations preformed for each of the analyses.

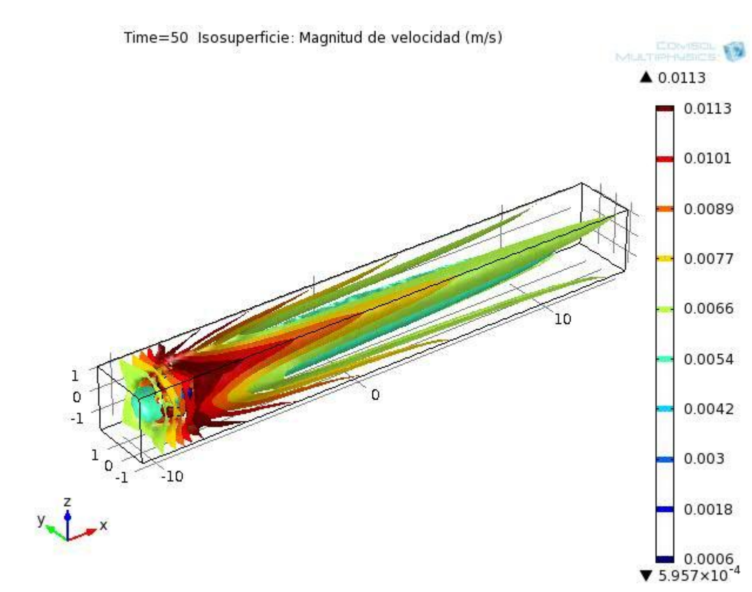

Figure 3. 3D velocity field

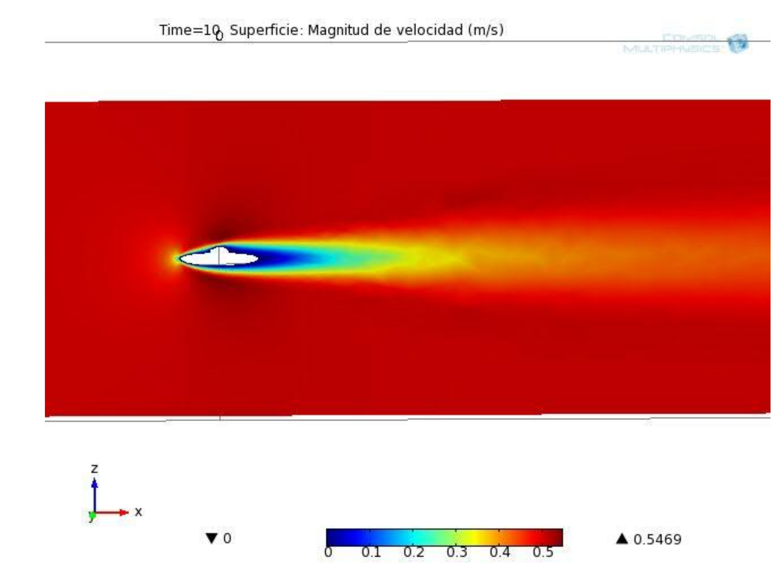

Figure 4. Velocity field in 2D

Reynolds	C_D measured in the simulations	C_D shown in literature	Percentage error
31.25	2.937875	2.903	1.2
59.375	2.252767	2.258	0.232
78.125	1.609433	1.6129	0.215
90.6	1.551598	1.5564	0.308
100	1.501333	1.5	0.089
312.5	1.4225	1.3225	7.561

Table 1. Drag coefficient for the cylinder

Reynolds	C_D obtained from the simulation	C_D found in the literature	Percentage error
32.25	2.44299	2.445	0.082
59.375	1.62162	1.623	0.085
78.125	1.47706	1.48	0.199
90.625	1.37277	1.3728	0.002
206.5	1.36427	1.3649	0.005

Figure 5. Drag coefficient for the sphere

Conclusions: The results obtained for the analyses of the flow around a cylinder and a sphere are within the range of those found in the literature, this is because the percentage error obtained for the drag coefficient is less than 8%. Because the geometry of NAV is not a simple one, there are no references of the drag an lift coefficients; therefore, the results obtained for the simulation of the NAV with COMSOL can be considered adequate.

References:

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