Low Reynolds Number Flow Around a Flying Saucer Micro Air Vehicle

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Abstract

Introduction:

The Unmanned Air Vehicles (UAV) today are a reality, for these are devices capable of making dangerous tasks without putting in danger the life of the pilot. The tendency of the design for these devices is to make the smaller, proof of that are the developments made by the Defense Advanced Research Projects Agency (DARPA) and the enterprise AeroVironment.

The purpose of this paper is to analyze the behavior in flight of a small scale UAV. This device has the shape of a flying saucer with dimensions: 0,1688 in (4.2885 mm) high and 0,3937 in (10 mm) width, seen in Figure 1. To achieve the objective of this paper we used the CFD Module of COMSOL Multiphysics®.

To better understand the results obtained by the program, two analyses with simple geometries were performed; the first one was a circular cylinder in 2D and the second one was the flow around a sphere.

Using COMSOL Multiphysics:

COMSOL was used to analyze the aerodynamic behavior of a small flying saucer, the parameter measured were the drag and lift coefficients. This was possible thanks to the tools built into the program, for this allows measuring these parameters depending on the time and displaying the results graphically.

In order to have enough information to validate the results obtained for the flying saucer, two more analyses were made. The first one of them was the flow around a circular cylinder in two dimensions, this analysis was carried out for various Reynolds numbers; in every trail the drag coefficient was registered and compared with the one found in the literature. Likewise, for the second analysis the same method was used, but now the study was made for a flow around a sphere.

Results:

In the results obtained for the analyses of the simple geometries, we can observe that the

program COMSOL is a very good tool to do this kind of analysis. This is because the measured parameters in the various simulations are very close to the ones found in the literature. In Figure 2 we appreciate the drag coefficient and Figure 3 we appreciate the velocity fields for the analysis of the cylinder. Therefore, we can ensure that the obtained parameters for the analysis around the small flying saucer are appropriate, seen Figure 4.

Conclusion:

The scope of this paper, though they may seem simple, allowed us to better understand it is not an easy task to determine parameters like the drag and lift coefficient in 3 dimensional bodies without the aid of computational tools such as COMSOL, otherwise we would have to make experimental arrangements that will allow us to obtain the same results.

This procedure is very laborious and expensive, including the time inverted in its implementation. Therefore, the computational tools allow us to do this work in less time. Also, the design phase becomes easier, as one has only to modify and adjust the results given by the simulation.

Reference

S. Piñol and F. Graul, Flujo alrededor de un cilindro: Efecto de la condición de contorno en la pared y de la anchura del dominio, Revista Internacional de Métodos Numéricos para Cálculo y Diseño en Ingeniería, (1996).

L. Nakamura, Steady wake behind a sphere, Physics of Fluids (1976).

Figures used in the abstract

Figure 1: Small UAV in the shape of a flying saucer.

Figure 2: Drag coefficient for the simulation of the cylinder at a Re=312

Figure 3: Velocity fields for the simulation of the cylinder at a Re=312

Figure 4: Velocity fields of the flying saucer simulation.