Results –KEDIMA Project

Summary

In the first Phase, "*Development of the theoretical basis and logistics for the demonstration of the method*", the methods of analysis and identification of turbulence intensity for diagnosis and forecasting in aviation, available in the specialized literature, were studied. The parameters for the characterization and evaluation of the turbulence have been identified. The most important parameter is the so-called EDR (Eddy Dissipation Rate), the cube root of the kinetic energy dissipation rate ε, by which the turbulence intensity is reported. Another parameter is Richardson's number defined as the ratio between the fluid density gradient and the fluid flow velocity gradient. The parameters EDR and Ri have well-defined roles in the analysis of the turbulence phenomenon. EDR provides a quantitative assessment of the intensity of the phenomenon, while Ri characterizes the probability that the turbulence will occur, but does not provide any indication of its intensity. Among the methods for determining the EDR, the rate of kinetic energy dissipation in the assumption of the Kolmogorov approach is used to make the connection between the inertial scale and the scale where energy is dissipated in heat.

Phase 2 of the project is called "*Testing, evaluation and preliminary demonstration of the methodology*" and consisted of a measurement campaign to establish the performance of the hardware part installed in the wind tunnel to find the flow region with the dissipative turbulent regime, according to the theory of the flow behind of a grid, and the optimal way to explore the region of interest. For this, a grid with square meshes was made, fixed perpendicular to the flow direction in the experimental chamber of the subsonic wind tunnel, according to Fig. 1a,b.

In Phase 3, "*Final measurements and analysis of the results*", measurements were made in the subsonic wind tunnel instrumented with an aircraft model and with the placement of hot wire probes near it to measure the turbulent air flow, Fig. 1c. A control, belonging to artificial intelligence, of the neuro-fuzzy type of turbulence vibrations on an intelligent wing in the wind tunnel was developed, Fig. 2. A significant reduction of more than 10 dB of vibrations is evident in the presence of active control, based on a steering of about 6 degrees of the control aileron, in the presence of a significant sinusoidal disturbance of 7.5 degrees on the first resonant frequency of 5.0953 Hz. The second graph of Fig. 2 illustrates the entry into saturation of the neural control, but quickly corrected by the supervising fuzzy control.

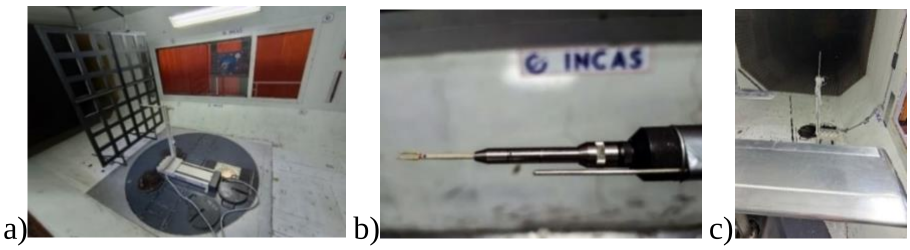

Fig. 1. *a: The experimental assembly consisting of the crossing system, the probe, the support and the turbulence generator; b: the measuring assembly composed of the "x" probe and the compensation RTD; c: experimental set-up with model airplane for measuring turbulent air flow*

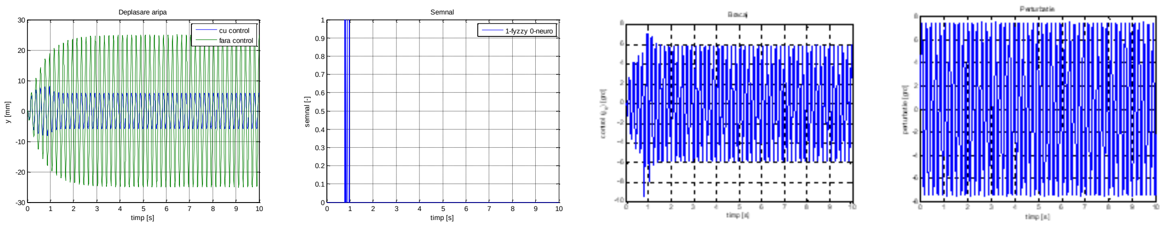

Fig. 2. *Sinusoidal perturbation: amplitude = 7.5 [grade], frequency = 5.0953[Hz]*