Characterization of Trailing Edge and Blade Tower Inter-action noise using semi-analytical model and fan noise experiments

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Project Description:

For low Mach number applications such as axial fans, marine propellers or wind turbines, the main noise mechanisms can be separated between tonal and broadband components. Tonal noise is characterized by discrete frequency peaks at the blade passage frequency and its harmonics and is dominated by unsteady loading noise due for instance to rotor-structure interactions (such as blade-tower interaction noise in the case of wind turbines). Broadband noise is generally dominated by trailing edge noise, although turbulence interaction noise (also called leading edge noise) can also be significant for applications with a turbulent incoming flow.

The objective of the thesis is to compare semi-analytical acoustic prediction models for trailing edge noise and blade-tower interaction noise to fan noise measurements. More specifically, the following tasks will be performed:

• implement Ffowcs-Williams and Hawkings acoustic analogy in the frequency domain using formulations that are adapted to tonal and broadband noise.

• validate the results using benchmark cases from the literature such as the rotated monopoles and dipoles, thickness and loading helicopter noise, turbulent boundary layer trailing edge noise, and blade-tower interaction noise. The input parameters such as the aerodynamic forces can be calculated using various tools available in the literature.

• perform fan noise experiments (see Figure 1) in the anechoic chamber of IMSIA using various configurations (tip Mach number, rotation speed) and blade-tower distances, and compare model predictions with measurements.

Figure 1 Fan Noise Experiment