LOW-ORDER ACOUSTIC SIMULATION METHODS FOR WIND TURBINE NOISE

zEPHYR Marie Skłodowska-Curie project: towards a more efficient exploitation of on-shore and urban wind energy resources

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CONTEXT

Fig. 1 from [1].

The deployment of green Aeolian energy in cities is an important component of future environmentally-friendly Smart Cities. The societal acceptance of urban wind parks will be strongly affected by their visual and **acoustic** impact.

PROBLEM DEFINITION

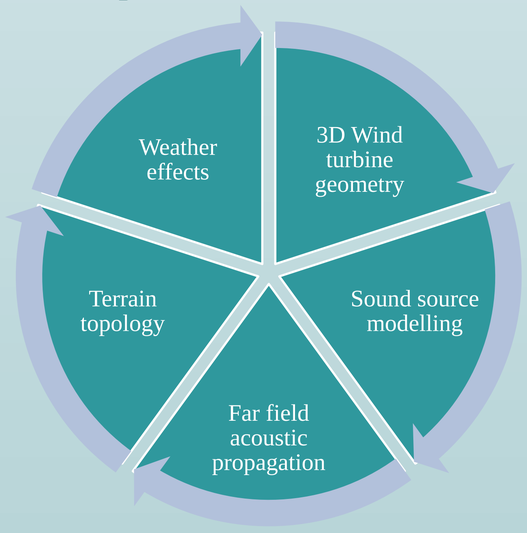


Fig. 2: Relevant phenomena for wind turbine noise propagation.

Fast wind turbine noise prediction in a complex urban environment is a challenging problem because of the wide variety of physical phenomena that need be considered. The most relevant ones are highlighted in Fig. 2. In order to account for them in the numerical simulations while keeping the computational cost reasonable, the development of low-order aeroacoustic models is of interest, especially for sensitivity analysis at the design stage of wind turbines.

OBJECTIVES

Near field source modeling

- Robust and accurate method for trailing edge noise prediction
- Automation of the workflow

Noise propagation in urban environments

- Analysis of the impact of terrain topology and atmospheric effects on noise emissions

Wind turbine noise auralization

- Audio synthesis to investigate the acoustic annoyance for societal acceptance

MODELS

RANS — Reynolds-Averaged Navier-Stokes simulations to compute mean flow properties

Amiet's model — Analytical model [2] to compute the trailing edge noise

Ray-based method — Harmonoise model [3] to simulate the far-field noise propagation in a complex urban environment

WORKFLOW

2D RANS around blade sections

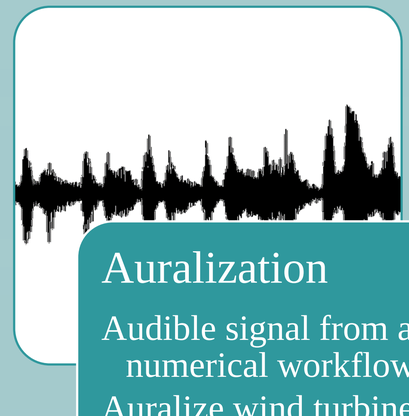
Automated extraction of the boundary layer properties

Sound source and near-field acoustic predictions

Comparison with experimental measurements

Far-field acoustic predictions

Including weather effects and urban environment



Auralization

Audible signal from a numerical workflow

Auralize wind turbine noise in an interactive VR environment

[1] *https://new.siemens.com/global/en/markets/wind.html*
[2] *R.K. Amiet (1976). Noise due to turbulent flow past a trailing edge. Journal of Sound and Vibration, Volume 47, Issue 3.*
[3] *E. Salomons, D. van Maercke, J. Defrance, F. de Roo (2011). The Harmonoise sound propagation model. Acta Acustica united with Acustica, Volume 97.*

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