Wind speed turbulence system identification and signal generator

Stéphane Victor*[1], Mohamed Hajjem[2], Patrick Lanusse[3], Pierre Melchior[3], and Thomas Lara[2]

[1]Laboratoire de l'intégration, du matériau au système – Intégration du Matériau au Système, CNRS, Université de Bordeaux – France

[2]Safran Data Systems – Safran Data Systems – France

[3]Laboratoire de l'intégration, du matériau au système – Intégration du Matériau au Système, CNRS, Université de Bordeaux – France

Résumé

This paper proposes a method to design a real-time wind turbulence simulator. The objective of such a simulator is to make dynamical models more accurate in order to develop more robust controls, especially in the case of mechanical systems operating outdoors such as tracking antennas. The models used to generate a random wind speed are based on the wind spectral characteristics rather than time domain ones. Indeed, turbulence is a stochastic and non-stationary process corresponding to the short-term component of wind and therefore is difficult to model in time domain.
Wind spectral characteristics are described by the power spectral density whose approximation is used in the real-time simulator to reproduce wind behavior.
The von Kármán model is the most commonly used model to approximate the power spectral density of wind turbulence. However, originally designed for aircraft, and therefore for high altitudes and moving systems, tracking antennas are used under different conditions: low altitude and slow moving systems. This makes the von Kármán model less precise in middle and high range frequency. Consequently, there is a need in more accurately modeling wind turbulence under these specific conditions.
Other models such as Cole-Cole and Davidson-Cole fractional models are compared and an improved fractional Cole-Cole model is proposed which has only four parameters.
Finally, an accurate turbulence wind speed generator is proposed.

*Intervenant