MECHANICAL ENGINEERING STUDENT SEMINAR

Wednesday, January 4 2023 at 13:00, D. Dan and Betty Kahn Building, Auditorium 1.
Online: https://technion.zoom.us/j/95981509494

DBD Plasma Actuators for Performance Improvement and Noise Reduction on Rotors

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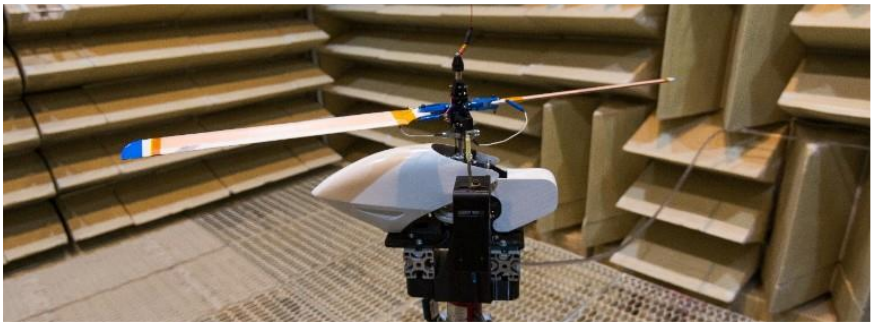
The popularity of electric quadcopter and helicopter drones, for manifold tasks, is on the rise due to their simplicity of use and functional diversity in urban and non-urban terrains. Nevertheless, both power consumption and noise pollution are factors that require constant improvement. Various techniques either increase performance or reduce noise, but usually one comes at the expense of the other. In this research, both of these factors were addressed using pulsed dielectric barrier discharge (DBD) plasma actuators mounted on the blade leading edges of a model helicopter rotor. Following a risk-reduction study, the model was balance-mounted in an anechoic chamber, recently commissioned by Prof. Oksana Stalnov, and pulsed DBD plasma actuation was applied with the blades in the post-stall regime. This approach resulted in an increase in the maximum Figure of Merit (hover efficiency) and thrust coefficient, accompanied by a decrease in broadband and tonal noise components. Broadband and loading noise reductions, of up to 3 dB, were due to boundary layer attachment, resulting in smaller and weaker turbulent eddies in the wake and the tip-vortex and, therefore, reduced turbulent surface pressure fluctuations. Noise reduction directivity associated with the blade passing frequency of up to 3 dB was consistent with Lowson's theory. Surprisingly, at most of the observer angles, both the plasma pulsation and ionization frequencies were not visible in the spectra. This directional acoustic signature was assumed to be due to the geometric mounting of the actuator and its effect on the boundary layer. A system study was performed to determine the minimum rotor diameter required for a net gain in rotor power. The assistance of Prof. Stalnov is gratefully acknowledged.



Model helicopter rotor with DBD plasma actuators mounted in the Technion's Anechoic Chamber (courtesy: Prof. Oksana Stalnov).

Note: the seminar will be given in English

Seminars Coordinator: Assoc. Prof. Matthew Suss.