Table-Top Fan Array Wind Generator for Educational Outreach and Larger Scale Design Validation

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Studies in fluid mechanics often rely on experimental testing, with most experiments conducted in wind or water tunnels. Traditional wind tunnels, designed for consistency and repeatability, fall short in replicating the dynamic and unpredictable nature of real-world aerodynamic conditions. Wind generating facilities built from modular fan arrays can create flow profiles that can be varied spatially and temporally. In addition, such facilities can be easily scaled, from small table-top implementations to larger arrays for research. The goal of this work is to develop a table-top fan array wind generator for educational demonstrations and outreach, while simultaneously developing a scalable design for a future larger research facility. The device, shown in Figure 1, was designed and built over the course of two academic semesters as part of the Senior Design Capstone project in the Queen's Mechanical Engineering program. The device is easily transportable, fitting within a 1.2 × 2.4 m footprint and requiring power from two 120V, 15A outlets. At maximum speed, the 3 × 3 array produces a flow speed of 20 m/s uniformly over an area of 0.22 × 0.22 m, however this yields a total noise level of 97 dB, requiring hearing protection. Decreasing the fan speed to 50% decreases the flow velocity to 11 m/s and the noise level to below the OHSA 8-hour safe noise limit with no hearing protection (80 dB) [1]. Higher flow velocities at this safe noise level were achieved by incorporating a 2:1 contraction, increasing the velocity to 17 m/s. A dual airfoil apparatus with servo-adjustable angle of attack, weighing 190 grams, was designed and built to showcase the aerodynamic concepts of lift, drag and stall. The NACA0018 profile was chosen for its relatively high lift coefficient and thin profile, with two airfoils (chord length c = 8 cm, span 20 cm) separated at distance of 1c to minimize interactions while providing sufficient force to lift the apparatus. Future development will include weight reductions to operate at lower fan speeds, flow conditioning to reduce freestream turbulence intensity, and control improvement to enable synchronization between flow variations and angle of attack control.

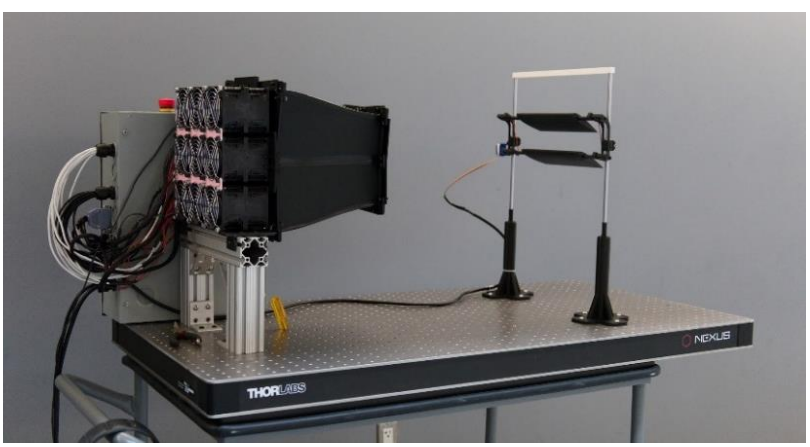

***Figure 1** – Table-top fan array wind generator with dual airfoil apparatus with servo-adjustable angle of attack.*

References

[1] "Noise - Occupational Exposure Limit Canada," *OHSA*. 2024. URL

[2] "NACA 0018" *Airfoil Tools*. 2025. URL

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