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Improving future low-noise aircraft technologies using experimental perception-based evaluation of synthetic flyovers

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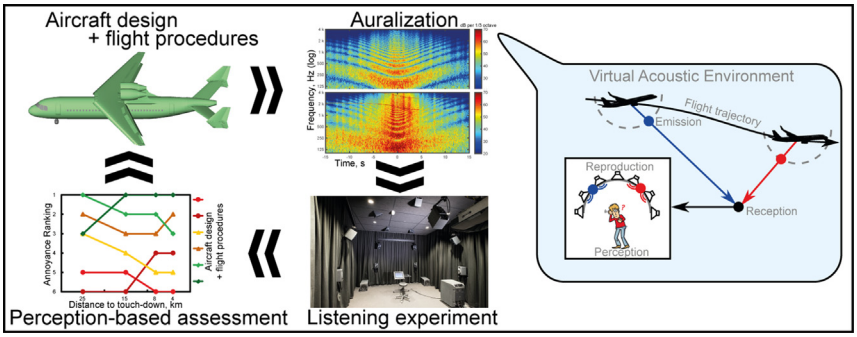
HIGHLIGHTS

- A comprehensive approach to reduce aircraft noise annoyance is proposed.
- Perception-based evaluation of future low-noise aircraft technologies is affirmed.
- Combined optimization of air vehicles and flight procedures is most beneficial.
- Reliable optimization requires consideration of several receiver locations.

GRAPHICAL ABSTRACT



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ABSTRACT

Residents living in the vicinity of airports are exposed to noise from departing and approaching aircraft. Noise may be reduced by introducing novel aircraft technologies into vehicle retrofit, aircraft design and flight procedures. Nowadays, noise assessment and communication of noise are accomplished using conventional noise indicators that consider neither the perception of sound, nor its health effects. To overcome these limitations, this article presents a more comprehensive approach that supports the movement for perception-influenced design in order to reduce the negative environmental impacts and adverse health effects caused by increased air traffic noise. By means of auralization (the acoustical counterpart of visualization), possible future changes can be evaluated by considering the human perception of sound. In this study, in a virtual acoustic environment flyovers of different aircraft types and flight procedures are auralized for ground-based receiver locations, and subsequently evaluated in a psychoacoustic laboratory experiment with respect to short-term noise annoyance. Flight approaches of an existing reference aircraft, a possible low-noise retrofitted vehicle and a future low-noise vehicle design were simulated along standard and tailored flight procedures. To create realistic listening experiences of synthetic flyovers, auralization technologies were further developed regarding source synthesis, transitions between aircraft conditions, sound propagation effects and immersive sound reproduction. Listening experiments revealed significant annoyance reductions for low-noise aircraft types and tailored flight procedures, and that maximum benefit is achieved by the combined optimization of aircraft design and flight procedure. Further, it is shown that spatially distributed receivers need to be considered for a reliable low-noise aircraft technology evaluation. The reduction potential in terms of perceived noise by retrofitting current vehicles and designing new vehicle

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Finally, with the proposed approach the feasibility of perception-based evaluation of future low-noise aircraft technologies could be affirmed. This supports the movement for perception-influenced design in order to reduce the negative environmental impacts and adverse health effects caused by increased (air) traffic noise.

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