Human Versus Artificial Intelligence in Turbulent Jet Control

Yu Zhou

Institute for Turbulence-Noise-Vibration Interactions and Control Shenzhen Campus, Harbin Institute of Technology, China

Abstract

An artificial intelligence control (AIC) system is developed, which consists of a sensing unit, a central control unit and an execution unit, for maximizing the mixing of a turbulent round jet. The sensing unit includes two hotwires placed in the jet, while the excecution unit deploys 6 unsteady radial minijets injected prior to the issue of main jet. The central control unit is based on a machine learning technique. Several control parameters are maneuverable, including the minijet configuration, number N, frequnecy ratio to the main jet preferred-mode frequency, mass flow rate ratio to the main jet, duty cycle α , and phase shift φ between neighbouring minijets. The AIC produces four typical forcing modes, i.e. axisymmetric, flapping, helical, and their combinations. The first three are achievable by conventional control; the fourth is not, at least not obviously, which is associated with a complicated deployment of the minijet configuration, N, φ and α . This mode takes the advantages of all the mixing mechanisms of the other three and makes the jet column flapping and rotating along with the generation of pulsed mushroom structures, thus outperforming greatly conventional techniques. The results demonstrate the great potential of the AIC for turbulence control. An empirical scaling analysis for jet control is also presented.

Brief biography

Professor Yu Zhou completed his PhD degree at The University of Newcastle in 1993. He was a Full Professor at The Hong Kong Polytechnic University and has since 2013 been the Full Professor and Director of the Institute of Turbulence-Noise-Vibration Interaction and Control at the Harbin Institute of Technology (Shenzhen). His main research interests are experimental studies of turbulent flows (wakes, jets, boundary layers, complex flows), flow-induced vibrations and active flow control. He has published over 160 archival journal papers, including 30+ in Journal of Fluid Mechanics. His work has received about 2500+ ISI citations. He was the recipient of the prestigious Chinese national "1000 Talent Scheme" award in 2010 and was elected to be the Fellow of Australasian Fluid Mechanics Society in 2014. He serves as Associate Editor of AIAA Journal.