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Closed-loop control of a globally unstable jet using genetic programming[1] ZHIJIAN YANG, BO YIN, YU GUAN, STEPHANE REDONNET, The Hong Kong University of Science and Technology, YUANHANG ZHU, Brown University, VIKRANT GUPTA, Southern University of Science and Technology, LARRY K.B. LI, The Hong Kong University of Science and Technology — When the density of a jet is sufficiently below that of its surroundings, it can become globally unstable, transitioning from a steady state to a self-excited state characterized by axisymmetric limit-cycle oscillations. We present experiments on the closed-loop control of such oscillations using an unsupervised data-driven model-free framework based on genetic programming (GP). Our implementation of this GP-based control framework relies on a hot-wire probe for sensing and a loudspeaker for actuation. We first initialize a generation of candidate control laws and evaluate their individual performance on the basis of a cost function that accounts for the amplitude of the global mode in a low-density jet and the actuation effort. We then breed further generations of control laws by enrolling them in a tournament and by executing genetic operations such as mutation, crossover, replication and elitism. By benchmarking the best GP-based control law against the best periodic forcing strategy found via conventional open-loop mapping, we show that GP-based control can provide a more efficient means of global mode suppression, offering new insight into the physics of hydrodynamically self-excited jets.

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ZHIJIAN YANG
The Hong Kong University of Science and Technology

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