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Jet manipulation using unsteady minijets

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A turbulent round jet is experimentally manipulated using 1-6 unsteady radial minijets injected prior to the issue of main jet. A parametric study is conducted on how jet mixing is influenced by the minijet configuration, the ratio of the minijet excitation frequency to the main jet preferred-mode frequency, the mass flow rate ratio of each minijet to the main jet, and the nozzle diameter ratio of the minijet to the main jet. The decay rate of the jet centerline mean velocity under manipulation may reach more than 11 times that in the natural jet. Two mechanisms behind the highly effective manipulation are identified from extensive flow visualization data captured in three orthogonal planes, along with the PIV data. One is the jet column flapping associated with asymmetric minijet injection, which increases dramatically the spread along the flapping direction. The other is identified for symmetric minijet injection, characterized by rapidly and sequentially 'tossed-out' mushroom-like structures along the mid plane between minijets. Conceptual models of the corresponding flow structures are proposed. An empirical scaling analysis is also conducted, along with a discussion on the Reynolds number effect on the jet manipulation.

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