Introduction

Louis Cattafesta · Jean-Paul Bonnet

Published online: 14 July 2013
© Springer-Verlag Berlin Heidelberg 2013

Flow control is a key issue for the future of aerodynamics and fluid-related subjects. This is a rapidly evolving field with innovative technical developments involving many different research disciplines. These innovations have tremendous potential for commercial applications. Compared to most fluid mechanics applications, flow control is intrinsically a multidisciplinary subject involving not only fluid mechanics but also control, dynamical systems theory and electromechanical transducers for actuators and sensors. For example, appropriate actuators must be selected, designed and implemented, typically first in open-loop, to explore the response of a flow to perturbations. Then, theory is usually required to derive reduced-order models (ROMs) to simplify the representation of typically turbulent flows and to derive feedback control strategies in concert with appropriate sensors.

This topical collection, consisting of 23 contributed papers by noted experts in the field, provides a representative cross-section of all of these topics. For example, several theoretical methods, such as POD and its variants, NARX, and ROM-based models, are described in detail. The issue also includes some novel examples of passive control, for example, flexible filaments for jet noise and flexible membranes for low Reynolds-number aerodynamic applications.

Flow control is also a field that requires experiments at various scales. This is a particularly important and under-appreciated aspect, given the scaling requirements imposed by small-scale laboratory experiments that require higher frequencies and smaller sizes for actuators and sensors. Sensing has to be made in view of controlling the flow via feedback, which is not identical to determining flowfield characteristics of turbulent flows, such as turbulent kinetic energy via conventional velocimetry methods. In this topical collection, several studies are devoted to the actuator designs or developments, including zero-net, mass-flux or “synthetic jets,” conventional and MEMS pulsed jets, fluidic oscillators, dielectric barrier discharge and arc-filament plasma actuators, electroactive polymers, and active surfaces. A few papers address novel sensing, estimation and detection schemes with an eye toward closed-loop control.

Indeed, the ultimate goal of many applications is closed-loop control due to its potential for reduced actuator power requirements and robustness, etc. The collection therefore contains several examples of feedback control methods applied to a variety of flows, ranging from jets to separated flows. Finally, we note that this topical issue presents all of these methods in the context of a particular application, such as noise reduction, separation control, drag reduction, aero-optics, transition, and stall control in laminar to turbulent and steady and unsteady flows. We therefore hope this collection of papers will provide both a snapshot of the current state-of-the-art in this multidisciplinary field and future trends and challenges.

L. Cattafesta (✉)
Florida Center for Advanced Aero-Propulsion (FCAAP),
FAMU/FSU College of Engineering, Tallahassee, FL, USA
e-mail: lcattafesta@fsu.edu

J.-P. Bonnet
Institut Pprime, UPR 3346, CNRS/University
of Poitiers/ISAE-ENSMA, Poitiers, France
e-mail: jean-paul.bonnet@univ-poitiers.fr