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A micro-power generator based on a semi-passive system of a NACA-0012 airfoil using a piezoelectric transducer

Hamayun Farooq
Pakistan

With the advent of small electro-mechanical systems in the variety of growing industrial and engineering fields, which operates at the micro-scale electrical power, continuously increase the demand of developing micro-power generators (MPGs) that harvest electrical energy by converting the ambient energy sources including light, thermal, chemical, solar, and mechanical energy to provide power on small-scale electronic devices. A typical MPG exploits structural vibrations due to cross-flow instabilities in fluid-structure interaction (FSI). Regarding this, we utilized the mechanical motion of a flapping foil to harvest useable electrical energy. Usually, the flapping motion of a foil is classified into three categories according to activation mode including fully forced system, semi-passive, and fully-passive system. In this study, we utilized a semi-passive system to develop an MPG and performed numerous highly-fidelity simulations of incompressible flow at Re=1100 using an in-house parallel FSI solver. In such a system, the foil is forced to perform pitching motion while the plunge motion is determined by the interaction between the foil, the flow, and elastic supports. For the transition of flow-induced plunging mechanical energy into electrical output, we attached a piezoelectric transducer with the plunging degree of freedom of a NACA-0012 airfoil. We investigate the effects of load resistance on the system response and harvested power. An optimum value of load resistance is found for which the harvested power is maximum. The obtained optimum value does not correspond to the case of the largest oscillations which is usually expected from a non-coupled analysis. Further, the findings support the linear analysis which provides us a qualitative nature of the possible instabilities in the electromechanical system.

Biography

Hamayun Farooq is a Ph.D. student in Centre for Advanced Studies in Pure and Applied Mathematics. (CASPAM), Bahauddin Zakariya University, Multan, Pakistan. He is also involved in research projects at Digital Pakistan Lab. His research interests include High Performance Computing, Fluid-Structure Interactions, and Energy Harvesting.