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MODELING AND DESIGN OF A NONLINEAR AEROELASTIC ENERGY HARVESTER

Abstract

In present era the demand of low power electronic instruments has been increasing and their energy consumption is decreasing. With this increasing demand of low power electronics systems, the researchers focus on piezoelectric energy harvesting, which is a process of converting mechanical energy into electrical energy. Piezoelectric materials are attractive source for energy harvesting because they can be used directly to recharge the batteries and to provide power to other electronic accessories like communication devices, wireless sensors and they can easily be fabricated in different scales. In particular, the possibility to extract energy from the operational environment where the component lives and works is of absolute interest in the present advanced industrial applications, especially in the aerospace field where energy saving is an absolute task and a network of wireless sensors for health management a very promising option. A typical condition for energy harvesting, which require a strong interaction between the external energy and the components where the harvester is embedded, is the Limit Cycle phenomenon arising after the flutter speed in aeroelastic systems. Indeed, aeroelastic systems are characterized by a mutual mechanical coupling between the structural system and the fluid flow surrounding it. The so-called aeroelastic, i.e., structure and fluid systems coupled, remains stable up to a critical velocity of the flow which is the flutter one depending on the flowing media and on the mechanical properties of the surrounded system. After this particular velocity the mechanical system is no longer stable in its unperturbed condition, the system cannot longer be considered linear and stable oscillations arises which are the so called Limit Cycle. In the present work, the possibility to extract energy by means of piezoelectric transduction from a post-critical aeroelastic behavior, as the Limit Cycle, is investigated. Moreover, a suitable designed aeroelastic harvester based on the use of piezoelectric components is presented. Finally, a design study on the main parameters characterizing the presented harvester is performed in order to assess the better operational conditions and to work as basis of future experimental developments.