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NUMERICAL AND EXPERIMENTAL INVESTIGATION OF PIEZOELECTRIC ENERGY HARVESTER BASED ON FLAG-FLUTTER

Abstract

In the present era, the demand for low power electronic instruments has been increasing and their energy consumption is decreasing. With this increasing demand for low power electronics systems, the researchers focus on piezoelectric energy harvesting techniques. The possibility to extract energy from an operational environment is of great interest in the actual advanced industrial applications. This is particularly true in the aerospace field where energy saving is an absolute task and a network of wireless sensors for health management a very promising option. Indeed, being able to extract energy from the environment would permit to reduce the necessity of batteries thus reducing the weight of the overall system a fundamental task in the aerospace sector. In the previous research activity, authors developed an eective analytical model of nonlinear aeroelastic piezoelectric energy harvester based on flutter mechanism and investigated the performance evaluation of the designed harvester analytically. Moreover, it was emphasized that the determination of the aerodynamic model is important for the correct prediction of the harvester performance [1,2].

In the present work, the possibility to extract energy by means of piezoelectric transduction from a post-critical aeroelastic behavior, as the Limit Cycle Oscillation (LCO), is experimentally investigated both numerically and experimentally. A suitable designed aeroelastic device based on the use of piezoelectric components and operating thanks to the flag-flutter phenomenon is presented. The presented harvester will be studied from both the numerical and the experimental point of view. Indeed, harvesting performances, flutter boundaries, aeroelastic modes, and Limit Cycle Oscillations (LCOs) amplitudes predicted by the different models, are compared with experimental data provided by wind tunnel tests. Finally, a study of the main parameters characterizing the presented harvester is performed in order to assess the better-operating conditions and evaluate the overall performances.

The output power of the designed aeroelastic energy harvester is analyzed experimentally, it will be shown that the overall system is suitable for energy harvesting and can be utilized to drive microelectronics i.e., wireless sensors in sub-orbital missions, launchers, space vehicles and in various aerospace applications.

1. Eugeni, M., Elahi, H., Lampani, L., Gaudenzi, P. Modeling and Design of a Nonlinear Aeroelastic Energy Harvester. 68th IAC 2017, Adelaide, Australia.

2. Elahi, H., Eugeni, M., Gaudenzi, P. Design and Performance Evaluation of an Aeroelastic Energy Harvester based on the Limit Cycle Oscillation Phenomenon. 69th IAC 2018, Bremen, Australia.