Preface

The recent advancements in the field of low power portable electronic devices and micro electromechanical systems (MEMS) technology have accelerated research in the field of energy harvesting. The main ambition is to make them self-sufficient by embedding an energy harvesting system within these devices, eliminating the requirement for periodic battery replacement or recharging. The embedded energy harvesting system can scavenge electrical energy by converting ambient energy sources such as solar, wind or mechanical motion energy. This book is focussed on the potential of converting mechanical motion or vibration energy into electrical energy and also investigates the effects of energy harvesting on the overall dynamics of the system.

Typically, there are three vibration-based energy harvesting techniques, (1) piezoelectric, (2) electrostatic and (3) electromagnetic. In piezoelectric vibration energy harvesting (PVEH), vibration energy is converted into useful electrical energy by using 'sensor effect' of piezoelectric materials. The work of this book is particularly presenting close-form, more accurate, experimentally validated mathematical modelling techniques. Additionally, MATLAB program codes are provided to allow researchers to more easily understand and apply complex PVEH system equations and design their own energy harvesting systems. The work presented in the book was mainly carried out during the doctorate and post-doctorate research of the author at renowned institutes.

The overall aims of this book are manifold: (1) a thorough theoretical and experimental analysis of a PVEH beam or assembly of beams; (2) an in-depth analytical and experimental investigation of a dual function piezoelectric vibration energy harvester beam/tuned vibration absorber (PVEH/TVA) or 'electromechanical TVA'; (3) example application of the dual function energy harvesting TVA to suppress the vibration of electronic box, and (4) ready-to-run MATLAB program codes to simulate PVEH mechanism.

Some of the distinct features of this book can be summarised as follows:

- An in-depth experimental validation of a PVEH beam model based on the analytical modal analysis method (AMAM), with the investigations conducted over a wider frequency range than previously tested.
- The precise identification of the electrical loads that harvest maximum power and that induce maximum electrical damping.
- A thorough investigation of the influence of mechanical damping on PVEH beams.
- A procedure for the exact modelling of PVEH beams, and assemblies of such beams, using the dynamic stiffness matrix (DSM) method.
- A procedure to enhance the power output from a PVEH beam through the application of a tip rotational restraint and the use of segmented electrodes.
- The theoretical basis for the concept of a dual function PVEH beam/TVA, and its realisation and experimental validation for a prototype device.
- A theoretical example illustrating the application of a dual function device to control the vibration of electronic box.
- An improved electrical circuit configuration is presented using the real time nonlinear electrical load.
- Easy to use programming codes to run simulations and observe the behaviour of dual function energy harvester tuned vibration absorbers.

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