Designing Piezoelectric Energy Harvesting Using COMSOL Multiphysics® Software for Mouse Telemetry Device

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Abstract

Mice are important animals used for biomedical research, and are widely used to study various disease models. When studying the behavior of mice and gathering biological data from them, miniature sensors and telemetry devices are needed. These devices must provide continuous monitoring without limiting mice mobility or behavior. One potential source of energy available in most biological systems is their natural motion.

This work presents the design and simulation of a piezoelectric-based device to generate electrical power by harvesting the available energy due to the natural movement of a mouse. The mouse energy harvester design is configured as a base excitation model, which consists of a cantilever beam with a piezoelectric upper layer, and a proof mass. Maximum power is obtained when the excitation source (mouse movement) frequency corresponds to the resonant frequency of the energy harvester.

A major issue is the small size of mice, and their relatively low frequency of motion. This creates challenges for the energy harvesting device design. The proposed cantilever energy harvester is designed to resonate at 11.7 Hz, which is close to the typical gait frequency while the mouse runs. The piezoelectric-based energy harvester is simulated using COMSOL Multiphysics® software that is based on the finite element method (FEM), to predict the electrical power for different mouse motion excitation frequencies with the matched load impedance. Additionally, the actual data of mouse runs that is captured by an accelerometer is used to simulate the proposed energy harvesting system.

Figures used in the abstract

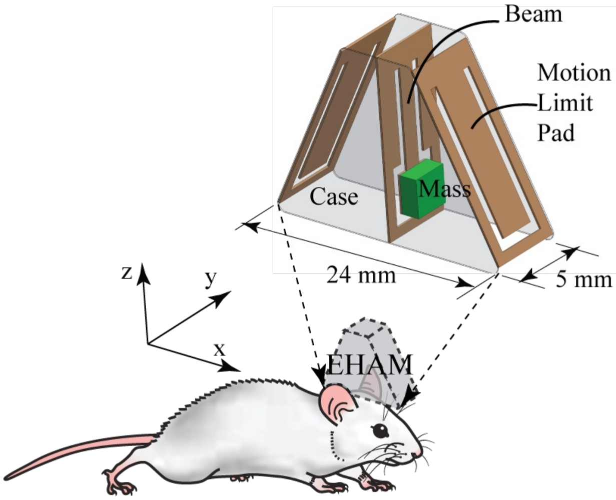

Figure 1: Illustration of energy harvester for mice motion.

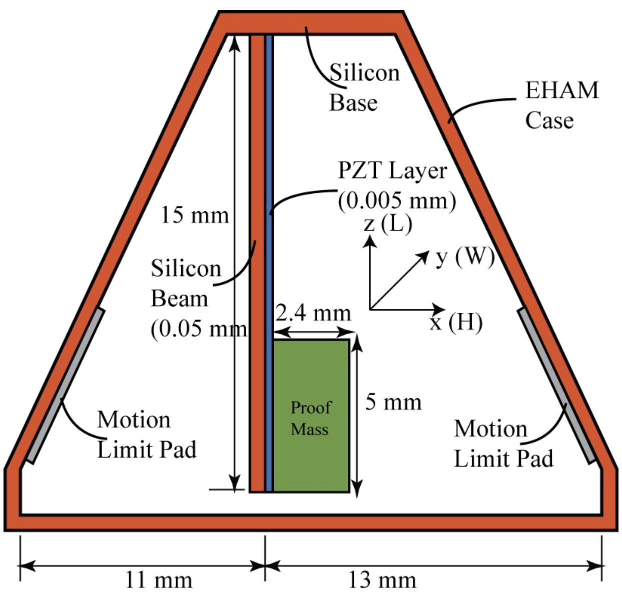

Figure 2: Illustration of dimensions for final design of EHAM cantilever (not to scale).

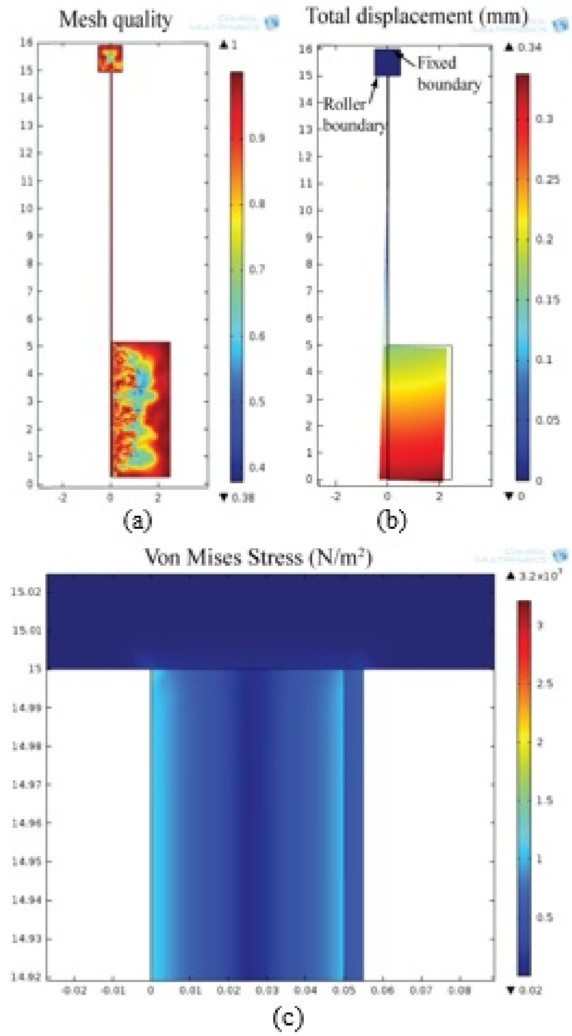

Figure 3: Simulation images showing the results of the Stationary study: (a) Mesh quality, (b) Total displacement, (c) Stress at the root.

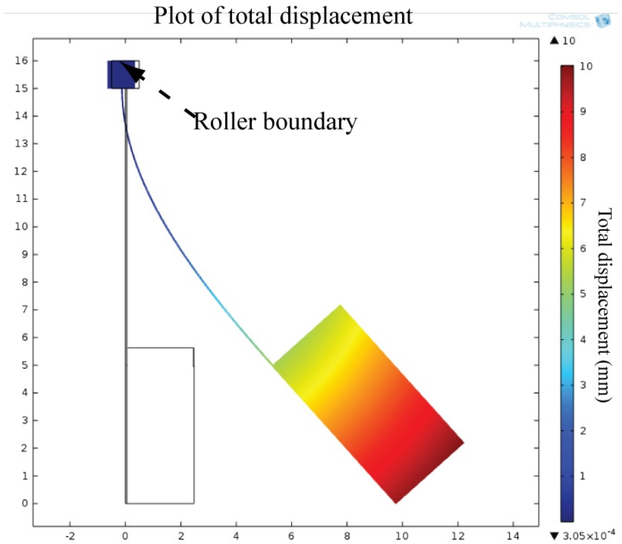

Figure 4: Total displacement in the sinusoidal excitation.