proceedings

Abstract

Design and Optimization of a MEMS-Based Piezoresistive Accelerometer for Head Injuries Monitoring: A Computational Analysis †

Marco Messina [1,*], James Njuguna [2] and Chrysovalantis Palas [1]

[1] Maritime and Mechanical Engineering Department, Liverpool John Moores University, L3 3AF Liverpool, UK; palasv@hotmail.com
[2] School of Engineering, Robert Gordon University, AB10 7QB Aberdeen, UK; j.njuguna@rgu.ac.uk
* Correspondence: m.messina@ljmu.ac.uk

† Presented at the 5th International Symposium on Sensor Science (I3S 2017), Barcelona, Spain, 27–29 September 2017.

Published: 4 December 2017

This work focuses on the design improvement of a tri-axial piezoresistive accelerometer specifically designed for head injuries monitoring where medium-G impacts are common, for example, in sports such as motorsport and American football. Given the particular biomedical and biomechanical application, the device requires the highest sensitivity achievable with a single proof mass approach, where basically all three axes of measurements are detected with a single mass suspended by surrounding beams. Moreover, a very low error, below 1%, is expected for these types of applications where accuracy is paramount. The optimization method differs from previous work as it is based on the progressive increment of the sensor mass moment of inertia (MMI) in all three axes. The work numerically demonstrates the hypothesis that an increment of MMI determines an increment of device sensitivity with a simultaneous reduction of cross-talk in the particular axis under study. A final optimal shape is selected as the best possible output of the optimization process and the final device shows a sensitivity increase of about 80% in the Z-axis and a reduction of cross-talk of 18% with respect to state-of-art sensors available in the literature. Sensor design, modelling and optimization are presented, concluding the work with results, discussion and conclusion.