Optimal coupling of active interface for magneto-inductive harvester for shoes

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ABSTRACT

In this paper, an energy harvesting system consisting of a magneto-inductive transducer embedded with an electronic interface for power conditioning is presented. The aim is to power supply a Bluetooth step-counter placed in the sole of a training shoe exploiting only the energy harvested by the impact of the heel on the ground during running activity.

The magneto-inductive transducer is designed to exploit the free oscillations of the magnet following the impulsive input due to the impact of the shoe on the ground. Optimal load impedance for maximum power transfer is investigated considering pure resistive load. Subsequently, an input-powered active interface for current rectification and voltage boost is adopted to connect the transducer to the load electronics. Based on a full wave active boost converter, the interface exploits high frequency switching with respect to the low frequency dynamics of the transducer to emulate optimal load impedance while charging an output capacitor.

A parametric simulation model is developed to design and optimise the energy harvesting system. Power transfer and efficiency of the energy conversion chain are studied. Performance with the standard AC-DC interface and with the proposed interface are simulated and compared to case of optimal resistive load.

The device consisting of a $\varnothing 27\times 16$ mm cylinder including the transducer, the active interface, the step-counter electronics and the protective shell, has been manufactured and tested during running activity. Numerical and experimental results show the effectiveness of the developed harvester step-counter device, demonstrating that the energy recovery during the impact is maximised and is sufficient enough to supply an electronic interface that detects the step and sends the information via low-power Bluetooth.

The considered application only represents a case study. In fact, since the design tool for the transducer is completely parametric in order to easily adapt the geometry to the mechanical input and constraints, and since the developed HI is easily tunable to set the load impedance to emulate, the proposed energy harvesting system is suitable for a very large variety of applications.

REFERENCES

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