

Live Demo of A Transient-Motion-Powered Human Motion Detector

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I. SYSTEM OVERVIEW

The development of Internet of Things (IoT) has placed a strong demand on human motion detection technologies. Motion detectors acts an essential role in many civil applications, such as home security, occupancy and activity monitoring, retail analysis, etc. Emerging energy harvesting technologies provide promising solutions towards the ubiquitous and everlasting deployments of motion detectors. However, most existing battery-free solutions require special environmental conditions and suffer from frequent energy outages. Therefore, their applications are still very limited. This live demonstration exhibits a transient-motion-powered motion detector, named ViPSN-E, where "ViPSN" stands for vibration-powered sensor node [1]; "E" stands for an energy-mode device. ViPSN-E can carry out maintenance-free motion detection and wireless communication by making good use of the energy harvested from an instantaneous motion. The prototype of ViPSN-E is shown in Fig. 1. The system is developed based on ViPSN [1], an open-source development platform specified for vibration-powered IoT devices. ViPSN-E is composed of four parts: a piezo-magneto-elastic structure as energy harvester, a self-powered synchronized switch harvesting on inductor (SP-SSHI) interface circuit [2], an enhanced energy management unit, and a Bluetooth low energy (BLE) unit. The piezo-magneto-elastic harvester is composed of a low-cost piezoelectric cantilever and a pair of magnets, which are used to induce a plucking excitation in a transient and one-way movement.

ViPSN-E has realized a co-design considering the cyber-electromechanical synergy among mechanical dynamics, energy harvesting circuit, and low-power embedded system. Through the sophisticated collaboration between the mechatronic design and computer program, ViPSN-E can provide a reliable energy harvesting solution for motion sensing and wireless transmission without any energy outages. By sophisticatedly designing an asymmetric plucking mechanical configuration, the motion direction can be identified according to the different amount of harvested energy in either direction. Fig. 2 shows that the energy harvested from a single transient plucking motion can be up to 2000 μJ , which is sufficient to carry out several rounds of sensing and wireless transmission. Although there are some variations in harvested energy due to the motion fluctuations under different plucking speed, the converted and available electric energy after each plucking motion is sufficient to properly carry out the IoT functions.

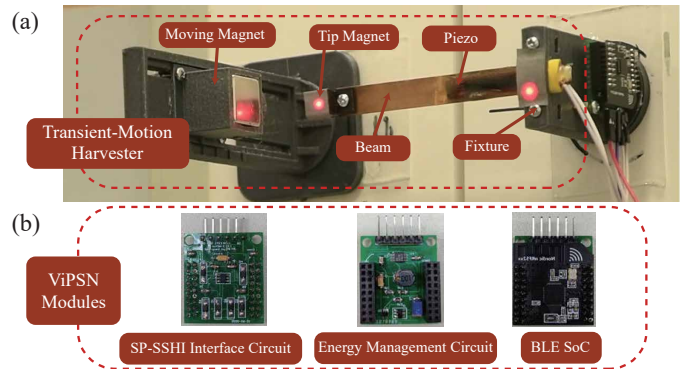


Fig. 1: Prototyped ViPSN-E device. (a) Motion energy harvester. (b) ViPSN modules.

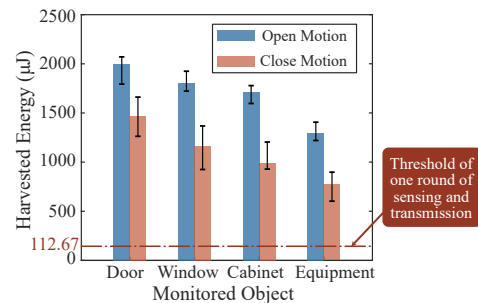


Fig. 2: Performance of ViPSN-E in some real-world scenarios.

II. VISITOR EXPERIENCE

In this proposed demonstration, visitors will experience a novel battery-free and maintenance-free motion sensing architecture. They will also get to know the importance of cyber-electromechanical synergy towards successful implementations of vibration- or motion-powered Internet of Things (IoT) systems. Besides the demonstration, the principle of such a co-design, as well as its potential IoT applications will be explained to the visitors in detail with an additional poster.

REFERENCES

- [1] X. Li, L. Teng, H. Tang, J. Chen, H. Wang, Y. Liu, M. Fu, and J. Liang, "Vipsn: A vibration-powered iot platform," *IEEE Internet of Things Journal*, 2020.
- [2] J. Liang and W.-H. Liao, "Improved design and analysis of self-powered synchronized switch interface circuit for piezoelectric energy harvesting systems," *IEEE Transactions on Industrial Electronics*, vol. 59, no. 4, pp. 1950–1960, 2011.