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PARAMETRICALLY EXCITED VIBRATION ENERGY HARVESTER

In recent years, there has been an increasing interest in vibration energy harvesting, especially to enable self-powered wireless sensor networks for structural health monitoring. While some early commercial solutions have witnessed increasing deployments, two of the key technical limitations still stubbornly persist; namely, the low power density relative to traditional power supplies and the mis-match between the narrow operational frequency bandwidth of conventional energy harvester and the wideband nature of real vibrations. Researchers at the University are addressing these issues through employing vibration energy harvesting based on auto parametric resonance rather than the standard approach of using the fundamental mode of resonance.

Key potential benefits over energy harvesting using fundamental mode of resonance:

- An order of magnitude on average higher power output
- Several times wider operational frequency bandwidth
- More efficient mechanical to electrical transduction

If you would like to work with us to develop this technology for your application, please contact:

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Background

Vibration energy harvesting (VEH) is the process by which ambient vibrational energy can be captured and transformed into a utilizable form such as electricity. Increasing market demand for remote-monitoring in inaccessible and concealed locations is driving this concept in new directions. Researchers at Cambridge have used auto parametric resonance for VEH achieving the benefits of wideband operation and increased power output over traditional approaches.

Technology

Auto parametric resonance occurs in multi-component systems where one part of the system parametrically excites another part, as shown in figure 1. This example demonstrates the increase in the amplitude of motion of a yoyo by coupling energy from a parametric excitation as compared to conventional excitation/resonance.

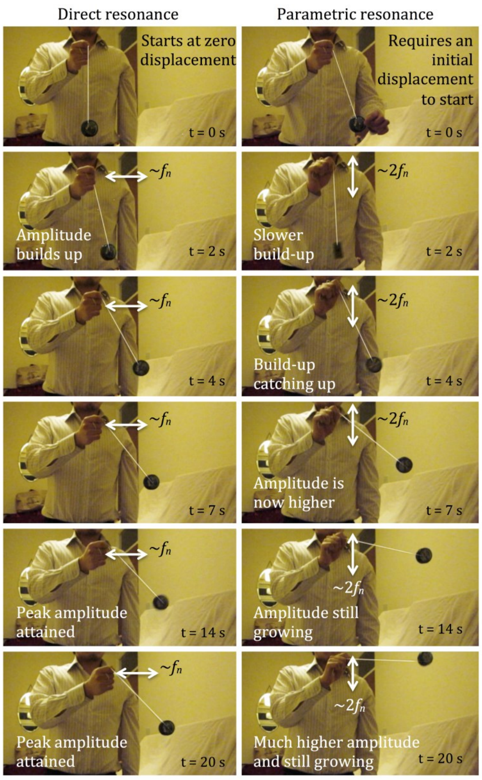

Figure 1. The effect of parametric resonance on the motion of a yoyo.

Cambridge researchers have demonstrated the feasibility of engineering the principle of parametric resonance into a MEMS format for VEH as well as in macro-scale prototypes. These prototypes demonstrate much higher output power and wider operational bandwidth relative to prototypes based on ordinary (direct) resonance and device modifications have been engineered to lower the initiation threshold amplitudes to levels compatible with real-world VEH applications.

Reference	Peak power (mW)	Freq. (Hz)	Normalised Power Density (μWcm^{-3}m^{-2}s^{4})
PEVEH prototype	171.5	3.6	***293***
Perpetuum PMG-17 (2008)	1.000	100	119
Lumedyne Technologies (2008)	1.000	53	37
Ferro Solutions VEH-460 (2009)	5.270	60	32.3
Waters (2008)	18.00	90	6.93
Glynne-Jones (2001)	2.800	106	4.53

Table 1. Comparative table between macro-scale VEH.

Reference	Power (μW)	Acc. (ms^{-2})	Freq. (Hz)	Index (μWcm^{-3}m^{-2}s^{4})
Parametric (1st order)	0.156	4.2	1380	***60.2***
Parametric (3rd order)	0.127	4.2	342.5	***49.0***
Despesse *et al.* (2005) [11]	70	9.2	50	25.5
Roundy *et al.* (2002) [2]	116	2.25	120	22.9
Wong *et al.* (2009) [10]	0.017	1.76	1400	17.2
Fundamental mode	0.011	4.2	700	***4.24***
Chu *et al.* (2005) [12]	32.34	40	800	1.01

Table 2. Comparative table between MEMS-based VEH.

Note: the power density values take into account the volume of the devices.

Commercialisation

This technology is protected by patent application US61/651867 and we are now seeking industrial partners to work with us to develop the technology further. If you would like to discuss how your company can be involved in this work please contact us using the details on the front page.