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STUDY OF ENERGY HARVESTING FROM TRAFFIC-INDUCED BRIDGE VIBRATIONS

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This paper deals with traffic-induced bridge vibrations as an energy source for energy harvesting systems to power sensor nodes. The development of low power electronic devices and energy scavenging is active [1] and it is worth to investigate the use of kinetic energy of bridges, which is in the form of vibrations [2, 3]. The vibrations considered are generally characterized by small amplitudes and low resonant frequencies (i.e. below 20 Hz). Such applications require the use of inertial (electromagnetic or piezoelectric) harvesters with significantly larger mass than available commercial devices.

Acceleration signals were measured for several hours at different locations on a heavily trafficked bridge [4]. The measurement locations included the girder beams as well as resonant equipments such as water pipes, so as to extend the investigation of promising energy sources of vibrations. The time structure patterns of the recorded random vibration data are classified into two categories: sequences of isolated transient responses corresponding to single lorry crossing and random narrow band vibration responses to clusters of lorries. From this classification and statistical estimates, base excitation models for inertial harvesters are proposed to obtain theoretical estimates of the mean power converted in relation with the traffic intensity of heavy vehicles crossing the bridge. Numerical simulations were carried out for experimentally validated models of cantilever electromagnetic and piezoelectric harvesters operating at resonance frequencies of 4 Hz and 14.5 Hz. The results of the predicted mean output power estimates are presented. Simple but effective guidelines for predicting the harvested power in terms of traffic intensity are derived.

REFERENCES

[1] E.Reilly ,F. Burghardt,R. Fain,and P.Wright. Powering a wireless sensor node with a vibration-driven piezoelectric energy harvester *Smart Mater. Struct.* **20** 125006,

2011.

[2] S.F.Ali, M.I.Friswell, and S.Adhikari. Analysis of energy harvesters for highway bridges, *J. Intell. Mater. Syst. Struct.* **22**,1929–1938, 2011.

[3] N.G.Elvin , N.Lajnef, and A.Elvin. Feasibility of structural monitoring with vibration powered sensors, *Smart Mater. Struct.* **15**, 955, 2006.

[4] M.Peigney, D.Siegert. Piezoelectric energy harvesting from traffic-induced bridge vibrations, *Smart Mater. Struct.* **22**, 095019, 2013.