K. Nakano Lab
Energy Harvesting in Rotating Tires Using Stochastic Resonance
Partner: The University of Sheffield
Fund: The special fund of Institute of Industrial Science

Introduction
In view of the principle of stochastic resonance, a multi-stable nonlinear model is proposed to validate that the phenomenon of stochastic resonance can occur at the rotating environments, is exploited to enhance the energy harvesting under practical automobile tire.

   The suggested application for this harvester is to provide electrical power for a tire pressure monitoring system.
   - Low frequency enhanced response
   - Broadband energy harvesting

Schematic of the system

When the proposed energy harvester model revolves with a radius of \( r \) at the frequency of \( \omega \), the motion equation is derived as follows:

\[
mx'' + cx' + \left[ k - \frac{F_m}{d} \right] x + \frac{F_m}{2d^3} x^5 = N(t) + G \sin(\alpha t + \theta_t)
\]

Duffing equation:

\[
mx'' + cx' - axx' + bx^3 = G \sin(\alpha t + \theta_t) + N(t)
\]

Rearrange Equation

Periodically rotational gravity

Ambient noise excitation

Experimental setup

Results

Conclusions and future works

The phenomenon of stochastic resonance can occur at the low-speed automobile driving.

Enhancement of the energy harvesting efficiency with a valid bandwidth of 25 km/h ~ 50 km/h.

The proposed system realized a high-performance of energy harvesting from 25 km/h ~ 129 km/h.

Publications
