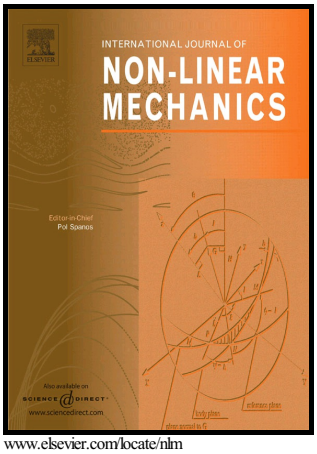

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Amin Dehyadegari, MirFaez Miri, Zahra Etesami

PII: S0020-7462(16)30357-2
DOI: http://dx.doi.org/10.1016/j.ijnonlinmec.2016.11.009
Reference: NLM2739

To appear in: *International Journal of Non-Linear Mechanics*

Received date: 12 June 2016
Revised date: 8 November 2016
Accepted date: 25 November 2016

Cite this article as: Amin Dehyadegari, MirFaez Miri and Zahra Etesami Dynamics of noncontact rack-and-pinion device subject to thermal noise Multiharmonic motion of the rack, *International Journal of Non-Linear Mechanics,* http://dx.doi.org/10.1016/j.ijnonlinmec.2016.11.009

Dynamics of noncontact rack-and-pinion device subject to thermal noise: Multiharmonic motion of the rack

Amin Dehyadegari[a], MirFaez Miri[a,b,*], Zahra Etesami[a]

[a] *Department of Physics, University of Tehran, P. O. Box 14395-547, Tehran, Iran*
[b] *School of Physics, Institute for Research in Fundamental Sciences, (IPM) Tehran 19395-5531, Iran*

Abstract

We study miniaturized *noncontact* rack and pinion composed of a corrugated plate and a corrugated cylinder intermeshed via the lateral Casimir force. We assume that the rack position versus time is a periodic multi-harmonic signal. The axle of the pinion is subject to Casimir torque, frictional torque, load torque, and random Gaussian torque. A Fokker-Planck rather than Langevin description of the pinion dynamics allows us to explore a huge parameter space in a reasonable computational time. We show that even at the room temperature, the device acts as a mechanical rectifier: The pinion rotates with a nonzero average velocity and lifts up an external load. For typical values of parameters, we find that the pinion rotates with an average angular velocity $\sim 1 - 30$ Hz. The thermal noise may even facilitate the device operation.

Keywords: Nanomachine, Lateral Casimir force, Thermal noise, Fokker-Planck equation
2010 MSC: 00-01, 99-00

1. Introduction

Microelectromechanical systems (MEMS) is a rapidly growing technology dealing with the design and fabrication of tiny machines [1, 2]. With the ongoing

*Corresponding author
Email address: mirfaez_miri@ut.ac.ir (MirFaez Miri)