Scopus

Documents

Tahir, M.S.M.[a] , Wahid, A.N.[b] , Hanif, N.H.H.M.[a] , Janin, Z.[c]

Micro Energy Harvesting via Piezoelectric and Electromagnetic Dynamics for Higher Power Output
(2023) *ICSIMA 2023 - 9th IEEE International Conference on Smart Instrumentation, Measurement and Applications*, pp. 274-278.

DOI: 10.1109/ICSIMA59853.2023.10373504

[a] International Islamic University Malaysia, Kuala Lumpur, Malaysia
[b] International Islamic University Malaysia, Gombak, Malaysia
[c] Universiti Teknologi Mara, Shah Alam, Malaysia

Abstract
Micro enery harvesting is a promising technology for powering small-scale electronic devices using ambient sources which are normally vibrating at low frequencies. Limitations arise when relying solely on a single energy conversion mechanism, such as the exclusive use of piezoelectric beams. Piezoelectric beams excel at high-frequency energy conversion, leaving low-frequency vibrations untapped. To address this issue, a hybrid energy harvester integrating both piezoelectric beams and magnetic coils emerges as a solution to complement the capability of a piezoelectric harvester. In this work, a copper wound coil is added to an energy harvester assembly that consist of a piezoelectric beam, an eccentric mass and NdFeB permanent magnets that act as proof mass. Each time the eccentric mass passes the beam, the magnets at a fixed distance, repel each other. This simultaneously change magnetic flux around the wound copper coil to generate a larger amount of current. This proposed hybrid configuration produced the highest energy output as compared to the piezoelectric only or electromagnetic only energy harvester, when subjected to a 5 Hz vibration input. This research demonstrated the ability of the hybrid energy harvester to produce electrical power at a low frequency input, which provides optimistic possibility to cater for the energy demand for wearable electronic and wireless devices. © 2023 IEEE.

Author Keywords
electromagnetic; hybrid energy harvester; low-frequency input; micro energy; piezoelectric

Index Keywords
Energy harvesting, Iron alloys, MEMS, Neodymium alloys, Piezoelectricity; Electromagnetics, Electronics devices, Energy Harvester, Hybrid energy, Hybrid energy harvester, Low-frequency input, Lower frequencies, Micro energy, Piezoelectric, Piezoelectric beam; Copper

Funding details
International Islamic University MalaysiaIIUM

ACKNOWLEDGMENT The authors would like to thank the Smart Structure Laboratory, Kulliyyah of Engineering, International Islamic University Malaysia and School of Electrical Engineering, Universiti Teknologi MARA, for supporting this project.

References

- Pullwitt, S., Tudyka, P., Wolf, L.
Leveraging Micro Energy Sources in Energy Harvesting Wireless Sensor Networks
(2022) *2022 17th Wireless On-Demand Network Systems and Services Conference (WONS)*, pp. 1-8.

- Xu, C., Song, Y.
Portable and wearable self-powered systems based on emerging energy harvesting technology
(2021) *Microsystems Nanoeng.*, 7 (25), pp. 1-14.

- Yang, Z., Zhou, S., Zu, J., Inman, D.
(2018) *High-Performance Piezoelectric Energy Harvesters and Their Applications*, pp. 642-697.

- Chen, K., Fang, S., Lai, Z., Cao, J., Liao, W.
A frequency upconversion rotational energy harvester with auxetic structures for

high power output
(2023) *Smart Mater. Struct.*, 32, pp. 1-12.

- Aphavyong, S., Murakami, S., Kanda, K., Fujimura, N.
Enhanced performance on piezoelectric MEMS vibration energy harvester by dynamic magnifier under impulsive force
(2022) *Appl. Phys. Lett.*, 121 (17).

- Digregorio, G., Pierre, H., Laurent, P., Redouté, J., Member, S.
Modeling and Experimental Characterization of an Electromagnetic Energy Harvester for Wearable and Biomedical Applications
(2020) *IEEE Access*, 8.

- M Iqbal, A.B., Nauman, M.M., Khan, F.U., Abas, E., Cheok, Q.
Nonlinear multi-mode electromagnetic insole energy harvester for humanpowered body monitoring sensors: Design, modeling, and characterization
(2021) *Proc. Inst. Mech. Eng. Part C J. Mech. Eng. Sci.*,

- Fan, K., Tan, Q., Liu, H., Zhu, Y., Wang, W., Zhang, D.
Hybrid piezoelectric-electromagnetic energy harvester for scavenging energy from low-frequency excitations
(2018) *Smart Mater. Struct.*, 27 (8).

- Mohamad Hanif, N.H.H., Jazlan Mohaideen, A., Azam, H., Rohaimi, M.E.
Rotational piezoelectric energy harvester for wearable devices
(2018) *Cogent Eng.*, 5 (1), pp. 1-11.

- Tahir, M.S.M., Hanif, N.H.H.M., Kassim, M.H.C.
Performance Measurement of Piezoelectric Energy Harvester with Permanent Magnet Assembly for Wearable Devices
(2021) *2021 IEEE International Instrumentation and Measurement Technology Conference (I2MTC)*, pp. 1-5.

- Azam, H., Mohamad Hanif, N.H.H., Md Ralib, A.A.
Magnetically plucked piezoelectric energy harvester via hybrid kinetic motion
(2019) *IIUM Eng. J.*, 20 (1), pp. 245-257.

- Tahir, M.S.M., Mohamad Hanif, N.H.H., Wahid, A.N.
Maximizing Output Voltage of A Piezoelectric Energy Harvester via Beam Defelction Method for Low Frequency Inptus
(2022) *IIUM Eng. J.*, 23 (1), pp. 432-446.

Correspondence Address
Tahir M.S.M.; International Islamic University MalaysiaMalaysia; email: mohamadsafidin@gmail.com

Publisher: Institute of Electrical and Electronics Engineers Inc.

Conference name: 9th IEEE International Conference on Smart Instrumentation, Measurement and Applications, ICSIMA 2023
Conference date: 17 October 2023 through 18 October 2023
Conference code: 196121

ISBN: 9798350343380
Language of Original Document: English
Abbreviated Source Title: ICSIMA - IEEE Int. Conf. Smart Instrum., Meas. Appl.
2-s2.0-85183468892
Document Type: Conference Paper
Publication Stage: Final
Source: Scopus

ELSEVIER

Copyright © 2024 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.

RELX Group™