

RAJARATHINAM M



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EDUCATIONAL QUALIFICATION

Doctor of Philosophy 2019

Department of Applied Mechanics, Indian Institute of Technology Madras, India.
Aggregate: **9 CGPA**
Thesis title: *Studies on vibration based hybrid energy harvester.*
Supervisor: Prof. Shaikh Faruque Ali.

M.E. Engineering Design 2009

Department of Mechanical Engineering, Kongu Engineering College, Erode.
Affiliated to Anna University, Coimbatore, Tamilnadu, India.
Aggregate: **9.34 CGPA** (First class with distinction)
Thesis title: *Vibration analysis of rolling element bearings under dynamic loading conditions.*
Supervisor: Prof. Vaggeeram Hariharan

B.E. Mechanical Engineering 2004

Department of Mechanical Engineering, Mahendra Engineering College, Thiruchengodu.
Affiliated to Periyar University, Salem, Tamilnadu, India.
Aggregate: **81.7%** (First class with distinction)

DME. 1999

Department of Mechanical Engineering, DDCSM Govt Polytechnic College, Palacode.
Affiliated to *Directorate of Technical Education*, Chennai, Tamilnadu, India.
Aggregate: **90.75%** (First class with honours)

EXPERIENCE

ACADEMIC POSITIONS:

Research Associate 3 September 2019

Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras, India.
Project: *Modeling and analysis of mistuned rotor blade systems.* Funded by: DRDO.
Mentor: Prof. Shaikh Faruque Ali.

Project Associate 1 February 2018 – 31 July 2018, 10 March 2019 – 31 August 2019

Industrial Consultancy & Sponsored Research, Indian Institute of Technology Madras, India.
Project: *Modeling and analysis of mistuned rotor blade systems.* Funded by: DRDO.
Mentor: Prof. Shaikh Faruque Ali.

Research Fellow 16 July 2012 – 2019

Department of Applied Mechanics, Indian Institute of Technology Madras, India.
Project: *Vibration based multifrequency energy harvester.* Funded by: DST
Supervisor: Prof. Shaikh Faruque Ali.

Assistant Professor 27 August 2011 – 19 June 2012

Department of Mechanical Engineering, Veltech University, Chennai, Tamil Nadu, India.

Assistant Professor 01 December 2010 – 31 May 2011

Lecturer 11 June 2009 – 30 November 2010

Department of Automobile Engineering, Dr Mahalingam College of Engineering and Technology, Pollachi, Tamil Nadu, India.

INDUSTRIAL POSITIONS: 5 Years

Quality cum Development Engineer

Esbee Precision Industries (100 % EOU), Bangalore, Karnataka, India.

Supervisor

S. M. W. Hydraulics (India), Bhavani, Erode, Tamil Nadu, India.

HONORS AND AWARDS

- University first rank received from Anna University Coimbatore for the master degree.
- Department topper in few semesters in bachelor degree.
- Department topper in few semesters at DDCCSM Polytechnic.
- Travel grant (Rs.1,50,000) from IITM (European Conference on Computational Mechanics and Computational Fluid Dynamics, Glasgow, UK, 2018).
- Travel grant (Rs.1,50,000) received from IITM (Conference on Dynamical Systems-Theory and Applications 2019, Łódź, Poland, 2019).

RESEARCH PROFILE

Vibration based energy harvesters

Studies on the novel design of a hybrid harvester which encompasses the principles of both the piezoelectric and electromagnetic transduction mechanisms have been carried out in my doctoral thesis. The proposed hybrid harvester consists of a unimorphed piezoelectric cantilever beam, a tip mass and a permanent magnet attached to the free end with a linear elastic spring. Numerical simulations are carried out to show the power output under harmonic and random base motion. The theoretical findings are validated by the experimental results.

Experimental and numerical investigations show that the proposed hybrid harvester produces power over a broad range of frequencies as opposed to its standalone counterparts under both deterministic and random environment. High current and high voltage are also obtained owing to the coupling of piezoelectric and electromagnetic transduction mechanisms. This makes the hybrid harvester suitable for both sensing and actuating applications. Demonstrations using an application show that the amount of power extracted from the hybrid harvester is adequate to power the wireless sensors and LEDs.

The effect of multiple electromagnetic units on the harvester performance is also studied. It is shown that the harvesting system with two electromagnetic units significantly improves the magnitude as well as the bandwidth of the harvested power compared to that of a system with a single electromagnetic unit. Further, the implications of the number of electromagnetic subsystems on the total harvested power of the hybrid system and the saturation trends for under constant input energy have also been studied.

Recently, work has also been carried out on conceptualizing a model of energy harvesting dynamic vibration absorber. Energy harvesting dynamic vibration absorber is used to suppress the undesirable vibrations in the host structure and to harvest the electrical energy out of these vibrations through a piezoelectric transducer simultaneously. This work analyses the prospect of using vibration absorber for possible energy harvesting under random excitation and parameter uncertainty. The vibration absorber is supplemented with a piezoelectric stack to enable both vibration reduction and energy harvesting. Analytical studies are carried out considering Gaussian noise excitation with a deterministic system and parametric uncertainty with harmonic excitation. The analytical results show that, with the proper selection of parameters, electrical energy can be harvested along with the reduction in vibration of the host structure.

PUBLICATIONS Journals

1. **M. Rajarathinam** and S. F. Ali, "Parametric uncertainty and random excitation in energy harvesting dynamic vibration absorber", *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems Part B: Mechanical Engineering*, 7(1), 1-18, 2021.
2. **M. Rajarathinam**, P. V. Malaji and S. F. Ali, "A nonlinear hybrid energy harvester", *Advances in Rotor Dynamics, Control, and Structural Health Monitoring*, Springer, 605-614, 2020.
3. **M. Rajarathinam** and S. F. Ali. "Energy generation in a hybrid harvester under harmonic excitation", *Energy Conversion and Management*, 155, 10-19, 2018.
4. **M. Rajarathinam** and S. F. Ali, "Investigation of a hybrid piezo-electromagnetic energy harvester", *tm-Technisches Messen*, 85(9), 541-552, 2018.
5. F. Ram, T. Ambone, A. Sharma, **M. Rajarathinam**, D. Kajale, V. Borkar, S. F. Ali, P.K. Balu, G. Kumaraswamy and K. Shanmuganathan., "Fluorinated nanocellulose-reinforced all-organic flexible ferroelectric nanocomposites for energy generation", *The Journal of Physical Chemistry C*, 122(29), 16540–16549, 2018.
6. S. Dipak, **M. Rajarathinam** and S. F. Ali, "Energy harvesting dynamic vibration absorber under random vibration", *IEEE International Conference on Control Applications*, 1241-1246, 2013.
7. P. V. Malaji, **M. Rajarathinam**, V. Jaiswal, S. F. Ali and I. M. Howard, "Energy harvesting from dynamic vibration pendulum absorber", *In Recent Advances in Structural Engineering*, 467-478, 2019.

8. A. Srinivasan, A. Jegan, **M. Rajarathinam** and S. Natarajan, “Numerical analysis of controlling base disturbance in long reach manipulators using eddy current damping”, IEEE International Conference on Electrical, Communication and Computer Engineering, 1-6, 2020.
9. **M. Rajarathinam**, V. Vinothkrishnan, M. Aravindan and S. F. Ali, “Coupled piezo-multiple electromagnetic energy harvesting”, Mechanics of Advanced Materials and Structures- (Communicated).
10. **M. Rajarathinam** and S. F. Ali, “Experimental and theoretical investigation of a hybrid energy scavenger under random base excitation” - (Under process).

International conferences

1. **M. Rajarathinam**, V. Vinothkrishnan, M. Aravindan and S. F. Ali, “Investigation of piezoelectric and multiple electromagnetic hybrid vibration energy harvester”, DSTA 2019, 2-5 December 2019, Łódź, Poland.
2. **M. Rajarathinam** and S. F. Ali, “Harvesting energy from coupled piezoelectric and multiple electromagnetic harvesters”, ECCM-ECCFD 2018, 11-15 June 2018, Glasgow, UK.
3. **M. Rajarathinam**, P. V. Malaji and S. F. Ali, “A nonlinear hybrid energy harvester”, 13th International Conference on Vibration Problems, 29 November-2 December 2017, IIT Guwahati, India.
4. P. V. Malaji, **M. Rajarathinam**, V. Jaiswal, S. F. Ali and I. M. Howard, “Energy harvesting from dynamic vibration pendulum absorber”, 21-23 December 2016, Structural Engineering Convention (SEC-2016), CSIR-SERC, Chennai, India.
5. **M. Rajarathinam** and S. F. Ali, “Vibration based hybrid energy harvester for broadband harvesting”, 6th International Congress on Computational Mechanics and Simulation (ICCMS 2016), 27 June-1 July 2016, IIT Bombay, India.
6. **M. Rajarathinam** and S. F. Ali, “Vibration based hybrid energy harvesting under harmonic excitations”, 12th International Conference on Vibration Problems (ICOVP2015), 14-17 December 2015, IIT Guwahati, India

National conferences

1. **M. Rajarathinam** and S. F. Ali, “Hybrid energy harvesting under random base motion”, INCAM-2015, 13-15 July 2015, IIT Delhi, India.
2. S. Dipak, **M. Rajarathinam** and S. F. Ali, “Analytical study of cantilever beam with energy harvesting dynamic vibration absorber”, INCAM-2013, 4-6 July 2013, IIT Madras, India.
3. **M. Rajarathinam**, V. Hariharan and P.S.S. Srinivasan, “Balancing of several masses with vibration analysis of end support bearings”, RAME-2009, 4 April 2009, MPNMJEC, TN, India.
4. **M. Rajarathinam**, V. Hariharan and P.S.S. Srinivasan, “Vibration analysis of shaft supported bearings considering balanced and unbalanced conditions”, DMS-2009, 26&27 March 2009, KCT, TN, India.
5. **M. Rajarathinam**, V. Hariharan and P.S.S. Srinivasan, “Vibration analysis of rolling element bearing under dynamic load condition”, DMM-2009, 12&13 March 2009, KEC, TN, India.

Invited Talk

1. “Innovations in Practice 2020” in Lublin, Poland, Energy Harvesting Workshop, 20 October 2020. Talk on “Simultaneous Energy Harvesting and Vibration Control using Dynamic Vibration Absorber”.

RESEARCH
INTERESTS

Dynamics, Energy Harvesting, Smart Structures and Vibration Control of Structures.

TEACHING
INTERESTS

Mechanical Vibrations, Strength of Materials, Finite Element Analysis, Fluid Mechanics and Machinery, Engineering Mechanics, Theory of Machines, Computer Aided Machine Drawing.

SOFTWARE
PROFICIENCY

CAD Software Packages:

AutoCAD, CATIA

Computational Software Packages:

MATLAB, ABAQUS

Other Software Packages:

LATEX, INKSCAPE, MAPLE

TEACHING
PROFILE

As a faculty, I have handled the following UG and PG Courses.

In Dr. MCET (Affiliated to Anna University)

Sr.No	Subjects Handled	Pass Percentage
1	Finite Element Analysis(PG)-2009 batch	100%
2	Fluid Mechanics and Machinery-2008 batch	90.91%
3	Transport Management-2007 batch	100%
4	Finite Element Analysis-2007 batch	93.55%
5	Fluid Mechanics and Machinery Lab-2008 batch	100%
6	Computer Aided Machine Drawing Lab-2008 batch	98.48%
7	Simulation and Analysis Lab-2007 batch	100%
8	Finite Element Analysis(PG) -2010 batch	100%
9	Hydraulic and Pneumatic Systems-2008 batch	96.17%
10	Strength of materials-2008 batch (Civil)	90.0%
11	Fluid Mechanics and Machinery Lab-2009 batch	100%
12	Engineering Practice Lab-2010 batch	98.33%
13	Kinematics and Dynamics Lab-2008 batch	100%
14	Strength of materials Lab-2008 batch (Civil)	100%

In Veltech Dr. RR & Dr. SR University

Sr.No	Subjects Handled (PG-Machine Design)	Pass Percentage
1	Finite Element Analysis	100%
2	Advanced Strength Of Materials	100%
3	Digital Manufacturing and RPT Lab	100%
4	Mechanical Vibrations	100%
5	Design For Manufacturing	100%
6	Innovative Test Lab	100%

OTHER
PROFESSIONAL
ACTIVITIES

In Dr Mahalingam College of Engineering and Technology (India)

- Department Office and Library Incharge
- Faculty Advisor
- AUT Audit Co-coordinator
- Time Table Incharge
- ISTE Committee Member
- Student's Project Supervisor
- Lab Incharge:
Prepared Simulation and Analysis Lab (Automobile) and Strength Of Materials Lab (Civil) Manuals

In Indian Institute of Technology Madras (India)

- UG Applied Mechanics Lab - Teaching Assistant's Coordinator.
- Various PG and UG course - Teaching Assistant.
- Short-Term Training Programme on "Computational Dynamics", Department of Applied Mechanics and Aerospace Engineering, 15 September 2014 - Volunteer.
- INCAM 2015, Department of Applied Mechanics - Volunteer.
- GIAN course: 171003L27 on Analysis and Design of Piezoelectric Vibration Energy", Department of Applied Mechanics- IITM, 30 October 2017 to 3 November 2017 - Volunteer.
- Short-Term Training Programme on 'Introduction to Smart Systems", Department of Applied Mechanics- IITM, 02-07 September 2018 - Volunteer.

FUTURE RESEARCH PLANS

Shortly, I am planning to develop a well-equipped vibration control and energy harvesting laboratory to carry out experimental and analytical research. Also, I am looking forward to write research proposals for national and international research funding which will help to develop the laboratory set-up.

At present, I am working on the experimental investigations of a broadband energy harvester with an array of electromagnetic units. The performance of the pendulum based harvester under mechanical and magnetic coupling will be investigated. Further, the proposed harvester will be used to power up wireless sensors for few practical applications.

In the long term, I will focus on developing the expertise and laboratory facilities to work on practical implementations of structural control and health monitoring systems. This will also be helpful in collaborating with the industry and carry out consultancy projects. The knowledge and expertise gained from this research may lead to the development of workable technology for smart, green and sustainable structures in the future.

REFERENCES

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Tamil Nadu, India.

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Indian Institute of Technology Madras
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