Adrian A. Rendon-Hernandez

Technical Expert Developing Creative Solutions to IoT (Internet of Things) Challenges by Maximizing the Benefits of Advanced Simulations

Multiphysics Simulation | Energy Harvesting Design | Wireless Power Transmission

Address: Gainesville, FL 32608, USA

Tel.: +1 352 870 0456 E-mail: abdala.rendon@gmail.com LinkedIn: www.linkedin.com/in/adrianrendon

WORK EXPERIENCE

University of Florida — 216 Larsen Hall, Gainesville, FL 32611-6200, USA

Post-Doctoral Research Associate — 10/14/2019 – To present

Achievements

- Increased lab productivity on an average of 15 % by publishing 12 articles and filling out 1 patent application
- Improved academia-industry engagement in the development of IoT systems with applied research projects
- Achieved effective cross-functional collaborations for analytical and experimental new product validations

Duties & Responsibilities

- Performing design, modeling, multiphysics simulation, fabrication, characterization, and validation of electromechanical devices such as electromagnetic, piezoelectric, magneto-electric energy converters, transducers, sensors, and wireless power receivers and transmitters through scientific method
- Preparing peer reviewed manuscripts, intellectual property applications, preparing/delivering presentations, as well as programmatic support and submission for funded research projects and research proposals

Projects on which I worked

- Piezoelectric wireless power receiver 'chip' for wearables and bio-implants: I carried out the design, modeling, and simulation for mechanical reliability and design optimization of a chip-sized wireless power receiver. This volume-efficient device (0.08 cm3) utilizes a meandering suspension and piezoelectric transduction to transfer energy wirelessly. More details can be found in our publications 10.1088/1361-665X/abe60f and 10.1109/WoW47795.2020.9291290
- Electrodynamic wireless power transfer (WPT) using micromachined silicon suspension: I performed the design, modeling, simulation, characterization and validation of a new miniature receiver for low-frequency (<1 kHz), near-field wireless power transfer. The device makes use of a serpentine suspension that leverages electrodynamic transduction–electromagnetic interaction between permanent magnets and coils–. More details can be found in our publications 10.1109/JMEMS.2020.3045350 and 10.3390/en14092368
- Dual-transduction electromechanical receiver for WPT: I performed the design, modeling, simulation and characterization of a dual-transduction micro receiver. A dual-transduction receiver has been demonstrated for the first time. Experimental results suggest an increase of the normalized power density about 18% when compared with single transduction device. Our publications 10.1109/MEMS51782.2021.9375416, 10.1109/Transducers50396.2021.9495543 and 10.1109/TPEL.2022.3140777
- Microfabricated electro-permanent magnet: I was responsible for the multiphysics modeling and simulation of an externally switchable miniature (3.6 x 3.6 x 0.3 mm3) electro-permanent magnet microfabricated on silicon wafers. The selected magnetic materials and corresponding fabrication methods are compatible with standard semiconductor processes, which enable batch fabrication capability. More details can be found in our publication 10.1109/LMAG.2021.3099454
- Hybrid piezo/magnetic transformer: I carried out the design, modeling, simulation and characterization of a novel electromechanical transformer that passively transfers electrical power between galvanically isolated ports by coupling electrodynamic and piezoelectric transducers. This sub-1 µW dissipation device achieves an open-circuit voltage gain of 48.7 when operating at 1015 Hz resonance frequency. More details can be found in our publications 10.3390/mi12101214 and 10.1109/PowerMEMS54003.2021.9658375
- Ultra-compact magneto-electric antenna nanowire: I was responsible for the modeling and multiphysics simulation of a novel approach for an ultra-compact antenna where the antenna size is much smaller than the electromagnetic wavelength. This device utilizes composite nanowires (strain-coupled piezoelectric + magnetostrictive materials) respond to an electromagnetic field by directly producing a voltage

- Magnetically coupled electromechanical resonators for WPT: I performed the design, modeling, simulation and characterization of a breakthrough WPT approach. In contrast to resonant inductive coupled WPT, this concept uses mechanical resonators rather than electrical resonators; permanent magnets rather than current-generated magnetic fields; and low-audio frequencies rather than RF frequencies. More details can be found in our publication 10.1109/MEMS51670.2022.9699458

Schneider Electric 408 Via de la Innovacion, Apodaca, NL 66629, MEXICO

Principal Technical Expert 11/5/2018 – 09/27/2019

Achievements

- Incorporated the newest multidisciplinary design software into product design by organization-wide efforts
- Accelerated an intellectual atmosphere conducive to the interchange of IoT-ideas by presenting at MEGHS

Duties & Responsibilities

- Developing innovative solutions to industrial and residential electromagnetic actuation and sensing applications, for instance, self-powered, wireless rocking switches for lighting applications
- Performing advanced simulations for new electromechanical devices and components aiming at validating design requirements fulfillment
- Interfacing with quality, design, industrialization and manufacturing teams for seamless integration of materials, software, and hardware on new product development processes

Projects on which I worked

- Beagle project: I was in charge to build the wireless switch multiphysics model which included an electromagnetic energy harvester with a wireless Bluetooth radio transmitter. I was able to quickly develop an accurate model for the whole system on a new simulation software Activate and Hyperstudy from Altair. This work was done in collaboration with the actuators team in France for the dynamic measures and parameters identification. This model was used to verify the robustness of the product
- Design optimization of an electromagnetic solenoid for a transfer switch: I worked on optimizing an electromagnetic solenoid of an automatic transfer switch to meet very specific actuation response times and operating temperature ranges. I used finite-element software FLUX from Altair to modeling and characterize the dynamic behavior of the device which was validated with experimental data. A design optimization process was then performed and as a result a new design was proposed
- Active participation at the internal technical community Micro Energy Harvesting Generation and Storage (MEHGS): I delivered two oral presentations on my research topics (energy harvesting for autonomous sensor nodes) for a specialized technical community on electronics and microenergy generation

Schneider Electric 408 Via de la Innovacion, Apodaca, NL 66629, MEXICO

Electromechanical Design Engineer 6/18/2012 – 11/5/2018

Achievements

- Coached 5 electrical engineers and 6 software developers toward embracing digitization across 19 projects
- Combined technical competence with dependability and loyalty to capitalize an educational leave (for PhD)

Duties & Responsibilities

- Performing, design and preparation of documents detailing the material requisitions, and assembly process of electromechanical devices (i.e., circuit breakers, motor control and protection and safety switches) for energy management in both industrial and residential applications.
- Modify design to correct operating deficiencies and/or reduce cost production issues, analyze engineering sketches, specifications and related data and drawings to determine design factors.
- Examine, prepare and verify technical drawings and specifications of electrical systems, to ensure that installation and operations conform to standards and customer requirements. Draft of detailed multi-view drawings of assemblies and sub-assemblies

Projects on which I worked

- Projects of type 'Product Evolution Process (PEP)' for the Switching and Controls business unit. I managed the cycle where electromechanical devices evolved in terms of features, functionalities, quality, offerings, and technology to better serve their purpose, customer needs, and to meet market standards.
- Project of type 'Project Management Process (PMP)' termed '*Velocity'*. In this project my role was Project Design Lead and was responsible for the quality, creativity, engineering, and delivery of the development of a modular-enclosed variable speed drive (for the range of 1 to 125 horsepower)

Alestra 175 Av. Munich, San Nicolas de los Garza, NL 66450, MEXICO

Optical Transmission Network Engineer 1/1/2009 – 1/8/2010

Acvhievements

- Awarded diligence and high-potential employee in recognition of an extensive contribution to department

Duties & Responsibilities

- Engineering, upgrade, technical oversight, and support for the optical and electrical transport networks of Alestra in Mexico and for its international connections with the network of AT&T in the U.S. including Dense Wavelength Division Multiplexing (DWDM), Synchronous Optical Networking (SONET), and Time Division Multiplexing (TDM) network infrastructures, equipment, and services.
- Provide engineering support during the installation and turn up of DWDM, SONET, and TDM network elements and Customer-premises equipment (CPE).

Projects on which I worked

- I worked on network planning and design including network protection schemes, network synchronization, and bandwidth availability and utilization. Also, I was responsible for the circuit design as per customer specifications including circuit protection, transport network selection, and interworking across networks.

TEACHING and RESEARCH EXPERIENCE

University of Brescia 38 Via Branze, I25123 Brescia, ITALY

Visiting PhD Candidate Researcher 3/13/2018 – 8/13/2018

Achievements, Duties & Responsibilities

- Developed a power management circuit for energy harvesting system and presented it at PowerMEMS18
- Research stay for a collaboration with the research group of prof. Vittorio FERRARI under the KIC InnoEnergy PhD school program

Polytech Grenoble 14 Place du Conseil National de la Résistance, 38400 St. Martin d'Hères, France

Teaching Assistant 12/1/2016 – 2/24/2018

Achievements, Duties & Responsibilities

- Taught and facilitated 4 physics lab courses for undergraduates in finite element analysis for microsystems
- Encouraged class discussions about advanced simulations into research and development with industries

Monterrey Institute of Technology 2501 Av. Eugenio Garza Sada, Monterrey 64849, NL, MEXICO

Research Assistant 1/11/2010 – 5/4/2012

- Achievements, Duties & Responsibilities
- Prepared, presented and defended novel research proposals on MEMS-based solution for water monitoring

EDUCATION

PhD, Doctor of Philosophy in Nanoelectronics & Nanotechnologies 10/1/2014 – 9/27/2018

Université Grenoble Alpes, Grenoble, France

Dissertation: "*Design, modeling and evaluation of a thermo-magnetically activated piezoelectric generator*"

Keywords: Thermo-magnetization, Piezoelectricity, Micro-power generators, multi-step energy conversion

Awards: Graduated congratulations of jury, National Grant Recipient 382045, KIC InnoEnergy certificate 18008

MSc, Master of Science in Electronic Systems Engineering 1/11/2010 – 5/4/2012

Thesis: "*A CMOS cantilever platform using adsorption-induced surface stress and piezoresistive transduction for biosensing*"

Keywords: Piezoresistivity, CMOS, MEMS sensors, adsorption-induced surface stress, water monitoring

Awards: National Scholarship Recipient 45345, ITESM Research Scholarship Recipient 10068

BSc, Bachelor of Science in Electronics & Communications Engineering 6/16/2003 – 12/1/2008

Autonomous University of Nuevo Leon, Monterrey, MEXICO

Awards: Graduated 1st in class 2008, Full scholarship recipient to spent 1year abroad @ Telecom INSA Lyon, FRANCE, Outstanding graduate engineering award of the year 2008 –National Association of Engineering Colleges and Schools (ANFEI) selects one most outstanding graduate for each university program per year–

Technical High School degree in Electronics 6/16/2003 – 12/1/2008

Centro de Bachillerato Tecnologico y de Servicios #36, Monclova, MEXICO

Awards: Graduated 2nd in class, finalist at National Mathematics Olympiad Contest 2003

SKILSS and INTERESTS

Computer	Finite-Element Analysis: ANSYS Maxwell, HFSS, Workbench, COMSOL Multiphysics, Altair Flux Design Exploration and Optimization: Altair Hyperstudy, Activate, Compose, Matlab/Simulink, Maple Electronic circuit simulation: PSpice, LTspice, Easy EDA, Cadence Allegro, KiCAD, Autocad Coding and documentation: LaTex, MS Office, C++, VHDL, FPGA
Hardware	Function generator, Network analyzer, Impedance meter, Oscilloscope, Tesla/Gauss meter, Lock-in amplifier, Multimeter, Data Acquisition Board (i.e., Diligent DAD2)
Language	Fluency in English and French (DALF C1 license No. 033076-008644). Native Spanish speaker

ACTIVE PARTICIPATION AS REVIEWER

- Science Progress, SAGE Journals, ISSN 00368504
- Transactions on Industrial Electronics, Institute of Electrical and Electronics Engineers (IEEE), ISSN 0278-0046
- Electronics, Multidisciplinary Digital Publishing Institute (MDPI), ISSN 2079-9292
- Energies, MDPI, ISSN 1996-1073
- Journal of Sensor and Actuator Networks, MDPI, ISSN 2224-2708
- Applied Sciences, MDPI, ISSN 2076-3417
- Journal of the Brazilian Society of Mechanical Sciences and Engineering, Springer, ISSN 1806-3691

SCIENTIFIC PRODUCTION

Patents

I. Hybrid Electromechanical Transformer, Reference number: US 63223756, Filed on: July 20, 2021, Subject: Electromechanical devices, Status: Provisional Application filed.

Referred (Peer Reviewed) Journal Articles

[1] “Miniature Electrodynamic Wireless Power Transmission Receiver Using a Micromachined Silicon Suspension”
[2] “Microfabricated Electro-permanent Magnets Using AlNiCo and CoPt”
[3] “A chip-sized piezoelectric receiver for low-frequency, near-field wireless power transfer: design, modeling and experimental validation”
[4] “A Wirelessly Rechargeable AA Battery Using Electrodynamic Wireless Power Transmission”
[5] “Hybrid Piezo/Magnetic Electromechanical Transformer”
[6] “Analysis of a Dual-Transduction Receiver for Electrodynamic Wireless Power Transfer”
[7] “On the design of a thermo-magnetically activated piezoelectric micro-energy generator: working principle”

Referred (Peer Reviewed) Papers in Conference Proceedings

[8] “Nondestructive characterization of residual stress within CMOS-based composite microcantilevers” (oral presentation)
[9] “Coupled multiphysics finite element model and experimental testing of a thermo-magnetically triggered piezoelectric generator” (oral presentation)
[10] “On the design guidelines for miniaturizing thermo-magnetically activated piezoelectric energy generator” (oral presentation)
[11] “Electrical modelling and characterization of a Thermo-Magnetically Activated Piezoelectric Generator (TMAPG)” (poster)
[12] “An Electrodynamic Wireless Power Receiver ‘Chip’ for Wearables and Bio-implants”
[13] “Dual-Transduction Electromechanical Receiver for Near-Field Wireless Power Transmission”

[14] “Electromechanical modeling and experimental validation of a dual-transduction electrodynamic wireless power receiver”
[15] “High-Gain AC-DC Step-Up Converter Using Hybrid Piezo/Magnetic Electromechanical Transformer”
[16] “Magnetically Coupled Microelectromechanical Resonators for Low-Frequency Wireless Power Transfer”

Master of Science Thesis and PhD Dissertation

[17] “A CMOS cantilever platform using adsorption-induced surface stress and piezoresistive transduction for biosensing” Master of science thesis, ITESM, Monterrey, Mexico 2009
[18] “Design, modeling, and evaluation of a thermo-magnetically activated piezoelectric generator”, PhD Dissertation, Université Grenoble Alpes, Grenoble, France, 2018

Workshops/Conferences (without proceedings)

[19] “Study of a piezoelectric microgenerator thermo- magnetically triggered” (oral presentation)
[20] “Design and optimization of a thermo-magnetically triggered piezoelectric micro-generator” (poster)
[21] “Conception et optimisation d’un générateur piézoélectrique à déclenchement thermomagnétique” (oral presentation)
[22] “Modeling and operating temperature tuning of a thermally activated piezoelectric generator” (oral presentation – Best paper and outstanding presentation award)
[23] “A PSpice model of a thermo-magnetically triggered piezoelectric generator” (poster)
[24] “ATCx Altair 2019 Mexico (oral presentation from Schneider Electric)”

References

[1] M. A. Halim, A. A. Rendon-Hernandez, S. E. Smith, J. M. Samman, N. Garraud, and D. P. Arnold, “Miniature Electrodynamic Wireless Power Transmission Receiver Using a Micromachined Silicon Suspension,” *J. Microelectromech. Syst.*, vol. 30, no. 1, pp. 144–155, Feb. 2021, doi: 10.1109/JMEMS.2020.3045350.
[2] Y. Wang, B. Y. Jimenez, C. S. Smith, A. A. Rendon-Hernandez, J. Samman, and D. P. Arnold, “Microfabricated Electro-permanent Magnets Using AlNiCo and CoPt,” *IEEE Magn. Lett.*, pp. 1–1, 2021, doi: 10.1109/LMAG.2021.3099454.
[3] M. A. Halim, A. A. Rendon-Hernandez, S. E. Smith, and D. P. Arnold, “A chip-sized piezoelectric receiver for low-frequency, near-field wireless power transfer: design, modeling and experimental validation,” *Smart Mater. Struct.*, vol. 30, no. 4, p. 045011, Apr. 2021, doi: 10.1088/1361-665X/abe60f.
[4] S. E. Smith, M. A. Halim, S. T. Chyczewski, A. A. Rendon-Hernandez, and D. P. Arnold, “A Wirelessly Rechargeable AA Battery Using Electrodynamic Wireless Power Transmission,” *Energies*, vol. 14, no. 9, p. 2368, Apr. 2021, doi: 10.3390/en14092368.
[5] A. A. Rendon-Hernandez, S. E. Smith, M. A. Halim, and D. P. Arnold, “Hybrid Piezo/Magnetic Electromechanical Transformer,” *Micromachines*, vol. 12, no. 10, p. 1214, Oct. 2021, doi: 10.3390/mi12101214.
[6] M. A. Halim, A. A. Rendon-Hernandez, S. E. Smith, and D. P. Arnold, “Analysis of a Dual-Transduction Receiver for Electrodynamic Wireless Power Transfer,” *IEEE Trans. Power Electron.*, pp. 1–1, 2022, doi: 10.1109/TPEL.2022.3140777.
[7] A. A. Rendon-Hernandez and S. Basrour, “On the design of a thermo-magnetically activated piezoelectric micro-energy generator: working principle,” *Sensors 2022, 22,* 1610. doi: 10.3390/s22041610.
[8] A. A. Rendon-Hernandez, S. Camacho-Leon, and S. O. Martinez-Chapa, “Nondestructive characterization of residual stress within CMOS-based composite microcantilevers,” in *SPIE Smart Structures*

and Materials + Nondestructive Evaluation and Health Monitoring, San Diego, California, USA, Apr. 2013, p. 869405. doi: 10.1117/12.2009903.
[9] A. A. Rendon-Hernandez and S. Basrour, "Coupled multiphysics finite element model and experimental testing of a thermo-magnetically triggered piezoelectric generator," in *Journal of Physics: Conference Series*, Paris, France, Nov. 2016, vol. 773, p. 012024. doi: 10.1088/1742-6596/773/1/012024.
[10] A. A. Rendon-Hernandez and S. Basrour, "On the design guidelines for miniaturizing thermo-magnetically activated piezoelectric energy generator," in Journal of Physics: Conference Series, Jul. 2018, vol. 1052, p. 012053. doi: 10.1088/1742-6596/1052/1/012053.
[11] A. A. Rendon-Hernandez, M. Ferrari, S. Basrour, and V. Ferrari, "Electrical modelling and characterization of a Thermo-Magnetically Activated Piezoelectric Generator (TMAPG)," in *Journal of Physics: Conference Series*, Nov. 2019, vol. 1407, p. 012058. doi: 10.1088/1742-6596/1407/1/012058.
[12] M. A. Halim, A. A. Rendon-Hernandez, and D. P. Arnold, "An Electrodynamic Wireless Power Receiver 'Chip' for Wearables and Bio-implants," in *2020 IEEE PELS Workshop on Emerging Technologies: Wireless Power Transfer (WoW)*, Jan. 2020, pp. 271–274. doi: doi: 10.1109/WoW47795.2020.9291290.
[13] S. E. Smith, M. A. Halim, A. A. Rendon-Hernandez, and D. P. Arnold, "Dual-Transduction Electromechanical Receiver for Near-Field Wireless Power Transmission," in *2021 IEEE 34th International Conference on Micro Electro Mechanical Systems (MEMS)*, Gainesville, FL, USA, Jan. 2021, pp. 38–41. doi: 10.1109/MEMS51782.2021.9375416.
[14] M. A. Halim, S. E. Smith, A. A. Rendon-Hernandez, and D. P. Arnold, "Electromechanical modeling and experimental validation of a dual-transduction electrodynamic wireless power receiver," in *2021 IEEE 21st International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers)*, Virtual Conference, Jun. 2021, vol. 21, pp. 1335–1338. doi: 10.1109/Transducers50396.2021.9495543.
[15] A. A. Rendon-Hernandez, M. A. Halim, S. E. Smith, and D. P. Arnold, "High-Gain AC-DC Step-Up Converter Using Hybrid Piezo/Magnetic Electromechanical Transformer," in *2021 IEEE 20th International Conference on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS)*, Exeter, United Kingdom, Dec. 2021, pp. 56–59. doi: 10.1109/PowerMEMS54003.2021.9658375.
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[18] A. A. Rendon-Hernandez *" Design, modeling and evaluation of a thermo-magnetically activated piezoelectric generator",* PhD Dissertation, Université Grenoble Alpes, Sep. 2018, http://tima.univ-grenoble-alpes.fr/publications/files/th/2018/2018_09_27_RENDON_HERNANDEZ_Adrian_474.pdf
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[24] A. A. Rendon-Hernandez, “Testing, modeling and simulation of the performance of an electromagnetic harvesting power generator for self-powered wireless lighting switch application”, ATCx Mexico, Altair, Cd. de México, 2019.