

# Ahmed Allam, Ph.D.

Postdoctoral fellow,

G. W. Woodruff School of Mechanical Engineering, Georgia Institute of Technology

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## PROFILE

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A postdoctoral fellow with research experience in smart materials and acoustics, as well as strong communication skills gained through teaching and working with multidisciplinary teams from academia and the industry. Special experience in:

- Wave propagation, acoustics, and vibrations
- Smart materials, metamaterials, and piezoelectric transducers
- Analytical and numerical modeling
- Data acquisition and signal processing
- Phased array systems and ultrasonic NDE
- Automation and mechatronics systems design

## EDUCATION

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**Georgia Institute of Technology.** Atlanta, GA

*PhD in Mechanical Engineering.* 2021

Focus: Acoustics and Vibration. Minor: Automation, Robotics and Control

Dissertation: Acoustic Power Transfer Leveraging Piezoelectricity and Metamaterials.

Advisers: Prof. Alper A. Erturk and Prof. Karim Sabra

**Ain Shams University.** Cairo, Egypt

*MSc in Mechanical Engineering.* 2017

Thesis: Wave Propagation Control Using Active Acoustic Metamaterials

Advisers: Prof. Wael Akl and Prof. Adel Elsabbagh

*BSc in Mechatronics Engineering with High Honors.* 2012

Graduation Project: Development of Piezoelectric Harvester Subjected to Magnetic Constraining Field

## RESEARCH EXPERIENCE

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**Smart Structures and Dynamical Systems Lab (SSDSL), Georgia Tech.** Atlanta, GA Jan. 2018 – Present

*Postdoctoral Fellow (Sept 2021 – Present)*

Supervising 3 Ph.D. students working on 3 research projects funded by Sandia National Laboratories and the NSF under the supervision of Prof. Alper Erturk

- Prototyping a portable ultrasonic data transfer system for transmitting data sealed metallic enclosure.
- Developing an active acoustic tag for underwater navigation.
- Investigating a high-intensity focused ultrasound (HIFU) solution for high strain rate testing of materials.

*Graduate Research Assistant* (Jan 2018 – Aug 2021)

Worked on 3 funded research projects under the supervision of Prof. Alper A. Erturk and Prof. Karim Sabra.

- Collaborated with 8 lab peers, 3 visiting scholars, and external collaborators from the industry, national labs, and other universities.
- Recommended and handled the requisition of **key lab equipment** including an ultrasonic phased array system, 3D printers, hydrophones, data acquisition systems, and other testing equipment.
- **Designed and fabricated** severable **wideband piezoelectric immersion transducers** capable of transmitting power and data simultaneously underwater using ultrasonic waves.
- Collaborated with Sandia National Labs to develop a **portable ultrasonic power transfer system prototype** for sealed metallic enclosures. The device was capable of transmitting 3W of power with 50% efficiency without the need for liquid coupling.

- Collaborated with engineers from Tronos Inc, and Prof. Massimo Ruzzene from the University of Colorado to develop concepts for **non-destructive testing of 3D-printed aerospace components** using phased arrays and scanning laser vibrometry. Defects down to 0.25 mm were detected in 3D-printed Inconel 625 alloys.
- Constructed and programmed a **3-axis automated stage** for a scanning hydrophone setup.
- Designed, 3D-printed, and experimentally tested the **first 3D acoustic lens** for focusing aqueous ultrasonic waves using **graded phononic crystals/metamaterials** concepts.
- Created and tested an **airborne sound energy harvesting system** leveraging phononic crystals for enhanced electric power output. The harvesting system generated 1.2 $\mu$ W of power compared to nWs previously reported in literature.
- Developed new **analytical models** to simulate acoustic power transfer systems with practical transducer sizes.
- Teamed with a visiting scholar to develop a new class of **active piezoelectric metamaterials** for manipulating **surface acoustic waves**. The material can be programmed to convert surface waves to shear waves or reflect them completely.

Ain Shams University ([ASU](#)). Cairo, Egypt

Sept. 2012 – Jan. 2018

**Research Assistant, Group for Advanced Research in Dynamic Systems [ASU-GARDS](#)**

Worked on 3 research projects funded by the EU in the fields of acoustics, educational software, vocational education, and virtual reality.

- Designed, modeled, and experimentally tested a new class of **active acoustic metamaterials** based on the adaptive feedback control of a piezoelectric diaphragm. The material is the 1<sup>st</sup> to achieve a wide range of actively **programmed density**.
- Programmed 3 **virtual laboratory experiments** that were integrated into Mechanical Design/Acoustics /Electrochemistry undergraduate courses helping potentially thousands of students.

## HONORS AND AWARDS

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International student stipend from the Acoustical Society of America (ASA).	2014
Certificate of merit from the Egyptian president for academic achievement.	2013
Faculty of Engineering Dean's list at Ain Shams University for academic achievement.	2007 – 2012

## PUBLICATIONS AND CONFERENCES ([GOOGLE SCHOLAR PROFILE](#))

### Journal Publications

1. **A. Allam**, C. Sugino, M. Harding, P. Bishop, A. Erturk, & M. Ruzzene, Phased array ultrasonic testing of Inconel 625 produced by selective laser melting, *ASME J Nondestructive Evaluation*, vol. 4, no. 041006, May 2021.
2. **A. Allam**, K. Sabra, & A. Erturk, Sound energy harvesting by leveraging a 3D-printed phononic crystal lens, *Applied Physics Letters*, vol. 118, no. 10, p. 103504, Mar. 2021.
3. **A. Allam**, K. Sabra, & A. Erturk, 3D-printed gradient-index phononic crystal lens for underwater acoustic wave focusing *Physical Review Applied*, vol. 13, no. 6, p. 064064, June 2020.
4. **A. Allam**, K. Sabra, & A. Erturk, Aspect ratio-dependent dynamics of piezoelectric transducers in wireless acoustic power Transfer, *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, vol. 67, no. 5, pp. 984–996, May 2020.
5. S. Alan\*, **A. Allam**\*, & A. Erturk, Programmable mode conversion and bandgap formation for surface acoustic waves using piezoelectric metamaterials, *Applied Physics Letters*, vol. 115, no. 9, p. 093502, Aug 2019. (\*contributed equally to this study)
6. **A. Allam**, A. Elsabbagh, & W. Akl, Experimental demonstration of one-dimensional active plate-type acoustic metamaterial with adaptive programmable density, *The Journal of Applied Physics*, 121(12), 125106, Mar 2017.
7. **A. Allam**, A. Elsabbagh, & W. Akl, Modeling and design of two-dimensional membrane-type acoustic metamaterials with tunable anisotropic density, *The Journal of the Acoustic Society of America*, 140, 3607, Nov 2016.

### Submitted Journal Manuscripts

8. **A. Allam**, O. Alfahmi, H. Patel, C. Sugion, M. Harding, M. Ruzzene, & A. Erturk, Ultrasonic testing of thick and thin Inconel 625 alloys manufactured by selective laser melting, under revision, *Additive Manufacturing*.
9. **A. Allam**, H. Patel, C. Sugion, C. Arrington, C. St. John, J. Steinfeldt, A. Erturk, & I. El-Kady, Portable through-metal ultrasonic power transfer using a dry-coupled detachable transmitter, under revision, *IEEE Transactions on Industrial Electronics*.

10. **A. Allam**, C. Sugion, C. Arrington, C. St. John, J. Steinfeldt, A. Erturk, & I. El-Kady, System-level DC-to-DC analysis and experiments of ultrasonic power transfer through metallic barriers, under revision, Ultrasonics.

#### **Journal Manuscripts under Preparation**

11. **A. Allam**, K. Sabra, & A. Erturk, Acoustic and electrical impedance matching for simultaneous power and data transfer.

#### **Conference Presentations and Publications:**

1. **A. Allam**, K. Sabra, & A. Erturk, Double phononic crystal lens-based enhancement of underwater power transfer, 181st Meeting of the Acoustical Society of America, Seattle, Washington, 29 Nov - 3 Dec 2021.
2. **A. Allam**, H. Patel, C. Sugion, C. Arrington, C. St. John, J. Steinfeldt, A. Erturk, & I. El-Kady, Detachable dry-coupled ultrasonic power transfer through metallic enclosures, in IEEE Ultrasonics Symposium (IUS), Virtual, Online, 11-16 Sep 2021.
3. Khotanen E, C. Sugion, **A. Allam**, A. Erturk, & I. El-Kady, Computational optimization of mechanical energy transduction (COMET) toolkit, in IEEE Ultrasonics Symposium (IUS), Virtual, Online, 11-16 Sep 2021.
4. C. Sugion, Oxandale S, **A. Allam**, C. Arrington, C. St. John, Baca E, J. Steinfeldt, Swift S, Reinke C, A. Erturk, & I. El-Kady, Experimental validation of crosstalk minimization in metallic barriers with simultaneous ultrasonic power and data Transfer, in IEEE Ultrasonics Symposium (IUS), Virtual, Online, 11-16 Sep 2021.
5. **A. Allam**, K. Sabra, & A. Erturk, Enhanced sound energy harvesting by leveraging gradient-index phononic crystals, in ASME 2020 Conference on Smart Materials, Adaptive Structures & Intelligent Systems, Virtual, Online, 15 Sep 2020.
6. **A. Allam**, C. Sugion, M. Harding, P. Bishop, A. Erturk, M. Ruzzene, Ultrasonic inspection of additive manufactured components, QNDE 2020, Virtual, Online Conference, 25 -26 Aug 2020.
7. **A. Allam**, K. Sabra, and A. Erturk, Controlling underwater sound propagation using 3-D-printed phononic crystals, 178th Meeting of the Acoustical Society of America, San Diego, California, 2-6 Dec 2019.
8. **A. Allam**, K. Sabra, and A. Erturk, Gradient index phononic crystals for manipulating sound in acoustic power transfer applications, Phononics 2019, Tucson, Arizona, 3-7 June 2019.
9. S. Alan, **A. Allam**, and A. Erturk, Surface acoustic wave manipulation using piezoelectric metamaterials, Phononics 2019, Tucson, Arizona, 3-7 June 2019.
10. **A. Allam**, K. Sabra, and A. Erturk, Comparison of various models for piezoelectric receivers in wireless acoustic power transfer, in Active and Passive Smart Structures and Integrated Systems XIII, Denver, Colorado, 2019, vol. 10967, p. 109670S.
11. **A. Allam**, and T. Elnady, Characterization of mufflers, in proceedings of the 22nd International Congress on Acoustics, Buenos Aires, Sept. 2016.

#### **TEACHING AND MENTORING EXPERIENCE**

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**Georgia Institute of Technology**, Atlanta, GA

Jan. 2018 – Present

*Postdoctoral Fellow (Sept 2021 – Present)*

Mentor for:

- Matthew Irving, 1<sup>st</sup> year Ph.D. student at Georgia Tech.  
Working on data transfer through metallic enclosures.
- Jacob Brody, 1<sup>st</sup> year Ph.D. student at Georgia Tech.  
Investigating high strain rate testing of materials using HIFU.
- Ananya Bhardwaj, 1<sup>st</sup> year Ph.D. student at Georgia Tech.  
Developing smart acoustic tags for underwater tags.

*Graduate Research Assistant (Jan 2018 – Aug 2021)*

Mentor for:

- Natasha Najmi, junior student at Georgia Tech  
Currently: Systems and Product Integration Co-op at Amazon Robotics.  
Research goals: Layout and assemble an amplifier PCB for ultrasonic power transfer systems.  
Perform experiments to measure system performance.
- Herit Patel, MSc student at Georgia Tech

Spring 2021

Fall 2020 & Spring 2021

Currently: Structures and Dynamics Engineer at Aerojet Rocketdyne

Research goals: Design a magnetic assembly for detachable ultrasonic power transfer.

Simulate ultrasonic phased arrays using the FEM.

Use laser Doppler vibrometry to detect defects in 3D-printed components.

- Clement Loneux, visiting scholar from Institut Catholique d'Arts et Métiers, France

Spring 2020

Currently: Space Systems Engineer at Space Exploration and Development Systems SEEDS

Research goals: Simulate the behavior of phononic crystal lenses using the finite element method.

- Mark Saad, senior student at Georgia Tech

Spring & Fall 2019

Currently: Software Engineer at Mathworks.

Research goals: Test the elastic and acoustic properties of 3D-printed polymers using thin rod vibrations.  
3D print phononic crystal lenses for underwater applications.

**Ain Shams University (ASU)**, Cairo, Egypt

March, 2014 – Jan. 2018

### ***Teaching Assistant, Mechatronics Department***

- Prepared lab materials, conducted labs, recitations, and practical tutorials; held weekly office hours; graded assignments, projects, and exams for undergraduate classes ( $\approx 50$  students per class). The courses taught were:
  - Modeling of Dynamic Systems (3 semesters),
  - Design of Measurement Systems (2 semesters),
  - Automatic Control (2 semesters),
  - Mechatronic Systems (3 semesters),
  - Mechanical Engineering Drawing (2 semesters),
  - Digital Image Processing,
  - Instrumentation using Micro Electromechanical Systems (MEMS).
- **Developed** teaching material for a new **diploma** for the development and training of **vocational teachers** in Egypt.
- Streamlined the assignment of teaching workload among 12 TAs in the mechatronics department.
- Prepared and conducted an introductory class to modeling and simulation using MATLAB and SIMULINK ( $\approx 12$  students).
- Prepared lab material and activities for a **C++ programming class**.
- Created and published **online educational videos** for the “Digital Image Processing” class.
- **Mentored 6 groups** of 4-5 students working on a variety of projects such as integrated measurement systems, mobile robots, articulated robotic arms, and other mechatronics projects.
- **Mentored 5** students to develop an automatic score estimator for the speedball sport.
- Maintained and updated the **mechatronics department website and social media** with an outreach of 250 students.

## **INDUSTRIAL EXPERIENCE**

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**Abbott Laboratories**, Atlanta, GA

Oct. 2021 – Present

### ***Sr. Test and Automation Engineer***

Responsibilities: Design, maintain, and upgrade test and automation equipment for verifying the performance of an implanted wireless and batteryless pulmonary artery blood pressure monitoring device.

**Elnady Engineering & Agencies (NC): Acoustics & Software Development**, Cairo, Egypt

Jan. 2016 – Jan. 2018

### ***Acoustic Engineer***

Worked with a **multidisciplinary team** of 5 engineers to develop software and hardware solutions for simulating sound propagation in ducts, muffler design, and experimental testing.

- Redesigned a software module for **exciting loudspeakers & collecting microphone signals** using the 4-microphone technique. The new module increased the acquisition speed 5 times without sacrificing accuracy.
- Integrated the module in **SIDLAB** commercial software for analyzing sound in ducts and **acoustic testing automation**.
- Collaborated with a group of multidisciplinary engineers to design, fabricate, and commission 3 setups for **acoustic testing of mufflers** to customers in the USA, China, Germany, and the UAE.

- Created a **data acquisition module** for testing **sound transmission** losses in **building materials**.
- Delivered the module to customers and provided comprehensive training on using the software.

## **SKILLS & INTERESTS**

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### **Technical:**

Proficient: Piezoelectric transducer design, FEA, lumped-parameter modeling, multiphysics modeling & simulation, data acquisition & signal processing, acoustic testing, 3D printing, scanning laser vibrometry, vibration analysis-measurement & control, underwater acoustic measurements, ultrasonic phased arrays, array beamforming, ultrasonic imaging.

Good command: RF and electronic circuit design, microcontrollers, mechanical design, traditional machining.

### **Programming Languages:**

Proficient: MATLAB, C/C++, JAVA. Good command: Python.

### **Engineering Software:**

Proficient: COMSOL Multiphysics, MATLAB, LabVIEW, Labwindows CVI.

Good command: SolidWorks, Keysight ADS, ANSYS APDL, Mathematica, SIMULINK.

Familiar: Autodesk Inventor, Simscape, ANSYS Workbench, AUTOCAD.

### **Laboratory Equipment:**

Proficient at using: Oscilloscopes, DAQs, signal generators, pulsers, impedance analyzers, hydrophones, microphones, power amplifiers, speakers, shakers, accelerometers, laser vibrometers, FDM & SLA 3D printers, laser cutters, bench drills, mills.

### **Other Software:**

Linux (Ubuntu and Debian), Latex, Git, JIRA, Microsoft office.

### **Languages:**

Fluent: English. Native: Arabic. Conversational: French, Spanish.

### **Hobbies:**

Learning new languages, DIY projects, car maintenance, soccer, technology enthusiast.

## **LEADERSHIP**

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- **Ain Shams University Student Union:** elected as a member of the scientific committee. Organized 3 seminars, 2 technical workshops, and 4 events aiming to spread scientific research awareness among  $\approx$  1000 undergraduate students (2011 – 2012)
- **Class Representative:** Elected to represent the Mechatronics class of 2012. (2010 – 2012)