Ahmed Allam, Ph.D.

Assistant Professor, Mechanical & Materials Engineering, University of Cincinnati

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PRINCIPAL AREAS OF INTEREST

Acoustics, Metamaterials, Piezoelectric Transducers, IoT, Ultrasonic Power Transfer, Underwater Comms

RESEARCH EXPERIENCE

University of Cincinnati. Cincinnati, OH — Jan 2024 – Present

***Assistant Professor,* Mechanical & Materials Engineering Department**

Leading the UC Metasonics lab, which integrates fundamental concepts from wave propagation, material science, signal processing, & electronics to build acoustic systems that solve global challenges in ecology, health, & industry.

MIT Media Lab, Massachusetts Institute of Technology. Cambridge, MA — Aug 2022 – Dec 2023

***Postdoctoral Associate,* Signal Kinetics Group**

Developed underwater battery-free sensor nodes and systems for the Ocean Internet of Things**.**

- Received **Best Paper Award** in Mobicom ’23, the leading conference on mobile communication, for deriving the 1st link-budget model for calculating the range of underwater backscatter communication.
- Co-founded Sensea, a leading start-up for commercializing ultra-low power underwater IoT sensors for Aquaculture. **MIT $100K Launch 3rd place winner**.
- Developed technical content for 3 research proposals raising more than $1M of funding from ONR and NSF.

Smart Structures and Dynamical Systems Lab (SSDSL), Georgia Tech. Atlanta, GA — Jan 2018 – Aug 2022

Graduate Research Assistant (Jan 2018 – Aug 2021), ***Postdoctoral Fellow*** (Sept 2021 – Aug 2022)

Led 6 research projects funded by the NSF, Sandia National Labs, the ONR, and Tronos Jet Inc. under the supervision of Prof. Alper Erturk and Prof. Karim Sabra.

- Recommended and handled the **requisition of key laboratory equipment,** including an ultrasonic phased array system, 3D printers, hydrophones, data acquisition systems, and other testing equipment.
- Designed and tested the **first 3D acoustic metalens** for focusing aqueous ultrasonic waves.
- Designed and fabricated wideband **piezoelectric immersion transducers** capable of transmitting power and data simultaneously underwater using ultrasonic waves.
- Patented a **portable ultrasonic charger** for sealed metallic enclosures.
- Collaborated to develop ultrasonic solutions for the **non-destructive testing of 3D-printed metallic components** using phased arrays and scanning laser vibrometry.
- Created and tested an **airborne sound energy harvesting system** leveraging phononic crystals for enhanced electric power output. The system generated µWs compared to nWs previously reported.
- Developed new **analytical models** for **piezoelectric transducers** in space-restricted environments.
- Teamed with a visiting scholar to develop a novel **active metamaterial** for manipulating **surface acoustic waves**. The material enables mechanically switchable SAW filters for wireless communications.

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 European Union in the fields of acoustics, educational software, vocational education, and virtual reality.

- Designed, modeled, and experimentally tested an **active acoustic metamaterial** based on the adaptive feedback control of a piezoelectric bimorph. The material is the 1st to achieve a wide frequency range of actively **programmed density**.
- Programmed 3 **virtual laboratory experiments** integrated into Mechanical Design/ Acoustics/ Electrochemistry undergraduate courses taught to thousands of students at ASU.

EDUCATION

Georgia Institute of Technology. Atlanta, GA
Ph.D. *in Mechanical Engineering.* GPA 4.0/4.0 2021
Focus: Acoustics and Vibrations. Minor: Automation, Robotics, and Controls
Dissertation: Acoustic Power Transfer Leveraging Piezoelectricity and Metamaterials.
Advisors: Prof. Alper Erturk and Prof. Karim Sabra

Ain Shams University. Cairo, Egypt
M.Sc. *in Mechanical Engineering.* GPA 3.9/4.0 2017
Thesis: Wave Propagation Control Using Active Acoustic Metamaterials
Advisors: Prof. Wael Akl and Prof. Adel Elsabbagh

B.Sc. *in Mechanical Engineering with Honors.* GPA 3.88/4.0 (Ranked 1st among ~1500 students) 2012
Focus: Mechatronics Engineering
Graduation Project: Development of Piezoelectric Harvester Subjected to Magnetic Constraining Field

PUBLICATIONS, PATENTS, AND CONFERENCES (GOOGLE SCHOLAR PROFILE)

Peer Reviewed Journal Publications & Conference Proceedings:

1. A. Bhardwaj, **A. Allam**, A. Erturk, and K. G. Sabra, "Ultrasound-Powered Wireless Underwater Acoustic Identification Tags for Backscatter Communication," IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, vol. 71, no. 2, pp. 304–313, Feb. 2024, doi: 10.1109/TUFFC.2023.3344638.
2. W. Akbar, **A. Allam**, and F. Adib, "The Underwater Backscatter Channel: Theory, Link Budget, and Experimental Validation," in Proceedings of ACM MobiCom 2023. Oct. 2023, pp. 1–15. doi: 10.1145/3570361.3613265. **(Best Paper Award)**
3. A. Eid, J. Rademacher, W. Akbar, P. Wang, **A. Allam**, and F. Adib, "Enabling Long-Range Underwater Backscatter via Van Atta Acoustic Networks," in Proceedings of the ACM SIGCOMM '23. Sep. 2023, pp. 1–19. doi: 10.1145/3603269.3604814.
4. **A. Allam**, C. L. Arrington, C. St. John, J. Steinfeldt, A. Erturk, and I. El-Kady, "System-Level DC-to-DC Analysis and Experiments of Ultrasonic Power Transfer Through Metallic Barriers," IEEE/ASME Transactions on Mechatronics, pp. 1–11, Aug. 2022, doi: 10.1109/TMECH.2022.3195973.
5. **A. Allam**, K. Sabra, and A. Erturk, "Piezoelectric transducer design for simultaneous ultrasonic power transfer and backscatter communication," Smart Mater. Struct., vol. 31, no. 9, p. 095003, Jul. 2022, doi: 10.1088/1361-665X/ac7b57.
6. **A. Allam**, O. Alfahmi, H. Patel, C. Sugino, M. Harding, M. Ruzzene, & A. Erturk, "Ultrasonic testing of thick and thin Inconel 625 alloys manufactured by laser powder bed fusion," Ultrasonics, vol. 125, p. 106780, Sep. 2022, doi: 10.1016/j.ultras.2022.106780.
7. **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, doi: 10.1115/1.4050963
8. **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, doi: 10.1063/5.0030698

9. **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, doi: 10.1103/PhysRevApplied.13.064064
10. **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, doi: 10.1109/TUFFC.2019.2962711
11. 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, doi: 10.1063/1.5110701
12. **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, doi: 10.1063/1.4979020
13. **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, doi: 10.1121/1.4966627

Submitted Journal Manuscripts:

14. **A. Allam,** H. Patel, C. Sugino, 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 review, Ultrasonics.

In preparation:

15. W. Akbar, **A. Allam**, & F. Adib, On the limits of bandwidth and range of underwater backscatter communication.

Patents

1. I. El-Kady, G. Ten Eyck, **A. Allam**, and A. Erturk. 2022. Detachable Through-Wall Ultrasonic Transducer System, U.S. Patent 63/401,849, filed Sept 21, 2022. Provisional patent.

Conference Proceedings, Demos, Posters, & Presentations:

1. **A. Allam**, W. Akbar, and F. Adib, "Demo: Underwater Backscatter Link Budget Tool," in Proceedings of the ACM SIGCOMM 2023 Conference. Sep. 2023, pp. 1191–1192. doi: 10.1145/3603269.3610836.
2. **A. Allam**, W. Akbar, and F. Adib, "An analytical framework for low-power underwater backscatter communications," in the184th Meeting of the Acoustical Society of America, Chicago, IL, 8-12 May. doi: 10.1121/10.0019235.
3. A. Bhardwaj, **A. Allam**, A. Erturk, and K. G. Sabra, "Optimizing wireless acoustic energy harvesting and communication with passive markers underwater," in the184th Meeting of the Acoustical Society of America, Chicago, IL, 8-12 May. doi: 10.1121/10.0019099.
4. **A. Allam** et al., "Ultrasonic inspection of additively manufactured metallic components using bulk and guided waves," in Health Monitoring of Structural and Biological Systems XVI, Apr. 2022, vol. 12048, pp. 195–201.
5. **A. Allam**, A. Bhardwaj, K. Sabra, and A. Erturk, "Piezoelectric transducer design and impedance tuning for concurrent ultrasonic power and data transfer," in Active and Passive Smart Structures and Integrated Systems XVI, Apr. 2022, vol. 12043, pp. 84–103.
6. **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.
7. **A. Allam,** H. Patel, C. Sugino, 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.

8. E. Khotanen, C. Sugino, **A. Allam,** A. Erturk, & I. El-Kady, Computational optimization of mechanical energy transduction (COMET) toolkit, in IEEE Ultrasonics Symposium (IUS), Online, 11-16 Sep 2021.
9. C. Sugino, 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.
10. **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.
11. **A. Allam**, C. Sugino, M. Harding, P. Bishop, A. Erturk, M. Ruzzene, Ultrasonic inspection of additive manufactured components, Annual Review of Progress in Quantitative Nondestructive Evaluation QNDE 2020, Virtual, Online Conference, 25 -26 Aug 2020.
12. **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.
13. **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.
14. S. Alan, **A. Allam**, and A. Erturk, Surface acoustic wave manipulation using piezoelectric metamaterials, Phononics 2019, Tucson, Arizona, 3-7 June 2019.
15. **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.
16. **A. Allam**, and T. Elnady, Characterization of mufflers, in Proceedings of the 22nd International Congress on Acoustics, Buenos Aires, Sept. 2016.

TEACHING EXPERIENCE

Georgia Institute of Technology. Atlanta, GA — Jan 2018 – Aug 2022

- Conducted 2 lectures and graded assignments for the Advanced Vibrations graduate course (~25 students)
- Developed and conducted 2 lab sessions for the Wave Propagation in Solids graduate course (~30 students)

Ain Shams University (ASU). Cairo, Egypt — Mar 2014 – Jan 2018

Teaching Assistant, Mechatronics Department

- Prepared lab materials & projects, conducted labs, recitations, and practical tutorials; held weekly office hours; graded assignments, projects, and exams for 9 undergraduate courses (~ 50 students per course), including:
    1. Modeling of Dynamic Systems (Fall 2014, Fall 2015, Fall 2016, Spring 2017, Fall 2017)
    2. Design of Measurement Systems (Fall 2014, Spring 2017)
    3. Automatic Control (Spring 2016, Summer 2016)
    4. Mechatronic Systems I-II (Fall 2014, Spring 2015, Fall 2016, Spring 2017)
    5. Mechanical Engineering Drawing (Spring 2016, Spring 2017)
    6. Digital Image Processing (Spring 2014, Spring 2015, Spring 2016)
    7. Instrumentation using Micro Electromechanical Systems MEMS (Spring 2014, Spring 2015)
    8. Introduction to Programming (Fall 2014, Fall 2015, Fall 2016)
    9. Introduction to Robotics (Fall 2017)
- **Developed** teaching material for a new **diploma** to train **vocational teachers** in Egypt.
- Prepared and conducted an introductory class on modeling and simulation using MATLAB (12 students).
- Created and published **online educational videos** for the "Digital Image Processing" course.

MENTORING & LEADERSHIP EXPERIENCE

Massachusetts Institute of Technology. Cambridge, MA Aug 2022 – Jan 2024

- Mentored 4 Ph.D. students, working on 3 research projects resulting in 3 high-visibility papers and 2 technical demos in top ACM conferences.
- Full-time mentees:

Ph.D.

1. Waleed Akbar — Aug 2022 – Now
2. Jack Rademacher — (16 months) 2022-2024
3. Purui Wang — (6 months) 2022-2024

Georgia Institute of Technology. Atlanta, GA Jan 2018 – Aug 2022

- Mentored 5 Ph.D. students, 5 MS students, and 3 undergraduates working on 7 research projects resulting in 1 MS thesis, 2 student-authored conference papers, 3 coauthored journal publications, and 2 technical demos.
- Assisted mentees with their academic and professional careers, securing positions in MathWorks and Aerojet Rocketdyne.
- Full-time mentees:

Ph.D.

1. Ananya Bhardwaj — Sept 2021 – Now
2. Obaidullah Alfahmi — (11 months) 2021-2022
3. Matthew Irving — (11 months) 2021-2022
4. Jacob Brody — (11 months) 2021-2022
5. Kevin Dix — (3 months) 2022

MSc

1. Allen Zhou — (3 months) 2022
2. Michael Robinson — (12 months) 2021-2022
3. Luke Pikaart — (3 months) 2022
4. Herit Patel — (12 months) 2020-2021
5. Mark Saad — (8 months) 2018-2019

Undergraduate

1. Jingchu Chen — (3 months) 2022
2. Natasha Najmi — (4 months) 2021
3. Clement Loneux, Visiting Scholar (France) — (2 months) 2020

Ain Shams University (ASU). Cairo, Egypt Mar 2014 – Jan 2018

- Streamlined the assignment of teaching workload among 12 TAs in the mechatronics department.
- Mentored 6 groups of 4-5 students developing mechatronics class projects such as integrated measurement systems, mobile robots, and articulated robotic arms.
- Mentored a group of 5 students to develop an automatic score estimator for the speedball sport.
- Maintained the mechatronics department website and social media with an outreach of 250 students.

SERVICE

- **Session Chair** in Active & Passive Smart Structures and Integrated Systems XVI conf., SPIE, Mar. 2022.
- **Reviewer** for Applied Physics Letters (1 review), Journal of the Acoustical Society of America (5 reviews), IEEE Transactions on Ultrasonics Ferroelectrics and Frequency Control (1 review), Smart Materials and Structures (1 review), IEEE Transactions on Industrial Electronics (5 reviews), Journal of Applied Physics (4 reviews), Journal of Intelligent Material Systems and Structures (4 reviews).

INDUSTRIAL EXPERIENCE

Abbott Laboratories. Atlanta, GA Oct 2021 – Jun 2022

Sr. Test and Automation Engineer – Part-time

Responsibilities: Design and maintain test and automation equipment for an implanted blood pressure sensor.

- Revised standard operating procedures and calibration procedures for an **RF test system** for testing sensor batches through **impedance measurements** using a **VNA**.
- Upgraded legacy **LabVIEW automation code** to conform with FDA non-product software guidelines.
- Recommended best practices, mechanical design standards, materials, surface treatments, and surface finish for test fixtures for improving usability, increasing yield, and extending their service life.

Elnady Engineering & Agencies (NC). Cairo, Egypt Jan 2016 – Jan 2018

Acoustic Engineer – Part-time

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.

- Designed a software module for **exciting loudspeakers** & **collecting microphone signals** using the 4-microphone technique. The new module increased acquisition speed 5 times without sacrificing accuracy.
- Integrated my module in **SIDLAB** commercial software for analyzing sound in ducts and **acoustic 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.

HONORS AND AWARDS

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

PROFESSIONAL AFFILIATIONS

Full Member, Acoustical Society of America	2017 – Present
Member, International Society for Optics and Photonics	2019 – Present

SKILLS

Technical:

Piezoelectric transducer design, FEM, 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 array beamforming, ultrasonic imaging, RF and electronic circuit design, wireless communications, mechanical design, traditional machining.

Laboratory Equipment:

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.

Programming Languages:

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

Engineering Software:

Proficient: COMSOL Multiphysics, MATLAB, LabVIEW, SolidWorks.

Good command: Keysight ADS, ANSYS, Mathematica, SIMULINK, Inventor, Simscape, AUTOCAD.

Languages:

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

REFERENCES

1. Fadel Adib
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