JACK RADEMACHER

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RESEARCH INTERESTS

- Underwater acoustics & piezoelectrics, circuit design for underwater IoT systems, sensing platforms for underwater instrumentation, ultra-low power hardware design
- Novel wireless sensing techniques, long-range digital communication systems, underwater signal processing, array processing & localization algorithms for multipath-rich environments

EDUCATION

Massachusetts Institute of Technology Sept 2021 - Present
Ph.D. Electrical Engineering & Computer Science, Minor in Chinese, MIT Media Lab

Massachusetts Institute of Technology Sept 2021 - May 2023
M.S. Electrical Engineering & Computer Science
Relevant Coursework: CMOS Analog and Mixed-Signal Circuit Design, Computer Networks, Power Electronics, Discrete-Time Signal Processing

University of Michigan, Ann Arbor Sept 2017 - May 2021
B.S.E. Electrical Engineering
Relevant Coursework: Microwave Circuits, Control Theory, Digital Communication Systems, Analog Circuits, Digital Circuits, Antenna Design and Radio Propagation

PUBLICATIONS

Analog Underwater Backscatter: Networked Underwater Sensing at Microwatt Power Levels
[Under submission]
Jack Rademacher, Ritik Patnaik, Fadel Adib
ACM MobiCom 2025

SeaScan: An Energy-Efficient Underwater Camera for Wireless 3D Color Imaging *[Accepted]*
Nazish Naeem, **Jack Rademacher**, Ritik Patnaik, Tara Boroushaki, Fadel Adib
ACM MobiCom 2024

Enabling Long Range Underwater Backscatter via Van Atta Acoustic Networks
Jack Rademacher, Aline Eid, Waleed Akbar, Purui Wang, Ahmed Allam, Fadel Adib
ACM SIGCOMM 2023

Demo: Enabling Battery-Free Wireless Underwater Imaging **[Best Demo Award]**
Jack Rademacher, Waleed Akbar, Sayed Saad Afzal, Osvy Rodriguez, Nazish Naeem, Purui Wang, Mario Doumet, Unsoo Ha, Reza Ghaffarivardavagh, Fadel Adib
ACM WUWNet 2022

High Power, High Efficiency Wireless Power Transfer at 27.12 MHz Using CMCD Converters
Jack Rademacher, Xin Zan, Al-Thaddeus Avestruz
IEEE ECCE 2021

HONORS AND AWARDS

MIT $100K Launch Competition Runner Up May 2023
Sensea: Bringing the Data & AI Revolution to Aquaculture

Best Demo Award Nov 2022
Demo: Enabling Battery-Free Wireless Underwater Imaging
ACM WUWNet'22

Summa Cum Laude May 2021
University of Michigan, Ann Arbor

EXPERIENCE

Signal Kinetics at the MIT Media Lab Sept 2021 - Present
Graduate Research Assistant, advised by Fadel Adib – Massachusetts Institute of Technology

- Actively managing multiple research projects on underwater backscatter localization and persistent oceanographic sensing
- Led a four-person team to design, build, and test a first-of-its-kind passive underwater retrodirective acoustic beamformer to provide orientation-agnostic backscatter
- Managed multiple undergraduates and masters of engineering students to design a sub-μW underwater temperature and pressure sensor
- Designed, built, and tested an ultra-low power platform for battery-free wireless imaging of underwater environments
- Designed hardware platforms and signal processing algorithms for ultra low-power acoustic backscatter communication

MITRE – Bedford, MA May 2023 — August 2023
Sensor Systems Engineering Intern, L156 (Underwater Systems) / L152 (Radio Signals Intelligence)

- Developed a mathematical model of the underwater backscatter link budget combined with the multipath acoustic channel
- Developed and wrote software for a network-layer packetization standard for underwater acoustic networks
- Analyzed and simulated array processing & beam steering techniques such as MVDR, MPDR, MUSIC, CBF, and power inversion for HF (3-30 MHz) radio antenna arrays

Analog Devices – Colorado Springs, CO May 2021 — August 2021
Microwave Design Engineering Intern

- Designed an integrated 6-14 GHz, 128 ps, 6 bit true-time delay unit for beamforming ASICs on a 45nm RF-SOI process
- Designed and simulated a time delay architecture not previously implemented by my team that improved layout area and time delay density by up to 45%
- Designed and simulated bypass networks for mimicking S21 of delay units and providing a flat differential time delay across 2ps, 4ps, 8ps, 16ps, 32ps, and 64ps units

Analog Devices – Colorado Springs, CO May 2021 — August 2021
Microwave Product Engineering Intern

- Created a test setup for characterizing IP3 of beamforming ICs from 2-33GHz through PCBs or an RF probe
- Collected data on worst/average case input and output IP3 to within $\pm$0.35 dBm of actual value across frequency & power to compare with designers' simulations
- Communicated and displayed summer work to upper level management, showing how my test bench is accurate, easy to use, and can be used over wide range of bandwidths, power levels, and device form factors

Power Electronics and Energy Research Studios (PEERS) Sept 2020 - July 2021
Undergraduate Research Assistant, advised by Al-Thaddeus Avestruz – University of Michigan

- Formulated major loss mechanisms in a current-mode class D (CMCD) converter for wireless power transfer
- Optimized the design of the CMCD converter for high power & efficiency by compromising output capacitance and conduction losses, resulting in a design that exceeds the current state-of-the-art when examining power-efficiency-frequency product
- Designed a custom wireless power transfer 4-layer PCB coil in COMSOL to obtain the required inductance and coupling

Apple – Sunnyvale, CA January 2019 — August 2019
Electrical Engineering Intern, Special Projects Group (SPG)

- Designed the schematic and layout for a "wireless oscilloscope" PCB to measure and log voltage, current and temperature
- Wrote C code to live-stream ADC samples to an SD card and wirelessly to a python application using the MQTT protocol
- Created a concurrent embedded application using FreeRTOS to manage ADC sampling, WIFI connectivity, wireless streaming & device control, SD card reading/writing, and RTC initialization using network time

PRESS COVERAGE

Popular Science, Andrew Paul, "This new subsea communications system can run on an iota of power" *Sept 7, 2023*

MIT News, Adam Zewe, "Device offers long-distance, low-power underwater communication" *Sept 6, 2023*

IEEE Spectrum, Edd Gent, "MIT Makes Low-Power Underwater Communication Practical" *Sept 15, 2023*

PATENTS

Fadel Adib, Waleed Akbar, Aline Eid, **Jack Rademacher**, Purui Wang, "**Van Atta Acoustic Networks for Long-Range Underwater Backscatter**", U.S. Patent No. US20240259112A1, filed Jan 26, 2024

SKILLS

Programming: MATLAB, C/C++, Python, HTML/CSS, JavaScript (React, ReactNative, NodeJS)

Tools & Softwares: Altium Designer, Cadence Allegro, Cadence Virtuoso, Keysight ADS, Solidworks, STM32CubeMX, LTSpice, NI Labwindows/CVI, NI Max, Ansys HFSS, COMSOL E/M

Hardware Platforms: STM32, Ettus USRPs, MSP430