MARK H. GOLDWATER

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EDUCATION

Massachusetts Institute of Technology &
Woods Hole Oceanographic Institution Joint Program

Ph.D. Student in Electrical Engineering and Computer Science *September 2021 – Present*
& Applied Ocean Science and Engineering
Advised by: Julien Bonnel and Daniel P. Zitterbart

Technical areas: bioacoustics, scientific machine learning, signal processing, underwater acoustics, optimization, remote sensing.

S.M. in Electrical Engineering and Computer Science *September 2021 – February 2024*
Advised by: Julien Bonnel and Daniel P. Zitterbart
Thesis: Automatic Baleen Whale Detection and 2D Localization Using a Network of Unsynchronized Passive Acoustic Sensors
GPA: 5.0/5.0

Franklin W. Olin College of Engineering

B.S. in Electrical and Computer Engineering *August 2017 – May 2021*
GPA: 3.97/4.00

RESEARCH

Woods Hole Oceanographic Institution
Woods Hole, MA *June 2020 – Present*

- Developed a machine learning approach to estimate the source-receiver range of impulsive broadband baleen whale vocalizations
- Formulated and implemented an algorithm to associate individual range measurements and localize simultaneously vocalizing whales
- Application areas of interest include source localization, bioacoustics, remote sensing of marine populations, and low-cost robotic sensing

Franklin W. Olin College of Engineering
Needham, MA *September 2019 – May 2021*

- Implemented an infrared (IR) communications link to transmit an acknowledgement of data receipt (ACK) on the uplink of a hybrid radio-frequency (RF) and visible-light communications (VLC) system
- Designed digital circuit logic to process the ACK
- Enabled the system to coexist on the same network with other 802.11-compatible devices that are sending data on the system's uplink over the saturated RF spectrum

Massachusetts Institute of Technology (MIT) Lincoln Laboratory
Lexington, MA *May 2019 – August 2019*

- Developed system to calibrate an infrared camera to serve as a highly accurate power meter in a laser communications terminal testbed

- Designed signal processing algorithm in MATLAB to detect non-functioning camera pixels and account for them in the power calculation

Franklin W. Olin College of Engineering
Needham, MA *January 2019 – May 2019*
- Developed open-source software to detect and catalog near-Earth asteroids using telescope images
- Implemented a preprocessing pipeline to account for thermal noise and varying pixel sensitivity in images

INDUSTRY EXPERIENCE

General Electric (GE) Healthcare – Senior Capstone Project in Engineering
Milwaukee, WI *September 2020 – May 2021*
- Developed improved digital intercom for Computerized Tomography (CT) machines to facilitate better communication between the patient and operator
- Enabled technicians to interface less directly with patients through improved audio communication to reduce the likelihood of COVID-19 transmission

Track Information, Inc.
Boston, MA *June 2018 – August 2018*
- Designed and prototyped RESTful API for a mobile app to track a user's health statistics using React Native in JavaScript as well as Ruby on Rails
- Engineered the app's backend data flow to easily interface with third-party APIs

PROJECTS

Domain Adversarial Neural Network (DANN) *November – December 2022*
- Implemented a DANN based on a paper from Ganin et al. in PyTorch to perform unsupervised domain transfer for the detection of impulsive Baleen whale vocalizations
- Data consisted of 6-second audio snippets of simulated impulse calls with added experimental noise and snippets which consisted only of experimental noise
- The source data (labeled) was from the Bering Sea and the target data (unlabeled) was from Cape Cod Bay
- Achieved 90% accuracy on the unlabeled data

Orthogonal Frequency-Division Multiplexing (OFDM) Implementation *April 2021*
- Implemented an OFDM receiver and transmitter from scratch using MATLAB
- Tested using B210 USRP software defined radios, and achieved a throughput of 1.2 Mbps with BPSK symbols and 0% error

OceanSense – Ocean Measurement Platform *October - December 2020*
- Designed a PCB using KiCad to monitor environmental conditions during ocean science experiments at the water's surface for up to seven days
- Device measured air temperature, surface humidity, and acceleration data
- Logged data to an onboard SD card for further processing

Image Inpainting *May 2020*
- Implemented an inpainting algorithm in MATLAB that used diffusion to iteratively fill in missing sections of images
- Created problem set and solution guide to teach image inpainting and its mathematical underpinnings to peers

Magnetic Levitation Control System *May 2020*

- Developed a mathematical model and simulation of permanent magnet levitation using an electromagnet
- Implemented a PD feedback control loop to levitate the permanent magnet and tested it in a custom simulation
- Successfully implemented the control loop on a realistic computational model of the system (rather than a physical system due to COVID-19)

Schroeder Reverb in C *March 2020*

- Implemented the Schroeder reverberation algorithm in C to add a reverb effect to music in a mono-channel 16-bit WAV file
- Built custom buffer data structures, a WAV file parser, and digital comb and all pass filters

American Sign Language/Spoken English Translation System *July 2019 – January 2020*

- Designed and presented system concept to take a user-oriented approach to the creation of an American Sign Language (ASL) language model to facilitate translation from ASL to English and vice versa
- Began initial data collection of ASL video data to train a machine learning model
- Spoke to local deaf and hard of hearing organizations to guide the design process

Digital Morse Code Decoder *December 2019*

- Designed and simulated a digital hardware system that takes Morse code input from a button and outputs the ASCII codes of inputted letters on LEDs
- Successfully programmed and tested the digital circuit on a Zybo Zynq-7000 FPGA SoC Trainer Board

Multi-Cycle CPU *November 2019*

- Designed, implemented, and simulated a multi-cycle CPU, using the MIPS architecture, in Verilog
- Wrote custom assembly programs to solve the Tower of Hanoi problem, the Spinout puzzle recurrence relation, and others to test the architecture

Computer Vision Assisted Origami *May 2018*

- Created software that used an overhead camera and a homography transform to project origami instructions onto a piece of square paper
- Used Python and OpenCV to calculate and display the projections on an assistive screen

Active Noise Cancellation *December 2018*

- Implemented Least Mean Squares (LMS) adaptive filtering in MATLAB to cancel background noise in a speech recording
- Implemented an ideal Wiener filter to characterize and cancel the noise as a benchmark

Inverted Pendulum Control System *November 2018*

- Implemented a PI control loop using Arduino C to enable an inverted pendulum robot to balance upright
- Modified the feedback loop to direct the robot to translate forward like a segway

Braille Sheet Music Printer *October - December 2018*

- Designed and built a device that can convert digitized music into braille sheet music and print it
- Implemented the electrical system and guided integration of the software, hardware, and electrical subsystem

3D Infrared Scanner *September 2018*

- Designed and 3D-printed hardware for a two-servo tilt/pan scanning mechanism

- Wrote software using Arduino C to take distance measurements and create a 2D projection of the scanned item by converting from spherical to cartesian coordinates

Autonomous Robot Obstacle Course Navigation *May 2018*

- Implemented the RANSAC algorithm that used LiDAR data to map an obstacle course which consisted of boxes and fences to block a small wheeled robot
- Imposed a vector potential field on the model of the course and used gradient descent to navigate to desired coordinates while avoiding obstacles

Facial Recognition Software *March 2018*

- Implemented the Eigenfaces facial recognition algorithm which achieved 95% accuracy on a dataset of 50 individuals with a 1.09 second runtime
- Also implemented the Fisherfaces facial recognition algorithm to better account for intraclass variance

Boat Hull Stability Simulation *February 2018*

- Implemented a 3D boat simulation in MATLAB to simulate the angle of vanishing stability (AVS) for various hull designs to predict at which tilting angle the boat would capsize
- Constructed final boat hull which met the design goals of having an AVS between 120 and 140 degrees

PUBLICATIONS

[4] **M. Goldwater**, D.P. Zitterbart, D. Wright, and J. Bonnel. "Machine-learning-based simultaneous detection and ranging of impulsive baleen whale vocalizations using a single hydrophone." *The Journal of the Acoustical Society of America* 153.2 (2023): 1094-1107.

[3] P. Boyalakuntla, **M. Goldwater**, U. Gupta, W. Q. Lohmeyer, and S. Govindasamy. "An Undergraduate-level, Problem-based Introduction to Orthogonal Frequency-Division Multiplexing." *2022 IEEE Frontiers in Education Conference (FIE).* IEEE, 2022.

[2] **M. Goldwater**, J. Bonnel, A. Cammareri, D. Wright, and D.P. Zitterbart. "Classification of dispersive gunshot calls using a convolutional neural network." *JASA Express Letters* 1.10 (2021): 106002.

[1] **M. Goldwater**, P. Dhulipalla, M. Kang, T. Kim, N. Tan, S. Govindasamy, and M. B. Rahaim. "An 802.11 Compatible Asymmetric Hybrid Visible-Light and Radio-Frequency Communications System." *2020 IEEE 31st Annual International Symposium on Personal Indoor and Mobile Radio Communications.* IEEE, 2020.

PRESENTATIONS

[4] **M. Goldwater**, D.P. Zitterbart, J. Bonnel, "Automatic detection and 2D localization using a network of unsynchronized passive acoustic sensors in a dispersive waveguide." At 186th Meeting of the Acoustical Society of America. Ottawa, ON. May 2024.

[3] **M. Goldwater**, J. Bonnel, D.P. Zitterbart, "Automatic Detection and 2D Sound Source Localization Using a Distributed Array of Unsynchronized Passive Acoustic Sensors in a Dispersive Waveguide." At IEEE Underwater Acoustic Signal Processing Workshop. Exeter, RI. October 2023.

[2] **M. Goldwater**, D.P. Zitterbart, D. Wright, and J. Bonnel. "Simultaneous detection and ranging of baleen whale impulsive vocalizations using a temporal convolutional neural network." At 183rd Meeting of the Acoustical Society of America. Nashville, TN. December 2022.

[1] **M. Goldwater**, J. Bonnel, and D.P. Zitterbart. "Classification of dispersive calls using a convolutional neural network." At 179th Meeting of the Acoustical Society of America. Virtual Meeting. December 2020.

INVITED TALKS

- "Automatic Detection and Range-Based Localization of Baleen Whale Gunshots in PAM Data."
  Global Ocean Science Education (GOSE) Workshop, University of Rhode Island, 5/23/2023.

- "A Machine-Learning Approach to Simultaneously Detect and Range Baleen Whale Gunshots in Single-Hydrophone PAM Data."
  Seminar for the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), virtual, 3/21/2023.

AWARDS, SCHOLARSHIPS, AND FELLOWSHIPS

1. The Daoma and Murray Strasberg Memorial Scholarship for Graduate Studies in Ocean Acoustics, $10,000 plus $2,000 to travel to an Acoustical Society of America (ASA) meeting (September 2024 – 2025)
2. National Defense Science and Engineering Graduate (NDSEG) Fellowship, $122,400 plus tuition, health insurance, and travel funds (2022 – 2025)
3. National Science Foundation Graduate Research Fellowship (2022, awarded & declined for NDSEG)
4. Woods Hole Oceanographic Institution's Summer Student Fellowship, $6,500 (June 2020 – August 2020)
5. First Place Overall in MIT Lincoln Laboratory's Intern Innovative Idea Challenge and funding to continue work during the fall 2019 academic semester (July 2019)
6. Best Poster in MIT Lincoln Laboratory's Intern Innovative Idea Challenge (July 2019)
7. Franklin W. Olin College of Engineering's four-year half-tuition merit scholarship, $100,800 (August 2017 – May 2021)

TEACHING AND MENTORING EXPERIENCE

Woods Hole Oceanographic Institution — Woods Hole, MA

Summer Student Fellow Near-Pear Mentor	June – August 2022, 2023
Duke University Master's in Interdisciplinary Data Science capstone co-advisor	August 2021 – May 2022

Franklin W. Olin College of Engineering — Needham, MA

MTH2110: Discrete Math	September – December 2020
Mathematics Tutor	January – April 2020
ENGR3420: Introduction to Analog and Digital Communication	August – December 2019

CIE2018A: Quantitative Engineering Analysis I	January – May 2019
Academic Resource Co-Designer	August 2018 – May 2021
OIE1000: Olin First Year Introduction	August – December 2018
ENGR1125: Introduction to Sensors, Instrumentation, and Measurement	August – December 2018

ACTIVITIES AND SERVICE

Review Activities

1. IEEE Access
2. Journal of the Acoustical Society of America – Express Letters
3. IEEE Journal of Oceanic Engineering
4. IEEE Sensors

Volunteering and Other Activities

Cambridge School Volunteers – Tutor	October 2022 – Present
"Frankly Speaking" Student Newspaper – Editor	August 2020 – May 2021
STEM K-12 Outreach Activity Design and Research	January 2020 – January 2021
Habitat for Humanity Volunteer	March 2018
Student Government – Representative for Campus Services	January 2018 – December 2018
Campus-wide silent auction organizer	November 2017
International Aerial Robotics Competition Team	September 2017 – February 2019
Engineering Discovery (K-12 STEM outreach)	September 2017 – January 2018

TECHNICAL SKILLS

Languages	C++, C, Python, MATLAB, Java, Verilog
Libraries	PyTorch, TensorFlow, NumPy, SciPy, Pandas, OpenCV
Tools	Git/GitHub, KiCad, 3D Printer