# MARK H. GOLDWATER

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## EDUCATION

**Massachusetts Institute of Technology &** *September 2021 – Present*
**Woods Hole Oceanographic Institution Joint Program**

Ph.D. Student in Electrical Engineering and Computer Science & Applied Ocean Science and Engineering
Advised by: Julien Bonnel and Daniel Zitterbart

**Franklin W. Olin College of Engineering** *August 2017 – May 2021*

B.S. in Electrical and Computer Engineering
GPA: 3.97/4.00

Relevant coursework: microcontrollers, software systems (C/operating systems), controls, Bayesian statistics, partial differential equations, wireless communications, circuits, data structures and algorithms, discrete mathematics, computer architecture.

## RESEARCH

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

- Built a convolutional neural network (CNN) to detect spectrograms of multi-modal calls from Southern right whales in large audio data
- Utilized the KRAKEN normal mode program to generate a training data set of impulsive calls with variable sources and environments to invert for range using machine learning techniques

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

- Implemented an infrared communication 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

**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 communication terminal testbed
- Developed 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*

- Developing improved digital intercom for Computerized Tomography (CT) machines to facilitate better communication between the patient and operator
- Enabling 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

**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 based in partial differential equations that iteratively fills in missing sections of images
- Algorithm applied anisotropic diffusion in between inpainting iterations to ensure correct evolution of the field
- 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 to model the forces of a permanent magnet positioned under 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 much 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 subsystems

**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 the 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 and floating flat

## PUBLICATIONS AND PRESENTATIONS

1. **M. Goldwater**, P. Dhulipalla, M. Kang, T. Kim, N. Tan, S. Govindasamy, 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*, London, United Kingdom, 2020, pp. 1-7.
2. **M. Goldwater**, J. Bonnel, and D. P. Zitterbart, "Classification of dispersive calls using a convolutional neural network," *The Journal of the Acoustical Society of America*, vol. 148, no. 4, pp. 2687–2687, Oct. 2020.

## AWARDS, SCHOLARSHIPS, AND FELLOWSHIPS

1. Woods Hole Oceanographic Institution's Summer Student Fellowship, $6,500 (June 2020 – August 2020)
2. 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)
3. Best Poster in MIT Lincoln Laboratory's Intern Innovative Idea Challenge (July 2019)
4. 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

Duke University Master in Interdisciplinary Data Science Capstone Mentor August 2021 – Present

**Franklin W. Olin College of Engineering** Needham, MA

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

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

## EXTRACURRICULARS AND COMMUNITY ENGAGEMENT

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| "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

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| **Languages** | C++, C, Python, MATLAB, Java, Verilog |
| **Tools and Libraries** | Tensorflow, Git, KiCad, OpenCV, 3D Printer |