ORE since 1966
OCEAN AND RESOURCES ENGINEERING
IN THE SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY AT THE UNIVERSITY OF HAWAI'I AT MĀNOA

HANA O KE KAI "Work of the Ocean"

NEWSLETTER OF THE OCEAN AND RESOURCES ENGINEERING DEPARTMENT, Spring/Summer 2024, Volume 27, Issue 1

Zhenhua Huang
ORE Chair

Chair's Message

Congratulations to Dr. Eva Nosal for her promotion to Full Professor and Dr. Mike Krieg for his promotion to Associate Professor with Tenure. Cheers to their well-deserved promotions. Dr. Kwok Fai Cheung will step down from his position as Graduate Chair, and Dr. Eva Nosal will be our new ORE Graduate Chair, effective Fall 2024. Thanks to Dr. Cheung for his 18 years of dedicated service as Graduate Chair.

Former ORE student helper Karen He graduated and will start her new job in California. Three new student helpers, Tristyn Terashima, Sua Jong, and Irene Hernandez, have joined us to assist in the ORE office. ORE Intranet will be officially launched in the Fall semester as a single place to "go-to" for all ORE procedures, forms, and requests. We launched an ORE LinkedIn Page, and encourage you to follow our LinkedIn page as you can also find announcements and updates there. Thanks to Karen He, ORE DA Jasmine Ogata, and Prof. Nosal and for leading these efforts.

ORE faculty have decided to use some department funds to create an ORE Graduate Travel Award. This award is intended to provide supplemental funds to graduate students presenting their research work at conferences in the next 5 years. We encourage our students to take advantage of ORE Seminars to practice their skills of giving an effective scientific talk. More information can be found on the ORE Intranet.

We are in the process of upgrading student offices with new desks and the ORE computer room with 5 additional workstations. It is expected this upgrading process should be completed in the first month of the Fall semester. Please be patient with us during this period.

In this issue

Eva-Marie Nosal
ORE Professor

Editor's Corner

I'm glad to have the opportunity to share updates in ORE with you via Hana O Ke Kai. If you have news, updates, announcements to share for future editions, please send them along to me at nosal@hawaii.edu. We especially welcome updates from alumni—Where are you now? What advice do you have for current students? Keep in touch!

Student News

Bethany Stafford defended her Plan B project **Feasibility of Fiber-Reinforced Polymer Piles for Marine Fender Systems at Coast Guard Base Kodiak, Alaska** in April 2024

Jomphol Lamoonkit defended his Plan A thesis **An In-situ Autonomous Sampler System for Vertical Benthic Biogeochemical Fluxes Detection** in April 2024

Jesse Gray defended his Plan B project **Viscous Damping Determination For Dynamic Modelling Improvement Of A Floating Oscillating Surge Wave Energy Converter (FOSWEC)** in April 2024

Elizabeth Hauschild defended her Plan B project Performance **Assessment of Wave Models for Cold Front Events in Hawai'i** in May 2024

(Stay tuned… Summer 24 completions will be published in the next edition)

Coastal Robotics Testing Range

Mike Krieg
ORE Associate Professor

There are certain locations where underwater robots excel and have largely replaced manned operations, such as oceanographic surveys of open waters with moderate depth. However, they still struggle in many locations such as very deep waters and the polar regions. Another difficult operating zone is coastal regions, due to confined spaces (limited depth and seafloor structures) and significant unsteady wave forces.

To address this shortcoming, Dr. Krieg is proposing to create a sophisticated robotic testing basin here in Hawai'i, piggy-backing off of the existing infrastructure at the Kilo Nalu Observatory (KNO), which is a permanent cabled observatory located on the seafloor just off the south shore at Kaka'ako park. Dr. Krieg recently received funding from the NSF to create this testing basin by installing a positioning system and acquiring a workhorse vehicle platform. Navigation for underwater vehicles is challenging because radio signals attenuate underwater and GPS cannot be used to locate your position. Instead, this testing site will have what is called a long baseline (LBL) acoustic positioning system which uses an array of acoustic beacons to triangulate the vehicle position and provide wireless communication. This will allow researchers at UH to test motion control algorithms and different maneuvering modules at the KNO testing site while receiving real-time position data and any necessary commands from the ground station.

We are please to report that the first major step of this initiative has been completed. After much administrative headache the custom LBL system has been ordered and is being manufactured, and the workhorse vehicle platform has now been received and is being programmed for custom operations. The vehicle is an IVER3 AUV, which is shown in Figure 1. The IVER3 is capable of performing extended oceanographic surveys in the open water with a sophisticated navigation and control system, but struggles in coastal and shallow water applications. The research to be conducted at the KNO testing basin will lead to vehicles like this being able to operate in chaotic coastal environments as well.

Stay tuned – Preliminary testing with this coastal facility is expected to begin as early as this fall.

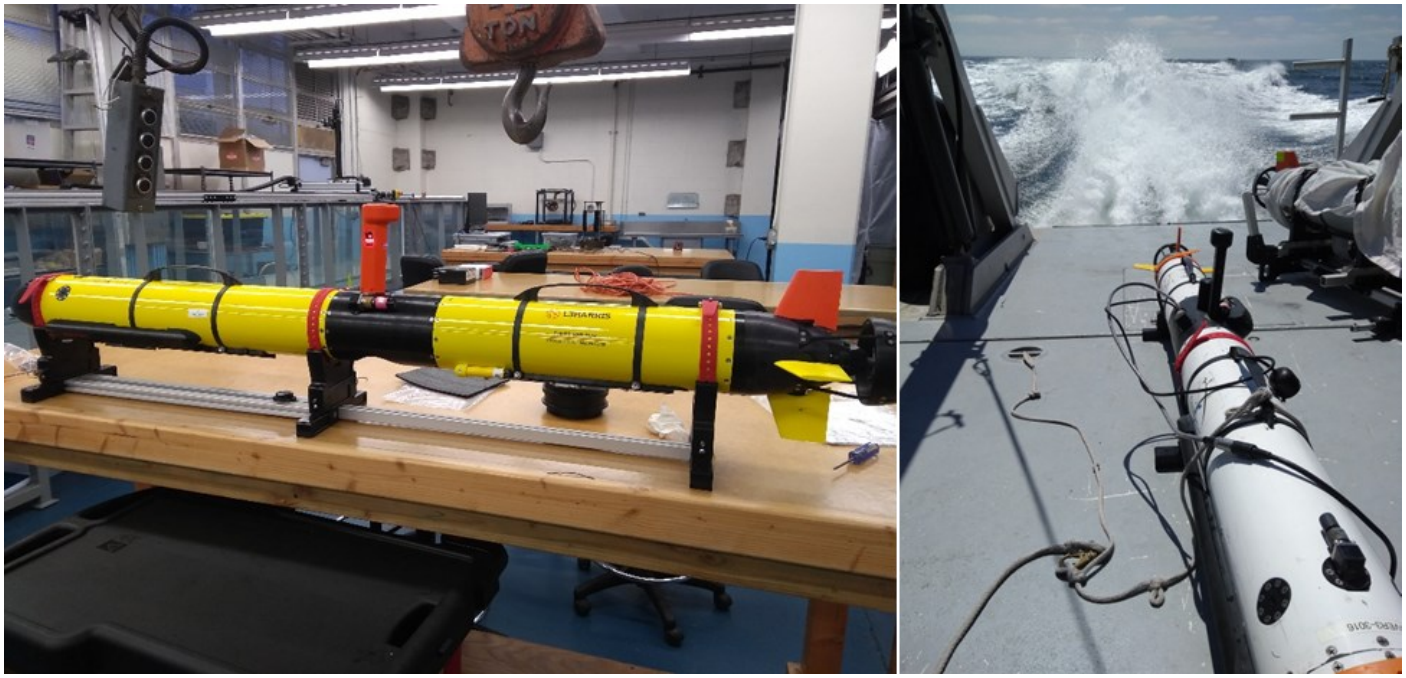


Figure 1: (left) Recently received IVER3 assembled and displayed in the ORE teaching/research laboratory (HIG 151). (right) Equivalent IVER3 ready for deployment during field training provided by the vendor.

MAMBAT: Multiple-animal model-based acoustic tracking of marine mammals

Pina Gruden, Acoustic Researcher
Eva-Marie Nosal, Professor

Localization and tracking of multiple marine mammals based on passive acoustics is an essential task for the purpose of abundance estimation and stock assessment, studying species behavior, and also mitigation. However, it is a challenging task. Not only do the numbers of the calling animals change constantly, and their calls overlap, but there are many instances when animals are present and we do not collect any measurements from them. This can be either due to animal vocal behavior (i.e. animals going silent), due to nature of their vocalizations (e.g. very narrow beam pattern of their echolocation pulses), or due to changes in the signal-to-noise ratio of their emitted signals. Moreover, any tracking or localization approach needs to contend with false alarms (measurements not originating from the animals).

Passive acoustic localization and tracking methods are well established in cases of single calling animals, or in cases where the call classification and association of the same call on different hydrophones can be readily achieved. However, cases with multiple calling animals with calls that cannot be associated, and cases when many missed detections and false alarms are present, still pose a significant challenge for tracking algorithms. Several localization approaches have been proposed for such cases, but most still rely on source separation/call association steps and are computationally demanding.

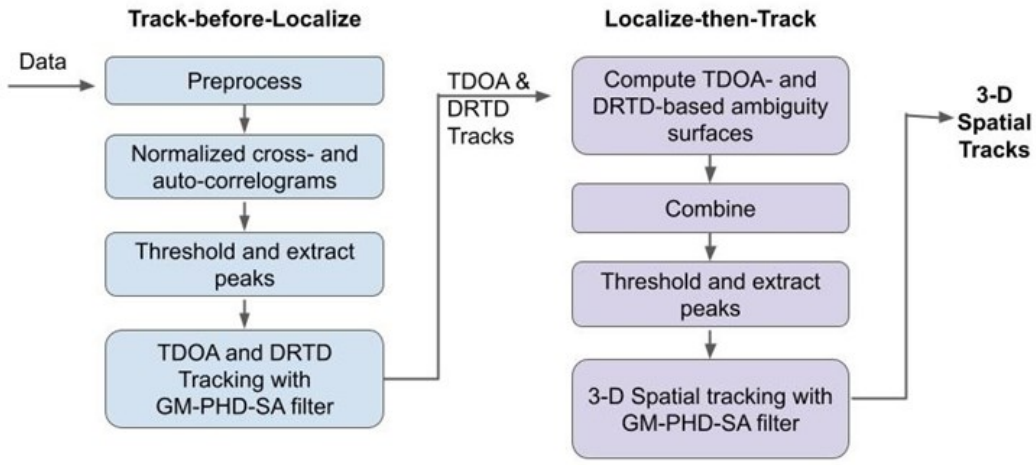


Fig. 1. Overall workflow of MAMBAT framework. The framework consists of two parts: Part 1 - "Track-before-Localize" and Part 2 - "Localize-then-Track"

We are funded by the Office of Naval Research to develop MAMBAT: Multiple-Animal Model-Based Acoustic Tracking. The goal of MAMBAT is to improve tracking methods for multiple marine mammals, and to develop a fully automated, computationally efficient workflow that incorporates missed detections, false alarms, source appearance and disappearance in the problem formulation. MAMBAT will ultimately be species and platform agnostic. But to start off, we are developing MAMBAT for large aperture bottom mounted arrays, such as those found on Navy Ranges (e.g. the Atlantic Undersea Test and Evaluation Center, AUTEC, and the Pacific Missile Range Facility, PMRF). We collaborate closely with Elizabeth Henderson and the Whale Acoustics Reconnaissance team at the Naval Information Warfare Center Pacific.

MAMBAT consists of two parts (Figs. 1- 3). In the first part, a "track-before-localize" strategy is employed to track Time-Difference-Of-Arrival (TDOA) and Direct-Reflected-Time-Difference (DRTD) information based on cross- and auto-correlograms, respectively, from multiple pairs of sensors. In the second part, a "localize-then-track" strategy is used to track sources based on ambiguity surfaces [1,2] in the 3-D spatial domain. The computation of ambiguity surfaces includes sound speed modeling to account for depth-dependent sound speed profiles. In both parts of the framework tracking is achieved with a modified version of the GM-PHD-SA filter [3], a multi-target Bayes filter formulated within the random finite set framework.

MAMBAT continued from prior page

While still a work in progress, the MAMBAT framework was tested on publicly available AUTEC range datasets [4] containing one and four clicking sperm whales. Our results compare well to prior reported tracks found by other researchers for the same dataset. MAMBAT is fully-automated, computationally efficient, and accounts for false alarms and missed detections. It also incorporates all available multipath information, and uses model -based methods that account for sound speed profile. Moreover, in contrast to most localization frameworks, it does not require detection, pruning of false targets or association.

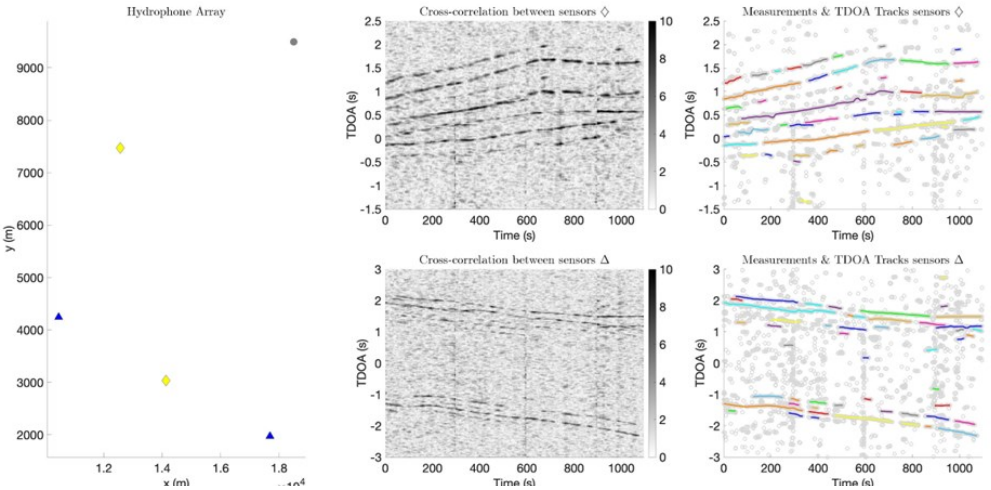


Fig. 2: Part 1 - "Track-before-Localize". Stationary hydrophone array (left); cross-correlograms (middle); measurements and extracted TDOA tracks (right). A cross-correlogram is computed and tracks extracted for each sensor pair combination.

Our future work will focus on a larger dataset from the PMRF range comprising five odontocete species, that produce a wide range of vocalizations with diverse characteristics- from narrowband frequency modulated whistles, to broadband echolocation pulses. This will enable us to develop and test MAMBAT as a unified framework for tracking and localizing different marine mammal species.

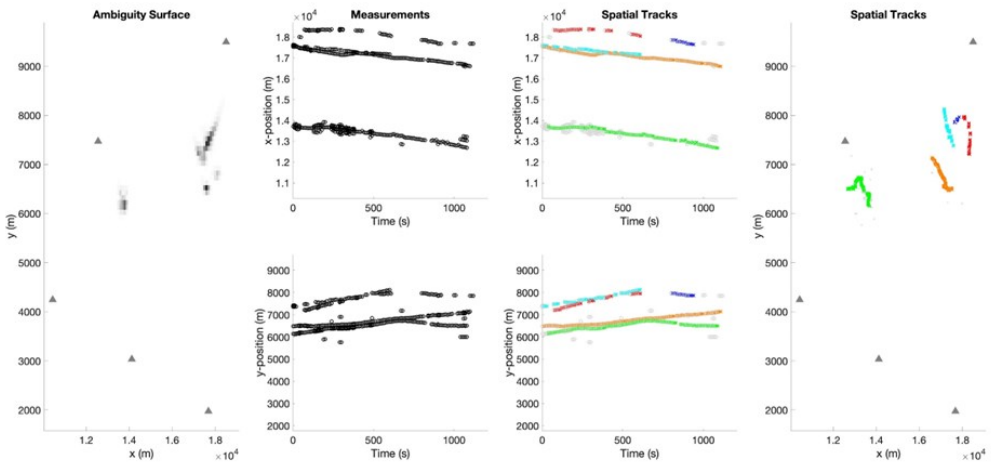


Fig. 3: Part 2 - "Localize-then-Track". An example of an ambiguity surface (left); measurements and extracted tracks for each coordinate (middle); extracted tracks top-down view (right).

References:

[1] E.-M. Nosal and L. N. Frazer (2006). "Track of a sperm whale from delays between direct and surface-reflected clicks," Applied Acoustics 67(11-12): 1187–1201.

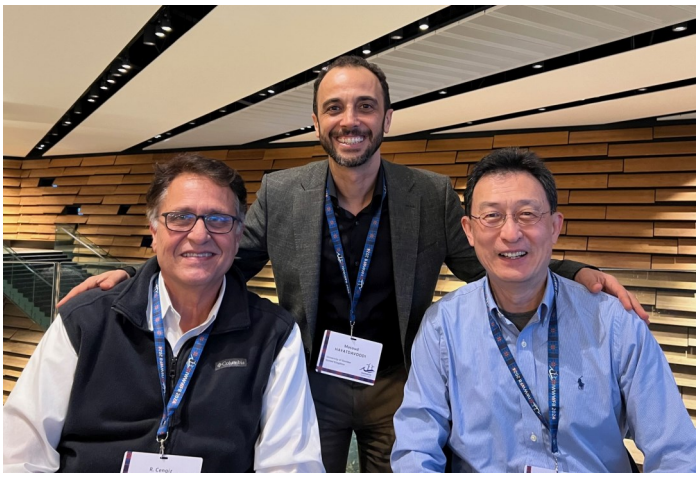
[2] E.-M. Nosal and L. N. Frazer (2007). "Sperm whale three-dimensional track, swim orientation, beam pattern, and click levels observed on bottom-mounted hydrophones," The Journal of the Acoustical Society of America 122(4): 1969–1978.

[3] P. Gruden, E.-M. Nosal, and E. Oleson (2021). "Tracking time differences of arrivals of multiple sound sources in the presence of clutter and missed detections," The Journal of the Acoustical Society of America 150 (5): 3399–3416.

[4] O. Adam, J.-F. Motsch, F. Desharnais, N. DiMarzio, D. Gillespie, and R. C. Gisiner (2006). "Overview of the 2005 workshop on detection and localization of marine mammals using passive acoustics," Applied Acoustics 67(11-12): 1061 –1070.

Inside ORE

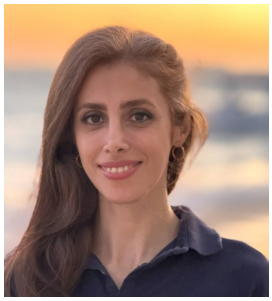
ORE Ohana members reunited at IWWWFB



ORE alumnus, Prof. Masoud Hayatdavoodi of Dundee University was the organizer of the 39th International Workshop on Water Waves and Floating Bodies in St. Andrews, Scotland during April 14 to 17, 2024. There were 105 participants from 15 countries, including Profs. Cengiz Ertekin and Kwok Fai Cheung, who very much enjoyed the workshop as well as the Scottish landscape and historical monuments.

New in ORE

Maliheh Gholizadeh Sarvandi, ORE MS Student



My lifelong fascination with the ocean led me to pursue a Master's in Civil Engineering, where I explored the dynamic relationship between tsunamis, earthquakes, and their impact on structures. Motivated by this research, I decided to further my studies specifically in Ocean Engineering upon moving to Hawaii. While I enjoy playing guitar and hiking in my spare time, nothing compares to the tranquility and wonder of watching ocean waves and immersing myself in their mysteries.

Emad Makki, Visiting Professor

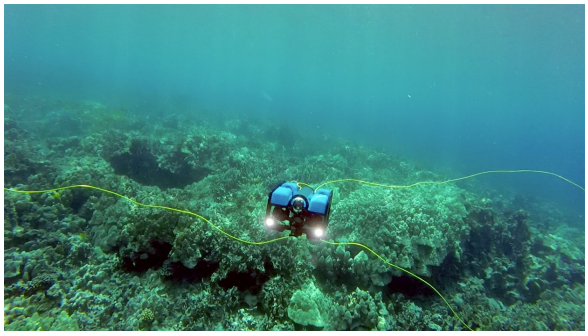
Dr. Emad Makki is an Assistant Professor of Mechanical Engineering and Applied Mechanics at Umm Al-Qura University: Makkah, SA. His research and teaching interests include but are not limited to Dynamic Events, Applied Mechanics, Advanced Materials, Experimental Mechanics, Composite Structures, Materials Engineering, and Sustainability. Professor Emad is an author of several scientific publications in his research areas of interest and serves as a reviewer in respective international journals.

Dr. Emad Makki received his B.S. from the King Fahd University of Petroleum & Minerals: Dhahran, SA in 2008, his M.S. from the University of New Haven: West Haven, CT, US in 2011, and his Ph.D. from the University of Rhode Island: Kingston, RI, US in 2017. During his Doctoral career, he worked with Dr. Arun Shukla at the Dynamic Photo-Mechanics Laboratory and defended his dissertation "Experimental Studies on Mitigating the Risk of Air Blast Loading." Currently, he is visiting Dr. Deniz Gedikli at ORE's Fluid Structure Interactions and Nonlinear Dynamics Laboratory to research the topic "Experimental and numerical investigation of flexible fluid-body interactions for ocean renewable energy purposes."

Company Profile

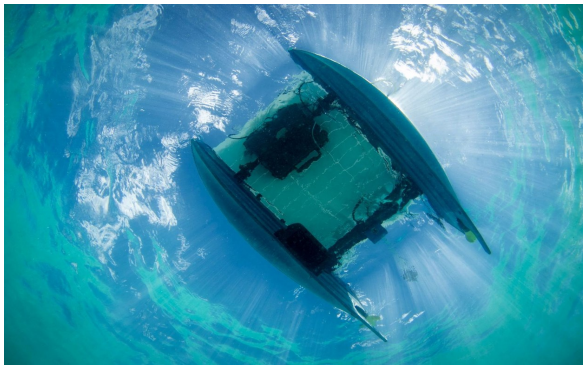
Tony White, Applications Engineer
Blue Robotics

After a gnarly wipeout left Blue Robotics founder Rusty with a decommissioned foamy, Blue Robotics was formed to do something cool that had never been done before: Send the first solar powered surfboard (Solar Surfer) from Los Angeles to Hawaii. While doing research, the realization that the limiting component was the thruster struck, and thus an affordable option that could resist saltwater, operate continuously, and be efficient for months on end was required. Scouring the internet for options, we found we were not alone; there were hobbyists, students, researchers, explorers, and maritime companies searching for the exact same product.



Realizing the high demand and zero options, we set out to design this elusive thruster ourselves, launching a 2014 Kickstarter Campaign for the legendary T100. This fully-flooded brushless motor was initially manufactured in Rusty's garage, but Blue Robotics quickly grew until those tight stone walls could no longer hold it. The company rented out its first official warehouse and Rusty took to Craigslist to build his salty crew. Feeling risky and untethered to her life on dry land, co-founder Elisa decided a Sunday warehouse interview was just the adventure she was looking for.

Since then, Blue Robotics has developed hundreds of low cost marine components from sensors and sonars to enclosures and penetrators and grown to employ over 60 humans, located in 7 time-zones around the world, including Hawaii. Our community has expanded to thousands of seafaring innovators and our BlueROV2, with over 4000 units sold, has explored waters off every continent. The newly launched BlueBoat uncrewed surface vessel is enabling exciting new development in hydrographic survey, oceanography, security and robotics with over 250 units sold since launch in Q4 2023. We take pride in thoroughly and openly documenting all our products, with prices, 3D models, and extensive guides available on our website. https://bluerobotics.com/



Applications Engineer and MTS Hawaii chapter Secretary Tony is based on the Big Island. He has an extensive background in commercial offshore aquaculture and marine swarm robotics, having used Blue Robotics hardware since the company's founding. We're all looking forward to meeting department members and providing application support. Our mission of enabling the future of marine robotics has opened the door for others to explore, innovate, create and share with our forums documenting many exciting projects. We couldn't be happier to have you aboard!

MTS Social

Join us for the

MARINE TECHNOLOGY SOCIETY

HAWAII SECTION SOCIAL

Come enjoy an evening with fellow MTS Hawaii members and connect with the community. Special guest - Chris Ostrander, MTS CEO - will be joining us. Light pupus will be provided (drinks and additional food available for purchase from Beerworks). Contact marine.tech.soc.hawaii@gmail.com for questions.

September 5, 2024
6:00 - 8:00 pm

Mauka Beer Garden at Honolulu Beerworks
328 Cooke St | Honolulu, HI

MTS marine technology society

Register by August 29: MTS members: Free | Non-members: $10 | Non-member students: $5

REGISTER

Some Recent ORE Publications

Note: This is only a partial list of publications. Please refer to individual ORE member websites for updated and complete publications.

The following publication is the product of the final project in ORE 657 Autonomous Marine Systems in Spring 2024. Congrats students!

Evans G, **Jandial P**, Hopkins B, **Chung N**, **Glass G**, Walker M, **Krieg M**. Frankenstein's Glider: Low-Cost Retrofit of a Buoyancy Driven Sea-glider. In Proceedings: IEEE/MTS OCEANS 2024, Accepted for Publication. Halifax, Nova Scotia, Sept. 23-26 2024

Yamazaki Y, Lay T, **Cheung KF**, Witter RC, La Selle SM, Jaffe BE (2024). A great tsunami earthquake component of the 1957 Aleutian Islands earthquake. Earth and Planetary Science Letters, 637, 118691.a

Chung N & **Krieg M**. Resident AUV Design for Deployment at the Kilo Nalu Observatory. In Proceedings: IEEE/MTS OCEANS 2024, Accepted for Publication. Halifax, Nova Scotia, Sept. 23-26 2024

Liu H, Yuan R, Lv Y, Yang X, Li H, **Gedikli ED** (2024). Multivariate phase space warping-based degradation tracking and remaining useful life prediction of rolling bearings. IEEE Transactions on Reliability.

Peel G, Groeschel V, **Behnen J**, **Demir O**, Hendrikse H, **Francis O**, **Gedikli ED** (2024). Navigating the New Arctic: Insights into Ship Activities, Ice Modeling, and Stakeholder Engagement in US Arctic Waters. In Cold Regions Engineering 2024: Sustainable and Resilient Engineering Solutions for Changing Cold Regions (pp. 47-59).

Encke CV & **Gedikli ED** (2024,). Vortex -Induced Vibrations of Low Mass Ratio Cylindrical Cantilever Beams. In Proceedings of the 34th International Ocean and Polar Engineering Conference, Rhodes, Greece, June 16-21, 2024.

Pappas KA, **Cross PS** & **Gedikli ED**. (2024). Structural Optimization for the Hawai'i Wave Surge Energy Converter Comparing Experimental and Simulated Results. In Proceedings of the 34th International Ocean and Polar Engineering Conference, Rhodes, Greece, June 16-21, 2024.

Lamei A, Hayatdavoodi M, Riggs HR, **Ertekin RC** (2024). Dynamic response of multi-unit floating offshore wind turbines to wave, current and wind loads, J. Renewable and Sustainable Energy, Vol. 16, No.2, 23307.

Kostikov VK, Hayatdavoodi M, **Ertekin RC** (2024). Moored Elastic Sheets under the Action of Nonlinear Waves and Current. Marine Structures, Vol. 93, January, p. 103542.

Zhao BB, Zhang TY, Duan WY, Wang Z, Guo XY, Hayatdavoodi M, **Ertekin RC** (2023). Internal solitary waves generated by a moving bottom disturbance. J. Fluid Mechanics, Vol. 963, pp. A32(1-26).

Hayatdavoodi M, Chen Y, Zhao BB, **Ertekin RC** (2023). Experiments and computations of wave-induced oscillations of submerged horizontal plates. Physics of Fluids, AIP, Vol. 35, No 1, pp. 017121(1-28).

Hayatdavoodi M and **Ertekin RC** (2023). Diffraction and Refraction of Nonlinear Waves by the Green-Naghdi Equations. J. Offshore Mechanics and Arctic Engineering, ASME, April, Vol. 145 pp. 021201 (1-13).

ORE is under full sail! We're powering forward strong and fast. Our faculty and student numbers are up, our office is in full swing, we have an exciting array of well-funded projects, our programs are being guided and supported by industry, and we are now developing our new spaces to jump-start our plans for an improved teaching lab, a computing lab/facility, and improvements to our student and researcher spaces. This is an exciting time for ORE— a time of expansion and impact. We've pulled people and resources together to make some exciting improvements, and we need your support! Your gift will be used directly in support of our programs, resources and infrastructure, and to help talented students reach their potential for impactful contribution to the Ocean State of Hawaii, and to a dynamic world that increasingly relies on well-trained engineers who are prepared to work in, on, and around the ocean. Please consider donating to ORE today:

https://giving.uhfoundation.org/funds/12373104

To pay by check, please make payable to University of Hawaii Foundation, indicate the donation is for "ORE 12373104", and send to:

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