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Members are encouraged to submit copy highlighting 1) Chapter Events, 2) People & Company News, 3) Student & Young Professional News, 4) Technology Updates, or 5) other material of broad interest to the OES. Please send to Beacon Editor-in-Chief, Harumi Sugimatsu <harumis@iis.u-tokyo.ac.jp>. Word format, 1-1/2 space; Photos (always encouraged): jpg, 300 dpi preferred. Material becomes property of IEEE-OES. Please send e-mail or physical address corrections or updates to the EIC.

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Member Benefits—Did You Know?

Group Insurance Plans

IEEE's member group insurance plans offer exceptional benefits, value and service. Active IEEE members in specified geographic areas may participate in insurance ranging from term life insurance, other life and health plans, professional liability insurance, auto and home insurance. In addition to the savings opportunities for members, IEEE may earn non-dues revenue from participating insurance providers. IEEE's professional staff and Board of Directors review and approve the insurance plans and providers that are available to members.

Insurance is part of one's risk management strategy, at home and at work. To learn more about a variety of risk management perspectives in business and engineering, see IEEE risk management resources. (https://www.ieee.org/membership/discounts/risk-mgmt-resources.html)

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From the OES BEACON Editors

Harumi Sugimatsu and Robert Wernli

Welcome to the September 2019 issue of the Beacon as we prepare for the next OCEANS conference in Seattle. The latest changes to all our committees and volunteers can be found on the inside of the front and back covers. Again, we'd like to thank all of the contributors to our quarterly newsletter. As you can see by the content, this is your newsletter, and we try to cover all aspects of the society activities from our workshops, symposia and conferences to what our individual members, chapters and committees are up to. And, don't forget, all issues of the Beacon are available on the OES website.

Of particular interest in this issue are the reports on our latest OCEANS 2019 Marseille conference that cover the conference in general and also the results of the Student Poster Competition. We also report on the Young Professional BOOST program and the resulting activity by the YPs at the conference. And a report from the French chapter on the first edition of the OES Festival of Distinguished Lectures that took place near Toulon, on the Mediterranean coast, in France following the conference.

The Journal EIC again provides recently released papers that are available to our members and our RECON chair reports on the latest activity in our OCEANS conference planning. And, beginning in this issue, we will provide reports from our technology committees, such as the one from the Ocean Sustainable Energy Systems (OSES) Technology Committee. There are 12 technology committees as shown on the inside of the back cover of this issue . . . get involved and enhance your career.

There is plenty going on in our chapters as reported in the articles from Singapore, Malaysia and Australia. Also, read the report from the OES Chapter Coordinator on upcoming financial support to the chapters.

And congratulations to team KUROSHIO from Japan, a joint research team, that includes several OES members, competing in the global competition of the "Shell Ocean Discovery XPRIZE." Among the 32 teams from all over the world, Team KUROSHIO finished 2nd in the grand-final, and were awarded the runner-up prize.

The Beacon continues to report on member activities in the robotic field. This issue includes a report on JAMSTEC's 2019 Underwater Robot Convention and also a report on the CMRE hosted annual European Robotics League Emergency 2019 robotics competition held in July.

We also take pride in our members. Be sure to see the latest articles on Member Highlights, Member Awards and "Who's Who in the OES." In addition, we have the latest on the "reboot" of Earthzine, OES's science outreach e-magazine, by its newly appointed editor.

Of particular interest in this issue is the result of our AdCom elections. The election included an excellent international slate of candidates. Congratulations to those elected and our encouragement to the others to become a candidate again in next year's elections.

Your Beacon editors at OCEANS 2019 Marseille, enjoying some "promotional" beverages at the OCEANS 2021 Porto exhibit booth.

There is a wealth of other information and articles in this issue that we hope you enjoy. And, as always, we'll close by inviting you to participate in your society. Submit articles and material for the Beacon. Or . . . volunteer for other society activities as a participant or an elected officer. It's your society and it is here to help you reach your professional goals. Enjoy.

Beacon Archives Now on Line

OES has totally updated the society website (ieeeoes.org) to make it more useful for our members. The latest additions, under the "Publications" tab, are an introduction to the Beacon that includes instructions on how to submit an article, a listing of the Beacon Editorial Board, pdf copies of past issues of the Beacon, and its predecessors, to 1978. We think we have all the prior issues, however, if you notice one missing, and you have a copy, please contact us so we can add it to the archives. The archives are listed at: http://ieeeoes.org/publications/oes-beacon/

Correction: In Robert Bannon's obituary in the June issue of the Beacon, it was written that he was born in 1984, which should have read 1948. Our apologies for the typo.

THE OES/MTS SOCIETY BOOTH IN MARSEILLE PROMOTES FUTURE OCEANS CONFERENCES

Chennai 2022, Gulf Coast 2020, Seattle 2019

OCEANS 2020 Gulf Coast

OCEANS 2021 Porto

OCEANS 2022 Chennai

From the Journal Editor's Desk: IEEE Journal of Engineering Early Access Papers

Mandar Chitre, Journal Editor-in Chief

Congratulations to the authors of our most recently approved papers for the IEEE JOE. The following papers were published as Early Access papers online on IEEE Xplore and will appear in regular issues soon. You'll find these papers now:

- "Research on Data Processing Method of Multi-Beam Bathymetry Based on Sparse Weighted LS-SVM Algorithm," X. Huang; C. Huang; G. Zhai; X. Lu; G. Xiao.
- "Estimates of Low-Frequency Sound Speed and Attenuation in a Surface Mud Layer Using Low-Order Modes," L. Wan; M. Badiey; D.P. Knobles; P.S. Wilson; J.A. Goff.
- "Robust Resolution of Velocity Ambiguity for Multi-Frequency Pulse-to-Pulse Coherent Doppler Sonars," C. Chi, H. Vishnu; K. T. Beng; M. Chitre.
- "Utilizing Orthogonal Coprime Signals for Improving Broadband Acoustic Doppler Current Profilers," C. Chi, H. Vishnu; K. T. Beng; M. Chitre.
- "Observation Based Nonlinear Proportional-Derivative Control for Robust Trajectory Tracking for Autonomous Underwater Vehicles," J. Geurrero; J. Torres; V. Creuze; A. Chemori.
- "Nonlinear Model Predictive Control Applied to an Autonomous Underwater Vehicle," R. Meireles Saback; A.G. Scolari Conceicao; T. L. Maia Santos; M. Reis.
- "Omnidirectional Multi-Camera Video Stitching Using Depth Maps," J. Bosch; K. Istenič; N. Gracias; R. Garcia; P. Ridao.
- "Autonomous Tracking and Sampling of the Deep Chlorophyll Maximum Layer in an Open-Ocean Eddy by a Long Range Autonomous Underwater Vehicle," Y. Zhang; B. Kieft; B.W. Hobson; J.P. Ryan; B. Barone; C.M. Preston; B. Roman. B.-Y. Raanan; R. Marin III; T.C. O'Reilly; C.A. Rueda; D. Pargett; K.M. Yamahara; S. Poulos; A. Romano; G. Foreman; H. Ramm; S.T. Wilson; E.F. DeLong; D.M. Karl; J.M. Birch; J.G. Bellingham; C.A. Scholin.
- "Interpolation Kernels for Synthetic Aperture Sonar Along-Track Motion Estimation," D.C. Brown; I.D. Gerg; T.E. Blanford.
- "Underwater Acoustic Communication Using Multiple-Input Multiple-Output Doppler-Resilient Orthogonal Signal Division Multiplexing," T. Ebihara; H. Ogasawara; G. Leus.
- "A Scheme for Multi-Target Lateral Velocity Measurement with High Frequency Monostatic Radar," M. Li; X. Wu; Z. Chen; J. Liu; W.J. Emery; C. Li.
- "Silicon-Photomultiplier-Based Underwater Wireless Optical Communications Using Pulse-Amplitude Modulation," M. Ali Khalighi; H. Akhouayri; S. Hranilovic.
- "Line of Sight Based Guidance and Adaptive Neural Path Following Control for Sailboats," Y. Deng; X. Zhang; G. Zhang.
- "Asynchronous Localization of Underwater Target Using Consensus-Based Unscented Kalman Filtering," J. Yan; H. Zhao; X. Luo; Y. Wang; C. Chen; X. Guan.
- "Broadband Waveform Geoacoustic Inversions With Absolute Travel Time," Y.-T. Lin; J. Bonnel; D.P. Knobles; P.S. Wilson.
- "In Situ Measurements of Compressional Wave Speed During Gravity Coring Operations in the New England Mud Patch," M.S. Ballard; K.M. Lee; A.R. McNeese; P.S. Wilson; J.D. Chaytor; J.A. Goff; A.H. Reed.
- "Seafloor Burial of Surrogate Unexploded Ordnance by Wave-Induced Sediment Instability," H. Klammler; A. Sheremet; J. Calantoni.
- "Manifold-Based Classification of Underwater Unexploded Ordnance in Low-Frequency Sonar," N.H. Klausner; M.R. Azimi-Sadjadi.
- "On the Achievable Rate of Multiple-Input Multiple-Output Underwater Acoustic Communications," P.-J. Bouvet; Y. Auffret.
- "Detection of Oceanographic Fronts on Variable Water Depths Using Empirical Orthogonal Functions," K.B. Hjelmervik; K.T. Hjelmervik.
- "Computational Fluid Dynamics Prediction of the Dynamic Behavior of Autonomous Underwater Vehicles," Y. Liu; Y. Yang; H. Zhang; L. Zhang.
- "Hydrodynamic Shape Optimization of an Autonomous Underwater Vehicle With an Integrated Lifting Line and Viscous Continuous Adjoint Approach," S. Wu; M. Cai; C. Yang; W. Wu; T. Wang.
- "Localizing Sources Using a Network of Asynchronous Compact Arrays," I.R. Urazghildiiev; D.E. Hannay.
- "Underwater Image Enhancement Using a Multi-Scale Dense Generative Adversarial Network," Y. Guo; H. Li; P. Zhuang.
- "Distributed Convex Optimization Compressed Sensing Method for Sparse Planar Array Synthesis in 3-D Imaging Sonar Systems," B. Gu; Y. Chen; X. Liu; F. Zhou; R. Jiang.
- "Evaluation of Alternative Direction of Arrival Methods for Oceanographic HF Radars," B.M. Emery.
- "Reinforcement Learning Based Relay Mobility and Power Allocation for UWSNs Against Jamming," L. Xiao; D. Jiang; Y.Chen; W. Su; Y. Tang.
- "Synthetic Aperture Sonar Track Registration with Motion Compensation for Coherent Change Detection," V. Myers; I. Quidu; B. Zerr; T.-O. Sæbø; R.E. Hansen.
- "Numerical and Experimental Investigation of Supercavitating Flow Development Over Different Nose Shape Projectiles," M.Y. Mansour; M.H. Mansour; N.H. Mostafa; M.A. Rayan.
- "Improving the Performance of a Vector Sensor Line Array by Deconvolution," D. Sun; C. Ma; T.C. Yang; J. Mei; W. Shi.
- "Efficient Estimation and Prediction for Sparse Time-Varying Underwater Acoustic Channels," Y. Zhan; R. Venkatesan; O.A. Dobre; C. Li.
- "Nonlinear Extraction of Directional Ocean Wave Spectrum from Synthetic Bistatic High-Frequency Surface Wave Radar Data," M. Teixeira Silva; R. Shahidi; E.W. Gill; W. Huang.

Earthzine Reboots Activities

Hari Vishnu, Earthzine Editor-in Chief

Earthzine is the science outreach e-magazine of the Oceanic Engineering Society, providing up-to-date information on Earth observation science and technology, and those contributing to its advancement. Oceans and other water bodies that cover a large portion of Earth are intuitively a key component of our coverage.

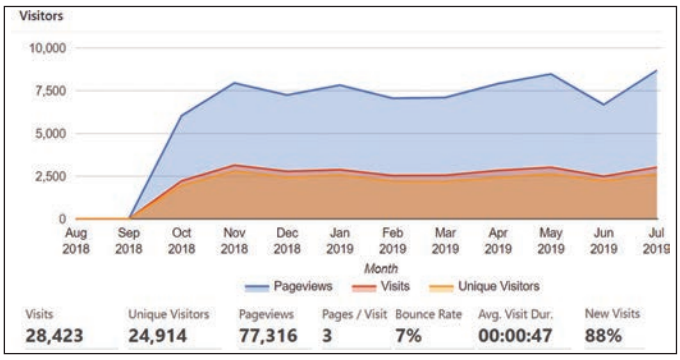
Earlier this year at OCEANS Marseille, I was appointed as the new Editor of Earthzine. My name is Hari Vishnu, and I am currently a Research Fellow at the Acoustic Research Laboratory in the National University of Singapore. The title of Earthzine Editor comes with great responsibility, and also the power to make a great impact on society. It is something I have always wanted to do, and I hope I do justice to this prestigious position. I have often felt that good science and research is not enough in isolation—it must translate into impact on the common man/woman and to the leaders of society, and thereby translate into policy and action. And it is our intention for Earthzine to fill this role.

I thank the OES Administrative Committee and the Earthzine board-of-directors for reposing their trust in me for the job. I also thank my mentors who helped me learn and become what I am, including but not limited to my colleagues at the IEEE OES Singapore chapter. A bunch of thanks to Brandy Armstrong who managed the publication in its interim period, brought a large energetic bunch of volunteers on board to get things running and played a pivotal role in hatching the magazine into its new form. I also thank our webmaster, Rajat Mishra, for optimizing, updating and maintaining the cool new website for Earthzine. For those who haven't seen it, it's here: http://www.earthzine.org. Go check it out!

Earthzine boasts a good coverage with a large readership. Our new website has been seeing increasing activity over the last few months. Earthzine was previously run under funding from NASA as a grant to the Group on Earth observations. We have ported the existing legacy articles from our previous system and made this large historical set of articles accessible to readers. Some website revamp activities remain to be done to clean up the website, but we are working to ensure these are done soon. We have also been getting excellent coverage on our social media channels (Facebook Earthzine and Twitter @earthzine), which will go towards promoting our reach further. So, things are looking good.

For readers, Earthzine aims to become an online source for news, articles, information and educational materials about Earth and Ocean science. We will have science communications, and articles covering scientific events and people involved. We will also have technical coverage of Earth and Ocean science-related events such as robotics competitions and conferences, with an aim to spread this information to the common man/woman. As one of our AdCom members put it, while our OES publication Beacon is the society's primary promotional product and an inward-looking publication with

The Earthzine team members who were able to make it to OCEANS Marseille.



Page views on Earthzine website. We have been getting a large number of page views since the new site was launched in Sep. 2018. As of July 2019, we have roughly 8000 views per month, at the rate of 3 pages per visit. Obviously there's a long way to go, but it's been a great start.

extensive coverage of society activities, Earthzine aims to become more outward-facing and reach out to a common reader with more general information. We write for readers who are not necessarily experts on Earth/Ocean sciences, and focus on the learning experience involved. We hope to do justice to our large reader base by continuing to bring out quality articles henceforth.

Readers need no introduction to the IEEE Journal of Oceanic Engineering (JOE) run by OES, which publishes technically peer-reviewed technical articles pertinent to this field. We see Earthzine as complementary to the JOE and envision a good Earthzine-JOE synergy. Authors publishing articles in JOE can use Earthzine to make the research accessible to a general reader, and enhance the impact and visibility of their publications. They can do this by submitting Earthzine articles that summarize and interpret their JOE articles. Earthzine articles are carefully edited for readability by a general reader, but not peer-reviewed for technical content.

For writers: Here's my pitch on why you should write for Earthzine:

- Ideal medium to get others excited about what science you do and how it impacts them.
- Good addendum to your published technical papers so that the research is accessible to a wider audience.
- Increase the impact of your research. Fulfill funding application open-access requirements and improve your citations.
- Great way to give back to the community by sharing your learning and expertise with the rest of the wider world.
- Improves your writing skills, which is helpful for all types of careers.
- Explaining research to a general reader helps to clarify your thought process and fine-tune your pitches.
- Get a boost on your CV, show-off your writing skills to potential employers. We can provide authors with performance statistics such as number of reads and geographic readership to help you advertise the potential of your writing.
- Earthzine articles will be further shared and publicized via our social media outreach portals, getting a larger visibility.

To submit, head over to our submission portal and get started! (https://earthzine.journals.publicknowledgeproject.org/index.php/earthzine/about/submissions)

RECON Report

Brian Horsburgh, OES RECON Committee Co-Chair

Welcome to my first report as RECON Co-Chair for OES. Its been a fairly busy first 6 months, working with my MTS Co-Chair, Andy Clark, and the members of the RECON Committee. Just prior to the Marseille conference, Andy Clark, Fausto Ferreira and I conducted a site visit to Ireland where we hope to hold OCEANS Europe in 2023. We met with an enthusiastic team in Limerick, led by Professor Dan Toal, a veteran OCEANS attendee and technical contributor. Also in the team is Professor Elfed Lewis, who has chaired previous IEEE conferences in Limerick, including IEEE Sensors in 2011 for 650 delegates, and IFOT (International Conference on Internet of Things) in April 2019. We had an extensive viewing of the facilities at the University of Limerick campus, which is well placed to accommodate an OCEANS conference, with the addition of a marquee for exhibits. There are good quality hotels nearby and extensive student style en suite accommodation on campus. Travel to Limerick is via either Dublin or Shannon international airports, with motorway connections to Limerick and excellent express bus services direct to the campus. We also visited The Marine Institute in Galway, whose staff are keen to support and assist with the conference, perhaps offering a technical visit to their Institute as part of the programme. The preliminary LOC in Limerick will reach out to Galway and other institutes in Ireland (Dublin/Cork) to form a strong Ireland team. Following the visit, Prof. Edin Omerdic made a brief

RECON committee meeting in Marseille.

presentation to the RECON committee in Marseille. The committee agreed to recommend to JOAB that Limerick is the site for OCEANS Europe in 2023.

At our RECON Committee meeting in Marseille, we approved the LOI for Portland, Oregon, for OCEANS N.A. in 2023, and recommended it to JOAB, with the proviso that they consider dates earlier in October '23. The LOC there is led by Rick Williams, and an all MTS team. The committee also heard a verbal update from Chris Whitt on OCEANS N.A. Halifax for 2024, where everything is progressing well. Chris suggested that a site visit be conducted before Seattle, to see the new convention centre and hotels in the city. This visit has now been fixed for 23/24 September '19. All three of the above LOCs will give their full presentations and budgets to the RECON Committee in Seattle on Saturday, 26 October.

On future sites, the Committee discussed and agreed the **following options be further investigated;**

OCEANS Australasia 2024 – Perth, Australia

OCEANS Europe 2025 – Hamburg, Germany or Croatia

OCEANS N.A. 2025 – Monterey, CA (now convention centre is open)

OCEANS Australasia 2026 – Kaoshiung, Taiwan or Quingdao, China

OCEANS N.A. 2026 – Still open for proposals

I hope we will have an update on Perth, from Bill Kirkwood, who is attending AUT 2019 there, just prior to Seattle. There will be discussions with potential industry partners and with local SUT members there.

Brian Horsburgh 14/08/19

Awards for OES Members

Contact the Editors with Your Submissions

Team KUROSHIO Place 2nd in the Shell Ocean Discovery XPRIZE

Reported by the OES Japan Chapter members of the Team KUROSHIO

On May 31, 2019, the Shell Ocean Discovery XPRIZE award ceremony was held at the Oceanographic Museum of Monaco. XPRIZE announced team KUROSHIO as runner-up in the grand-finals, and awarded a prize of $1 million. Team KUROSHIO consists of young Japanese scientists, engineers and researchers including many IEEE OES Japan Chapter members (https://team-kuroshio.jp).

The winner of the grand-finals was GEBCO-NF Alumni, an international team based in the United States who received a total of $4 million. Team Tao from the United Kingdom received the $200k Moonshot award for the uniqueness of their approach to seafloor mapping.

Team KRUSOHIO's story is also in this issue. Please enjoy it!

Team KUROSHIO received the runner-up prize at the Shell Ocean Discovery XPRIZE Awards Ceremony on 31st May at the Oceanographic Museum of Monaco.

YPs at OCEANS 2019 Marseille

Frederic Maussang, OES Young Professionals Rep.

Our new YP-BOOSTs—Hari, Jeff, Roberto, and Stephanie—were particularly active at OCEANS 2019 Marseille. They were present at the OES AdCom meeting and participated in the conference organization. Notably, they evaluated conscientiously the Student Poster Competition.

Many thanks to them!

In parallel, a meeting was organized on Thursday, June 20th assembling the YP-BOOSTs, former YP-BOOSTs, and other YPs interested in our activities.

A dozen attendees were present. The current and former YP-BOOSTs talked about the origin of their interest and candidature to the YP-BOOST program, their experience, and their activities in the OES.

The meeting provided the opportunity to discuss the advantages of the YP-BOOST program and what could be improved for the future campaign.

This next YP-BOOST candidature session will be open in November 2019, just after OCEANS 2019 Seattle. The two

The YPs at OCEANS 2019 Marseille.

new selected candidates will assume their role for two years from January 2020.

The info on opening the YP-BOOST application process will be transmitted via social media, email, and on the OES website.

See you soon!

Fred
Email: frederic.maussang@imt-atlantique.fr

Team KUROSHIO's Story, Runner-Up of the Shell Ocean Discovery XPRIZE!

Takeshi Nakatani (Beacon Associate Editor and Team Leader), Takeshi Ohki, Yuya Nishida, Blair Thornton (Beacon Associate Editor); Team KUROSHIO Board of Directors

Team KUROSHIO is a joint research team taking on a global competition "Shell Ocean Discovery XPRIZE." Among the 32 teams from all over the world, Team KUROSHIO finished 2nd in the grand-final, and were awarded the runner-up prize. The team members come from eight different organizations, including government research institutes, universities, and private companies[*1], all with a background and passion for marine robotics, sensing and deep-sea exploration.

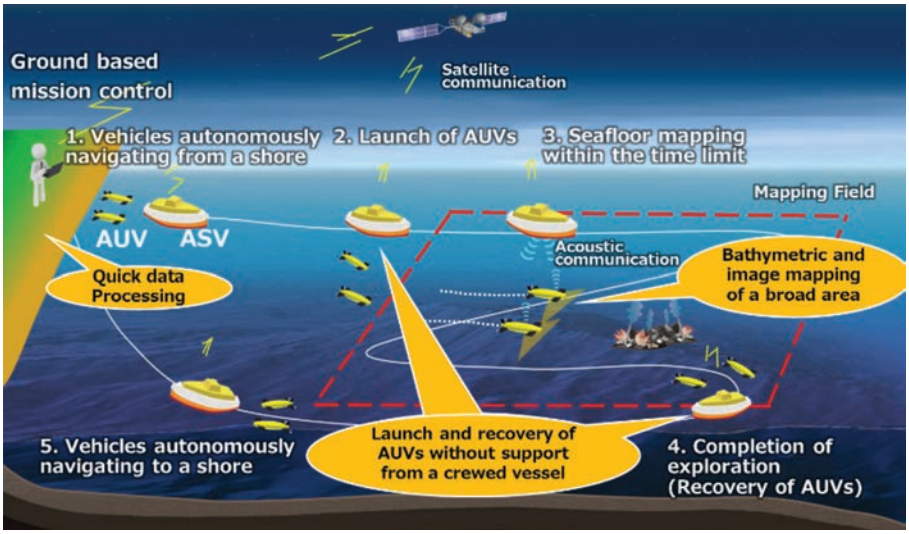
The ocean covers 71.1% of the Earth's surface, but to date, only around 10% of the ocean floor has been mapped. In other words, we do not really know what is out there for about two-thirds of the surface of our own planet. The competition challenged teams to think differently, and advance deep sea technologies for autonomous, fast, high-resolution ocean exploration. This article introduces our team's story, and reports on our testing in the final round held in Kalamata, Greece in December 2018.

Our journey started 1009 days before the prize ceremony, on the Island of Maui, Hawaii, on 25 August 2015. A member of what would become Team KUROSHIO had just presented some data collected by a Japanese Underwater Vehicle in the Iheya North Field, off the coast of Okinawa. Jyotika Virmani,

Competition schedule of "Shell Ocean Discovery XPRIZE."

Team KUROSHIO. A joint research and development community by eight Japanese organizations.

[*1] Japan Agency for Marine-Earth Science and Technology, Institute of Industrial Science, the University of Tokyo, Kyushu Institute of Technology, National Institute of Maritime, Port and Aviation Technology, Mitsui E&S Shipbuilding Co., Ltd., Nippon Marine Enterprises, Ltd., KDDI Research, Inc., and Yamaha Motor Co., Ltd.



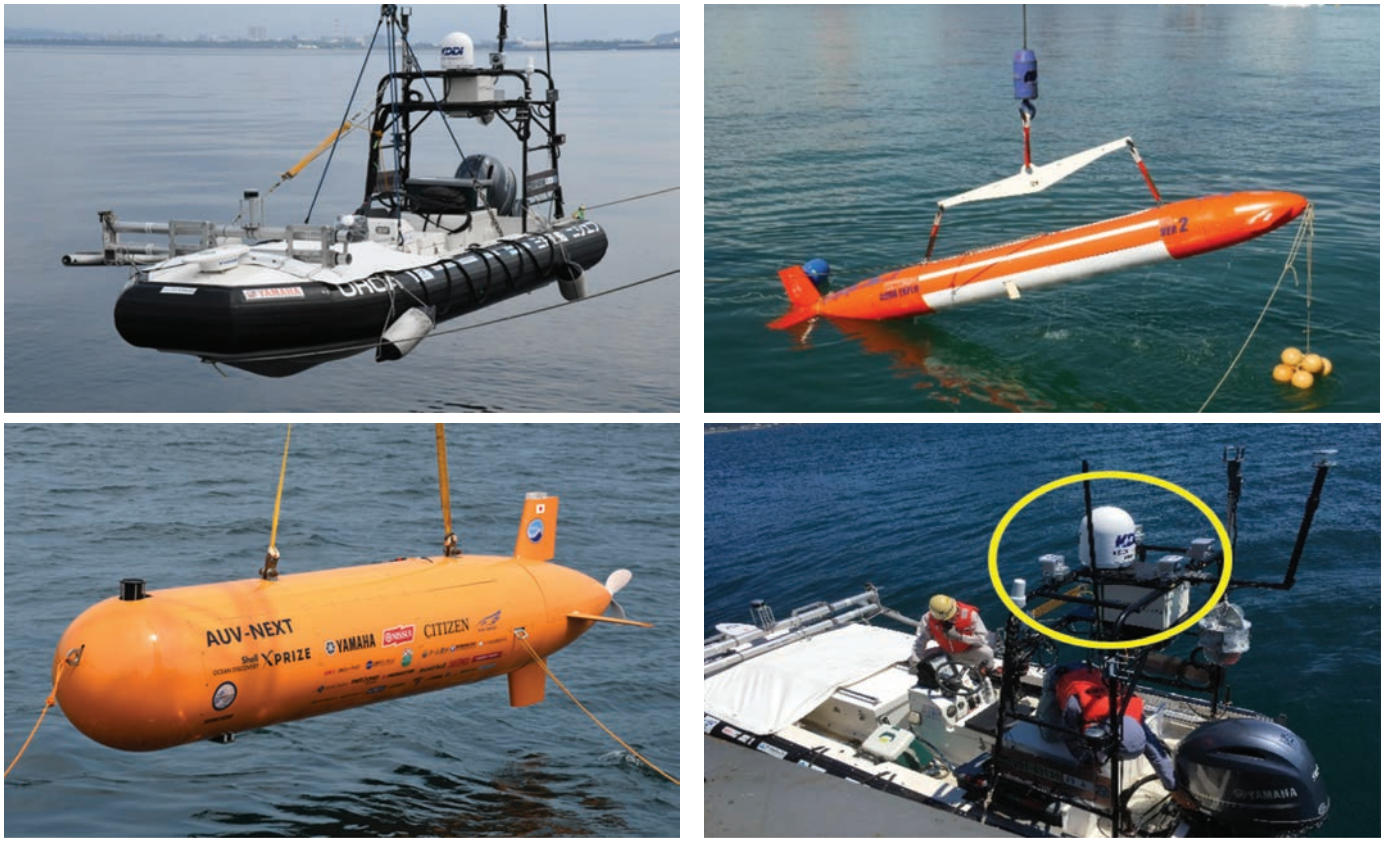
Mission strategy of team KUROSHIO.

Executive Director at XPRIZE, came up to us and told us about the new concept she was developing, an XPRIZE competition for deep-sea mapping. At the time, the details were still being worked on, but what was for certain was that it would involve mapping huge areas of the seafloor using underwater robots, probably several of them. In December 2015, the XPRIZE was announced, and Team KUROSHIO was born.

The challenge set was for robots to map a huge region of 500 square kilometers, the size of a large city, at a resolution high enough to spot a car, at a depth deeper than the height of mount Fuji. The real challenge was that this all had to be done in 24 hours, with no ships or people to support the robots during the entire operation.

Team KUROSHIO started out as a series of meetings where a handful of young engineers met and brainstormed. We exchanged hundreds of ideas, drew thousands of sketches, we challenged each other and ruthlessly eliminated concepts that weren't robust. We also realized that the challenge required more than just good technology. It required us to be organized. We formed a board of directors, a development group, an operations group, and management and communications teams. We grew from a handful of young engineers into a team of more than 30 engineers, administrators and publicists spanning academia, government and industry.

Through the three-years of international competition, there were three gateways teams had to battle through. The first, was the technical proposal and document review. Next was the

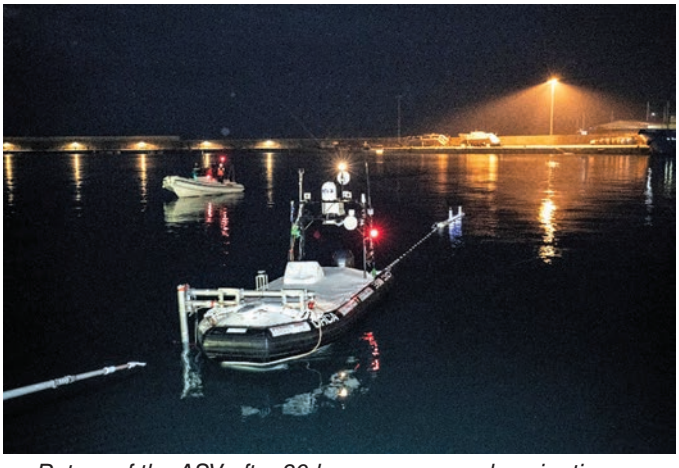


Team KUROSHIO's vehicles and equipment: ASV, AUV "AUV-NEXT," AUV "AE-Z," and communication equipment on the ASV being setup.

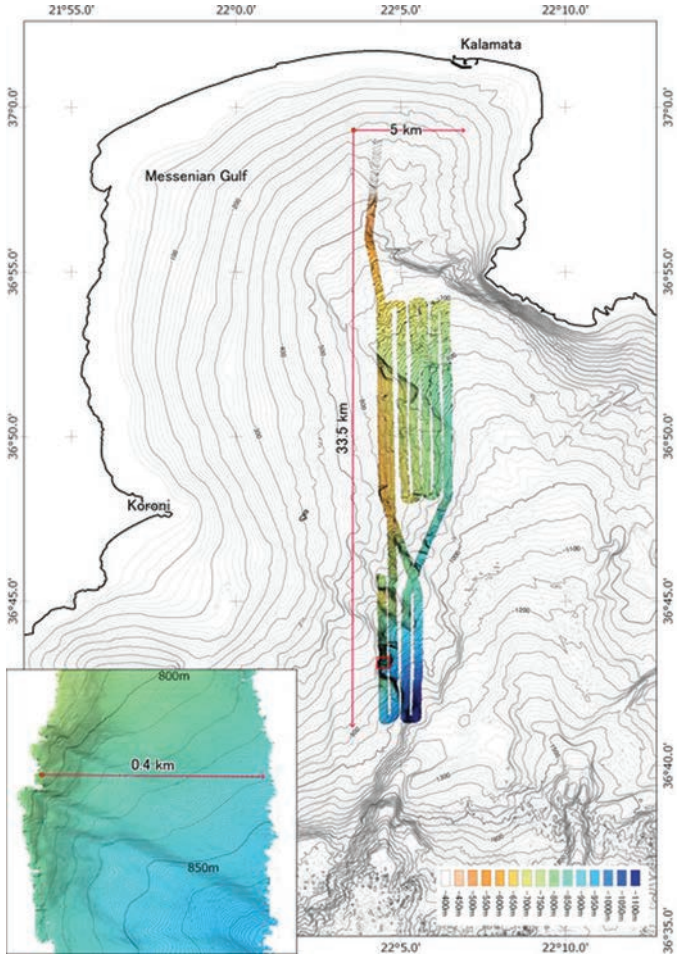
AUVs being towed by an ASV near the port of Kalamata, Greece on Dec.11, 2018.

Data submission ceremony of team KUROSHIO on Dec.19, 2018.

Departure of an ASV and AUV from the port of Kalamata, Greece on Dec.16, 2018.



Return of the ASV after 30 hours unmanned navigation on Dec.17, 2018.



Bathymetry data acquired by Team KUROSHIO during Round 2 (Lower left) Extended figure of the bathymetry.

Round 1 technology readiness test, which included hardware demonstrations in water. The final gateway, Round 2, was the sea-trials. The Round 1 technology readiness test was held from November 2017 to January 2018. The competition judge evaluated each team's technology across 11 criteria, in each team's home country. Round 2 tests were held from November to December 2018, where eight teams, including Team KUROSHIO, had advanced to the final stage. The competition judges evaluated each team's seafloor survey performance through sea trials in the Mediterranean Sea.

Team KUROSHIO received the Runner-up prize for the Grand final at the Shell Ocean Discovery XPRIZE Awards Ceremony on 31 May at the Oceanographic Museum of Monaco.

The mission requirements of Round 2 testing are as follows:

- Operators have to stay onshore, operate the team's survey system from a land-based mission control center.
- The entire survey system has to fit into single 40 ft container.
- The survey system has to be launched and recovered from a shore base and make their own way to the survey site.
- The teams need to acquire bathymetry of 5 m resolution horizontally and 0.5 m resolution vertically at the site. Several seafloor images also have to be captured.
- The survey system has to acquire a minimum of 250km^2 of bathymetry up to 4,000 m depth in 24 hours.
- The seafloor map must be extracted, processed and outputs submitted within 48 hours.

To satisfy the above missions, Team KUROSHIO proposed a compact and mobile suite consisting of multiple robotic systems capable of fast and ultra-wide area bathymetric survey without a crewed support vessel. The proposed system consists of two autonomous underwater vehicles (AUVs), an autonomous surface vehicle (ASV), and ground mission control. The proposed system includes a system that enables towing, deployment and recovery of AUVs by an ASV without the support of a crew. The ASV can tow multiple AUVs from shore to the competition area and release the AUVs once at the site. The released AUVs dive down to an altitude of ~100m and follow pre-programmed waypoints. The land-based operators monitor the AUVs' status via the telemetry suite on the ASV, which communicates with the AUVs using underwater acoustics, and communicates with the land-based operators through satellite communication. The bathymetry data is saved on hard disks inside AUVs, which are extracted and processed after the AUV recovery.

Team KUROSHIO conducted Round 2 testing between December 9-19, 2018, in the midst of the Greek rainy season, with spurts of activity taking place between thunderstorms and gales.

12/1: Team departs for Greece.

12/10-: Final systems tests for robot mission control. Decision made to carry out Round 2 testing with our ASV and the AUV-NEXT due to hardware trouble.

12/16: Round 2 testing off Kalamata. The ASV towed the AUV 15 nautical miles to the competition area and then released the AUV. Subsequently, the AUV started seafloor survey for 24 hours.

12/17: After 24 hours, the AUV finished the survey and returned to the mission control, the port of Kalamata. The acquired date was extracted from hard disks inside the AUV and was handed over to the team's data processing group.

12/19: Team completed the data processing and submitted the data products to the judges.

We succeeded in acquiring bathymetry data over a 5 by 33.5 km region, at 1 m lateral resolution using AUV-NEXT's multibeam sonar. Several side scan images were also acquired and submitted.

On May 31, 2019, the Shell Ocean Discovery XPRIZE award ceremony was held at Oceanographic Museum of Monaco. XPRIZE announced that team KUROSHIO won the runner-up prize in the Grand final and awarded our team the "official" prize of $1M and a trophy, where the latter was unfortunately held in customs.

We appreciate the XPRIZE foundation and Royal Dutch shell for the opportunity that they have provided us and the marine research community. We thank our sponsors, suppliers and supporters. It was an intense, unforgettable, and valuable experience. For us, the "real" prize was the journey XPRIZE took us on; the sense of achievement in seeing ideas that were first sketched on scraps of paper play out in Kalamata for the whole world to see; the thousands of supporters following our activities on Facebook and twitter and the tens of thousands of likes we got on YouTube; the fact that marine robotics has become a more familiar term to everyday people around the world; and most importantly, the opportunity it gave for the members of Team KUROSHIO to work closely alongside each other, because these people are the community of engineers, operators, administrators and publicists who will drive the next generation of marine robotics research in Japan.

From Your Chapter Coordinator

Gerardo Acosta, OES Chapter Coordinator

Gerardo Acosta, Chapter Coordinator.

Still with the joy of sharing four wonderful days at the OCEANS Conference in Marseille, France, exchanging top level knowledge and advances in our disciplines, as well as spending great moments with friends, I would like to bring you a brief update about our Chapter Chairs meeting there. We were talking about a New Funding Scheme for Chapters (see next), about the Distinguished Lecturers Program giving tips to a better use of it, and also how to make the communications to and among chapters much more fluid. We still have some difficulties to reach some chapters. I also invite all of the OES Chapter Chairs spread in the world to meet each other in our next meeting in Seattle, at next OCEANS, and to contact me at: gerardo.acosta@ieee.org with questions, requirements or initiatives in your local chapters.

New Funding Scheme for Chapters Since 2020

In the past Administrative Committee Meeting in Marseille, France (June 2019), our Oceanic Engineering Society, decided to start up a new chapters activity funding scheme (CAFS), lead by our Vice-President for Technical Activities (VPTA), Mal Heron. It will be implemented on January 1st 2020. This new proposal is as follows: a fund will be set aside annually for this CAFS, so Chapter Chairs are invited to request support for specific planned events or activities from it. Proposals are invited up to 2 years ahead to allow planning for Workshops or Symposia, or on a shorter time scale for conference special sessions or streams, and on an even shorter time scale for technical meetings and events. The CAFS can support planning or promotion activities and assistance, where appropriate, for a volunteer who is a Chapter Member to attend an activity. Note that formal meetings, like Workshops and Symposia, must be approved by the OES Administrative Committee at least one year in advance and that approval includes budget estimates and possibly requests for funding. Normally a proposal to the CAFS for meetings and activities will show significant support from other sources.

The Chapter Coordinator, jointly with the VPTA, will administer the funds within this CAFS. There is no closing date because the CAFS operates on a rolling schedule. For this reason, Chapter Chairs are encouraged to submit their proposals as early as possible to the Chapter Coordinator. A template for this request will be soon provided.

For proposals that are approved, funds will be transferred to the designated Chapter's Bank Account. OES will require an expense report, the L31 report, and an article in the Beacon Newsletter for each funded project. Each activity or event should have an outreach element that promotes the Society and its membership.

Chapter News

Submit Chapter News to Beacon Co-Editors and OES Chapter Coordinator

Singapore Chapter

Reported by Venugopalan Pallayil

The Chapter has been active in organising technical talks and a social gathering for its members this year. At the beginning of the year, we organised a talk by Prof. Thomas Cronin from the University of Maryland Baltimore County (UMBC). The talk was titled "The Eyes of Mantis Shrimp: Models for Bioinspired Optical and Imaging System Design" and was presented on the 8th of January, 2019. The talk focused on how biological sensors can bring unexpected innovations and novel concepts into visual system design. These may be useful in the inspiration of new engineered solutions to problematic challenges. He discussed the unusual eyes of mantis shrimps and how our understanding of its usage could inspire new designs for spectral/

Dr. Tom Cronin delivering his talk on "Eyes of Mantis Shrimp: Models for Bioinspired Optical and Imaging System Design."

Talk on "Acoustic Doppler Current Profilers and their applications" by Dr. Sairajan Sarangapani.

Social networking dinner for IEEE OES Singapore chapter at PocoLoco Microbrewery.

polarimetric imaging systems for medical and material imaging applications.

On 30th April, 2019, the Chapter hosted a talk on "Acoustic Doppler Current Profilers and their applications" which discussed the history of development of acoustic Doppler current profilers, and the latest innovations and performance envelope of such systems. The speaker was Dr. Sairajan Sarangapani, Director of Research and Development at Rowe Technologies Inc. We also organised a talk on "RTSys—capabilities and systems" by Mr. Maxime Velu from RTSys on 4th April 2019. In his talk Mr. Maxime showcased some of the products developed by RTSys and how it can support research in underwater acoustics and oceanic engineering.

A social networking dinner for OES chapter members and volunteers was organised on 22nd March at Poco Loco Microbrewery. This was a fun meetup for our members and volunteers, which facilitated fruitful interaction. The event also served as a good channel for discussions on several upcoming events such as SAUVC 2020 and OCEANS 2020 Singapore.

Malaysia Chapter—Visit to Oceanographic and Environmental Institute (INOS), UMT

Reported by Khalid Isa and Mohd Rizal Arshad

On 21st March 2019, IEEE OES Malaysia Chapter organized a visit to Universiti Malaysia Terengganu (UMT). The activities include a session meeting with YBhg. Prof. Dato' Dr. Nor Aieni Hj Mokhtar, UMT Vice-Chancellor, setup of IEEE OES Malaysia Chapter material for the LIMA 2019 exhibition and visit to UMT Oceanographic and Environmental Institute (INOS). There are many opportunities given by UMT Vice-Chancellor and Director of INOS, such as research collaboration, scientific exchange and visiting lecture.

Round Table Discussion with IEEE OES Malaysia Industrial Advisor

Reported by Mohd Shahrieel Mohd Aras

IEEE Oceanic Engineering Society (OES) Malaysia Industry Advisory Group.

On 17th March 2019, IEEE OES Malaysia Chapter organized a Round Table Discussion with Industries which took place at the Residence @ UTM Kuala Lumpur. The discussion unleashes the expertise of professionals in a friendly discussion and the potential of collaboration between Universities and Marine Industry. It is a great platform for delegates to discuss and share their insights on the trends, issues and possible solutions to prevailing concerns in the field of Ocean Engineering. The lunch meeting involved four companies and three universities related to oceanic engineering and maritime. The four companies were the Fugro Geodetic (Malaysia) Sdn Bhd, Temasek Hidroteknik Sdn Bhd, MTC Engineering Sdn Bhd, and Efogen Sdn Bhd. Meanwhile, the universities involved were the Universiti Teknikal Malaysia Melaka (UTeM), Universiti Sains Malaysia (USM) and Universiti Teknologi Malaysia (UTM). In the meeting, Past Chair of IEEE OES Malaysia Chapter, Prof. Ir, Dr. Mohd Rizal Arshad from USM, Assoc Prof. Ir, Dr. Zool Hilmi from UTM and Assoc Prof. Dr. Mohd Shahrieel Mohd Aras and Assoc Prof. Dr. Ahmad Anas Yusof represented UTeM. Additionally, the Vice-Chair and Executive Committee for IEEE OES Malaysia Chapter 2019 were also present in the meeting. The meeting has given the opportunities for the universities to collaborate in research activities that are aligned with the needs of the industries. Most of the industries members of this society are willing to share their experience in an industry talk and collaborate with universities for research grants. They also welcome any academic staff interested in Industrial Attachment.

After-School STEM Educational Program

Reported by Mohammad Fauzi Zakaria and Herdawatie Abdul Kadir

On Saturday, May 4th, 2019, the after-school Science, Technology, Engineering and Mathematics (STEM) Educational program was held at Universiti Tun Hussein Onn Malaysia

(UTHM), Johor. The event organized by a sub-committee of ROBOCON UTHM. Fifteen students from selected schools and 35 undergraduate students have joined the program. They were introduced to the world of mobile robots, how to build and control them. The program exposed the design skills and development of the basic robot. In addition, it helped foster awareness and understanding among students about the collaboration between different engineering skill-sets to create an end product. The participants have shown extending interest in and understanding of STEM. Each participant was awarded with a certificate of attendance, and the top three teams were awarded with a winning certificate.

Australia Chapter—OzChap Action

Reported by Mal Helon

OES Distinguished Lecturer Dr. Rick Spinrad Oregon State University.

The OES Australia Chapter had two technical meetings recently. The first was in April 2019, held jointly with the Circuits and Systems Society Chapter under the auspices of the Victoria Section. Dr. Richard Spinrad is an OES Distinguished Lecturer and was on his way home from the MTS International Buoy Workshop in Hobart when he stopped over in Melbourne to give a talk. Rick gave a brilliant

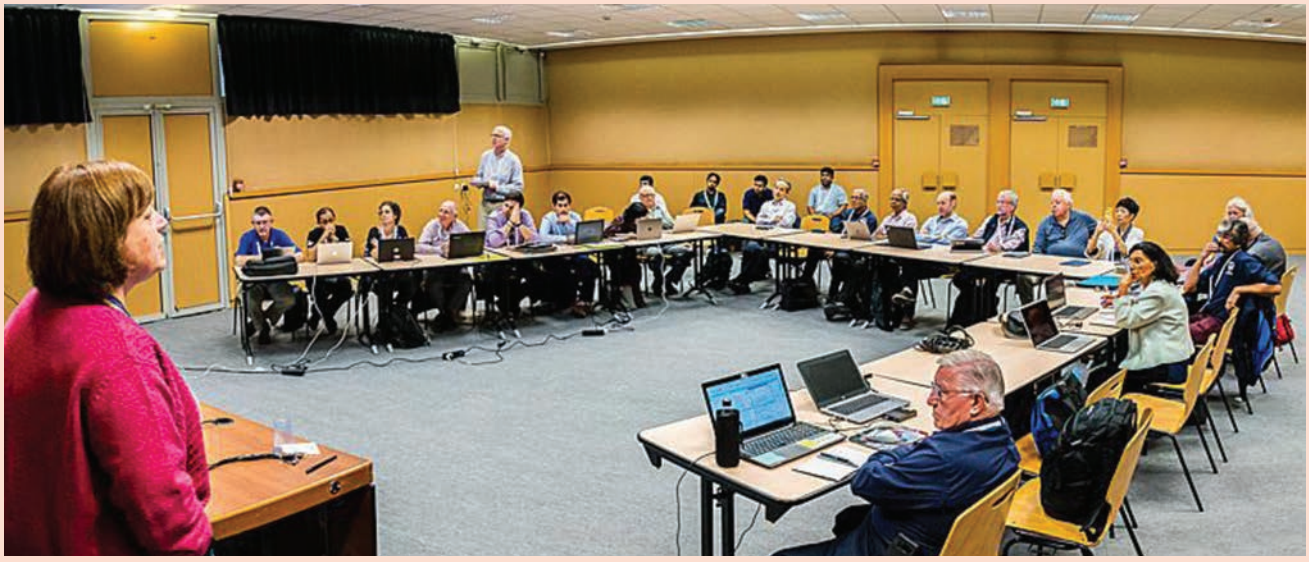
overview of the driving forces for marine technology. The most obvious driver for advancement is the pull factor of enhanced performance, in terms of cost, efficiency and safety. The traditional maritime industries like oil and gas exploration, commercial fishing and marine transport have driven improvements in a range of areas such as dynamic positioning, acoustic sensors, imaging techniques, and data management. In parallel, research and development communities are providing a push factor in areas like advanced materials, genetic probes, and compressive sensing. Coupled with developments of a "New Blue Economy," and the role of technological disruptions, Rick pointed to an exciting era for defining the trajectory of marine technology.

The second OzChap event was a visit by Dr. Jules Jaffe from Scripps Institution of Oceanography to the Australian Institute of Marine Science and the Northern Australia Section in Townsville. Jules is an Emeritus Distinguished Lecturer, having served for many years and was welcomed to the OES Australian Chapter by Melanie Olsen from AIMS. Jules delivered a majestic trajectory of underwater imaging from the scale of sunken ships and lost aeroplanes through to the microbes, which we discovered make up about 90% of the ocean biomass. Dr. Jaffe is a seasoned raconteur and the story about imaging microbugs in low light to investigate strategies of predation and survival in the deep ocean capped off a most interesting presentation. The attendees enjoyed a bite to eat at a social gathering following the meeting.

Jules Jaffe ponders on his next point.

Melanie Olsen welcoming Jules Jaffe in Townsville.

YOUR OES ADCOM AT WORK IN MARSEILLE



The OES Festival of Distinguished Lectures

Philippe Courmontagne, French Chapter Chair

Just following the OCEANS conference in Marseille, the first edition of the OES Festival of Distinguished Lectures has taken place near Toulon, on the Mediterranean coast, in France.

Jointly organized with the OES French chapter and Naval Group, the European leader in Naval Defence, this festival welcomed five distinguished speakers warmly.

During the whole day, and after an "ice-cream party" the night before the festival, these five presenters have given enthusiastically their lectures and have fascinated the large audience of scientists, engineers and students.

These five lecturers were:

- Rick Spinrad, distinguished lecturer, MTS President, who gave a talk on "*The drivers of Marine Technology*"

Comfort before effort.

In front of the Naval Group building, from left to right: Christian Audoly (Naval Group), James Candy, Aymeric Bonnaud (Naval Group), Frédérique de Ruiter (Naval Group), William Kirckwood, Rick Spinrad, John Potter, Kenneth Foote, Philippe Courmontagne (Naval Group) and Christian de Moustier, IEEE OES President.

William Kirkwood giving his talk.

John Potter explaining JANUS.

- James V. Candy, distinguished lecturer, who presented "*Ocean Acoustic Signal Processing: A Bayesian approach*"
- Kenneth G. Foote, distinguished lecturer, who warmly explained "*Standard-target method of calibrating active sonars, with applications to the quantitative imaging and measurement of scattering*"
- John R. Potter, who shared the knowledge acquired at the CMRE (Centre for Maritime Research and Experimentation) about acoustic underwater communications with "*Janus: The first (and so far only) digital underwater communications standard*";
- William J. Kirkwood, who delighted the audience with his presentation "*AUVs: A possible future*", where he presented the MBARI (Monterey Bay Aquarium Research Institute) Shearwater, a heterogeneous vehicle for Autonomous Marine Observations and Operations.

This first edition was really successful. All these lecturers thrilled the audience (around 30 people) with their outstanding performances.

No doubt, this edition is the first one of a long series.

Technology Committee Reports

Submit TC Reports to VPTA and Technology Committee Coordinator with cc to Beacon Co-Editors

The BEACON newsletter introduces the hot topics of the Technology Committee activities every issue from this September issue. Please submit your TC activities to the VPTA (mal.heron@ieee.org) and Technology Committee Coordinator (shyamblast@gmail.com) with cc to the Beacon Co-Editors (harumis@iis.u-tokyo.ac.jp, wernli@ieee.org) in by the due date.

OCEAN Sustainable Energy Systems TC—The 2019 Offshore Energy Storage Symposium

Reported by Seamus Garvey, Chair Ocean Sustainable Energy Systems Technology Committee

One of the topical pillars of the Ocean Sustainable Energy Systems (OSES) Technology Committee is energy storage. Energy storage is emerging as the most immediate problem for renewable energy and the 2019 Offshore Energy Storage Symposium squarely addressed this.

OSES2019 retained all of the magic of its predecessors. The conference series is unique in its combination of topics addressing how to capture renewable energy ever more effectively from the vast resources available offshore and how to enable that energy to be most useful as it comes ashore. OSES2019 was also replete with contributions around how to construct business cases such that full systems embracing both the harvesting and the dispatchability can be realised in the near future.

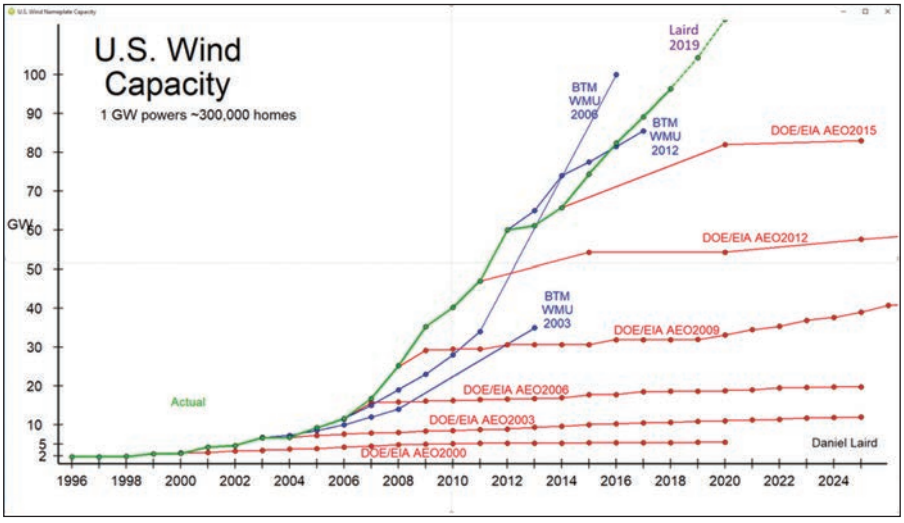
The OSES conferences were sparked-off initially by a recognition occurring simultaneously in several places that retaining pressurised air underwater could be a highly effective way of storing energy. This conference series has been the natural home for this thinking since 2014 and this year, at least 8 papers addressed this topic further.

Desalination is also emerging as a consistent theme since the energy service (potable water) is extremely cheap and straightforward to store and to transport (it floats on seawater). There are obvious and considerable advantages of driving reverse osmosis directly from wind, wave and tidal sources rather than making electricity first and then doing transmission and conversion separately.

Wave energy featured strongly also, led by an excellent keynote overview from Prof. Gregorio Iglesias of University College Cork with several other papers introducing new ideas for integrating wave energy converters with shoreline protection and integrating wave energy with wind generation.

Prof. Yann-Herve de Roeck of France Energies Marine set the local context of marine energy in France—ranging from the tidal barrage at La Rance to the new floating wind farms planned in five locations.

Prof. Daniel Laird from NREL brought the USA perspective to OSES2019 with his keynote. Notwithstanding the nominal withdrawal of USA from COP21, Daniel reassured the conference that renewable was fit and well in the USA—and developing very rapidly. One of Daniel's charts (below) showed the consistent propensity of institutions to underestimate what wind energy would do in the future. This chart should give heart to all who work in the field of renewable energy.



US wind capacity forecasts and actuals over two decades. (provided by Daniel Laird)

The closing session of OSES2019 addressed "Getting the message across," which was led by the TC co-chairs, Rupp Carriveau (University of Windsor) and Seamus Garvey (University of Nottingham). Whilst the technical progress in offshore energy continues with impressive resolve, the session uncovered that there are strong indicators that the policy-makers continue to underestimate the future importance of the connection between the collection and the local storage of energy. The OSES conferences have a big job ahead of them to influence this.

The European Robotics League (ERL) Emergency 2019

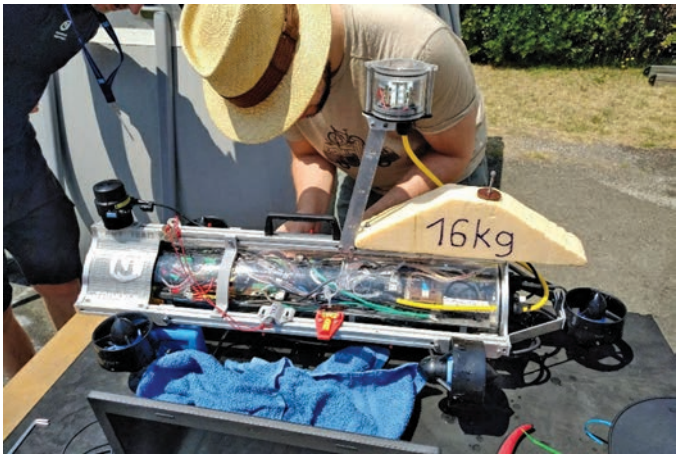
Gabriele Ferri[1] and Fausto Ferreira[2]
[1]ERL Emergency 2019 Director [2]OES AdCom 2018–2020

NATO-STO Centre for Maritime Research and Experimentation (CMRE) has been organizing Student AUV Challenge—Europe (SAUC-E), the premier European student competition for underwater vehicles, since 2010. Over the years, we have been fostering the use of heterogeneous robots in our competitions. In SAUC-E we have given teams the possibility to also deploy marine surface vehicles, introducing tasks that required robot cooperation. In fact, only teams composed of cooperative heterogeneous robots can be effective in solving complex tasks in real world scenarios. This interest led CMRE to locally organize the euRathlon 2015 Grand Challenge at Tor del Sale power plant site (Piombino, Italy) in September 2015. euRathlon 2015 Grand Challenge, organized in the framework of the euRathlon EU project, was the first world's multi-domain robotics competition. Disaster response tasks were proposed to teams composed of land, sea and air robots. The inspiration came from the Fukushima 2011 accident.

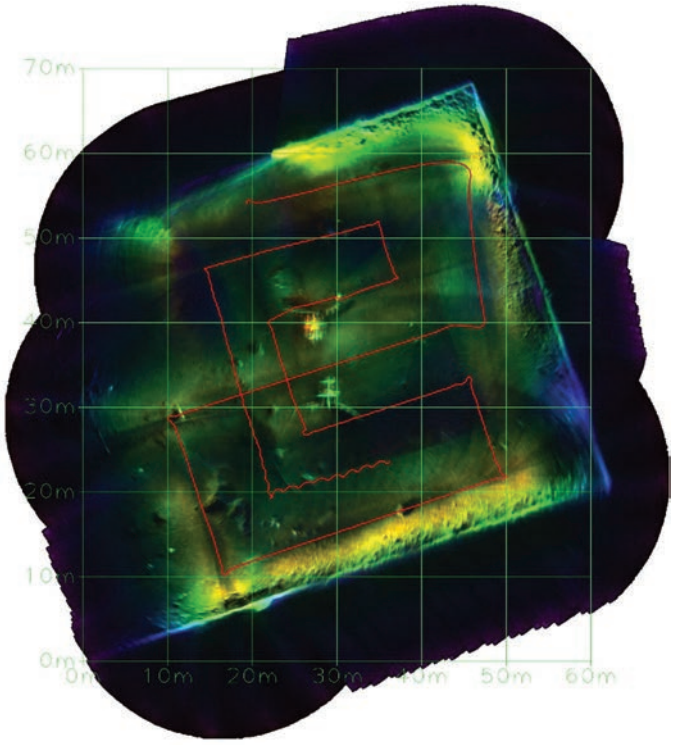
This formula of multi-domain competitions has continued with the European Robotics League (ERL) Emergency. ERL is a common framework for robotics competition funded by the European Union. ERL was launched in 2016 in three vibrant fields of robotics: industrial, service and emergency robots. The first season culminated with the ERL Emergency 2017, a multi-domain competition again locally organized by CMRE at the Tor del Sale power plant site in Piombino. Since 2018, supported by the SciRoc project, the ERL concept has been extended to Smart City environment.

The Competition

CMRE hosted also this year the annual European Robotics League Emergency 2019 robotics competition from 14 to 19 July. SAUC-E 2019 was integrated in the competition. ERL Emergency 2019 was a double domain competition where land robots and AUVs could participate. The areas of robot operations included a building with the surrounding outdoor space for land robots and the CMRE water basin for underwater robots. The areas were prepared to simulate a yacht accident in a harbour connecting it to the general theme of the SciRoc project: Smart Cities. Tasks similar to those present in ERL Emergency



The new vehicle developed by AUV Team TomKyle.



Sonar mosaic of ERL Emergency 2019 Arena with the AUV trajectory in red by AUV TEAM TOMKYLE. The two underwater pipe structure are visible in the centre of the image.

2017–2018 were proposed to teams. Land robots had to survey the outdoor area detecting colored markers, to localize pipes and a mannequin representing a missing worker. Then, inside the building, the robots had to find and close a valve and to detect a canister. They were asked to move the canister to a simulated fire location in the outdoor area.

Underwater robots inspected a pipe structure, passed through validation gates and searched for a missing person underwater, represented by a realistic mannequin. This year we added several buoys of four possible colors. The buoys had to be detected, localized and their color recognized. A different action was requested to the teams depending on the buoy color: for instance, turning around the buoy in a clock-wise circle or stopping for 30 seconds increasing the depth. The objective was to force teams to integrate perception with adaptive mission planning in a realistic environment such as CMRE water basin. As in the previous SAUC-E editions, the challenges were held at the CMRE waterfront sea basin, which is a sheltered harbor that offers participants the opportunity to grapple with real-life sea conditions, including limited visibility and salty water, but within a safe, controlled environment. The limited visibility added severe difficulties to object recognition by AUVs, even if the targets were bright orange or red in color.

Nonetheless, several teams were able to tackle the tasks, achieving many goals. Out of the 5 marine teams registered, all tested their vehicles in the water. We tried to provide the teams as much time as possible to test their robots in the water basin. Only testing the robots in the water can allow teams to solve the technical issues and to prepare the robots for the proposed tasks. To support the practice at sea, a test arena containing the objects to be detected was also prepared next to the competition area. This allowed the teams to collect data, for instance to acquire images of the colored buoys to train and test their classifiers.

One of the interesting things we have noticed is the evolution of the teams over the past years. We have seen significant and steady progress from year to year in several teams and a constant look for improvement. For instance, AUV Team TomKyle learned a lesson from last year when their DVL broke. So, they brought a new and lighter vehicle not relying on a DVL for its navigation. For its navigation, they developed a laser altimeter system which led them to win the IEEE OES Innovation Award. At the same time, they brought the vehicle used in past editions as backup, which they had to use due to an issue with their newer vehicle. Another team that showed steady progress since last year's first participation was Team Bath Marine Drones. Last year the team components were few and they had some basic issues that prevented them to barely go to the water. This year's performance was improved. The vehicle was more robust and they reached the sea after a couple of days. They are creating a robotics club in which knowledge is passed from one generation to the next one. For this reason, we expect them to be competing for some higher places next year.

The Participant Teams

This year we limited the number of teams to 8 teams (4 land and 4 sea) due to the logistics involved for a double domain competition in the La Spezia site. 9 teams applied and 7 teams finally participated. The marine domain had 5 teams while the land part had 3 teams. One of the teams had two domains. Some of the teams matched to form multi-domain teams. At the end, 3 multi-domain teams were present. Of the competing teams, 5 had previously participated in our competitions, showing how ERL/SAUC-E is today a fixed appointment for several European research groups. Moreover, one of the teams had been away from the competition for 1 year and came back this year; a new entry from 2018 came back and a team led by a previous participant in 2012 (now mentor) participated for the first time, which highlights that the competition can be a strong stimulus for research groups to continue working on underwater vehicle technology.

The Participant Teams Were:

1) AUV Team Tom Kyle (sea); from the University of Applied Sciences of Kiel, Germany. This team has participated since 2014 in our competitions yearly. They competed together with TELEROB in the double-domain challenges.
2) MSAS (land); the MSAS land team comes from Poland. They participated previously in 2015 and 2017 and 2018. They competed together with UNIFI in the double-domain challenges.
3) SEAL (sea + land); from EPITA in Paris, France. This team participated for the first time showing that the competition continues to attract new teams. Moreover, it was the only team with both domains.
4) Team Bath Marine Drones (sea); from the University of Bath, UK. After winning the best rookie award in 2017, this year the team came back with an improved vehicle.
5) UNIFI Team (sea); from the University of Florence, Italy. A veteran of our competitions (first participation in 2012). They competed together with MSAS in the double-domain challenges.
6) KN Robocik (sea); from the Wroclaw University of Technology in Poland. Another first-time participation.
7) TELEROB (land); the TELEROB team comes from Germany. Participated previously in euRathlon 2013, 2015 and ERL Emergency 2017 and competed together with AUV Team TomKyle in the double-domain challenges.

The winners of ERL Emergency 2019.

The Winners

The winners of the ERL Emergency 2019 sea + land Tournament were:

- 1st Place – AUV Team TomKyle + TELEROB.
- 2nd Place – UNIFI Robotics Team + MSAS.
- 3rd Place – SEAL.

Other prizes awarded were:

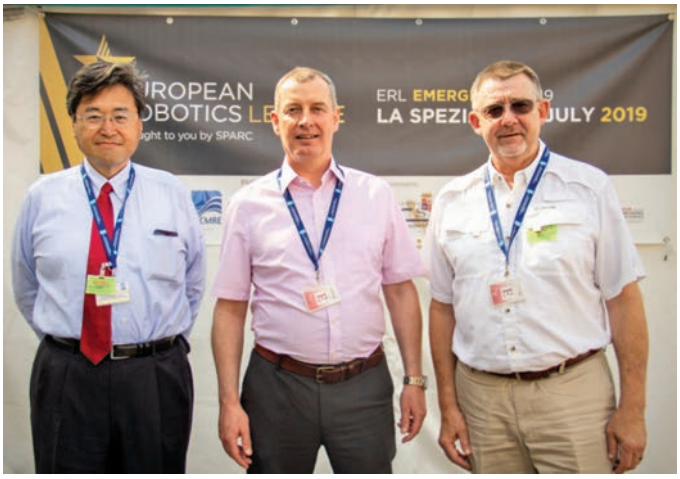
- IEEE OES Innovation award: AUV Team TomKyle.
- "Best Rookie Award" – KN Robocik.
- "Persistency Award" – Team Bath Marine Drones.
- "Multi-domain Robonation award" – SEAL.
- "Best Marine Team Award" – UNIFI Robotics Team.
- "Best Land Team Award" – TELEROB.
- "Best Presentation Marine" – AUV Team TomKyle.
- "Best Presentation Land" – MSAS.

Parallel Events

This year, we had a rich parallel program of events. First of all, the teams were received with a barbecue after long trips on the road. This was important to start creating a fair play spirit and good companionship among new and old teams.

In order to provide a better learning experience for the teams, we have setup a program of short talks. Dr. Bill Kirkwood from MBARI (U.S.) spoke about how to educate engineers through robotics competitions and challenges and what competitions can bring to students and the community. Prof. Shinji Kawatsuma, from the Fukushima College in Japan, gave the audience some lessons learned from the robotics intervention after the Fukushima Daiichi Nuclear Power Plant accident in 2011. The talk was an interesting way of learning about the

The participants with Gabriele Ferri and Fausto Ferreira, the ERL Emergency 2019 chairs.



The speakers of the talks. From left to right: Prof. Shinji Kawatsuma, Mr. David Mackay and Dr. Bill Kirkwood.

Team Hydrocarbot with their oil spill mitigation USV.

Team ITIS Giorgi with land vehicle.

real-world problems of intervention robots. Finally, Mr. David MacKay from Kongsberg (Norway) introduced the EELUME Sub-sea resident AUV for inspection, maintenance and repair, which gave an industry perspective on marine robotics.

Moreover, in collaboration with the School of Robotics of Genova (Italy), the organizer of "Olimpiadi di Robotica" (Robot Olympics), we have had the participation of three high school teams. These teams won the Olimpiadi di Robotica competition, an event sponsored by the Italian Ministry of Research and Education and each of them had a robot for one domain (sea, land and air). They had the opportunity of performing a small demo and of introducing their robots to a pool of international judges. One interesting aspect is that their robots were also designed for emergency response. For instance, the team Hydrocarbot designed an Unmanned Surface Vehicle (USV) for oil spill mitigation using a nano-techonology-based spounge made by the Italian Institute of Technology (IIT). The team from ITIS Giorgi brought a small land vehicle that albeit looked like a simple RC car it had a large suite of sensors for measuring essential info in a disaster scenario such as gas, temperature and radioactivity levels.

The local community was also engaged. CMRE's staff member families were invited to attend the event, which made many kids very happy and excited. Local schools from the La Spezia area were also involved in the framework of Giona's Project. This allowed around 20 students close to high school graduation to come and interact with the teams.

Media Coverage

A press release and a press kit in Italian was distributed to local and national press on 15 July. This led to 3 articles on the 16th (1 printed media, 2 online) introducing the competition. A Media Day was also established for Friday 19th. Several journalists attended leading to two printed articles in regional newspapers and a TV news on the regional channel Rai3 (https://www.rainews.it/tgr/liguria/notiziari/video/2019/07/ContentItem-a080b6a9-993d-43d3-abe7-bea2261df4a0.html).

In parallel, we had a strong investment in the social media channels with daily posts on the CMRE's Facebook and Twitter profiles, on the SAUC-E FB page, on the ERL FB page and on the IEEE OES FB page. Besides CMRE's staff, part of this effort was possible through the IEEE OES Social Media Initiative. Short interviews were made with teams and judges and will be published soon.

Feedback

The feedback from both the participants and the judges was very positive. A post-event survey was filled by the participants on the spot and the results show that most participants liked the competition, the helpfulness of the staff and are interested to participate again. In particular, over 73% of the participants rated the event as excellent or very good and over 80% considered it extremely or very organized. The staff was deemed extremely helpful by almost two thirds of the participants and very helpful by a third. The duration was considered about right for over 80% of the attendees that answered the survey. The location and facilities were given 4 or 5 stars by over 70% of the respondents. Over

50% of the attendees gave an extremely likely probability of recommending the event to a friend or colleague. Finally, while almost half of the participants considered the tasks hard, 86% considered them interesting or very interesting.

In terms of technical feedback, as the competition becomes harder and harder every year (in order to push the state of the art), some participants are in favor of keeping or creating some simple tasks for the newcomers. Another topic that came out as feedback is to promote more the autonomy in the land domain. While at sea, vehicles need to be fully autonomous (no ROV mode is allowed), in the land domain some tasks can be performed tele-operating the robot (such as manipulation and partially navigation). Tele-operation is important for some end-users, such as firefighters or rescue teams, that prefer to have the human-in-the-loop. Teams more interested in research in autonomy would like to see more points awarded to autonomous achievements. This is a trade-off that we will try to balance to make sure the best research teams are attracted while having still a realistic scenario (close to end-users).

The Judges

This year we had a large pool of judges and visitors coming from all over Europe, Asia and the U.S. We are pleased to thank IEEE OES, CNR-INM (Italy), Jacobs University (Germany), CATEC (Spain), SPAWAR (U.S.), ENEA (Italy), University of Limerick (Ireland), National University of Singapore (Singapore), Kongsberg (Norway), University of Pisa (Italy), National Oceanographic Centre (NOC) (UK), Robonation (U.S.), Office of Naval Research (ONR) (U.S.) and the University of Zagreb (Croatia), who provided exceptionally qualified judges, increasing the quality of the competition. Dr. Bharhat Kalyan and Rajat Mishra, two organizers of the SAUV-C competition in Singapore, were part of the judges and visited us in the framework of the IEEE OES committee Marine Autonomous Systems Competitions Coordination (MASC2), working globally to standardize student marine robotics. Dr. Bill Kirkwood also presented a plaque in appreciation for the organisation of the competition to the local organising committee.

Sponsors

IEEE OES played a fundamental role as the Main Sponsor. One of the ERL goals is to educate future multi-disciplinary engineers. Therefore, the sponsorship of 'Breaking the Surface' 2019, the 11th Interdisciplinary Field Workshop of Marine Robotics and Applications, is well aligned with our mission. The organizers of 'Breaking the Surface' provided 2 complimentary registrations to the best rookie team, 1 as persistency award and 1 to the best presentation from a marine team. These students will have the opportunity to participate in the 11th edition of this multi-disciplinary and educational workshop that, since 2019, counts with the IEEE OES sponsorship. Robonation sponsored the Multi-domain Robonation prize, awarding the efforts of the only institution presenting robots for both domains.

Like in 2018, we had again the marine robotics commercial sector involved. Blue Robotics gave a Ping echosounder to the Best marine team as well as three vouchers for their online shop to the teams that won the Persistency award, the Best rookie and to the second-best marine team. This support is fundamental to help these teams improve their vehicles for the next editions.

Our aim is to continue to develop ERL Emergency as a unique event that challenges teams with realistic conditions, with an emphasis on multi-vehicle cooperation (through double and three domain competitions). These achievements were made possible thanks to the fundamental support of IEEE OES and all our other sponsors. We thank all the teams, judges, presenters, visitors, staff and everyone involved, who made ERL Emergency 2019 such a successful event.

The Organizing Committee receives the plaque from Dr. Bill Kirkwood.

OceanObs'19 Conference, An Ocean of Opportunity

Jay Pearlman, Christopher Whitt and Mal Heron

OceanObs is a conference held every 10 years to celebrate the successes of the past decade and to make plans for the next. IEEE OES is an Intellectual Sponsor of the upcoming OceanObs'19 and our participation is led by the Ocean Observation Systems and Environmental Sustainability Technology Committee.

This conference meets every ten years and has had significant impacts on the way that ocean observing is done. The Argo float system is an outcome of OceanObs'99 and the Governance structure "Framework for Ocean Observing" is a product of OceanObs'09. What will be the next step forward? OceanObs'19 seeks to improve response to both scientific and societal needs by a global scale integrated ocean observing system. It is reinforcing the importance of serving society to meet the grand challenges of food, climate, security and sustainability.

Overall, OceanObs'19 will strive to improve the governance of a global ocean observing system, including advocacy, funding, and alignment with best practices and to designate responsibility for product definition, including production and timely delivery at the appropriate scales (global, basin, regional, national) to serve user needs. The Conference flyer gives the vision, the mission and the impacts expected for the meeting.

THE VISION In recognition of the central role the ocean plays in supporting all life on earth, we see a resilient world whose societies prosper through sustainable interactions with our ocean, guided by timely, reliable, and accessible information.

THE MISSION OceanObs'19 is a community-driven conference that brings people from all over the planet to communicate the decadal progress of ocean observing networks and to chart innovative solutions to society's growing needs for ocean information.

THE IMPACT OceanObs'19 will determine how we meet future user needs (information), improve the delivery of products across the globe (interoperability), advance technology and services (innovation), and balance needs, capabilities, and knowledge worldwide (integration). Achieving these outcomes will result in a fit-for-purpose Global Ocean Observing System over the next decade.

Societal benefit themes have been chosen to support the vision and mission. These reflect major issues and opportunities of our times, including:

Discovery

The deep sea is one of the last frontiers of ocean discovery. Rapid technology development is expected to lead to more exciting discoveries of the ocean.

Ecosystem health & biodiversity

Human society benefits from marine biodiversity and healthy ecosystems that are under increasing pressure from multiple stressors. Observing complex ecosystem, biodiversity, and biogeochemical dynamics in a globally integrated manner is a challenging task for next decade.

Climate variability & change

Monitoring, understanding, and predicting oceanic variations associated with natural climate variability and human-induced changes informs societies on how to plan and adapt to climate impacts. Ocean observers play a key role in shaping climate strategies.

Water, food, & energy security

To sustain provisional and regulating services from the ocean, communication between oceanographers and multiple stakeholders is indispensable in planning and implementing ocean observation and monitoring.

Pollution & human health

Ocean observations are discovering that human activities on-land and at-sea are polluting the oceans at increasing concentrations and depths. Plastic pollution has also captivated the public's attention and observers are finding that their impacts extend to the deepest points of our ocean. Monitoring and assessing these pollutants from source-to-sinks is needed for better management to sustain ocean and human health.

Hazards & maritime safety

Improving ocean forecasts, seasonal and weather predictions, and hazard monitoring translates to more advanced maritime safety, search and rescue, natural disaster prediction, and weather impact resiliency.

Blue economy

Ocean observing data, products, and services underpin the blue economy. Determining how societies leverage ocean businesses is a priority for the next decade.

These societal benefit themes will be examined by their relationship to ocean observing and how information products can be best supported through three observing system themes:
observing system governance; data & information systems, and observing technologies & networks.

The ocean community has contributed significantly to the Conference through Community White Papers (CWP) already submitted to Frontiers in Marine Science for peer reviewed publication. Authoring these CWP has brought together experts in our community to discuss current capabilities and to define the vision looking forward. IEEE OES has lead authorship for two papers. One is the "Future Vision for Autonomous and Remote Observing Technologies" led by Christopher Whitt and the second is "Evolving And Sustaining Ocean Best Practices And Standards For The Next Decade" led by Jay Pearlman.

IEEE OES is an Intellectual Sponsor of OceanObs'19. We are pleased to have this role in a decadal ocean event.

If you have the opportunity, we encourage you to attend. The conference will be held at the Hawaii Conference Center, Honolulu HI during September 16-20 2019. Registration is available through http://www.oceanobs19.net

The authors note that the contents of this article include selected information on the Conference provided by the organizers.

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EXCELLENCE IN ASIA

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The biennial Offshore Technology Conference Asia (OTC Asia) is where energy professionals meet to exchange ideas and opinions to advance scientific and technical knowledge for offshore resources and environmental matters.

OTC Asia aim to:

- Meet the demand for technical information to support the growth of the offshore energy industry in Asia.
- Provide opportunities for industry professionals and their employers to share their applied technologies and best practices with other producing areas in the world.
- To create opportunities to institute and strengthen intersociety collaboration and cooperation with member societies based in Asia.

For more info., please visit the URL: http://2020.otcasia.org/welcome

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OCEANS 2019 Marseille

Philippe Courmontagne, General Chair

After fourteen years, the international biennial OCEANS conference came back to France. Indeed, for this 64th installment, this co-sponsored conference, by Marine Technology Society and IEEE Oceanic Engineering Society, took place on the Mediterranean coast, in the sunniest place we have in France: Marseille.

The common thread of this edition "Let's sea our future together" has reflected our concern to understand the future of our oceans in terms of the preservation of marine, animal or plant life, as well as the exploitation of new energies.

For this OCEANS edition, 1,116 attendees joined us to participate in panel discussions, to share their knowledge during the technical sessions, to discover new products in the exhibit hall, to learn new concepts during the tutorials, to discover/appreciate the point of view of our plenary speakers…

Plenary Session

The plenary session took place on Wednesday morning. Three main speakers came on the stage to share with the public their enthusiasm.

The first one, Vice-Admiral (ret.) Anne Cullerre, who is the first woman to reach the 3-star level in the French Navy,

Vice-Admiral (ret.) Anne Cullere:"Why do women command at sea … and why they're good at it!"

addressed the question, "Why do women command at sea … and why they're good at it!." It was fantastic to assist in this presentation, seeing this woman, having passed 10 years at sea with 2 commands of French Navy vessels, sitting on a chair, with, as material, a simple piece of paper, explaining the history of women at sea. Should I mention that one member of my Local Organizing Committee is the IEEE Women In Engineering French Chapter Chair?

The second one, Jan Opderbecke, head of the Unit for Underwater Systems, from IFREMER, the French Institute for Ocean Research, presented "Technological opportunities and challenges for next generation underwater vehicles in ocean sciences." He has explained that recent and emerging advances in instrumentation, signal processing and information technology provide exciting opportunities that will respond to the high expectations expressed by more and more challenging research programs in ocean sciences and has illustrated his speech presenting, as example, recent vehicle developments focusing on novel hybrid system architectures—e.g., HROV Ariane are the 6000 m AUV CORAL.

Jan Opderbecke:"Technological opportunities and challenges for next generation underwater vehicles in ocean sciences."

Damien Leloup:"Altaussee 2019."

One technical session.

Walter Munk Scholar Award with from left to right: Rick Spinrad, Alfredo Giron, Mary Munk and Andrew Clark.

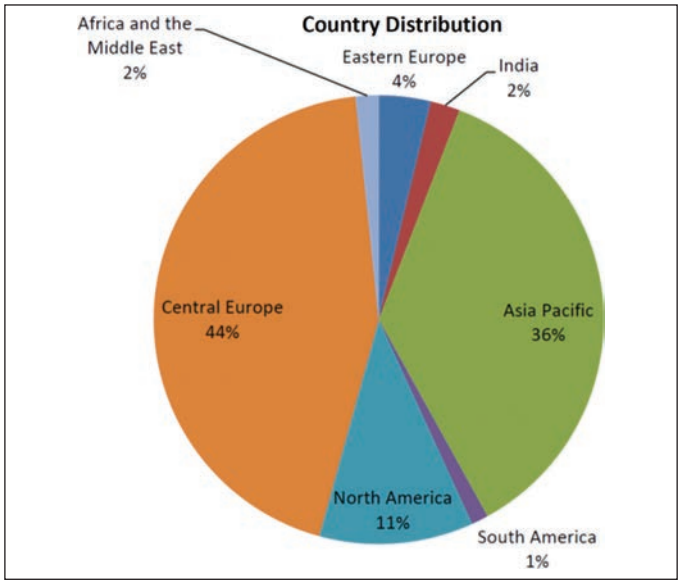
Exhibition hall.

Our third main speaker, Damien Leloup of Flinders University Department of Underwater Archaeology and Walter Munk Foundation for the Ocean Executive Director, made a presentation about the expedition "Altaussee 2019." The Purpose of the Expedition was to study the depth and characteristics of the lakebed and collect water and sediment samples to determine the health of what appears to be a pristine alpine lake, nestled beneath the Loser Plateau in the Liezen district of Austria. During his presentation, Damien Leloup explained that, even in this pristine lake, micro-plastics and fibers have been discovered. Such a discovery will serve as an indication of what measures must be taken in this lake and in similar alpine lakes to preserve their health.

During this plenary session, a warm homage was paid to Walter Munk. Indeed, Walter Munk had planned to join us at OCEANS 2019 Marseille to present the inaugural Walter Munk Scholar Award to Alfredo Giron, in recognition of his outstanding achievements. Unfortunately, Walter Munk passed away in February 2019. For this reason, his wife, Mary Munk, and Rick Spinrad, President of MTS, presented the award.

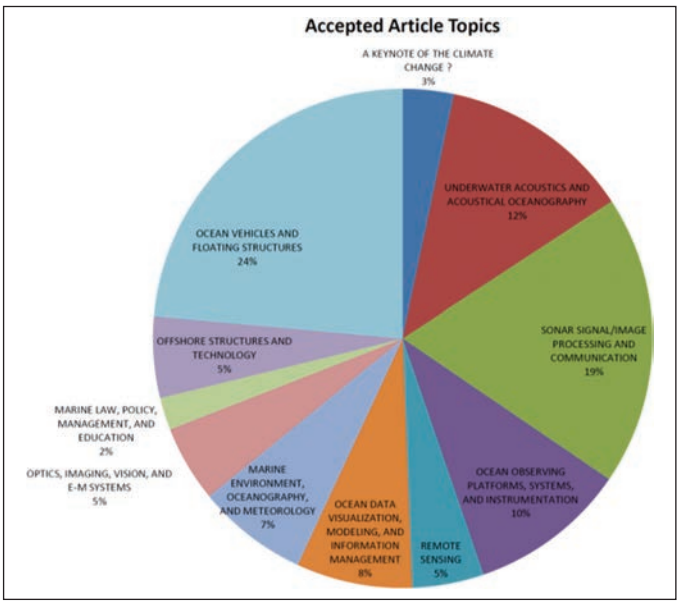
Oceans Marseille Statistics

For this edition, we received 837 abstracts, one of the higher numbers of received abstracts for an OCEANS conference. 529 presentations were made (63.2% of the received abstracts), making OCEANS Marseille the first conference of the OCEANS series in terms of scientific presentations coupled with the highest level of selection.



36 countries were present, coming mainly from Central Europe and Asia Pacific.

In the exhibit hall, where 69 industrial/academic/institutional booths presented their products, 5 panel discussions were held on the following topics:



Panel session "Man and the Ocean in 100 years in the context of climate changes" with from left to right: Rick Spinrad (Moderator), Patricia Ricard (Paul Ricard Oceanographic Institute), Damien Leloup and René Garello.

- The place of Europe in ocean research
- Manage innovation for Ocean future
- Man and the Ocean in 100 years in the context of climate changes
- Artificial intelligence for Ocean-going autonomous vehicles
- Big data processing: What is the added value, for which applications?

Social Events

France is the country of wine. Most of our attendees had the opportunity to verify this assertion during the Icebreaker reception, which has held in the Palais des Arts, a historical Palace from the 1922 World Fair.

During this reception, while some of the attendees enjoyed playing "pétanque," Eric Langlois, chairman of the International Federation of Hydrographic Societies (IFHS), presented two student awards in recognition of their accomplishments to Hamza Mazih and Christopher Haddon.

During the exhibitors' reception, the attendees had dedicated time to meet the Exhibitors while enjoying live-cooking chefs' cuisine.

Icebreaker reception: Stan Chamberlain and Shyam Kumar Madhusudhana.

Icebreaker reception: Ana Paula Lima, Brian Horsburgh, John Watson, Harumi Sugimatsu and Gerardo Acosta.

Eric Langlois, IFHS Chairman.

Enjoying wine during the Exhibitors' reception.

Gala banquet: Casa Delauze in front of the Mediterranean Sea.

Gala banquet: The Dance Floor.

The Gala banquet took place at the Casa Delauze, a luxury villa raised on wooden piles, at the entrance of Marseille old port, created in 1981 by Henri Delauze, explorer of the subsea floor. Escorted by a catchy and jazzy melody, the attendees discovered several attractions, while tasting French wines and eating tasty dishes. Moreover, and for some of them, the dance floor was the place to be until the end of the night.

Some last words

Thank you to all who traveled to Marseille to participate in OCEANS 2019 Marseille, making this conference a great event.

I would like to thank my team for having supported me from the beginning to the end.

We would like to thank one more time for their support our Gold Patrons: Naval Group, iXblue and Comex.

From left to right: Claude Jauffret (Co-Technical Chair), Philippe Courmontagne (General Chair) and Jerome Mars (Co-Technical Chair).

The LOC, from left to right: Helene Tonkia (Co-Exhibit Chair), Claude Jauffret (Co-Technical Chair), Jerome Mars (Co-Technical Chair), Philippe Courmontagne (General Chair), Frederic Maussang (Tutorial Chair), Eric Langlois (IFHS Chair), Gaultier Real (SPC Chair), Pascal Lorenz (Financial Chair), Aymeric Bonnaud (Co-Exhibit Chair) and Christian Audoly (Co-Exhibit Chair).

Jean-Pierre Hermand MEMORIAL Session—OCEANS 2019 Marseille, France

James Candy, OES AdCom Member

The special session entitled the "Jean-Pierre Hermand Memorial" was held at OCEANS 2019 Marseille and was co-chaired by his loving wife Dominique Planchon-Hermand and James Candy. It was well-attended by many friends and colleagues. The session was opened by Dr. Candy briefly reviewing JP's career accomplishments, both technical and professional leadership roles, summarizing with the now classic photo of JP and his companion bicycle. As recalled by Patricia Candy.

"JP was always joyful and supportive. The glimmer in his eyes and his mischievous smile could easily illuminate a room and bring great joy to those around him. If he could have traveled at the speed-of-light he would have, but instead he took his special bicycle everywhere."

Dr. Dominique Planchon-Hermand then spoke of their relationship, family and a wealth of experiences they shared while attending a number of OCEANS Conferences together. Dr. Sergio Jesus then followed with a discussion of the joint experiments, workshops and texts produced during JP's illustrious 10-year career at the Center for Maritime Research & Experimentation (CMRE) leading experiments with published results in conference proceedings and journal papers. Dr. Jesus recounted many of his joyful and humorous experiences of working with JP.

Dr. Andrea Caiti then detailed many of Dr. Jean-Pierre's technical accomplishments and results of joint efforts, providing results that have led to further research in such areas as model-based matched field (time reversal) processing, seagrass, geoacoustic inversion, and the development of theoretical adjoint methods for propagation. JP's contributions to the IEEE along with his broadening relationships in South America (Rio Acoustics Conference) and Asia Pacific (Yellow Sea experiments) were also high-lighted during the session.

Special place—special bike—special guy!

JP Hermand Memorial Session: S. Jesus, A. Caiti, D. Planchon-Hermand and J. Candy (L to R).

A. Caiti (up) and S. Jesus (down) in the Session.

A Blast from the Past! . . . In Honor of JP

Bob Wernli—Beacon Co-Editor-in-Chief, Photos by Stan Chamberlain

Jean-Pierre Hermand has been remembered in the December 2018 issue and in a special memorial session at the OCEANS 2019 Marseille conference, which is reported in this issue. However, since JP has always been a major participant at all our OCEANS conferences, other workshops and within the society, and always involved with a smile and an attitude that brought warmth to his friends and colleagues, your Beacon editors decided that a special "Blast from the Past" to highlight JP was warranted.

OCEANS 2018 Kobe.

OCEANS 2016 Monterey.

OCEANS 2013 San Diego.

OCEANS 2014 Taipei.

OCEANS 2013 Bergen—Dominique and JP.

The "Bike" was with JP at every OCEANS.

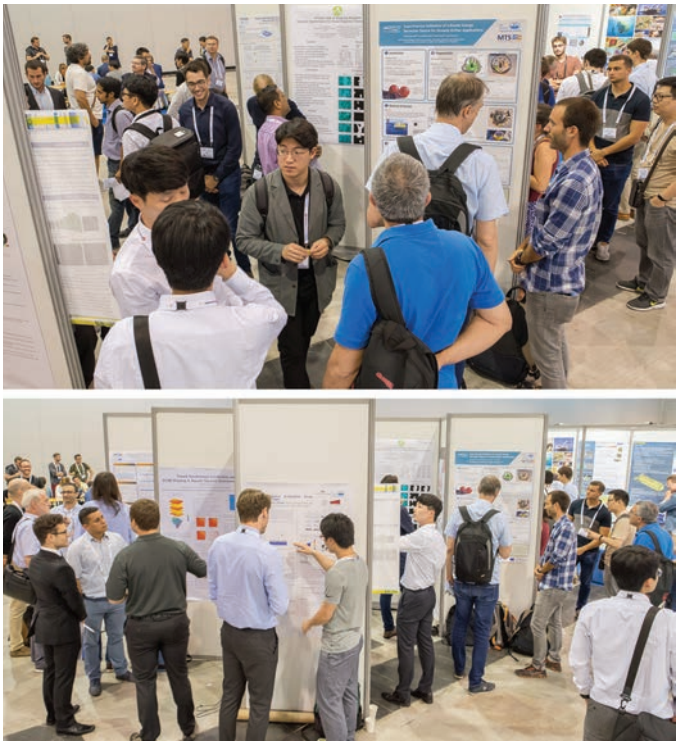
The Student Poster Competition at OCEANS 2019 Marseille

Shyam Madhusudhana, OES Student Poster Competition Chair,
Photos by Stan Chamberlain (OES)

The Student Poster Competition (SPC) is a flagship event of the MTS/OES OCEANS conferences in which students (both undergraduate and graduate) from colleges and universities around the world participate. Col. Norman Miller had created and implemented the first SPC in 1989 during the OCEANS conference in Seattle, Washington, and it has been a feature of OCEANS conferences ever since. During each conference, typically about twenty students are selected from the pool of aspiring applicants, based on their submitted abstracts, to present a poster describing their work. The selected students' travel, accommodation and conference registration are fully supported by the conference. In addition, monetary prizes are also awarded to the top three best presenters among the selected participants.

The first of this year's SPC was held during OCEANS 2019 Marseille at the Marseille Chanot Exhibition and Convention Centre from the 17th to the 20th of June. The SPC program was funded by a grant from the Office of Naval Research Global (ONR-G), and we offer our sincere gratitude for their continued support. Preparations in the run-up to the event were ably managed by the SPC chair on the local organizing committee, Gaultier Real, with minimal assistance from me and Liesl Hotaling (MTS SPC Chair, who unfortunately could not attend). Out of the 59 applicants (from 16 different countries) that chose to submit their abstracts for consideration for the SPC, 18 students were chosen to present their work at the event.

Following a mandatory short oral presentation to the judges on Monday morning, the students put up their posters at the designated slots in the Exhibition Hall and were eager to pitch their research to conference attendees. They enthusiastically described their work to the judges and the other delegates that visited their posters. We had a total of 11 volunteers that offered to serve as judges, some of whom were contestants themselves in prior editions of the SPC. Given the high standards in the work presented by the participants and the breadth of topics covered, judging seemed to be a rather difficult task, spanning over two days and numerous hours of



The poster sessions were quite popular at the conference, with packed sessions on all days.

Gaultier (left) and Shyam (right) distributing certificates to the students and the judges.

The judging team.

SPC participants along with Gaultier Real (local SPC chair; top row, left), Shyam Madhusudhana (OES SPC chair; top row, middle) and Vincent Rigaud (Ifremer; top row, right).

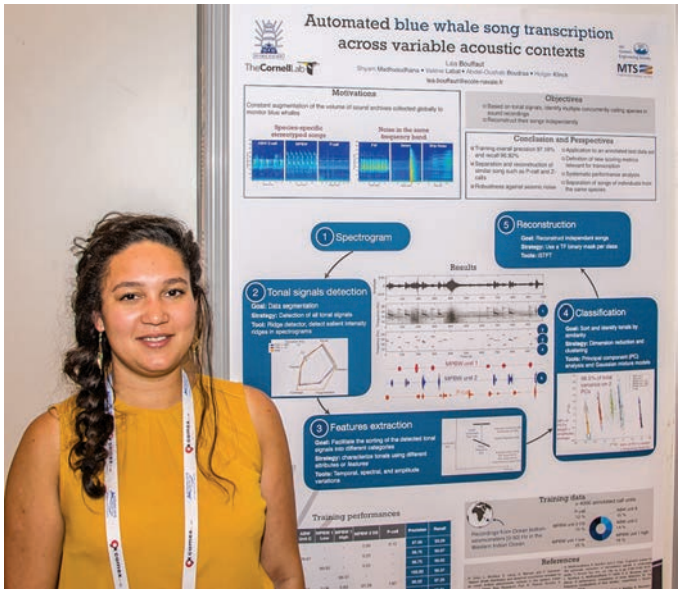
very intensive assessment. Our gratitude and appreciation goes out once again to the judges.

The award ceremony took place during the conference gala banquet at the Casa Delauze, Marseille on Wednesday June 19th. Each participating student was awarded a Certificate of Attendance, and the judges' tireless efforts were acknowledged by presenting each of them a Certificate of Appreciation. The three top-ranked posters were announced and prizes were awarded. The awards were handed out to the winners by Dr. Vincent Rigaud, Director of Underwater Systems Unit, Ifremer, the organization which generously sponsored the monetary awards.

The full list of participants (including the prize winners) together with their affiliation, poster title and an abstract of their poster is given below.

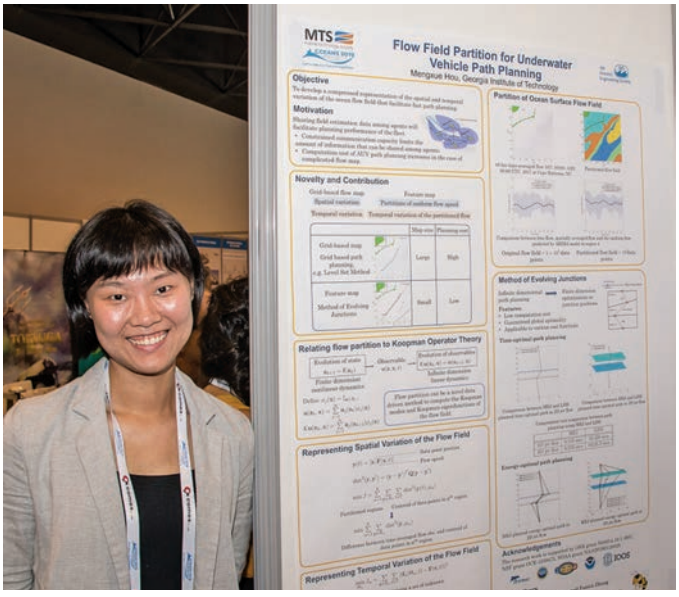
First Prize and Norman Miller Award (Certificate and $3000 prize)
Léa Bouffaut, Naval Academy Research Institute, France
Automated blue whale song transcription across variable acoustic contexts

Abstract—The size of sound archives collected globally by the community to monitor cetaceans, including blue whales, is rapidly increasing. Analyzing these vast amounts of data efficiently requires reliable automated detection algorithms. Typically these algorithms focus on a specific call type produced by a single species. We developed an automatic transcription algorithm which can identify multiple concurrently calling species in sound recordings. The algorithm was tested on data containing series of calls (songs) of Madagascar pygmy blue whales and series of the 27 Hz tonal unit named "P-call." The algorithm is based on pattern recognition of tonal calls in the time-frequency domain where (1) segmentation is realized by detection of tonal signals, (2) features are extracted from their time-frequency-amplitude information, and (3) classification is realized by clustering. The classified tonal signals are then used to reconstruct, separately, the underlying songs. We successfully trained and tested the algorithm on data (>4000 annotated calls) in the Western Indian Ocean and achieved an overall precision of 97.2% and a recall of 96.9%, respectively.



Second Prize (Certificate and $2000 prize)
Mengxue Hou, Georgia Institute of Technology, USA
Partitioning ocean flow field for underwater vehicle path planning

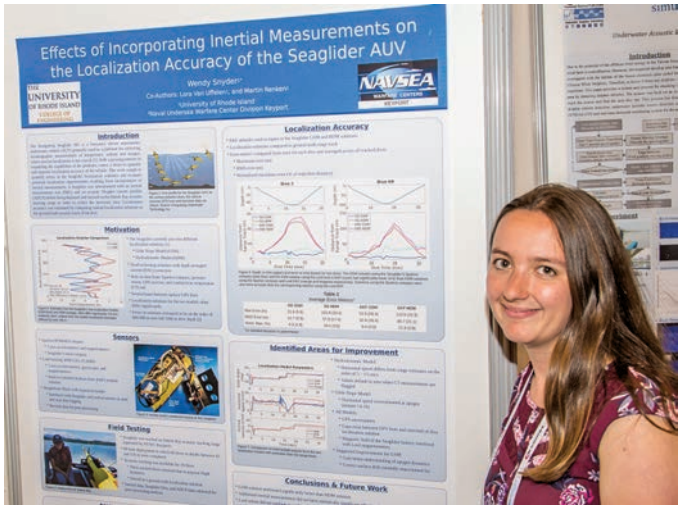
Abstract—In this paper, we present a flow field partition method that extracts the key features, which are the spatial and



temporal variation of the flow field. The partition method is developed based on K-means algorithm. In the case where the temporal pattern of the flow field contains only a periodic tidal component, we propose an algorithm that partitions the flow field into static clusters of piece-wise constant flow, by performing K-means clustering over the time-averaged flow field. Then the method is extended to partitioning the flow field into clusters of uniform time-varying flow, by fitting the spatially averaged flow in each static partitioned region to a parametric flow model. Simulation results of partitioning both a simulated jet flow field, as well as the ocean surface flow data into time-invariant and time-varying uniform flow are presented to demonstrate that the proposed method can represent the true flow field with significantly less amount of data. Result of using Method of Evolving Junctions to plan the time-optimal path in the partitioned flow field is also presented to demonstrate that the proposed flow partitioning method can be applied to facilitate path planning, and can reduce the path planning computational cost.

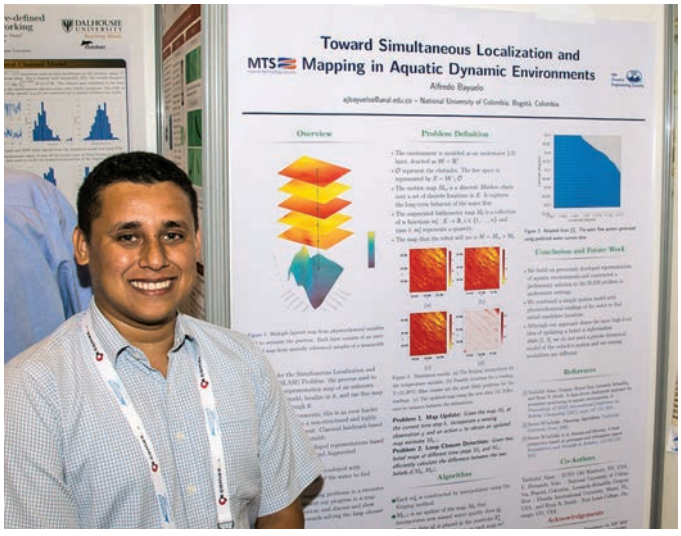
Third Prize (Certificate and $1000 prize)
Wendy Snyder, University of Rhode Island, USA
Effects of Incorporating Inertial Measurements on the Localization Accuracy of the Seaglider AUV

Abstract—Seaglider is a buoyancy driven autonomous underwater vehicle (AUV) primarily used as a platform for oceanographic measurements of salinity, temperature, and oxygen, where precise localization is not crucial. A recent experiment tracked a Seaglider, instrumented with an attitude and heading reference system (AHRS), on an acoustic tracking range in an effort to quantify the accuracy of the Seaglider's two localization solutions and determine the effects of incorporating additional inertial measurements into the solution. Preliminary analysis of results has shown the Seaglider's glideslope model (GSM) is more accurate and reliable than the hydrodynammic model (HDM) during typical flight dynamics. Errors in the



GSM solution did not exhibit a clear drift behavior but remained on average within 22 m of the ground truth acoustic track over dives with a maximum depth of 90 to 125 m. Errors in the HDM solution exhibited linear growth until the apogee point of the dive when errors began to linearly reduce. On average the error increased at a rate of about 5 m/min between the surface and maximum dive depth, with maximum errors in excess of 100 m during dives with a maximum depth of 90 m. The substitution of attitude estimates from the AHRS into the localization models provided similar but less consistent results with slightly higher errors.

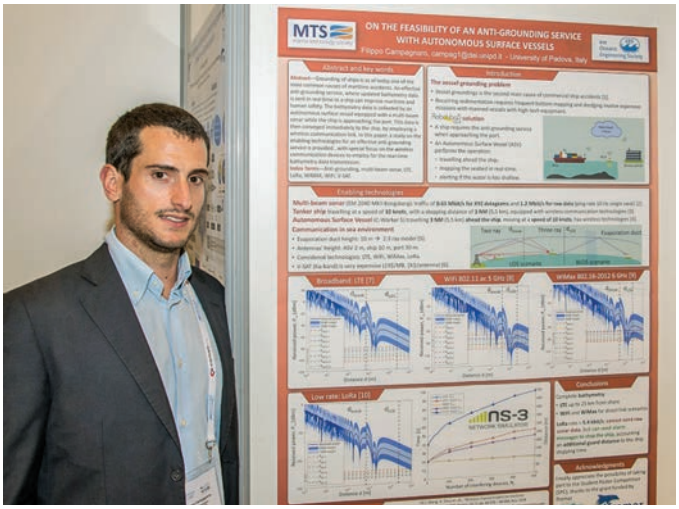
Alfredo Bayuelo Sierra, National University of Colombia, Colombia
Toward Simultaneous Localization and Mapping in Aquatic Dynamic Environments



Abstract—Simultaneous Localization and Mapping (SLAM) is a desired capability for an autonomous vehicle. SLAM is the process used to construct a representation map of an unknown surrounding world, localize in it, and use this map to navigate through it. For aquatic environments, this is an even harder challenge since it is a non-structured and highly dynamical

environment in which classical landmark-based approaches to the SLAM problem are not suitable. In this paper, we use previously developed representations of aquatic environments based on Dynamical Systems and Augmented Bathymetry to construct a preliminary solution to the SLAM problem. A simple motion model is combined with physicochemical readings of the water to find candidate locations. Our ideas were preliminarily tested in a dataset acquired in the Lake Nighthorse, CO, obtaining promising results in the new strategy.

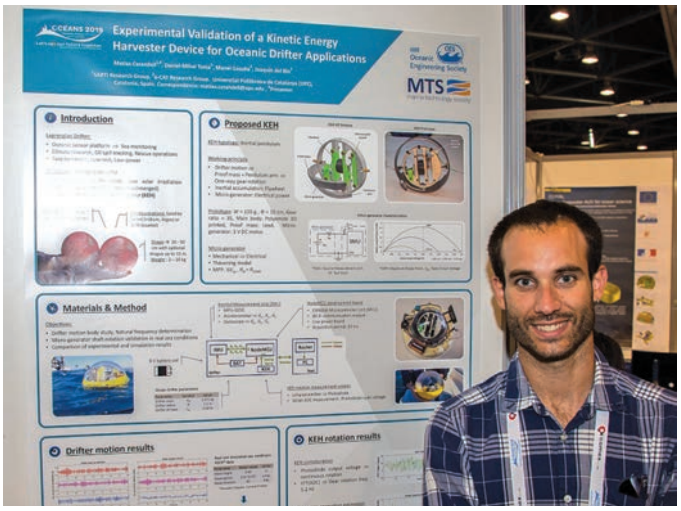
Filippo Campagnaro, University of Padova, Italy
On the feasibility of an Anti-grounding Service with Autonomous Surface Vessels



Abstract—Grounding of ships is as of today one of the most common causes of maritime accidents. An effective anti-grounding service, where updated bathymetry data is sent in real time to a ship can improve maritime and human safety. The bathymetry data is collected by an autonomous surface vessel equipped with a multi-beam sonar while the ship is approaching the port. This data is then conveyed immediately to the ship, by employing a wireless communication link. In this paper, a study on the enabling technologies for an effective anti-grounding service is provided, with special focus on the wireless communication devices to employ for the real-time bathymetry data transmission.

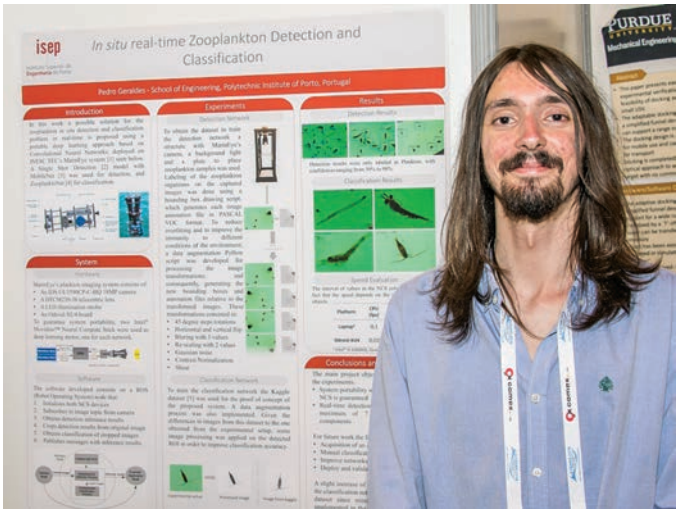
Matias Carandell, Universitat Politecnica de Catalunya, Spain
Experimental validation of a kinetic energy harvester device for oceanic drifter applications

Abstract—A Kinetic Energy Harvester (KEH) device under design for drifter applications has been tested at real sea conditions in a controlled area. The KEH consists on a pendulum system capable to transform the oscillations of the waves into rotation which will be converted into electrical energy thanks to a dc micro generator. The KEH has been placed inside a drifter. First, the motion of the drifter was obtained through an embedded Inertial Measurement Unit, showing natural pendulum frequency of 1.5 Hz. Simulations with OrcaFlex validate the experimental results. Then, the rotation speed of the micro generator



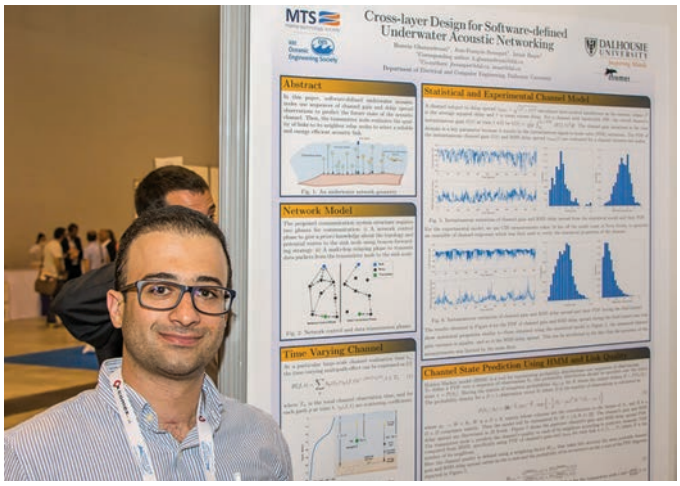
was measured. Results show a prevalence of speed of 1400 rpm, which should lead to a potential power output of 2 mW.

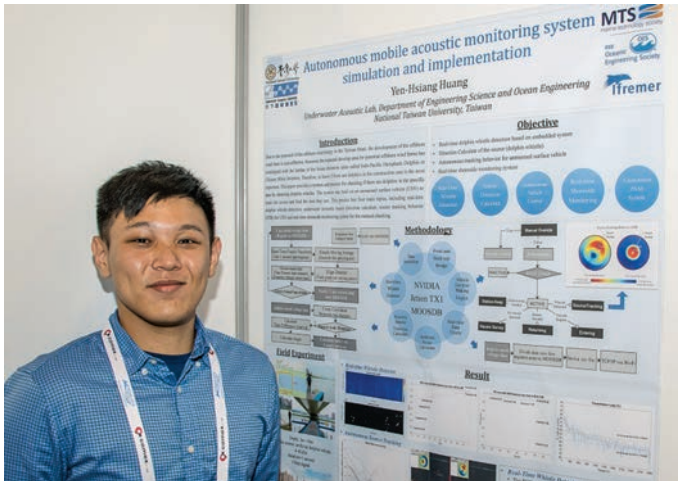
Pedro Geraldes, ISEP, Portugal
In situ real-time Zooplankton Detection and Classification



Abstract—Zooplankton plays a key-role on Earth's ecosystem, emerging in the oceans and rivers in great quantities and diversity, making it an important and rather common topic on scientific studies. Given the numbers of different species it is not only necessary to study their numbers but also their classification. In this paper a possible solution for the zooplankton *in situ* detection and classification problem in real-time is proposed using a portable deep learning approach based on Convolutional Neural Networks deployed on INESC TEC's MarinEye system. For detection a Single Shot Detection model with MobileNet was used, and ZooplanktoNet for classification. System portability is guaranteed with the use of Movidius™ Neural Compute Stick as the deep learning motor.

Hossein Ghannadrezaii, Dalhousie University, Canada
Cross-layer Design for Software-Defined Underwater Acoustic Networking



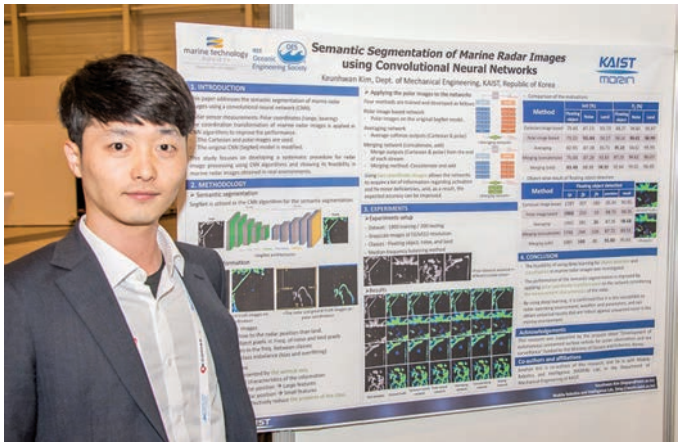


Abstract—In this paper, a network relying on software-defined underwater acoustic nodes is proposed: by receiving a periodic beacon signal from the sink node, each node in a cluster obtains a prediction about the communication quality of the potential links to its one-hop neighbors as well as to the available relay nodes within the cluster. A hidden Markov process is used to predict the next state of the channels, using the probability distribution of the channel amplitude and delay spread from previous observations. Each transmitting node evaluates the quality of links to its next hop neighbor relay nodes. Accordingly, a normalized weight representing the channel quality is assigned to each link. The channel gain and its delay spread are the two metrics that are used to define the channel quality. To evaluate the network performance in realistic conditions, the output of a statistical model combined with the Bellhop ray tracing software is compared to experimental data. Using the channel quality, each transmitter node in the network selects its next hop optimum relay node. This scheme minimizes the number of transmitted control packets and also reduces the re-transmission of data packets, by predicting the channel status rather than exchanging an excessive number of control packets which typically convey expired channel state information. Minimizing the overhead and selecting the optimum channel saves on the energy per bit consumption while maintaining high packet delivery ratio and low latency.

Yen-Hsiang Huang, National Taiwan University, Taiwan
Autonomous mobile acoustic monitoring system simulation and implementation

Abstract—Due to the potential of the offshore wind energy in the Taiwan Strait, the development of the offshore wind farm is cost-effective. However, the expected develop area for potential offshore wind farms has overlapped with the habitat of the Sousa chinensis (also called Indo-Pacific Humpback Dolphin or Chinese White Dolphin). Therefore, to know if there are dolphins in the construction area is the most important. This paper provides a process for checking if there are dolphins in the specific area and using an unmanned surface vehicle to track the source and find the area they are. This process has four main topics, including real-time dolphin whistle detection, underwater acoustic source direction calculate, source tracking behavior (STB) and real-time shoreside monitoring system of the surface vehicle. The whole system was developed using the open source middleware MOOS-IvP and testing in the embedded system (NVIDIA Jetson TX1). The whole system was implemented and successfully tested in the field experiment using artificial dolphin sound.

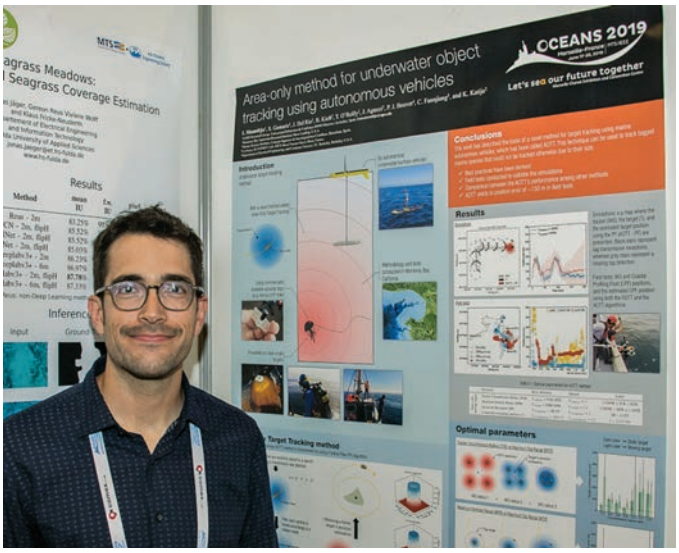
Keunhwan Kim, KAIST, Republic of Korea
Semantic Segmentation of Marine Radar Images using Convolutional Neural Networks



Abstract—Marine radar is essential for ship navigation and control. Several studies exist that are focused on eliminating unwanted noise signals to properly detect targets in radar images. However, in general, radar image processing techniques are sensitive to radar sensor specifications and operating conditions, and ad-hoc image preprocessing steps are required to adjust many parameters to achieve an overall satisfactory performance. This paper addresses the semantic segmentation of marine radar images using a convolutional neural network (CNN). SegNet is utilized as the CNN algorithm for the semantic segmentation. In order to improve the performance of the CNN considering the measurement characteristics of the radar, Cartesian coordinate system based images are transformed into polar coordinate systems. The Cartesian and polar images are used and the original SegNet model is modified to train the

network in a variety of methods. The results show the feasibility of using a deep learning network to achieve effective and robust semantic segmentation in several different sets of marine radar images.

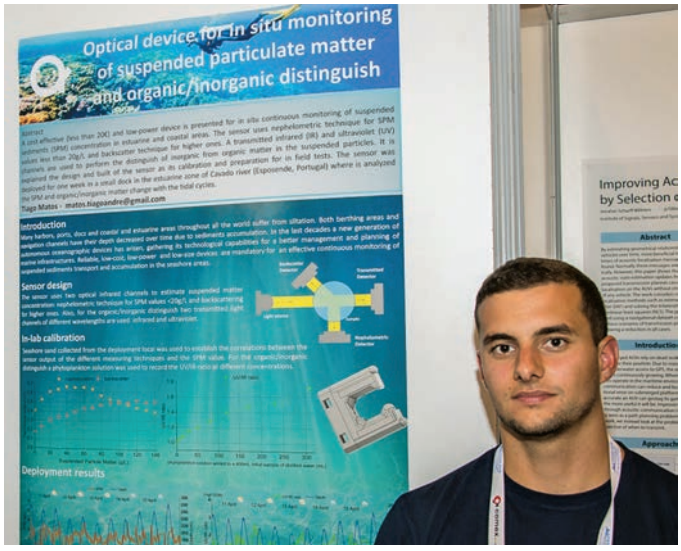
Ivan Masmitja, Universitat Politècnica de Catalunya, Spain
Area-only method for underwater object tracking using autonomous vehicles



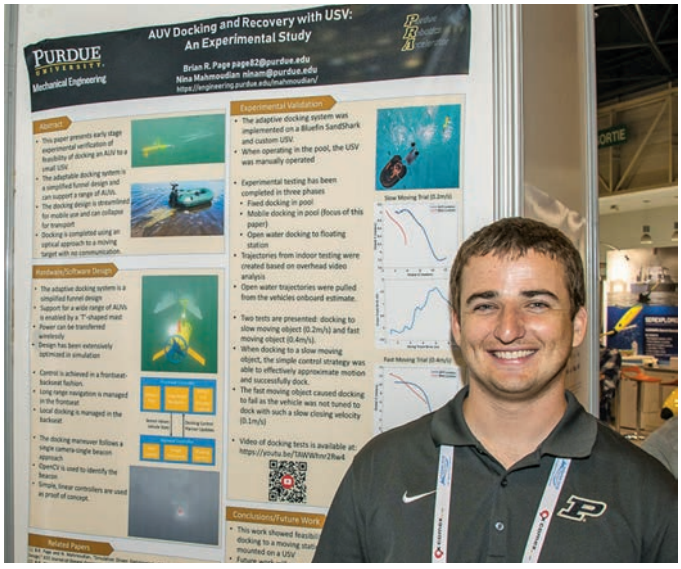
Abstract—The use of autonomous underwater vehicles for ocean research has increased as they have a better cost-to-performance ratio than crewed oceanographic vessels. For example, autonomous surface vehicles (e.g. a Wave Glider) can be used to localise and track targets even in the deep-sea. While other researchers have focused on target tracking using acoustic modems, none explored up to date the area-only target tracking methodology. Here we present such a novel method with commercially available acoustic tags, thereby reducing the costs and complexity over other tracking systems. Moreover, this method can be used to track small targets (e.g., jellyfish) due to the tag's small size. The methodology behind the area-only technique is shown, and results from field tests conducted in Monterey Bay are also presented.

Tiago Matos, University of Minho, Portugal
Optical sensor for in situ monitoring of suspended particulate matter and organic/inorganic distinguish

Abstract—A cost-effective (less than 20€) and low-power device is present for in situ continuous monitoring of suspended sediments (SPM) concentration in estuarine and coastal areas. The sensor uses nephelometric technique for SPM values less than 20 g/L and backscatter technique for higher ones. A transmitted infrared (IR) and ultraviolet (UV) channels are used to perform the distinguish of inorganic from organic matter in the suspended particles. It is explained the design and built of the sensor as its calibration and preparation for in field tests. The sensor was deployed for one week in a small dock in the estuarine zone of Cavado river (Esposende, Portugal) where is analyzed the SPM and organic/inorganic matter change with the tidal cycles.

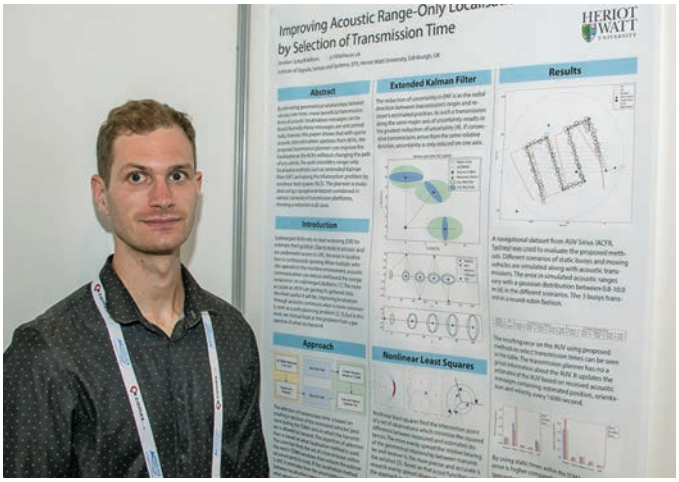


Brian Page, Purdue University, USA
AUV Docking and Recovery with USV: An Experimental Study



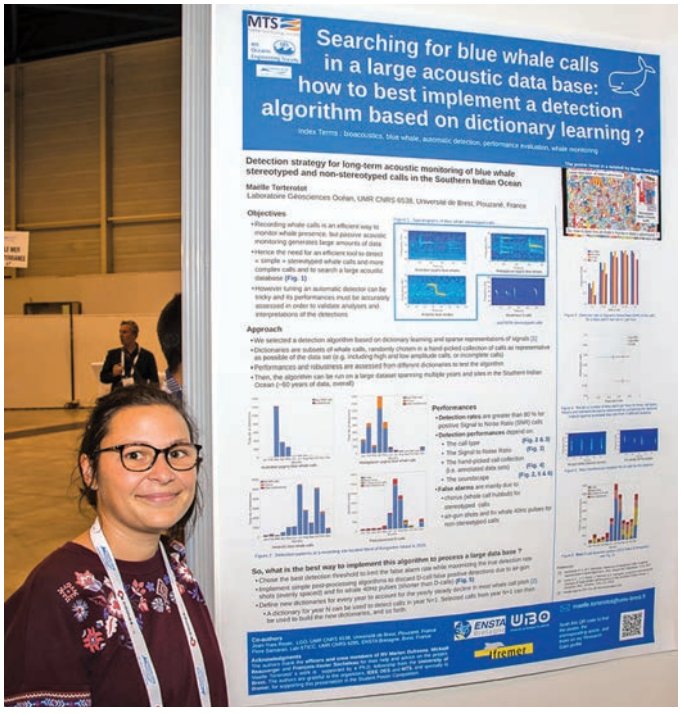
Abstract—This paper presents an early stage work on docking and recovery of Autonomous Surface Vehicles (AUVs) with Unmanned Surface Vehicles (USVs). The docking system is collapsible and adaptable to a wide range of AUVs. Control of the docking maneuver is completed based on a one camera, one light approach using a frontseat-backseat control setup. In this scenario, the vehicle navigates under frontseat control to within visual range of the dock. The backseat controller then takes over and performs terminal homing. Pool and open water testing was completed with docking to a small dinghy in both a manned and unmanned configuration. Two experimental docking attempts are presented, one docking to a slow moving target and another docking to a quickly moving target. The empirical results show that docking and recovery of an AUV from a USV while underway is feasible.

Jonatan Scharff Willners, Heriot-Watt University, United Kingdom
Improving Acoustic Range-Only Localisation by Selection of Transmission Time



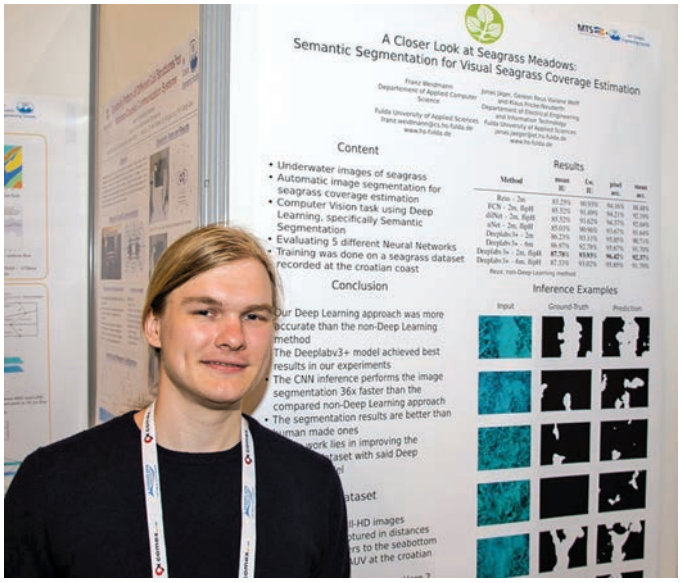
Abstract—This work looks at when to transmit localisation messages in the scenario where an Autonomous Surface Vehicle (ASV) has a planned path and can estimate a submerged AUV's positions based on acoustic updates. Acoustic localisation messages are in general transmitted periodically, but by estimating the movement of the involved vehicles, messages can be transmitted at a time when the geometrical relationship between vehicles should reduce the receiving vehicles error and uncertainty to the greatest extent. This paper looks at how selection of Time of Launch (ToL) within a Time-Division Multiple Access slot can reduce this based on history of transmission and the estimated geometrical relationship between vehicles over time. The method to select ToL is dependent on the localisation method, we look at this from the perspective of Extended Kalman Filter and to solve the trilateration problem using Non-linear Least Squares. The benefit of proposed approach is in scenarios where the operating vehicles have their own objectives, and cannot adapt their path to achieve a more beneficial transmission position. The proposed approach shows a reduction of error and uncertainty, while using a navigational dataset collected by an Autonomous Underwater Vehicle when compared to other methods of which transmission times are selected.

Maëlle Torterotot, Institut Universitaire Européen de la Mer, France
Detection strategy for long-term acoustic monitoring of blue whale stereotyped and non-stereotyped calls in the Southern Indian Ocean



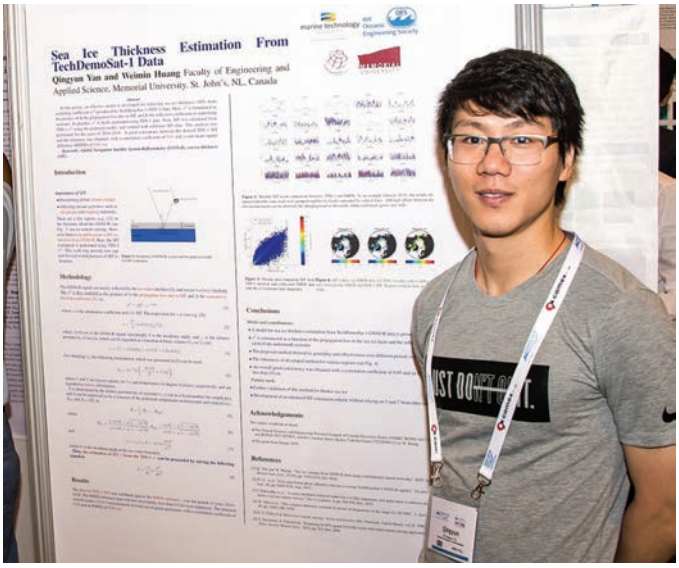
Abstract—The most common approach to monitor mysticete acoustic presence is to detect and count their calls in audio records. To implement this method on large datasets, polyvalent and robust automated call detectors are required. Evaluating their performance is essential, to design a detection strategy adapted to study the available datasets. This assessment then enables accurate post-analyses and comparisons of multiple independent surveys. In this paper, we present the performance of a detector based on dictionaries and sparse representation of the signal to detect blue whale stereotyped and non-stereotyped vocalizations (D-calls) in a large acoustic database with multiple sites and years of recordings in the southern Indian Ocean. Results show that recall increases with the SNR (Sound to Noise Ratio) and reaches 90% for positive SNR stereotyped calls and between 80% and 90% for high SNR D-calls. A detailed analysis of the influence of dictionary composition, SNR of the calls, manual ground truth as well as interference types and abundance, on the performance variability is presented. Eventually, a detection strategy for long term acoustic monitoring is defined.

Franz Weidmann, Fulda University of Applied Sciences, Germany
A Closer Look at Seagrass Meadows: Semantic Segmentation for Visual Coverage Estimation

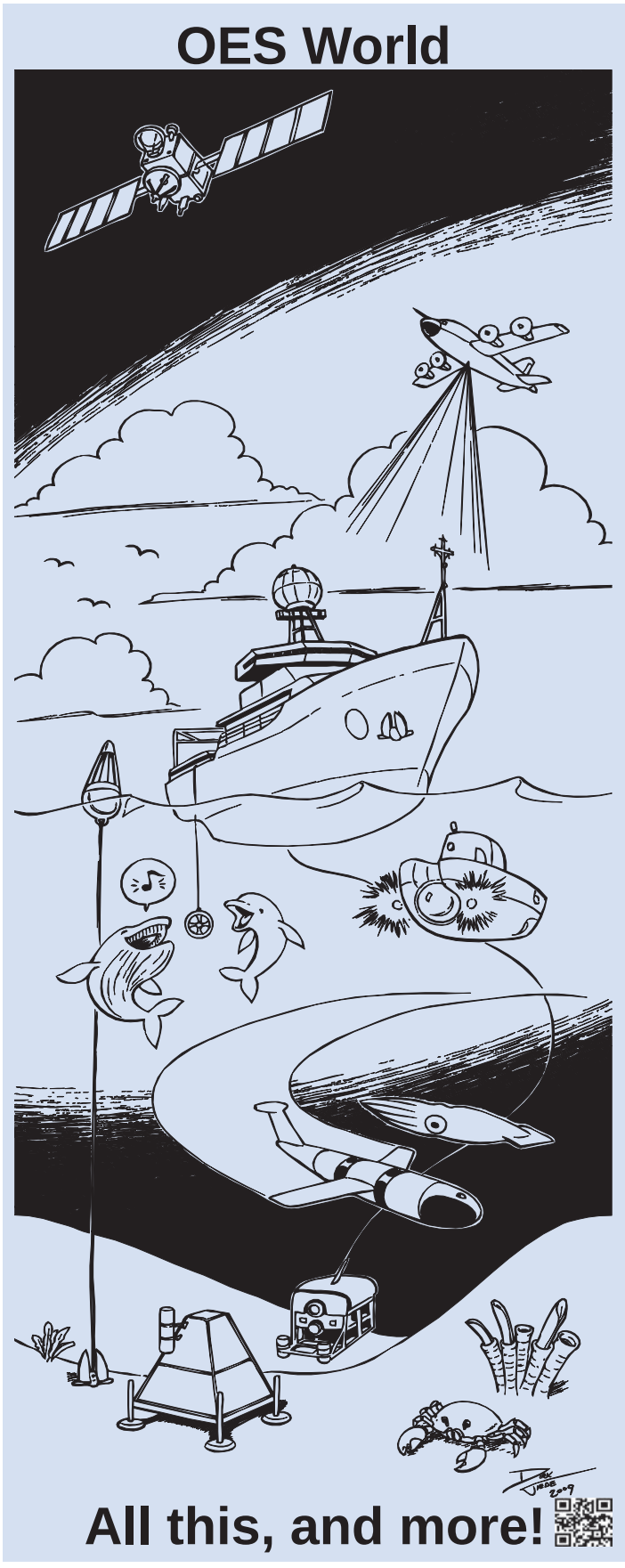


Abstract—Underwater imaging enables marine researchers to collect large datasets of seagrass images. These images can be used to monitor the health state of underwater meadows by estimating the area that is covered by seagrass and how this area changes over time. Since the manual analysis of such images is slow and error-prone, we follow the path of deep learning for automatic image analysis. Our contribution is the investigation of deep semantic segmentation for the specific task of seagrass coverage estimation. We evaluated multiple Deep Neural Network Architectures including the DeepLabv-3Plus Network which performs best, with a mean intersection over union of 87.78%. The qualitative results in our experiments indicate that the Deep Learning approach is not only more accurate than a human but also multiple times faster in annotating underwater meadows. Our code is available on GitHub: https://enviewfulda.github.io/LookingForSeagrassSemanticSegmentation/

Qingyun Yan, Memorial University of Newfoundland, Canada
Sea Ice Thickness Estimation From TechDemoSat-1 Data



Abstract—In this paper, an effective model is developed for retrieving sea ice thickness (SIT) from scattering coefficient (σ^0) produced with TechDemoSat-1 (TDS-1) data. Here, σ^0 is formulated as the product of the propagation loss due to SIT and the reflection coefficient of underlying seawater. In application, σ^0 at specular point was firstly generated based on radar equation using TDS-1 data. Next, SIT was calculated from TDS-1 σ^0 using the proposed model, and verified with reference SIT data obtained by the Soil Moisture Ocean Salinity (SMOS) satellite. The data used here were from measurements over the year of 2015. Comparison results showed a good consistency between the derived and reference SIT, with a correlation coefficient of 0.90 and a root mean square difference of 8.68 cm, which demonstrates the potential of developed model and the utility of TDS-1 data for SIT retrieval.



Winning Poster Paper

Automated blue whale song transcription across variable acoustic contexts

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Ecole Navale / Arts et Métiers ParisTech - BCRM Brest CC600, 9240 Brest Cedex 9, France
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***Abstract*—The size of sound archives collected globally by the community to monitor cetaceans, including blue whales, is rapidly increasing. Analyzing these vast amounts of data efficiently requires reliable automated detection algorithms. Typically these algorithms focus on a specific call type produced by a single species. We developed an automatic transcription algorithm which can identify multiple concurrently calling species in sound recordings. The algorithm was tested on data containing series of calls (songs) of Madagascar pygmy blue whales and series of the 27 Hz tonal unit named "P-call". The algorithm is based on pattern recognition of tonal calls in the time-frequency domain where (1) segmentation is realized by detection of tonal signals, (2) features are extracted from their time-frequency-amplitude information, and (3) classification is realized by clustering. The classified tonal signals are then used to reconstruct, separately, the underlying songs. We successfully trained and tested the algorithm on data (> 4000 annotated calls) in the Western Indian Ocean and achieved an overall precision of 97.2% and a recall of 96.9%, respectively.**

***Index Terms*—Passive acoustic monitoring, Signal processing, Bioacoustics, Blue whale.**

I. Introduction

Passive acoustic monitoring (PAM) has been proven to be an economical and non-intrusive way of surveying blue whales [1]. Analysis of large volumes of data resulting from continuous and long-term monitoring efforts greatly benefits from the automated detection of target signals. Blue whale songs, known to be subspecies specific, typically occur below 50 Hz and are described as regularly sequences of tonal units that can be polychromatic [2]–[4]. The stereotypical nature of the blue whale songs make them well-suited for automatic detection.

There are two major trends for the detection of whale songs [5]: methods based on temporal or spectrogram matched-filtering [6], [7] and methods based on pattern recognition (that find "all" sounds in the spectrogram, extract features of those sounds and classify them based on similarity between the measured features and those learned from multiple exemplars.) [8], [9]. The proposed method falls into the second category. The idea is to associate successive calls of a type in reconstructing an underlying baleen whale song and to use this information to isolate species-specific songs which are overlapping in time.

This research was supported by the Ecole Navale, the GdR ISIS and the Bourse de la Fondation de la Mer.

To transcribe whales songs, the algorithm operates in the time-frequency domain and follows the different steps of a pattern recognition algorithm (Sec. III): segmentation, feature extraction, and classification. Then, classified data are reconstructed as independent waveforms.

II. Data

An array of 8 autonomous Ocean Bottom Seismometers (OBS) was deployed along the Southwest Indian Ridge (SWIR; Lat. $27.5 - 27.8$°S, Long. $65.3 - 66.0$°E), from October 2012 to November 2013, as part of the the RHUM-RUM (Réunion Hotspot and Upper Mantle - Réunions Unterer Mantel) seismological experiment (Fig. 1) [10]–[12].

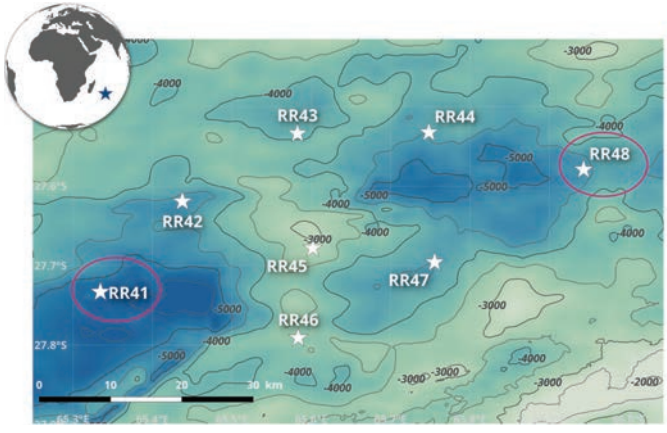

Fig. 1. RHUM-RUM network Southwest Indian ridge (SWIR) ocean bottom seismometer (OBS) array.

Each OBS was equipped with a three-component seismometer and a hydrophone which recorded data continuously at a sampling frequency of 100 Hz. Only the data collected by the hydrophone are used in this work. The frequency response of the hydrophone is flat in the frequency range of the studied blue whale vocalizations [13]. The SWIR array covered an area of 70 km $\times$ 40 km with depth varying from 2822 m to 5430 m (Fig. 1).

Marine mammal vocalizations captured in the monitored frequency range (0-50 Hz) included those of Antarctic blue whales (ABW) (*Balaenoptera musculus intermedia*), Madagascar pygmy blue whales (MPBW) (*Balaenoptera musculus brevicauda*), fin whales (FW) (*Balaenoptera physalus*) and an unknown caller that produces P-calls [14] (or "spot" call [15]). A representation of each vocalizations is shown in Fig 2 and their acoustic characteristics are listed in TABLE I. Blue whale calls do not always present harmonics (see Fig 2 (c-e)). This work focuses on tonal signal reconstruction and hence FW pulses are not considered.

The training dataset comprises data from unit RR48 recorded on May 18^{th}, 2013 (day 138) and from unit RR41 recorded on May 15^{th}, 2013 (day 135), respectively. All blue whale vocalizations within the data were manually annotated by drawing a box (describing a call's begin and end times and its minimum and maximum frequencies) around the calls using *Raven Pro 1.5*.

TABLE I
TONAL SIGNAL UNITS OF BALEEN WHALE SONGS CONSIDERED IN THIS STUDY AND THE NUMBER OF INSTANCES (N) IN THE TRAINING DATASET. UNITS' DESCRIPTIONS (PEAK FREQUENCY f_p AND DURATION; FROM [14]) ARE INCLUDED FOR INFORMATIONAL PURPOSES.

Species	Tonal name	N	f_p (Hz)	Duration (s)
ABW	unit A	674	26.2	12
	unit C	603	18.7	8
MPBW	unit 1 - high	806	33.4	27
	unit 1 - low	1133	13.5	27
	unit 2 DS[a]	681	24.4 to 21.6, mean 23.3	24
?	P-call	555	26.9	14

[a] DS: Down-sweep

III. METHOD

The processing methodology description follows the sequence shown in Fig. 3.

A. Tonal signal detection

In a prior study [16], some of the popular tonal signal detectors from different fields such as speech and musical signal processing or image processing were compared. Performances of the instantaneous frequency estimator, YIN estimator, harmonic product spectrum, cost-function detector and ridge detector were assessed using relevant metrics to quantify (i) the effectiveness of these detectors to reliably retrieve tonal signals and (ii) the quality of the detection results [17], [18]. The detectors were extensively tested against data covering a wide range of acoustic contexts and signal to noise ratio values. The ridge detector [19] performed best [16] and is therefore chosen for this work. This algorithm relies on ridge detection, a widely used image-processing technique for automatic selection and image segmentation.

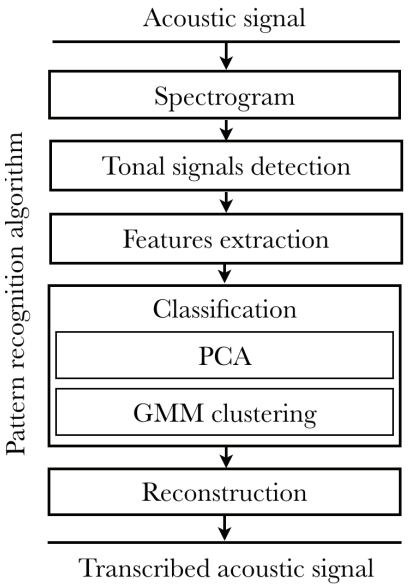

Fig. 3. Automatic transcription algorithm flow chart.

B. Feature extraction

Tonal signals detected by the ridge detector are characterized using different attributes *or features*. Features have to facilitate the sorting of the detected tonal signals into different categories. They should also be simple to measure and not too sensitive to noise [20]. They are generally closely related to the application. Based on the work presented in [21] and [5], the selected set of features measures temporal, spectral, and amplitude variations. They included -

- average $\overline{f}$ (Hz),
- center frequency (frequency reached at half of the cumulative signal amplitude; Hz),
- bandwidth (Hz),
- average amplitude and amplitude standard deviation (dB),
- minimal, maximal, average and instantaneous slope (dB/s) and,
- least concurrent frequency ratio Ω (dimensionless; described below).

When multiple (M) tonal signals occur concurrently, ratios of the average frequencies ($\overline{f}$) are computed for each pair of concurrent tonal signals, with the higher $\overline{f}$ of a pair as the numerator so that the ratios are > 1. For a tonal signal m_i ($i \in 1, 2, 3, ..., M$), Ω_{m_i} is taken as the least of such ratios among all pairs m_i and m_j ($j \in 1, 2, 3, ..., M$ and $i \neq j$). In the absence of concurrent signals, $\Omega = 1$. Ω provides a way for quantifying the polychromatic nature of tonal signals and is expected to be 1.45 ($= \frac{26.2}{18.7}$) for ABW calls, 2.5 ($= \frac{34}{13.5}$) for MPBW unit 1, and 1 for for each of MPBW unit 2 DS and P-calls (no expected concurrent tonals). ω could, however, be adversely impacted by the simultaneous occurrence of multiple whale species tonal signals or shipping noise.

C. Classification

1) Dimension reduction: Principal Component Analysis (PCA) is a tool for feature dimension reduction that aims

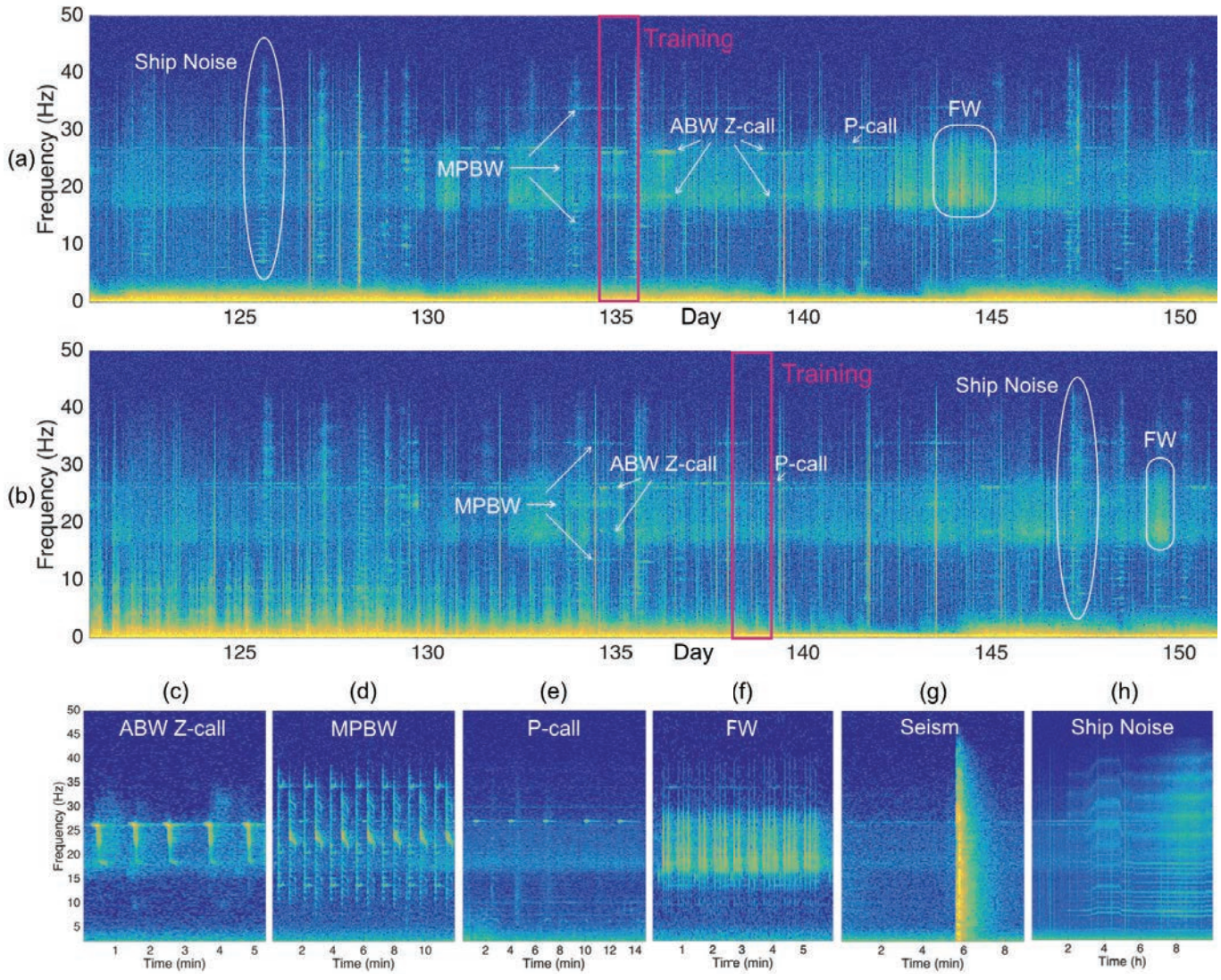

Fig. 2. Long-term (31 days, a and b) spectrograms of OBS data recorded in May 2013 (year day Nb. 121 - 151). Long-term spectrograms of OBS RR41 (a) and RR48 (b). Pink rectangles indicate days annotated for training. Bottom-row panels show spectrograms of (c) 5 ABW Z-calls over 5.2 min, (d) 7 MPBW calls over 12 min, (e) 5 27 Hz P-calls (or "spot"calls) over 14.5 min, (f) 23 FW 20 Hz-pulses grouped by 2 or 3 over 6 min, (g) a seismic event lasting over 8.5 min, and (h) ship harmonic noise lasting over 10 hours.

to find mutually orthogonal global directions in data that maximize variance [22]. When applied to the detected tonals in the dataset, just two principal components (PCs) describe 98.5% of the total variance.

2) Clustering: In the reduced 2-dimensional space, points corresponding to call units are grouped together into clusters using Gaussian mixture models (GMMs). For the training data, six distinct clusters were observed and they corresponded well with the six annotated tonal types (see TABLE I. Data points, during inference, are associated to the closest cluster based on Mahalanobis distances.

D. Reconstruction

Detected tonal signals associated with a particular class are used in the reconstruction of a putative independent song. First, the short time Fourier transform (STFT) $X(t,f) \in \mathbb{C}$ of the input signal is calculated. Complex STFT enables the subsequent reconstruction of a signal without phase losses. A binary mask $Y_i(t,f) \in \{0,1\}$ for the i^{th} class (prepared by setting points along all detected TF contours in the i^{th} class to 1, and 0 elsewhere) is applied to the STFT as

$$Z_i(t,f) = Y_i(t,f) \odot X(t,f). \tag{1}$$

Finally, the time-series data representing an independent song is obtained by computing the inverse STFT of $Z_i(t,f)$, i.e., $z_i(t) = \text{iSTFT}\{Z_i(t,f)\}$.

IV. Results

A. Training

Training data projected on the first and second PC are presented in Fig 4 and color-coded according to the clustering.

PC1 conveys 55.5% of the total variance, 94% of PC1's weight is attributed to frequency features ($\overline{f}$ and center frequency). PC2 conveys 43% of the total variance, 88% of PC2's weight is attributed to the average amplitude.

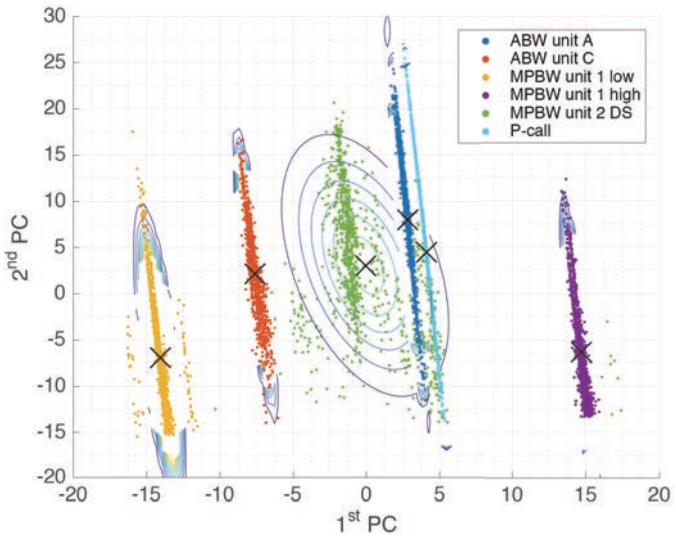

Fig. 4. Training data projected on the first and second PC. Colors represent the results of the GMM clustering with precision and recall of TABLE II.

The different tonal signal types are well separated in this 2D representation. Most of GMMs are narrow ellipses except for the most central one (in green), attributed to MPBW unit 2 DS. The clustering performance is quantified using the metrics Precision and Recall, defined as

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}} \tag{2}$$

and

$$\text{Recall} = \frac{\text{TP}}{\text{TP} + \text{FN}}, \tag{3}$$

where TP = number of true positive classifications, FP = number of false positive classifications and FN = number of false negative classifications. A confusion matrix of the classification outcomes, along with the per-class Precision and Recall values, are presented in TABLE II.

The higher values in the confusion matrix occur along its primary diagonal, indicating high Recall rates. Precision was the lowest for cluster 5 (86.52%). Overall, the average Precision and Recall are 97.18% and 96.92%, respectively.

B. Testing: unsupervised application

The complete process described in § III is illustrated using a recording containing multiple MPBW calls and P-calls as well as FW chorus and seismic noise (Fig. 5(a-b)). The output of the ridge detector is shown in Fig. 5(c) where colors represent the associated data clusters. Detected tonals occurring outside of the $[10 - 40]$ Hz frequency range and with power (on the normalized spectrogram) below -60 dB were discarded. Transcribed and reconstructed waveforms are displayed in Fig. 5(d). An MPBW song constructed by associating clusters 3 (MPBW unit 1 low) and 4 (MPBW unit 1 high) is displayed in pink. Another MPBW song consisting of the unit 2 DS only (cluster 5) is displayed in purple. A song consisting of tonals from the P-call cluster (6) is plotted in orange.

V. Discussion

Acoustic data used in this study were recorded in a deep-sea environment with a highly reflective basaltic seafloor [13]. Multiple-path arrivals (echos) caused by the bathymetry makes it difficult to isolate and extract the direct signal. Measuring the duration of tonal signals in these conditions can produce inaccurate estimates that may not be representative of the actual signal. For example, estimated duration of ABW unit A calls from the training dataset is 20 ± 12 s, whereas the known duration is 12 s (cf. TABLE I, [14]). Hence, signal duration is not considered as a feature (in III-B) for classification purposes.

In the annotated dataset, a unit and its echos are considered as one annotated tonal signal with a unique label. Tonal extraction using the ridge detector, however, marks each of such spectro-temporally disjoint components as independent units. This leads to fragmentation of the detection corresponding to a single annotation. For example, on Fig. 5, at 110-120 s the MPBW unit 2 DS is detected in at least two parts. As a consequence, the percentages presented in TABLE II are reflective of the number of fragmented signals associated with each class and are not representative of the actual number of annotated signals.

Among the tonal signals included in the analysis, ABW unit A and P-calls exhibit high similarities in f_p and duration (see TABLE I). For this reason, P-calls could easily be mistaken for distant ABW unit A [15], [23]. However, PCA and clustering approaches employed here readily separate the two signal types (see Fig. 4). As can be seen from TABLE II, only 0.12% of P-call occurrences were falsely classified as ABW unit A.

MPBW unit 2 DS, is a relatively complex signal in comparison to the other units. Also, the frequency range of a MPBW unit 2 DS is close to that of P-calls and ABW unit A. When the extracted TF contours are fragmented, subsequent estimation of attributes (especially $\overline{f}$ and center frequency) is less accurate. Given that frequency attributes convey the most weight on the PC1 axis (§ IV-A), fragmentation significantly influences the location of the data point on the PCs axes. The wider spread of the MPBW cluster and the resulting misclassifications can be attributed to fragmentation of the extracted TF contours. Furthermore, echoes of the trailing segments of MPBW unit 2 DS might also yield in incorrect classifications as the corresponding detections can present vastly different attributes. As an example, the echoes, at $\simeq 340$ s and $\simeq 710$ s in Fig. 5, were wrongly classified as P-calls.

The results presented in Fig. 5 indicate the ability of the automatic transcription algorithm to retrieve and regroup tonal signals for the reconstruction of independent song tracks. Interfering noises, such as those of the seismic events, have been successfully suppressed in the resulting tracks.

TABLE II
CLASSIFICATION RESULTS PRESENTED AS A CONFUSION MATRIX, ALONG WITH PER-CLUSTER RECALL AND PRECISION VALUES

		ABW		MPBW			?	Precision (%)	Recall(%)
		unit A	unit C	unit 1 low	unit 1 high	unit 2 DS	P-call		
Cluster No.	1	93.28	-	-	-	2.09	0.12	97.69	93.28
	2	-	99.67	-	-	0.25	-	99.75	99.67
	3	-	-	99.92	-	0.25	-	99.75	99.92
	4	-	-	-	99.37	-	-	100.00	99.37
	5	6.24	0.33	0.08	0.63	97.29	7.87	86.52	97.29
	6	0.47	-	-	-	0.12	92.01	99.36	92.01

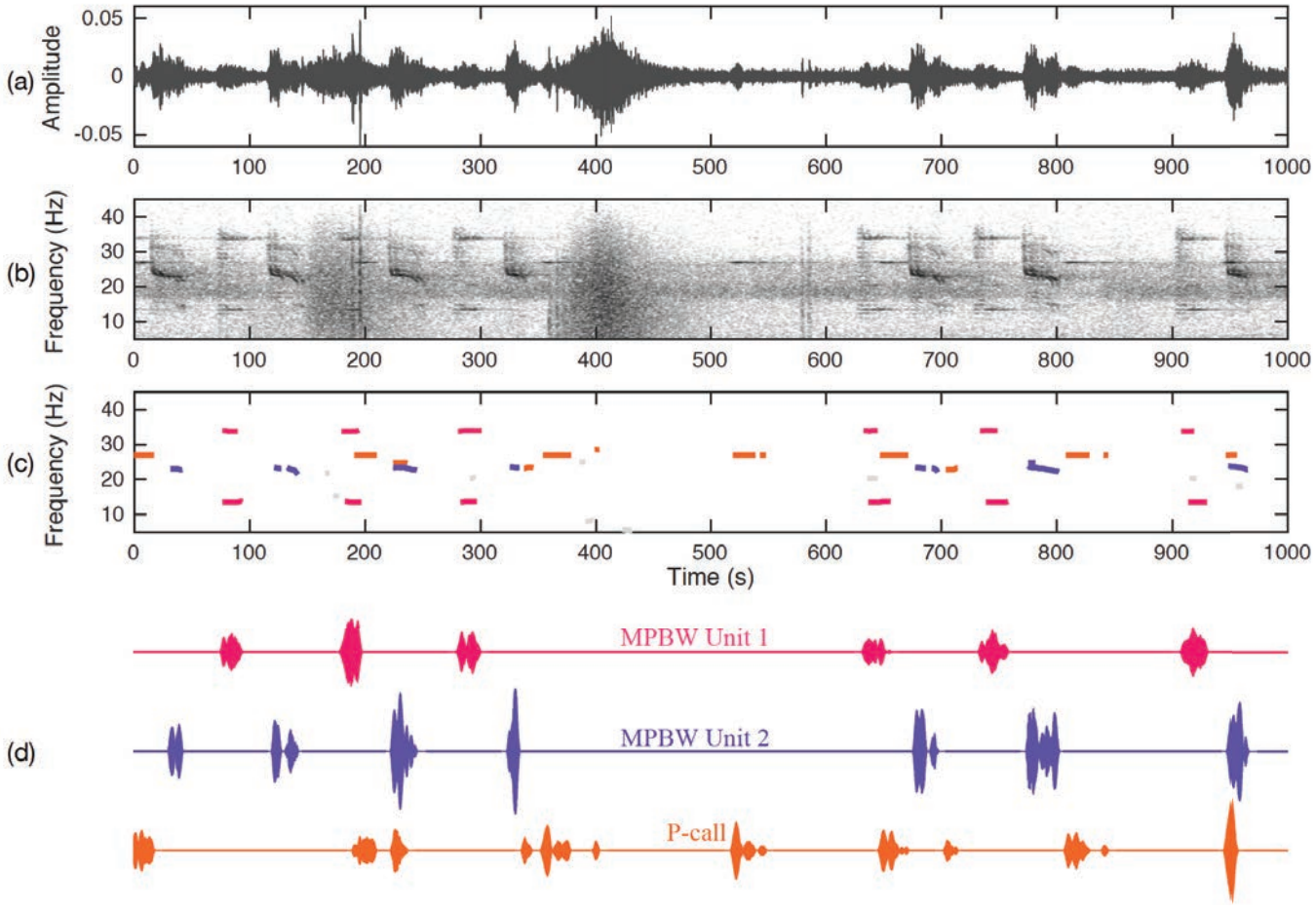

Fig. 5. Illustration of the performance of the developed method using a recording (waveform (a) and spectrogram (b)) containing MPBW calls and P-calls, FW chorus and two strong seismic events (at 180 s and 420 s, respectively). Tonal detector outputs are shown in (c) and color-coded by the classification results. Waveforms of reconstructed songs are shown in (d).

On the current version of the algorithm, every detection is assigned to a cluster. To improve its performance in terms of precision and to increase its robustness to reverberations, a distance threshold could be applied. It would delimit how far a detection point can be from any cluster to be considered for assignment. In this case, tonals with distances above a predefined threshold could be automatically discarded.

Separation of songs of individuals from the same species improves the utility of the algorithm in visual and aural analyses. Consideration of inter-call-intervals [4] in the signal reconstruction step of the algorithm could help achieve it. To that extent, other options might be taken into consideration, i.e., received level comparison and echoes analysis.

Preliminary experiments focused on a short ($<$ 17 min) recording used for testing which contained MPBW and P-calls. Work in progress focuses on testing the method on a new, extended annotated dataset which was also recorded by the RHUM-RUM OBSs. Using these data we will assess the performance in more detail and construct confusion matrices similar to the one presented in TABLE II.

A systematic performance analysis of an automatic transcription algorithm faces two main issues. First, there are

very few ground-truth datasets available and, labeling data is time consuming. Second, traditional performance evaluation metrics (e.g., precision and recall) do not suffice in quantifying the performance of transcription methods. The evaluation of the performances requires to determine new scoring metrics to: assess the accuracy of the transcription or, the percentage of transcribed songs, compare its efficiency on different types of signals or, evaluate units associations in a multi-individuals context.

VI. Conclusion

To address the issue of the automatic analysis of PAM recording, this work presents a method for automatic blue whale song transcription based on the time-frequency representation of acoustic signals and pattern recognition. First, segmentation is realized by the ridge detector then, features describing tonal signal time-frequency-amplitude information are extracted. Data are represented on the first two principal components, describing 98.5% of the total variance. GMM clustering is applied, performing training performances of 97.2% precision and 96.9% recall. In a preliminary application, transcription of a recording of Madagascar pygmy blue whales and P-calls, polluted with seismic noise, provides supportive results. Future work must focus on (1) improvements of the algorithm to lower false alarms on broader units such as MPBW unit 2 DS, (2) separating songs from individuals of the same species (3) finding scoring metrics, to be able to evaluate the complete transcription process performances and realize comparisons to similar algorithms.

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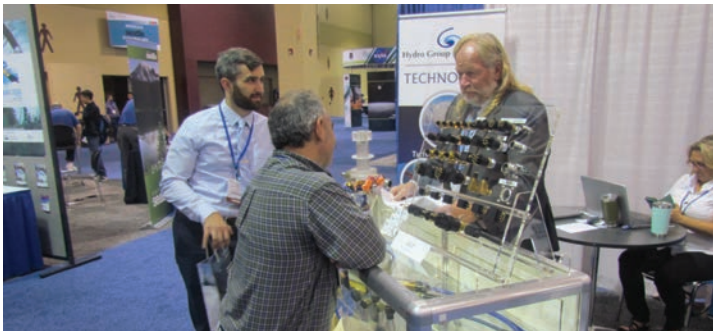

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Who's who in the OES

Ken Takagi, RECON Committee, Associate Editor of JOE

I'm writing this article during a short summer vacation in my hometown of Osaka. I was born and raised in a town called Suita in northern Osaka. A boy who loves ships, airplanes and cars naturally chose an engineer's path and entered a naval architecture department at Osaka University. After that, I was involved in the field of naval architecture and ocean engineering for 42 years and became 60 years old this year.

In Japan, age 60 has a special meaning and is called "Kanreki." Kanreki is the year at which a numeral with a period of 60, which is widely used in Asia, goes around one round. I was celebrated by family members with a red garment (hat and waistcoat) that is often used as baby clothes. Wearing it means that I will return at birth, or be reborn, after 60 years. Although current retirement age is 65 years, it was customary to retire at the age of 60 in Japan.

At Osaka University, I was working on wave power generation. This project was a great opportunity to turn my research direction toward the ocean, but the series of research conducted

University R&D showcase at OTC.

"Kanreki" (60 years old) celebration.

Basilique Notre-Dame de la Garde in Marseille.

in Japan did not reach the demonstration phase. I had to wait until the start of the second trend on the marine renewable energy in recent years. On the other hand, my interest expanded to the theory of water waves, the interaction between waves and ships and hydroelasticity.

There was a big turning point in my life in 2008. I moved to the Department of Ocean Technology, Policy and Environment, which was newly established at the University of Tokyo. My field of expertise here is ocean technology policy, and it is required to look at ocean engineering not only from the viewpoint of engineers but also from an economic and policy perspective. Here, the new research theme I started was ocean current power generation. This research, with support from the New Energy and Technology Development Organization, continues with IHI Corporation, and a prototype demonstration with a 100-kW class generator will start from August this year. In addition to the development of the prototype, this R&D also conducts research on local social acceptance and coexistence strategies. My team is also expanding research themes on the safety of marine operations and the integrity of mooring systems as basic technologies that support marine engineering, and on reduction of GHGs emission from ships as a contribution to global warming.

As an OES member, I have served as the general chair of OCEANS 2008-MTS/IEEE Kobe Techno-Ocean, AdCom member in 2013–2018, Associate Editor of IEEE Journal of Oceanic Engineering since 2013 and RECON member from 2017. In addition, I am also serving as Chairman of the Ocean Energy Association Japan, Director of Techno-Ocean Network, Director of Japan Society of Naval Architects and Ocean Engineers and Editor in Chief of the Journal of Marine Science and Technology. Through these academic activities, I would like to make a baton touch for young people. As part of this, my team regularly participates at the University R&D Show Case in OTC. (Https://www.youtube.com/watch?v=KI6PDlZM9VM)

Finally, I would like to briefly introduce my family. I was married with Yuko 33 years ago and have two children. The whole family loves Hawaii, and it was the primary reason why we participated in OCEANS 2001 in Hawaii, the first OCEANS conference for me, and that was the starting point of my activity in OES. Since my children got jobs, it is difficult for them to travel with us. However, my wife is looking forward to traveling with me and participating in future OCEANS conferences. Visiting La Provence this year was one of best travel experiences for us. My wife will be in the 60th birthday next year, but, nowadays, the age of 60 is still in the middle of life. We wouldn't be able to go around the second 60 years round, but we would like to expand our range of activities further to enjoy our life.

Member Highlights

Contact the Editors If You Have Items of Interest for the Society

Visiting U-Tokyo by Hsin-Hung Chen and Yu-Cheng Chou
Institute of Undersea Technology, National Sun Yat-sen University, Taiwan

As supported by the International Targeted Research Areas Project of the National Sun Yat-sen University (NSYSU), we had a short-term research visit from July 30 to August 2 at the Institute of Industrial Science (IIS), the University of Tokyo (U-Tokyo) (Figure 1). Prof. Toshihiro Maki was our host professor. Prof. Maki is one of the key members in the Center for Integrated Underwater Observation Technology, and his research focuses on the development and application of underwater platform systems.

Prof. Maki led a facility tour for us in the morning of July 30. He introduced different AUVs, the full-ocean-depth hydrostatic pressure testing system, and the large/small water pools for testing underwater vehicles. There was a workshop held in the afternoon of July 30. Prof. Maki started the workshop by introducing the U-Tokyo, the IIS, and the research directions and achievements of his lab (Figure 2). Next, we exchanged presents with Prof. Maki and Ms. Harumi Sugimatsu (Figure 3). Ms. Sugimatsu is currently a specially appointed researcher in Prof. Blair Thornton's lab. Afterward, we introduced the Institute of Undersea Technology (IUT) at NSYSU and the research achievements of the Underwater Mechatronics Laboratory (UML) (Figure 4). Lastly, research members of Prof. Maki and Prof. Thornton presented their research topics, current results, and future works.

On July 31, Dr. Takumi Matsuda (a specially appointed researcher in Prof. Maki's lab) introduced the purpose and specifications of AUV Tri-TON. Dr. Matsuda also used AUV Tri-TON to demonstrate wireless remote control, mission setup, and data access on the water surface, and underwater waypoint navigation (Figure 5). We also tested the performance of AUV Tri-TON's motion controller by specifying the coordinates of waypoints and the desired depth of AUV Tri-TON. Additionally, we participated in the hydrostatic pressure test for the main housing and battery housings of

Figure 1. Prof. Hsin-Hung Chen (left) and Prof. Yu-Cheng Chou (right) at the entrance of the IIS, U-Tokyo.

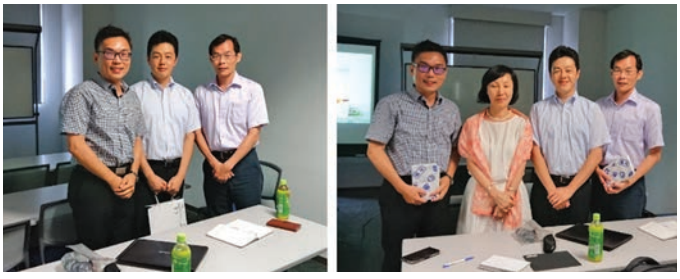

Figure 3. We exchanged presents with Prof. Toshihiro Maki and Ms. Harumi Sugimastu.

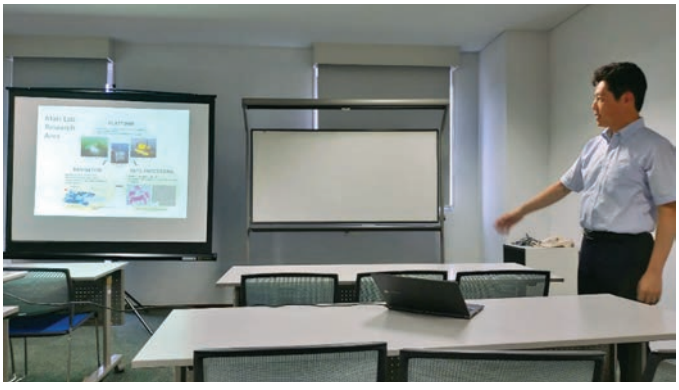

Figure 2. Prof. Toshihiro Maki introduced the U-Tokyo, the IIS, and the research directions and achievements of his lab.

Figure 4. Prof. Yu-Cheng Chou introduced the IUT at NSYSU and the research achievements of UML.

Figure 5. Dr. Takumi Matsuda introduced AUV Tri-TON and demonstrated waypoint navigation using AUV Tri-TON.

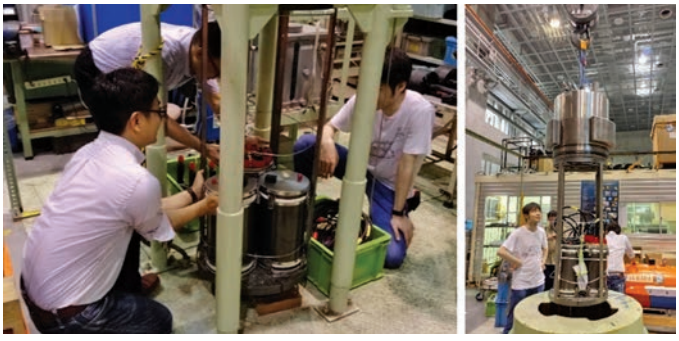

Figure 6. Hydrostatic pressure test for the main housing and battery housings of AUV MONACA.

Figure 7. AUV MONACA for under-ice survey of Antarctica.

AUV MONACA (Figure 6). AUV MONACA is a variable and compact AUV developed for conducting under-ice surveys in Antarctica (Figure 7).

On August 1, with assistance from Dr. Matsuda, we acquired basic understanding and hands-on experiences for the Robot Operating System (ROS), which is the AUV software development platform used in Prof. Maki's lab. We successfully modified an ROS-based AUV control program in order to read sensor data through the RS-232 serial communication interface of our laptop computer (Figure 8).

On August 2, we participated in the multi-AUV experiments conducted by Mr. Yuya Hamamatsu (a graduate student in Prof. Maki's lab) and Dr. Matsuda. The experiments aimed to test the performance of a short-distance multi-AUV following method based on LED images (Figure 9). In addition, we also performed the underwater positioning experiments through our laptop computer, an underwater USBL transponder connecting to our laptop computer, an ROS-based AUV control program,

Figure 8. We installed ROS and modified an ROS-based AUV control program to read sensor data through the RS-232 serial communication interface.

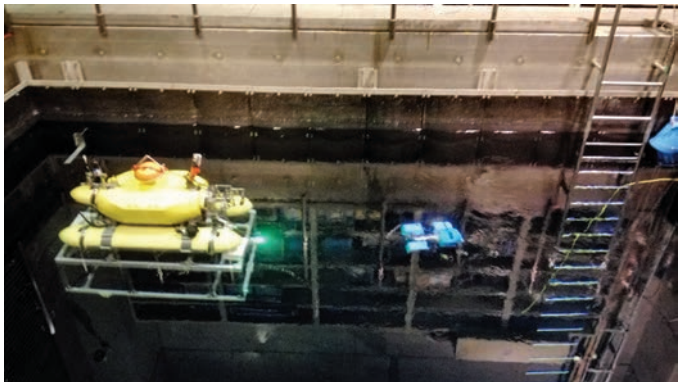

Figure 9. Experiments for an LED image-based short-distance multi-AUV following method.

Figure 10. We performed underwater positioning experiments using USBL sensors, an ROS-based AUV control program, and our laptop computer.

and an underwater USBL positioning station fixed on the bottom of the water pool. With Dr. Matsuda's help, we successfully modified the ROS-based AUV control program in order to obtain the relative distance and angle information between the underwater USBL transponder and the underwater USBL positioning station (Figure 10).

We would like to thank Prof. Maki for the excellent visiting arrangement he made for us. Prof. Maki was so considerate by helping us make the best use of our limited time to learn more of his AUVs. Everything went quickly and smoothly as planned and we could not be more satisfied with the entire visit.

AdCom Election Results

The election results are in for the 2020–2022 Administrative Committee members. This year we had a great list of 12 candidates from around the world (see their bios in the last issue of the Beacon) and the results were very close. Congratulation to the following six candidates who were elected:


João Alves


Brandy Armstrong


James V. Candy


Timothy Duda


Ken Foote


John R. Potter

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Underwater Robot Convention in JAMSTEC 2019

Takumi Matsuda, The University of Tokyo, IEEE OES Japan Chapter

Introduction

Underwater Robot Convention 2019 was held in JAMSTEC (Japan Agency for Marine-Earth Science and Technology) from August 23rd to August 25th, 2019 [1], [2]. This event in JAMSTEC was held from 2010 and it is 10th time this year. More than 200 researchers, engineers, students, and visitors from institutions across the country participated in the convention. The convention has three sections: a free style section, an AI challenge section, and a junior section.

The Underwater Robot Convention by the NPO Japan Underwater Robot Network [3] can strengthen research cooperation between underwater robot researchers in Japan and neighboring Asian countries, and develop next-generation underwater robot researchers. The convention has been introduced in this newsletter several times in the past [4]–[6]. This event usually involves about 20 teams. Most of them are researchers and students who are interested in underwater robotics. Each team brings the latest underwater robot that realizes the latest ideas and innovations that occur in the laboratory. As a result, this is a unique and wonderful opportunity to discuss and exchange the latest ideas and innovations in a friendly and competitive atmosphere.

Free Style Section

Each team develops a robot based on unique ideas and participates in the convention. They compete for the originality of their robots. In addition to the development background, the practicality and originality of their robot is evaluated. Each team competes for the total score of weight points, presentation points, and competition points. The competition points are determined by performing a 4-minute performance twice.

AI Challenge Section

This section is held for the first time this year. Each team implements their developed algorithms on their robot provided in advance or developed on their own, and compete for their processing capabilities. They compete for the sum of presentation points and competition points. A training seminar is held in this section to provide knowledge for development.

Junior Section

The junior section is a competition for junior high school students, high school students and technical college students. Underwater robot kits are provided free of charge to the teams entered one month before the tournament. Participants assemble and modify them before the competition. The task in this competition is collecting cans. Each team is evaluated based on how many cans can be collected within the limited time. Higher scores can be expected if cans can be collected from a field simulating seaweed.

Prior to the competition, the seminar was held. The objective of this seminar is to encourage the information exchange and

The guidance of the junior section.

The scene of the seminar. The Honorary Professor Tamaki Ura in the University of Tokyo talked about the investigation of shipwrecks.

The opening ceremony.

The poster session in the free style section and the AI challenge section. Each team introduced the specification and originality of their robot.

strengthen the technical expertise of the whole community. More than 100 researchers, engineers, and students attended the seminar this year. There were lectures about the investigation of shipwrecks using underwater robot technology, about reproducing extinct creatures as robots, and about Team KUROSHIO which participated in the Shell Ocean Discovery XPRIZE [7], [8].

Results

In the free style section, there were various kinds of robots, such as robots developed based on a paleoorganism and Gokai, a multicopter, which moves underwater and in air, and a helicopter type robot. Each team developed the robot based on their unique ideas. Each robot is introduced in the following sections.

OYG-YKT_3 (Keio Shonan Fujisawa Senior High School)

The series of this robot was developed six years ago to investigate the ecosystem of the Gulliver Pond in the school. OYG-YKT_3 is the third edition. Cameras are equipped for the investigation of the environment. This pond is very shallow (depth is 1m), so the robot must be low and flat. A PVC pipe and an acrylic board are used for the robot. Four vertical and horizontal thrusters are installed. Arduino and Raspberry Pi are used for control.

Drepana First Edition (Tokyo Tech High School of Science and Technology)

This robot is an underwater glider that was developed based on a paleoorganism called Drepanaspis. The robot can perform several actions: diving, surfacing, and swimming. It swims from the starting point to the destination using the GPS position and then dives for an arbitrary time. The purpose is to collect water temperature data at regular intervals using a temperature sensor in the destination area. After completing collection of data, the robot surfaces and returns to the starting point.

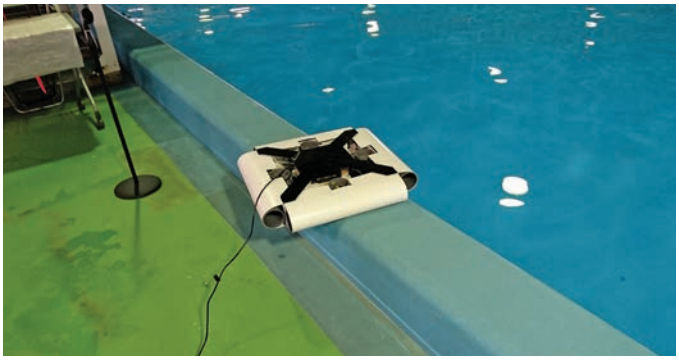
The robot was made by PP board. Inside the robot, Arduino and GPS modules used for control are installed. Waterproof servo motors are fixed to the robot. Systems for adjusting buoyancy and moving the tail fin are installed.

Moonswim III (Shinshu University)

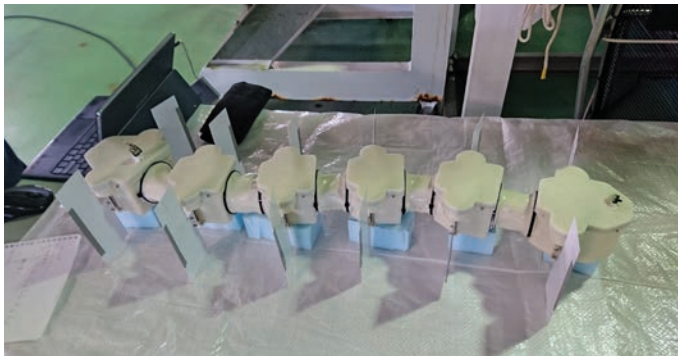
This robot was developed by focusing on Gokai. It has a fin that correspond to the warts. By changing the angle of the fin, it can swim in all directions and move back as if it is moving forward, so it was named as Moonswim. After that, several generations were developed. Moonswim II can move left and right fins actively, and Moonswim III has improved actuators and control system.

MizudeppoTaro (Tokyo Institute of Technology)

This robot can recognize moving objects and knocks them out with a water gun. It recognizes the surroundings by a phased array sonar using multiple ultrasonic sensors. In addition, the sonar recognizes the signal from the fixed marker placed on the ground, so that the distance and direction from the fixed marker are determined, and then self-position estimation can be performed. This phased array is also assumed to be used for underwater terrain mapping and object recognition.

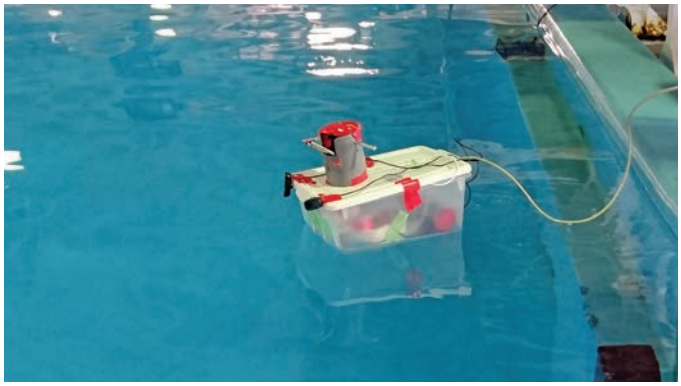


OYG-YKT_3.



Moonswim III.

Drepana First Edition.



MizudeppoTaro.

gen4 (Tokyo Institute of Technology)

gen4 has 4 thrusters which consist of one surge thruster, one heave thruster, and 2 sway thrusters. Pressure hulls for thrusters and computers are separated. It is designed to launch a handset. The robot is covered with a plastic plate to reduce the water resistance so that it can move forward faster. The thruster for forward movement is being improved so that large power can be used.

Ginjiro (Keio University)

Ginjiro is an autonomous underwater robot that is aimed to investigate the oceans of the extraterrestrial bodies. The robot takes images of the seabed over a wide area after being transported to the target celestial body by a rocket. And then, it transmits the information to the station of the earth. In the future, a seafloor map can be obtained by analyzing the video. Besides, water temperature, components contained in the water can be measured and mapped. The robot has a pressure-hull that contains the control unit. Camera unit is located in the front. It has four thrusters that consist of two horizontal thrusters and two heave thrusters for navigation.

Stingray (Tokyo Metropolitan College of Industrial Technology)

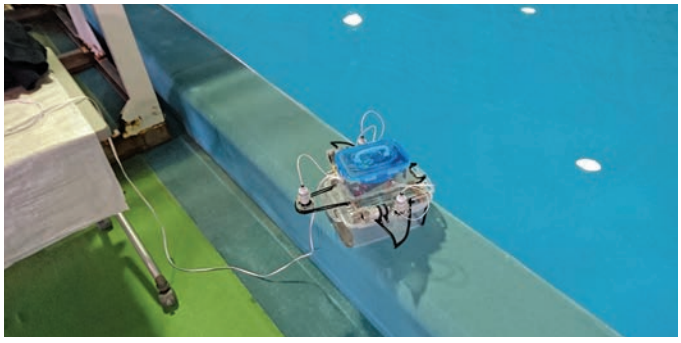
This robot can be controlled in surge and yaw directions by two horizontal thrusters. Heave, roll and pitch control is performed by three vertical thrusters. A wide variety of equipment can be attached to the 20 mm rail at the bottom of the robot. Attachments can be selected depending on the application. Since the robot is operated by tether cable, stable operation can be realized.

HSK-19 (Hakodate Fisheries High School)

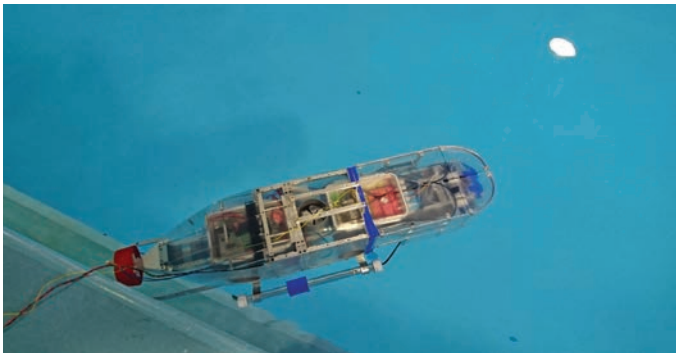
HSK-19 is an ROV equipped with both horizontal and vertical thrusters. The thruster uses a kerosene pump motor. Power is supplied from the battery on the land side by wired cable. In addition to the power cable, a video output cable is provided. The action cam is used for video output and recording. Although the heavy materials, such as aluminum plates, are used in the robot structure, this team still tries to reduce the design weight.

DTRU (Tokushima University)

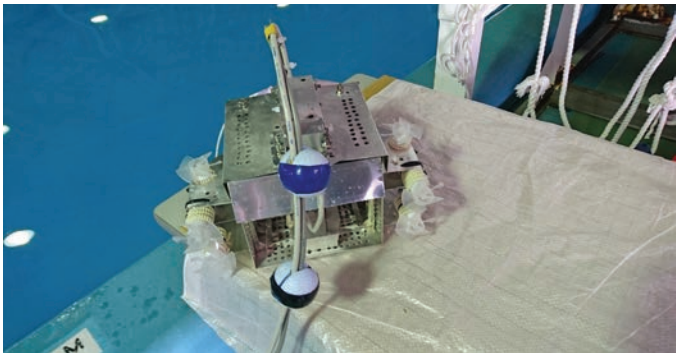
Diving Tilt Rotor UAV (DTRU) is an underwater and aerial multicopter, which was developed based on a 4-shot tiltrotor multicopter. A radio wave of 72 MHz is used for control. It can dive by its thrusters and move underwater by tilting its thruster. It succeeded in diving 3 m depth in the pool. It has also navigated successfully in rivers.



Stingray.



gen4.



HSK-19.

Ginjiro.

DTRU.

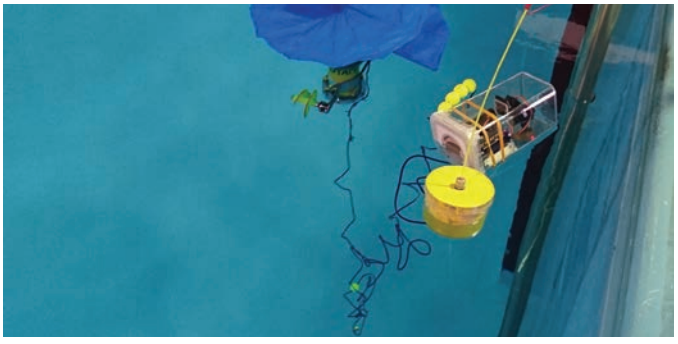
Marine Da Vinci Copter (National Institute of Technology (KOSEN), Oyama College)

This robot is developed based on a helicopter devised by Leonardo da Vinci. An air screw (hereinafter referred to as a Da Vinci screw) is used for the propeller of this helicopter. This helicopter cannot fly in the air, but when operated in water, the helicopter can move due to the high viscosity of the fluid and buoyancy. This robot can realize a Da Vinci helicopter that flies elegantly underwater.

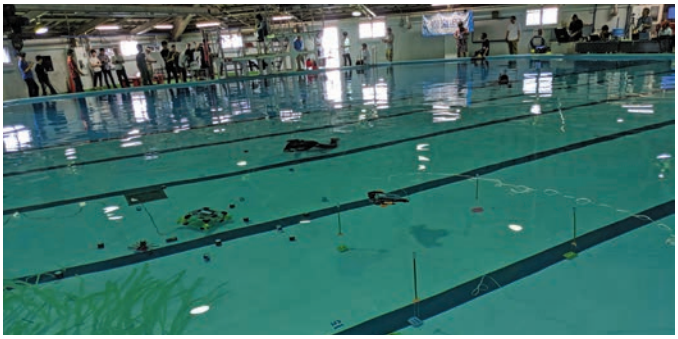
There were many robots based on unique ideas in this year's competition. Among them, Moonswim III from Shinshu University won the first prize. This team demonstrated that their robot can change the moving direction by changing the angle of the fin.

In the AI challenge section, the robot recognizes and breaks red, yellow, and blue balloons deployed in the water. Scores vary by color, with 30 points for red, 20 points for yellow, and 10 points for blue. A method of recognizing by masking and a method of recognizing using machine learning were adopted. In addition, each team showed its own uniqueness, such as focusing on a specific color and crushing balloons from above. The robot named jellyfish from Toyohashi University of Technology won the first prize this year. This team succeeded in breaking five red balloons.

In the junior section, each team competes the performance of their robots and skills. Each team developed the robot before the convention using a kit provided from the committee. On the first day, they conducted an operation test of their robots. On the second day, they competed to control the robot, pick up

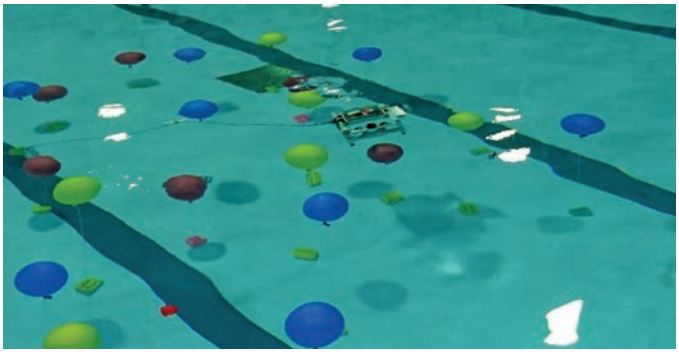


Marine Da Vinci Copter.



The scene of the junior section.

The scene of the free style section. The left: Moonswim III from Shinshu University (first prize). The right: Marine Da Vinci Copter from National Institute of Technology, Oyama College (second prize).



The scene of the AI challenge section. The left: the robot tried to break the yellow balloon using a machine learning approach. The right: the robot from Toyohashi University of Technology which won the first prize.

The awards ceremony. Top three or two teams in each section were awarded. The top left: Shinshu University, which won the first prize in the free style section. The top right: Toyohashi University of Technology, which won the first prize in the AI challenge section. The bottom left: Shibaura Institute of Technology Senior High School, which won the first prize in the junior section. Special award was also given to one team shown in the bottom right.

empty cans on the pool floor, and competed their ability to operate the robot.

In all the sections, many teams were confronted with difficulty of hardware trouble such as thrusters, cameras, water leak and so on. The convention provided an excellent opportunity for all participants to show and share the latest technique in the field of underwater robots. After the convention, they share each idea and leave with a sense of satisfaction. Human networks made through the convention will lead to the development in underwater techniques and the encouragement of the next generation of underwater robotics researchers.

Group photo.

For more details about the activity of the Underwater Robot Convention, NPO Japan Underwater Robot Network, visit the links shown in the references.

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