

OES BEACON

Newsletter of the Oceanic Engineering Society



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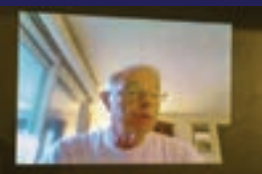
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Wishing Everyone a
Happy New Year!



2022



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Editor-in-Chief:

Harumi Sugimatsu—harumis@iis.u-tokyo.ac.jp

Co-Editor-in-Chief:

Robert L. Wernli—wernli@ieee.org

Associate Editors:

Masakazu Arima
Kenichi Asakawa
Toshihiro Maki
Takumi Matsuda
Katsunori Mizuno
Takeshi Nakatani
Hisashi Shiba
Farley Shane
Blair Thornton

Contributing Editors:

Australia—Mal Heron
China—Lian Lian
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India—M. A. Atmanand
Japan—Blair Thornton
Korea—Son Cheol Yu
Scotland—John Watson
Singapore—Venu Pallayil
Taiwan—Jenhwa Guo
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Member Benefits—Did You Know?

Free IEEE-USA E-Book: Engineering Activities for the Classroom—Vol. 3: Engineering

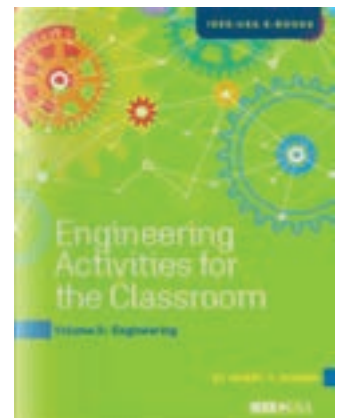
From the IEEE Member Benefits Bulletin

In Volume 3 of his Engineering Activities for the Classroom series, author Harry T. Roman focuses on getting young minds thinking about technology, engineering and invention. Teachers and parents can use the books in this series to build lesson plans and further engage children in the world of STEM (free download for all IEEE members).

Members: \$0.00

Non-members: \$2.99

<https://ieeusa.org/shop/policy/stem-education/engineering-activities-for-the-classroom-volume-3-engineering/>



From the OES BEACON Editors

Harumi Sugimatsu and Robert Wernli

Welcome to the December 2021 issue of the Beacon. And welcome once again to a face-to-face OCEANS meeting in San Diego in addition to Porto's virtual portion of the 2021 hybrid conference. As you can see in the San Diego and Porto reports on the OCEANS 2021 conference, and the smiling faces in the "Blast" photos, everyone was happy to not be meeting via a computer screen. The conference also held the Student Poster Competition, both in person and virtually, and the results are included in this issue in addition to the winning paper.

Our issue begins with reports from our President and VPs for Professional Activities (VPPA), Technical Activities (VPTA) and Workshops and Symposia (VPWS). Overall, they show us that the future is definitely getting brighter regarding our events, chapter activities and our goals to encourage and increase the involvement of our young professionals and women in engineering. The VPTA report, in addition to the latest on the technical committees and chapters, which includes our new committee chairs and co-chairs, also provides details on the 5 recently approved Distinguished Lecturers.

The Journal EIC again provides recently released papers that are available to our members. And we'll be adding more papers to that list in the future as we hold our OCEANS 2022 Chennai and OCEANS 2022 Hampton Roads conferences, which are discussed in their related articles.

Our Chapters continue to be active. This activity is highlighted in the reports from our Japan and Singapore chapters. Articles also address the Japan chapter winning an AUV competition and a student video competition held by the Delhi chapter. Two other events showcased include the successful UComms21 conference organized in Italy and Croatia's Breaking the Surface 21 workshop.

Our members are certainly active and being recognized. Enjoy our Member Highlights, Who's Who in the OES and the articles on our annual OES award winners who received their awards virtually at the OCEANS 2021 San Diego plenary. In addition, a report addresses the Alvin submersible that was recently given the prestigious Alvin Milestone Award.

Our last issue provided the list of those elected to the 2022-2024 OES AdCom. Congratulations to those who were elected, or reelected, to the AdCom. If you're interested in getting involved in the society, and maybe becoming a future AdCom candidate, see the invitation in this issue for our upcoming 2023-2025 AdCom election. Also, our members can get good exposure by providing Member Activities for future issues of the Beacon. Maybe you'll get highlighted like our latest Who's Who in the IEEE OES.



Harumi with AUVs on her latest at sea expedition.



OCEANS 2021 San Diego - Your Beacon editor welcoming the attendees.

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.

From the President

Christopher Whitt, OES President

It's hard to believe 2021 is almost over. While it was a different year, it was still a year of much activity for OES.

We were thrilled to see some of you in person at OCEANS 2021 in San Diego. A huge thank-you to both the San Diego and Porto teams for their hard work in organizing a very successful conference! While we still expect the effects of the pandemic to last into 2022, we look forward to conditions safely allowing more in-person meetings. I hope to see you at OCEANS 2022 Chennai in February or at OCEANS 2022 Hampton Roads next October.

We are excited about our new partnership with Schmidt Ocean Institute to support our Student Poster Competition at OCEANS, and we look forward to working with SOI for many years to come.

The UN Decade of Ocean Science for Sustainable Development (the Ocean Decade) continues to gather momentum among science and technical communities. See the article in the September issue of the Beacon and look for an editorial in an upcoming issue of the Journal. If you are passionate about sustainability, there will be many ways to get involved with OES and the Ocean Decade in 2022.

In addition to sustainability, we also need more volunteers to help with student activities, as well as equity, diversity, and inclusion (EDI). We are working to build on



the initial steps of the WIE Pledge that the Society approved in our June AdCom, and to improve EDI in all aspects of Society operations.

Despite a second year of pandemic challenges, the Society has kept our finances positive through very careful reduction in spending. In the meantime, there have been several new Chapters and Student Branch Chapters formed and I look forward to hearing more about your local activities in this and future Beacon issues.

It is my pleasure to recognize Dr. Jay Pearlman, Dr. Andreas Marouchos, and Dr. Michael Lamoureux, who are completing their term on the Society Administrative Committee at the end of December. Thank you all for your service, and I look forward to working with you as continue your volunteering with the Society in other ways.

As we enter the final weeks of 2021, I wish peace and happiness to you and your loved ones and look forward to a healthy and productive 2022.



Figure 1. Dr. Jay Pearlman.



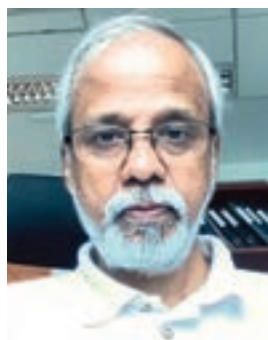
Figure 2. Dr. Andreas Marouchos.



Figure 3. Dr. Michael Lamoureux.

VPTA Column

Venugopalan Pallayil, Vice President for Technical Activities, IEEE OES



OES colleagues,

Time flies and we are already at the far end of 2021. Even COVID-19 does not seem to have slowed down things. The year 2021 has kept me very busy with work (including working at, not from, home) and OES volunteering work. While we look forward to a new year of promises, it is also time to look back and see how we have been

doing amidst the pandemic and how to plan the activities forward. This report, in some sense, is also an assessment on VPTA activities.

Technology Committees (TC)

The technology committees have been active in organizing online technical talks, virtual Workshops, and webinars as reported in the previous reports. Two TC Chair's online meetings were also organised to discuss how the TC activities can be coordinated in the wake of ongoing pandemic. We have one of our TC Chairs, Rene Garelo, resigned and a new person has

been appointed with AdCom approval. Three TCs have nominated co-chairs and two of them were approved in our October AdCom. The third nomination will be put up for approval in the December AdCom. Details of these have been covered in a separate report by the TC Coordinator.

I would like to request TC Chairs to engage their members on various activities such as review of manuscripts for OES sponsored and co-sponsored workshops and symposia; to support OES initiated and supported UN Decade of Oceans activities, etc. Many of the TCs are yet to setup their website. Explore with the members of your TC who are willing to help setup and manage the website contents. So far, the Singapore chapter has been supporting TCs in this regard and the chapter will be completing its three-year service offer by the end of this year. Any future services will only be on a goodwill basis and possibly would need additional financial support. So, make use of the existing opportunity.

Chapter Activities

We have 30 full chapters and two joint chapters and only 8 chapters have been active or reported their activities. It is understood that some of the chapters have been organizing many in-person activities, which are difficult to transition into virtual events and this has limited chapter level activities. Nevertheless, 8 out of 32 is not an encouraging outcome. There is a need for us to work more closely with the chapter chairs to make sure each chapter reports at least two activities per year. Chapters are required to login at least two technical activities to be eligible for chapter rebates from IEEE Member and Geographic Activities (MGA). Chapters can engage the services of Distinguished Lecturers (DLs) and TC Chairs for hosting technical talks or half-day workshop like events. We also need to explore how the chapters can be utilized in community level engagement.

It is time now for the chapters to elect new office bearers. I would like to request the current chapter chairs to find their replacements if they have served two years (or more). We should bring a sense of ownership and feeling of responsibility to the members and the chapter should nurture them to be valuable contributors to the society objectives. For example, the current vice-chairs can graduate into chairs and so on and so forth with the consent of chapter members. At least one of the 'senior members' should have a presence in the executive committee to guide the new committee using the expertise they have acquired over years. This way we can ensure a healthy chapter and membership for the society. We welcome feedback from chapter chairs and suggestions on how the society can help to improve and support chapter activities. If you have creative ideas, please share with us.

We are still working on the 2022 budget final numbers and at this time no chapter activity funds support for the chapters are available for 2022 activities. We shall review this decision early next year and inform the chapter coordinator if there is any fund availability.

Distinguished Lecturers (DL)

Four new DLs have been appointed by the AdCom for a four-year term starting from Jan 2022. And one of the DLs has been

re-appointed for a second term. It is encouraging to note from the applications received that there is a strong desire for subject experts to get engaged with the OES activities and share their knowledge with the OES community. The names of DLs, their areas of expertise and short biographies are available in a separate section of this newsletter.

The DL activities have been progressing well, and we had 5 talks delivered since my last report. Milica Stojanovic, delivered yet another exciting talk on 'Underwater Communications' at the request of Technology Innovation Institute, Autonomous Robotics Research Centre, Abu Dhabi. There were 21 participants, including me, who attended this talk. As the talk was organised at short notice, wide publicity could not be given. This talk was important from another perspective that there is an opportunity for IEEE OES to explore more association with Middle East and form a Chapter there.

In January 2022, Prof Hanumant Singh has planned for a DL at the request of DAIMS Technology Committee. Announcement of this talk will be communicated to all members in the coming week over e-Notice.

Ocean Sciences Meeting (OSM 22)

We have received reasonably good response to our call for papers for most of the sessions proposed for Ocean Sciences Meeting 2022. A list of sessions and the names of the lead persons have been provided in my last report. Sessions that did not receive enough papers will be merged with other sessions. Jay Pearlman represented OES at the Technical Programme Committee scheduling meeting held on Nov 11th in DC. The final listing of the papers selected, after reviews, for various sessions are expected to be available by 15 Dec 2021. The conference, which was planned to be in hybrid format initially, will now be held fully virtual due to prevailing state government restrictions on the number of people allowed and the need for safe distancing. We would hence miss an opportunity to engage effectively with the participants. Each presenter is now required to send a 5-min recorded presentation and each session will have 6 such presentations followed by a 30-min Q&A session, live.

Non-VPTA Activities

Apart from the above VPTA related activities, I have also been volunteering my time on many other OES related events. As OES Liaison, I have been working closely with Chennai LOC and provide necessary guidance for a successful organization of OCEANS 2022 Chennai, including sourcing of funds from ONR Global for the student poster competition. I also attend JOAB meetings regularly and provide my views and suggestions to run OCEANS more actively and efficiently. As General Co-Chair for IEEE OES AUV 2022 Symposium, I have been taking part in discussions with the LOC members and support in sourcing patronage. This conference is planned to be an in-person event during Sep 2022 and to add more vitality our Chapter's flagship event Singapore AUV Challenge 2022 will be held just after the conference. Recently I have been nominated as a member of the Technology Innovation Informal Working Group under the UN Decade of Ocean Science for

Sustainable Development-Ocean Decade. More about this group and its objectives have been provided in a separate section of this Newsletter.

2022 Outlook

Many countries have now accepted that COVID-19 is an endemic and will stay here for a longer period than anticipated, perhaps even forever. International travels are opening-up and border controls are becoming less restrictive. We also see that

the infection rates are on the high across many countries. But it is still unpredictable how 2022 will turn out to be. Though I remain optimistic that there will be some possibilities for us to interact over an in-person international conference, most of our activities are still going to be online. Our current financial position is bleak and meeting operational expenses for next year would be an uphill task. I would therefore request our TC Chairs, DLs and Chapters to plan for their technical activities to be online for the coming year as well.

Distinguished Lecturer Roster

Venugopalan Pallayil, Vice President for Technical Activities

Each year Oceanic Engineering Society appoints Distinguished Lecturers (DLs) who serve a four-year term in their positions. DL nominations are to be endorsed by one of the Technology Committees and reviewed by the DL committee who recommends their appointment to AdCom. The AdCom held on 26th Oct 2021 has appointed the following DLs to serve a four-year term starting from 01 Jan 2022. The full CVs of all the DLs will be posted on the related OES website.



Milica Stojanovic (Milica): Milica Stojanovic has been serving as a DL since Jan 2018 and will continue to serve another term. She is an IEEE Fellow and a Professor at the Department of Electrical Engineering, Northeastern University. She also serves as a Guest Investigator at Woods Hole Oceanographic Institution. Milica has presented many exciting talks in the areas of underwater communications and position-

ing with as many as three virtual talks delivered this year alone to a largely international audience. Milica Stojanovic is endorsed by the Underwater Communication, Navigation & Positioning (UNCP) Technology Committee, of which she is also the Chair. A list of topics she has expertise in is available at <https://ieeeco.es.org/technical-activities/distinguished-lecturers/>.



Nicholas P. Chotiros (Nick): Nick is a Visiting Fellow at the UK National Oceanographic Center, Southampton. His nomination was endorsed by the Underwater Acoustics Technology Committee. He had worked as a Research Associate and Lecturer at University of Birmingham and has been working as a Research Scientist at the Applied Research Laboratory,



Mandar Chitre (Mandar): is an Assoc. Professor at National University of Singapore. He is a Senior Member of IEEE (OES) and Editor in Chief of the Journal of Oceanic Engineering (JoE). Mandar has expertise and experience in many areas of underwater acoustics such as underwater communications, signal processing, especially in non-gaussian environments and marine robotics. He has given talks

in many international conferences and forums including UN. IEEE OES community will be highly benefited from the sharing of his knowledge and perspectives in the areas of his expertise through DLs. His nomination was endorsed by the Underwater Communications, Navigation and Positioning Committee, of which he is also a Co-Chair.



Eliza Michalopoulou (Eliza): Eliza has been with the New Jersey Institute of Technology since 1994 and currently a Professor there. She is also the Chair of Department of Math-Science. She is a senior member of IEEE (OES) and a Fellow of ASA. She also has been an Assoc. Editor for Journal of Acoustical Society of America (JASA) and IEEE OES. Her nomination was endorsed

by the Underwater Acoustics Committee. Inversion problems, sediment characterisation, multi-path localisation, etc., are some of the areas where Eliza has her expertise and proposes to give her DLs.

Shyam Madhusoodhana (Shyam): Shyam has 16 years of research experience spread across both industry and academia. Data science and machine learning in the field of marine bioacoustics is relatively new and is an emerging area of research. The appointment of Shyam as a DL will help to excite the OES members, especially the student community, and coach them to be proficient in this emerging field of research. Shyam is an IEEE (OES) Senior Member and is a Post-doctoral Research



Associate at Cornell Lab of Ornithology, USA. He serves as a reviewer for reputed journals such as Journal of Ocean Engineering, JASA, Applied Acoustics, etc. He has been endorsed by the Data Analytics, Integration and Modeling (DAIMS) Committee. Data Science and Machine Learning as applied to marine bioacoustics, Automation and modeling are some of the areas Shyam has the expertise on and will be offered as part of his DLs.

Hybrid is the New Normal

Brandy Armstrong, VP for Professional Activities

The year is almost finished, where did the time go? I am already in the last few months of my first term and looking forward to my second term as your VP for Professional Activities. Thanks to AdCom for entrusting me with another two years!

The third year of our Social Media initiative is coming to a close. As part of the initiative, we continue to add great content to the IEEE OES YouTube channel. Please subscribe so you never miss an update. Check out one of our latest videos on Science outreach by Early Career Ocean Professionals of IEEE OES.

As we get ready to judge the Young Professional (YP) Boost applicants for our fourth cohort, we are also gearing up for our first year of the Women in Engineering (WIE) Propel program. Open to members who identify as women, as well as those who support Women in Engineering, we hope that WIE Propel will be successful in bringing more women into society leadership and ensuring IEEE OES is an equitable and inclusive professional home. Please check our WIE page in January for details on how to apply.

Despite the ongoing global pandemic, I made it to a couple of hybrid events this year to greet people at the IEEE OES booth, of course fully vaccinated and masked up when necessary. I thoroughly enjoyed the face-to-face time at OTC Houston and OCEANS 2021 San Diego—Porto, as well as the increase in outdoor social events. We held successful live and hybrid events for Young Professionals and Women in Engineering, which focused on diversity, equity, and inclusion. I even helped to judge the student poster competition for the first time, both live and virtually. I am a big supporter of the way that virtual participation has expanded who can participate at OCEANS, but I also thought it was much easier to judge a poster presenter and ask questions face to face. These hybrid experiences are helping us improve our inclusivity and clarify how we can best connect at OCEANS.

For those of you who could not make it to OCEANS 2021, you can catch our WIE breakfast panel and the IEEE OES



Dr. Jyotika Virmani of Schmidt Ocean Institute, IEEE OES President Christopher Whitt, VP for Professional Activities Brandy Armstrong, and Marine Technology Society ECOPs Chairperson Joshua Baghdady at the Women Leadership in Ocean Science and Technology luncheon at OCEANS 2021.



Student Poster Competition judging during OCEANS 2021.

awards ceremony on the IEEE OES YouTube Channel. The WIE panelists will really get you thinking about the role you play in ensuring diversity, equity and inclusion in your professional space. I hope that 2022 sees us finding more ways to connect responsibly and work towards diversity, equity and inclusions at OCEANS and in all levels of our Society.

From the Vice President for Workshops & Symposia

Fausto Ferreira, Vice President for W&S



As the last issue in 2021, it is now time to make a balance of this year and look forward to 2022! But first, the most recent news on my portfolio.

China Ocean Acoustics (COA) 2021

This conference was already reported in the previous newsletter. I would just like to mention that the proceedings are now

available at <https://ieeexplore.ieee.org/xpl/conhome/9519848/proceeding>.

Underwater Communications and Networking (UCOMMS) 2021

The 2021 Fifth Underwater Communications and Networking (UCOMMS) took place online, from 31 August to 2 September.

Almost 200 attendees joined the conference over the 3 days, which is significant for a single-track conference with 30 paper presentations organized in 8 sessions. This number of attendees shows the quality of the technical program.

The proceedings are now available online at <https://ieeexplore.ieee.org/xpl/conhome/9598005/proceeding>. I strongly recommend you to check the high-quality papers published and keep an eye for the JOE special issue coming up based on a selection of these papers. You can read more about UComms in the dedicated article in this newsletter.

Breaking the Surface 2021

The 13th International Interdisciplinary Field Workshop of Maritime Robotics and Applications—Breaking the Surface (BTS) 2021—took place from the 29th of September to the 3rd of October in Biograd na Moru, Croatia. This was a special edition as it marked the return to a fully in-person event. All participants travelled to Croatia and only a few talks were held online due to last minute impediments. The workshop had over 100 participants from 39 institutions from all around the world, which can be considered a great achievement given the pandemic situation.

The OES University of Zagreb Student Branch Chapter has been involved in the organization of this workshop since 2019 and, as before, brought some undergraduate students to provide them access to state-of-the-art lectures and hands-on tutorials/demos and getting involved in the organization for the sustainability of the workshop. You can read more about BTS on their article in this newsletter.

Symposium on Ocean Technology (SYMPOL) 2021

The International Symposium on Ocean Technology (SYMPOL) 2021 is currently planned to take place in Kochi, India (and online), from the 9th to the 11th of December, 2021. There were 36 papers submitted of which 29 were accepted. Please consult the website for all updates. <http://sympol.cusat.ac.in/>

2021 Summary

When I took over to complete Philippe Courmontagne's mandate, a mix of uncertainty and hope was in my head (and most of us) due to the COVID-19 pandemic restrictions and the beginning of vaccination. While our Workshops & Symposia were still affected in 2021 by the pandemic, all of them were very successful, regardless of being held online, in-person or hybrid. As you can read in this and previous newsletters, each workshop/conference took different approaches, but all with successful results. In total, we had over 300 papers presented and published and over 700 attendees in our 2021 Workshops & Symposia! The merit of this achievement goes to all the Local Organizing Committees (LOCs) that had to take hard calls based on uncertain data and forecasts, so I would like to thank all of them and acknowledge their vital role.

Another thing I mentioned in the beginning of the year was the updating of the Guidelines for Workshops & Symposia Organization. I am happy to inform that the updated version of this document has been prepared with the help of a diverse and experienced pool of volunteers: Andreas Marouchos, Gerardo Acosta, Hari Vishnu, Harumi Sugimatsu, Kenneth Foote and René Garello (thanks to all!). The document is currently open for the feedback from the OES Executive Committee and Administrative Committee (AdCom) and will be submitted to a vote at the December AdCom meeting. The Guidelines will then be updated on the website and shared with conference organizers.

The Year Ahead

Looking towards 2022, exciting plans have been made. While the COVID-19 pandemic still affects our workshops and symposia, plans are moving forward to hold all planned conferences, either in hybrid, virtual or in-presence mode throughout 2022. As mentioned before, we have established a new partnership with the Ocean Sciences Meeting (OSM) 2022 and we are going ahead with concrete plans for our biennial AUV symposium.

Ocean Sciences Meeting 2022

The OSM'22 Organizing Committee has recently decided to move the whole conference to the online world from the 27th

of February to the 4th of March, 2022. I hope that the online format will allow for increased participation, especially from those unable to travel to Hawaii. By the time you will be reading this newsletter, authors will be already notified regarding the acceptance of their abstracts. More info can be found on <https://www.aslo.org/osm2022/>.

2022 IEEE OES Autonomous Underwater Vehicles (AUV) Symposium

The IEEE OES Autonomous Underwater Vehicles (AUV) 2022 is currently planned to take place in Singapore from the 19th to the 21st of September, 2022. The website is now open so the readers can check all important dates and prepare the submission of their papers! <http://auv2022.org/>

Future Plans

Very recently, I was elected VP for Workshops & Symposia for my first full term (2022–2023) and I hope to continue doing my job as I did until now. After having updated the Guidelines for

Workshops & Symposia Organization, my next priority is to prepare the Policies and Procedures (PnP) for VPWS (besides accompanying all the upcoming conferences). Currently, there are no PnPs for the role of VPWS due to historical reasons (VPWS is a fairly recent role within OES structure). Similarly, the Workshops & Symposia Committee is currently only formed by the VPWS (historically it has been like that). However, I believe this committee should include a diverse group of volunteers and have primarily two roles: liaison with the different OES workshops & symposia and scout for new/existing conferences to be part of the OES portfolio. The rules of nomination and term for this committee will be included in the new PnPs and after this document is officially adopted by ADCOM, nominations will follow.

Finally, I would like to remind any OES members that wish to get involved in current workshops, or propose new ones, to contact me at vp-workshops-symposia@ieeeoes.org. We are here to serve the OES members and the larger community, and if you have ideas on improving current workshops, you are more than welcome to forward them to me!

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:

- D. P. Knobles, C. Escobar, M. Buckingham, W. Hodgkiss, P. Wilson, T. Neilsen, J. Yang and M. Badiy, "Statistical Inference of Sound Speed and Attenuation Dispersion of a Fine-Grained Marine Sediment."
- Z. Wang, T. Hu, W. Wang, S. Guo and L. Ma, "Modal Analysis of Acoustic Energy Periodic Fluctuations Due to Internal Tides in the Yellow Sea."
- X. Liu, D. Ma, M. Yang, X. Xia and P. Guo, "Modified Block A* Path-Planning Method for Hybrid-Driven Underwater Gliders."
- M. Li, C. Sun, H. Zhao and P. Willett, "Robust Mode Space Detection in Uncertain Shallow Water With Incomplete Mode Sampling."
- A. Trucco, R. Bozzano, E. Fava, S. Pensieri, A. Verri and A. Barla, "A Supervised Learning Approach for Rainfall Detection From Underwater Noise Analysis."
- J. D. Chaytor, M. Ballard, B. Buckzkowski, J. Goff, K. Lee, L. Reed and A. Boggess, "Measurements of Geologic Characteristics and Geophysical Properties of Sediments From the New England Mud Patch."
- B. Thomas and A. Hunter, "Coherence-Induced Bias Reduction in Synthetic Aperture Sonar Along-Track Micronavigation."
- C. Dearden, T. Culmer and R. Brooke, "Performance Measures for Validation of Oil Spill Dispersion Models Based on Satellite and Coastal Data."



- Y. Zhou, K. Yan and X. Li, "Underwater Image Enhancement via Physical-Feedback Adversarial Transfer Learning."
- N. Palomeras, T. Furfaro, D. P. Williams, M. Carreras and S. Dugelay, "Automatic Target Recognition for Mine Countermeasure Missions Using Forward-Looking Sonar Data."
- P. C. Chu, C. Fan, J. Calantoni and A. Sheremet, "Prediction of Mobility and Burial of Objects on Sandy Seafloor."
- S. Li, J. Zhao, H. Zhang and Y. Zhang, "Automatic Detection of Pipelines From Sub-bottom Profiler Sonar Images."
- J. Li, T. Chen, Z. Yang, L. Chen, P. Liu, Y. Zhang, G. Yu, J. Chen, H. Li and X. Sun, "Development of a Buoy-Borne Underwater Imaging System for In Situ Mesoplankton Monitoring of Coastal Waters."
- H. B. Amundsen, W. Caharija and K. Y. Pettersen, "Autonomous ROV Inspections of Aquaculture Net Pens Using DVL."
- T. Paviet-Salomon, J. Bonnel, C. Dorffer, B. Nicolas, T. Chonavel, D. Tollefsen, D. Knobles, P. Wilson and A. Dreameau, "Estimation of Frequency-Wavenumber Diagrams Using a Physics-Based Grid-Free Compressed Sensing Method."
- M. Ma, J. Tang, H. Zhong and H. Wu, "Multireceiver Synthetic Aperture Sonar Chirp Scaling Algorithm Considering Intrapulse Doppler Shift."
- S. -M. Steele and A. P. Lyons, "Development and Experimental Validation of Endfire Synthetic Aperture Sonar for Sediment Acoustics Studies."

OES Society Awards

Mal Heron and Marinna Martini

Each year the Oceanic Engineering Society honors one OES member for outstanding service in furthering the objectives and activities of the Society with the Distinguished Service Award, and the Distinguished Technical Achievement Award is awarded to an individual for an outstanding fundamental or applied technical contribution to oceanic engineering. This year the awards ceremony was held during the OCEANS 2021 Conference in San Diego.



Christopher Whitt, the OES president at the Awards Ceremony.

The Oceanic Engineering Society honored **René Garello** with this year's Distinguished Technical Achievement Award for contributions to signal and image processing of remotely sensed physical oceanography.



René is widely recognized for his contributions to signal and image processing of remotely sensed measurements of the ocean. He took a leading role in analysis of speckle in SAR images to extract information on sea state when others were treating it as noise. He has shown the value of multidisciplinary approaches that combine signal and image processing techniques with

geoscience knowledge using synergy between different sensors. Recently, René has turned to the problem of marine debris and plastics in the ocean, and is applying satellite observation techniques to several programs.

Prof René has recently retired from a full professorship at IMT Atlantique, Brest, and has been appointed Emeritus Professor. He became a Fellow of IEEE in 2005 and has taken on many tasks within IEEE including President of OES, 2011-2014, and workshops on ocean remote sensing. He was elevated to Life Fellow of the IEEE in 2019. He participated in the creation of the satellite reception station VIGISAT in 2009, which allowed the creation of the scientific interest group BreTel, of which he is the Foundation Director.

René Garello is one of those active people who keeps popping up when we least expect it and we can be sure he will be leading high-level workshops and mentoring newcomers to remote sensing of the oceans on many future occasions.

2021 Distinguished Technical Achievement Award: Professor René Garello



2021 Distinguished Service Award: Albert (Sandy) J. Williams, 3rd



It was an honor to present this year's Distinguished Service Award to Albert (Sandy) J. Williams, 3rd. Sandy was chosen for his long involvement with OES Technology Committees as well as with the Joint Oceans Advisory Board (JOAB), guiding the development of these regular OCEANS Conferences and Exhibitions.



Sandy's vision for Technology Committees included that they should each run a regular Symposium or Workshop with published papers, as a means to bring session streams to OCEANS. He led CMTC (later CWTM, then CWTMA) as a role model for that concept.

The alignment of OES Technology Committees with OCEANS tracks was imperfect, and Sandy guided the

merger between the Marine Technology Society and the Oceanic Engineering Society to manage OCEANS conferences by stressing unity between the contributions from each society.

Sandy's service as JOAB Co-Chair was significant in establishing the working relationship between OES and MTS. In

particular, his work on the OCEANS Conference Operations Policy contributed to the documentation of the partnership.

Sandy was a great recruiter of volunteers and participants. Sandy's service in the global spread of OES is shown in his leadership in SYMPOL in India, and in the Baltic Symposiums. Nearer home he worked to establish the OES Chapter of the Providence Section, which has become one of the more active Chapters in OES.

Marinna Martini has fond personal memories of working with Sandy on a variety of things OES and looks forward to seeing him more around the local Chapter. She can't quite remember exactly how Sandy Williams enticed her to volunteer for the Oceanic Engineering Society 25 years ago. It may have been because she attended a CMTC (Current Measurement Technology Committee) meeting in the 1990s. However Sandy did it, Marinna wasn't the only recruit. The fact that many OES volunteers came from the Woods Hole, MA, science community is no accident; Sandy always had his eye out for someone to get involved, somehow. Sandy's mentorship to Marinna and many others through OES volunteer projects is an excellent example of how membership in a professional society and community is a great advantage to professional growth.

Awards for OES Members

Contact the Editors With Your Submissions

Congratulations to Dr. Daniel D. Sternlicht for Being Selected as one of Three Recipients of the National Defense Industrial Association (NDIA) Bronze Medal



Congratulations to Dr. Daniel D. Sternlicht, a distinguished scientist for littoral sensing technologies at the Naval Surface Warfare Center Panama City Division (NSWC PCD), an outstanding OES member and General Co-Chair of OCEANS 2022 Hampton Roads, who was recently selected as one of three recipients of the National

Defense Industrial Association (NDIA) Bronze Medal for this year—2021.

The NDIA Bronze Medal recognizes key individuals in the principal Navy and University laboratories engaged in Undersea Warfare (USW) related achievements in either science or engineering. His pioneering work and publications, advanced techniques, and leadership has led to the international recognition as an authority in maritime reconnaissance and surveillance technologies.

Dr. Peter Adair, NSWC PCD technical director, said Sternlicht's wealth of knowledge and experience sets the bar high for others in the defense establishment.

"Dr. Sternlicht's commitment and dedication to the evolution of littoral sensing research and effective collaboration across the USW enterprise is just one of the many reasons he is an ideal candidate to represent the Navy and NSWC PCD on the national stage and to be selected for this prestigious award," said Adair.

The award was presented at the 2021 Joint Undersea Warfare Fall Conference.

Request for Nominations for OES Awards 2022

Jerry Carroll, Chair of IEEE/OES Nominations and Appointments Committees

Each year at the beginning of January, the Oceanic Engineering Society is proposing a call for four Awards, with a **closing date of June 30th**. A reminder call for nominations is issued mid-March. The Awards Committee requests the nominator to provide the listing of qualifications of the nominee relevant to the award criteria, and up to 5 references, by filling the Awards Nomination on-line form (<https://ieeeyes.org/menu/award-forms/oes-awards-nomination-form/>).

The Awards descriptions are given below.

Request for Nominations for DTAA: The Distinguished Technical Achievement Award 2022

The Distinguished Technical Achievement Award is given to honor an outstanding technical contribution to oceanic engineering in either the fundamental or applied areas. The award recognizes either a single major invention or scientific contribution or a distinguished series of contributions over a long period of time.

Request for Nominations for DSA: The Distinguished Service Award 2022

The Distinguished Service Award is given to honor an individual IEEE OES member for outstanding contributions towards furthering the objectives of the Oceanic Engineering Society.

Company/Institution Award

The award will be presented to a corporation or institution that has significantly supported the activity and goals of OES through such areas as conference participation, patronage, technical innovation and technical or administrative participation.

Emeritus Award

The award will be presented to an OES member having been particularly important for the Society and who is no longer in any position of Society governance.

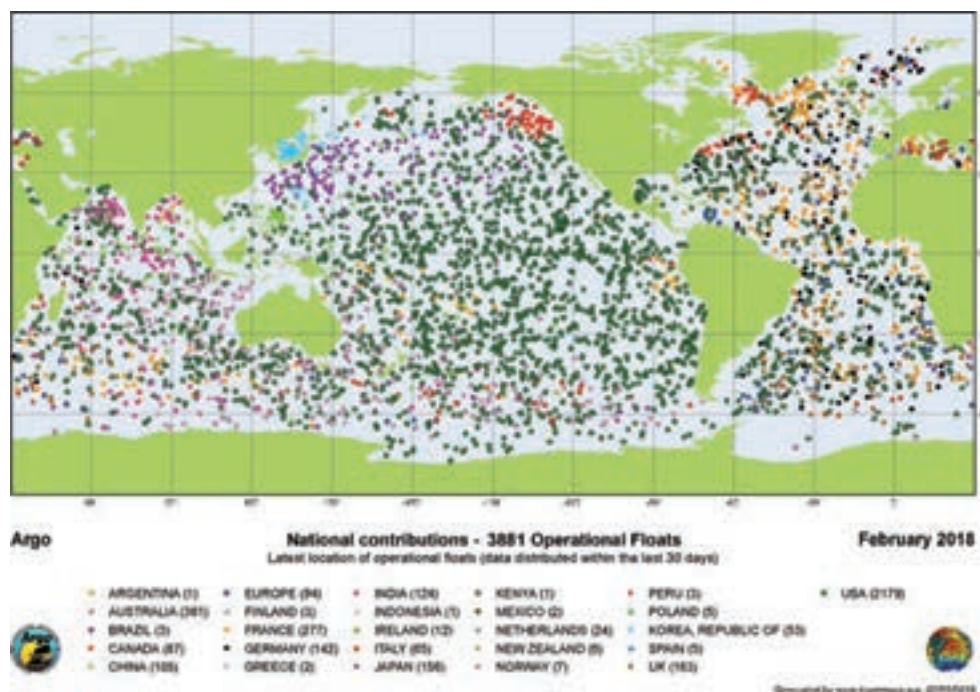
For more info, please visit the OES website as below: <https://ieeeyes.org/menu/award-forms/>

IEEE Corporate Innovations Award for 2022 Goes to the ARGO Program

Mal Heron and Marinna Martini

One of the highest awards in IEEE in 2022 goes to The Argo Program “For innovation in oceanography with global impacts in marine and climate science and technology”. This is a fitting and timely acknowledgement of the importance of the ocean to humanity as we embark on the UN Decade of Ocean Science for Sustainable Development.

The Argo Program serves society’s critical need for knowledge of the oceans and climate by maintaining a massive global array of 4000 autonomous under-sea vehicles (see OceanOPS (ocean-ops.org)) to continuously measure and report on the state of the oceans. The oceans receive more than 90% of the excess heat that is warming the Earth’s climate



system, and Argo is the primary measurement of this key climate index. The New York Times called Argo “one of the scientific triumphs of the age” (J. Gillis, August 11, 2014). Argo is continuing along its innovative trajectory with floats that reach the sea floor (Deep Argo, 6000 m), others that operate under ice cover, and floats that carry biogeochemical (BGC Argo) sensors for observation of the carbon cycle, ocean acidification, and productivity and health of oceanic ecosystems. Argo’s innovations are continuing to revolutionize global oceanography.

The Argo Program recognized global potential in the new technology of autonomous profiling floats, and then deployed the unprecedented subsurface ocean array. Nearly 4000 Argo floats are spread evenly around the World Ocean, with support and participation drawn from more than 25 partner

nations. Floats rise from 2000 m depth to the sea surface, all the while measuring the physical state of the ocean, and repeatedly cycle from 2000 m to the sea surface every 10 days for 5 years or longer. Argo floats transmit their measurements ashore in near real-time for immediate public release. The entire Argo dataset is freely available from either of two Global Data Assembly Centers. Argo data have been used in over 4400 publications in basic research, assessment of climate variability and change, education (350 PhD theses), and operational modeling for ocean and coupled forecasting and ocean state estimation.

The distribution of active floats in the ARGO array, color coded by country that owns the float as of February 2018. Attribution: Hjfreeland—Own work, CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=67718669>

Chapter News

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

Japan Chapter

OES Japan Chapter Distinguished Lecture Program
Reported by Harumi Sugimatsu, OES-J Vice Chair

The first “OES Japan Distinguished Lecture Program” for young people, in collaboration with the Techno Ocean Network (TON: <https://www.techno-ocean.com/en/>), was held in Kobe on July 25th, 2021. The lecture was given as one of the Pre-Events of Techno-Ocean 2021 (<https://www.techno-ocean2021.jp/en/>).

Tamaki Ura, OES Distinguished Lecturer, gave a talk on the underwater robots to encourage the young to be a marine engineer. Due to the COVID-19, the number of participants was limited, but, after the talk, attendees enjoyed the experiences of programming and operation of the underwater robots.



Tamaki Ura and the participants.



Enjoying the underwater robot operation.

The 6th Underwater Technology Forum • ZERO—Online

Reported by Harumi Sugimatsu, OES-J Vice Chair

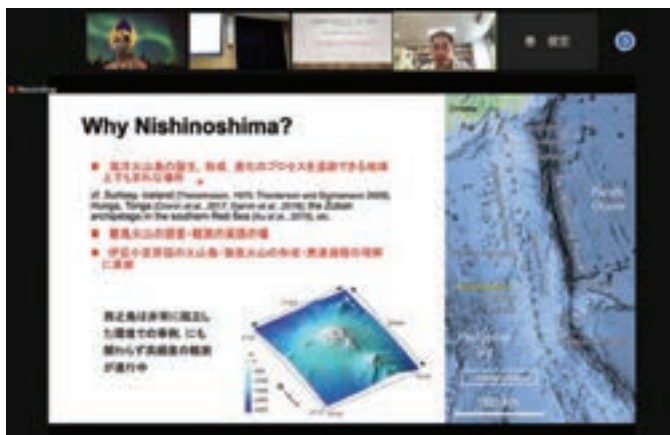
The 6th Underwater Technology Forum • ZERO was held online from 13:00 to 17:00 on 8 October 2021, on the U-Tokyo Kashiwa Campus in Chiba. Since the state of emergency due to COVID-19 was over, the organizers and several speakers met and shared the information in a face-to-face meeting at the venue, and gave the lectures to online attendees.

The topics of this forum are as follows;

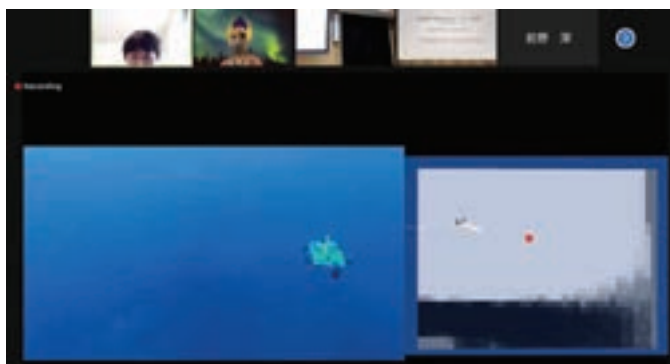
- Discovery of genes that prevent animals to migrate from the ocean onto the freshwater and the land
- Nishino-Shima Island now—Challenge to monitor the volcanic eruptions of the isolated island in the sea
- Nishino-Shima Island Investigation by a low-cost AUV “HATTORI”

- Comprehensive EEZ management Offshore base networking Review of “Grand Design for the OCEAN in the 21st Century” by Nippon Keidanren (Japan Business Federation) in 2000
- AUV SPICE-1 challenge to the North Sea!
- Expanding the possibilities of underwater monitoring with the “Amphibious drone”
- Top predator in the deep sea—Discovery of a new species, a giant deep-sea fish “Narcetes shonan”

More than 260 people participated in the forum and enjoyed the discussions. The next forum will be held on April 22nd 2022. We hope that a larger audience can attend the next forum face-to-face.



From the talk “Nishino-Shima Island now”



From the talk “low-cost AUV”



From the talk “Amphibious drone”



Speakers at the venue.



From the talk “Top predator in the deep sea”

Singapore Chapter

Chapter-Activity Report for the Year 2020-21

Reported by *Bharath Kalyan & Hari Vishnu*

The Singapore chapter has been active in organizing technical talks and various administrative meetings. Due to COVID-19 related restrictions, all meetings were held in a virtual setting with no in-person social events in 2021. In the middle of this year, we organized a talk by Prof Milica Stojanovic from the Northeastern University. It was organized as part of the on-going distinguished lecture series. The talk was titled “Multicarrier Acoustic Communication in Doppler-limited Regimes” and was presented as a virtual session on May 25th, 2021. The lecture was aimed at learning custom made Doppler compensation methods and their application to multi-carrier systems with an aim to improve performance under extreme Doppler distortion scenarios.



Figure 1. Divers on horseback - A 19th century French postcard possibly depicting underwater navigation/communication (An illustration used by Prof Stojanovic during her presentation).

Several chapter members helped to solicit papers and organize a special session on underwater competitions in the just completed OCEANS 2021 San Diego-Porto hybrid conference (20–23 September 2021). One of our chapter members was on the local organizing committee for this conference as publicity chair. Some of our members also chaired some sessions at the conference.

OES Singapore chapter migrated its website from Google pages to Github pages for ease of editing, versioning, and flexibility (new website available at ieeooessg.org/). The chapter members are involved in setting up the technology committee (TC) websites under the VPTA initiative. We have already set-up 3 OES TC websites

- 1) Autonomous Marine Systems Technology Committee,
- 2) Polar Oceans Technology Committee, and
- 3) Underwater Communications Technology Committee.

Our Young Professional members have been involved in OES efforts as part of the ongoing UN Ocean Decade and helped towards making a video for the Global Virtual early career ocean professionals (ECOP) day, that is available on the OES YouTube channel (<https://youtu.be/JnU2gr4hGLg>). They are also helping with making other videos as part of the OES outreach initiative. The chapter members have also been

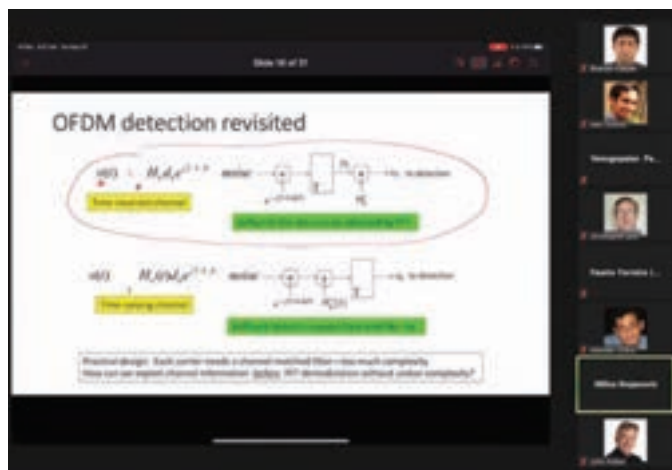


Figure 2. Snippets from DL series.

involved with OES global social media updates, Earthzine article management and website update, and conference publicity support. Apart from this, one of the chapter members delivered a talk at the IEEE Delhi section titled “Studying climate-change induced Arctic ice melting using an acoustics-based approach” on the 29th of September, 2021.

The chapter held two administrative meetings along with an annual general body meeting (AGM). The AGM held on the 15th of October, 2021, concluded with an election nominating the 2022 executive committee. The nominated 2022 executive committee members are listed below.

- Hari Vishnu (Chair)
- Bharath Kalyan (Vice Chair)
- Rajat Mishra (Secretary)
- Too Yuen Min (Treasurer)
- Mandar Chitre (Exco Member)
- Manu Ignatius (Exco Member)
- Koay Teong Beng (Exco Member)
- Chi Cheng (Exco Member)

The annual flagship Singapore AUV challenge (SAUVC) was cancelled for the year 2021 due to COVID-19 related restrictions. The chapter is gearing up for hosting SAUVC 2022 alongside the prestigious AUV Symposium. The event dates are listed below.

- IEEE OES AUV Symposium: September 19–22, 2022. Please visit www.auv2022.org for more details.
- SAUVC 2022: September 23–26, 2022. Please visit www.sauvc.org for more details.

Inspiring Voices of the Ocean Decade

A DECADE-LONG, INTERNATIONAL
PRESENTATION SERIES TO INSPIRE
ACTION FOR THE OCEAN WE WANT

Each year we will explore one of the ten **Ocean Decade Challenges for Collective Action** by inviting speakers to share their experience, start a conversation about the Ocean we want, and provide tangible ways that we can each contribute to the challenge. Scientists, engineers, developers, environmentalists, regulators, researchers, lawyers, policy makers, science-minded citizens - we'll hear from them all.

Starting in January 2022, we'll explore Challenge #10:
CHANGE HUMANITY'S RELATIONSHIP WITH THE OCEAN

Gatherings will be held in-person (as much as locally permitted) by each partner section, with refreshments and inter-section discussion to follow.

Vancouver
9 am PST

Canadian Atlantic
1 pm AST

Norway
6 pm CET

Other sections are very welcome to join! Afterwards recorded presentations will be posted on the IEEE OES YouTube channel.

FOR MORE INFORMATION AND TO REGISTER
TO ATTEND, VISIT:
CAS.IEEE.CA/OCEAN-DECADE

New Technology Committee Chair and Co-Chairs

Shyam Madhusudhana, Coordinator of Technology Committees



OES welcomes three new appointees to its slate of Technology Committees (TC)—Dr. Ferdinando Nunziata (Parthenope University of Naples), Dr. Ananya Sen Gupta (University of Iowa) and Dr. Mandar Chitre (National University of Singapore). Nominations were received from current TC Chairs, and the motion to appoint

the nominees, proposed by VP for Technical Activities, Dr. Venugopalan Pallayil, was approved by the AdCom via eVote. Dr. Nunziata will replace Dr. René Garello as the Chair of the *Ocean Remote Sensing* TC and serve for the remainder of the current term until December 2022. Dr. Sen Gupta and Dr. Chitre were appointed, with immediate effect, as Co-Chairs to the *Data Analytics, Integration and Modeling* and *Underwater Communication, Navigation and Positioning* TCs, respectively. Congratulations to the new appointees! Dr. Pallayil and I look forward to working with them.

Alvin Milestone Report

Albert J. Williams 3rd, IEEE Life Fellow

IEEE launched the Milestone Program in 1983 and 218 Milestones have been designated as of September 2021. On September 30, 2021, the IEEE Board voted to accept the Alvin Milestone proposal that was submitted by Albert J. Williams 3rd. Congratulations! Enjoy the Alvin's adventures below.



Figure 1. Framed drawing of Alvin.

In 1964, a deep-diving three-person submersible was delivered to Woods Hole Oceanographic Institution to be used for scientific research but initially to survey the ARTEMIS hydrophone listening array of importance to the Navy, the submersible's sponsor. Alvin, as the submersible came to be called, passed its initial depth certification at Tongue of the Ocean in 1965, but almost before it could start, there was a call to search for a hydrogen bomb, lost in a mid-air collision between a

bomber and an aerial tanker over Spain. Three of the unarmed bombs had fallen on land but the fourth fell into the sea. Alvin was transported to Palomares, Spain, where the bomb was eventually located, but the bomb got dislodged during the first recovery attempt. A second relocation and even more careful netting, with the net being pulled over the bomb by Alvin, helped achieve the recovery, gaining recognition within the Navy for the sub.

Navy tasks and geological research were interrupted by an accident in 1968, fortunately with no loss of life, when a cable parted while the sub was starting a second dive at a test



Figure 2. Alvin personnel sphere—Titanium.



Figure 3. Alvin in garage aboard R/V Atlantis.



Figure 4. Alvin on R/V Atlantis.

mooring with its crew aboard the sub, awaiting launch. The loss of Alvin in about a depth of one mile turned out to yield a serendipitous benefit. The box lunches for the pilot and two observers were still edible after almost a year submerged in the surface water that had flooded the sub through the open hatch. Baloney in the sandwiches and soup in the flooded thermos were not decayed and the apples were still crisp. Microbiologists were surprised but realized pressure is an environmental condition to which specific microbes are adapted and bottom samples won't grow when brought to the surface unless the pressure, as well as the temperature, is maintained. Their solution was to do microbial studies on the sea floor and revisit the sites to see the results. Some hyperbaric collection chambers were also utilized. But understanding the role of pressure on microbial activity was stimulated by the box lunches aboard Alvin during its submergence.

The rebuilt Alvin came back online in 1971, but Navy funding had dried up for submersible chores. NSF (National Science Foundation) became a principal sponsor under the newly organized UNOLS (University National Oceanographic Laboratory System) to share resources and costs for ships and submersibles. This led to the discovery of hydrothermal vents in which Alvin has, and continues to play, a major role. The East Pacific Rise was of interest to geologists as a possible tectonic spreading center. In 1977, using the ALNAV (ALvin NAVigation) transponder network developed in 1974 for acoustic navigation, a visit to the Galapagos vent site was made with the ANGUS towed camera sled. This was followed the next day by Alvin, which revealed the rich biological activity at this site.

Hydrothermal vents were predicted at ocean ridges because new sea floor was being created with magma filling the rift as oceanic plates separated. Temperature anomalies had been

observed in the near bottom water above the rift and ANGUS had photographs of large bottom dwelling organisms beneath the slightly increased temperature it measured. But when Alvin descended the next day, the concentration and size of these organisms was surprising. These observations, in 1977, inspired a biological expedition in 1979, along which I was fortunate to be invited. An attempt had been made in 1977 to measure the warm water upwelling from the fractured rubble where these organisms dwelt, but crabs climbed on the propeller blades of the current sensor causing it to not rotate. I had developed an acoustic current meter with no moving parts and was permitted to dive in Alvin, watching the pilot place my array of four vector flow sensors over the plume of 8° C water issuing from the bottom. It was revealed to be upwelling at about 12cm/s. Even then, marine biologists were convinced that the source of energy supporting this benthic life was chemical rather than sunlight generated. Hydrogen sulfide dissolved in the seawater, heated by its diffusion through the hot rubble of the rifting sea floor, was oxidized by bacteria and subsequently ingested or otherwise utilized as food by the giant clams and vestimentiferan worms. Since conditions such as those on the ridge near the Galapagos were probably ancient and broadly available along the 40,000-mile-long mid-ocean ridge on earth, at least since plate tectonics, it may have been the cradle of life when conditions at the surface were too extreme for life to develop. It is possible that similar conditions are present on Europa or other watery moons in the solar system. A major part of present research supported by Alvin is focused on vents including hot smokers and cold seeps.

Alvin was engaged in many other scientific studies as well as an exploration of HMS Titanic. The engineering developments that permitted these expeditions have continued to a major retrofit completed in July 2021. In 2014 Alvin was

rebuilt with a new titanium sphere incorporating five Plexiglass windows with hemispherical outer faces for increased field of view (overlapping views) and a depth rating of 6500m. Alvin has had more than 5000 dives and will reach its original design depth target after it completes its tests.

At a dinner, after an OES Providence Section Chapter talk, I was approached by Gilmore Cooke suggesting I propose that an IEEE Milestone be awarded for Woods Hole Oceanographic Institution 's Alvin. Since I had been present on the WHOI dock when the bedraggled Alvin was craned off the barge that had brought it back from its recovery after 10 months at a mile down on the bottom, and I had subsequently had an Alvin dive to a hydrothermal vent, I agreed to make the proposal. Cooke also suggested that I participate in the IEEE Milestone proposal for the first direct telegraph cable laid from Brest, France

to Orleans, Massachusetts, Le Direct. The OES Providence Chapter was involved and provided a second bronze plaque (in English) that was placed at the Cable Museum in Orleans alongside the French plaque from the OES French Chapter. This was in 2015.

IEEE launched the Milestone Program in 1983 and 218 Milestones have been designated as of September 2021. On September 30, 2021, the IEEE Board voted to accept the Alvin Milestone proposal. The citation will be cast in bronze on a plaque to be mounted on an outside wall accessible to Woods Hole visitors. There is to be an unveiling ceremony in about 18 months. But I feel pleased to have participated in this project and brought it to a state where it should result in appreciation by the public of a technical accomplishment with scientific and social value.

Remember What it was Like to Travel to Distant Lands?

John R. Potter

The pandemic has brought many changes, and some of us have found positive, as well and less desirable, impacts to working from home and meeting our colleagues only online. I, for one, find video conferencing a very thin and miserable substitute for in-person face-to-face interaction, where so many more channels of communication are open and operating than available online, even with decent bandwidth and good video, let alone when technical difficulties intervene to make a videoconference more like a séance than an in-person meeting... "Is there anybody there? Can you hear me? I think you're muted..." I find this communication gap particularly damaging when creating new relationships, rather than trading on existing trust and working practice with someone I already know how to work with. This is especially true when reaching out across cultural differences, to people from very different countries. I have always greatly enjoyed visiting and learning about different cultures, and so I have felt particularly hemmed in by the travel restrictions that have necessarily been imposed to combat the pandemic. So it was with great relish that I recently embarked on exploring options for being able to visit Malaysia, as part of preparations for an expedition to the Chagos Archipelago, about which more later.

Malaysia has been essentially closed to international visitors for some time, but they now have a mechanism by which professional visits can be made. I seized on the opportunity to reach out to the Maritime Institute of Malaysia (MIMA), Universiti Malaysia Terengganu (UMT) and the Universiti Teknologi Malaysia (UTM) to arrange a visit, representing the Norwegian University of Science and Technology (NTNU), where I am now a full Professor in the Electronic Systems Department, working primarily with the new Centre for Geophysical Forecasting. I was accompanied by Casper Potter, a PhD student in the Maritime Technology Department of NTNU, who specializes in maritime robotics and hydrodynamics.



Visiting MIMA in KL.

MIMA is a government maritime policy organization based in Kuala Lumpur (KL) on the west coast, with interests covering a broad range of regulatory and security aspects of interest in Malaysian waters. We were very warmly welcomed and spent an interesting morning discussing aspects of interest associated with the introduction of autonomous and robotic maritime systems into maritime commercial operations, particularly with regard to the very busy and congested Malacca Straits, one of the highest density traffic corridors in the world. NTNU is pioneering autonomous ship technologies and maritime robotics and has a newly established Centre for Innovation called 'Autoship', as well as many international research projects and some spin-off companies in this domain.

UMT, by contrast, is a new and progressive University on the east coast, bordering the South China Sea. UMT already has collaborative ties with NTNU and is keen to develop a closer relationship. There are many overlapping interests.



Jocara out of the water for emergency repairs.

Like Norway, Malaysia derives a major portion of its GDP from offshore hydrocarbons and aquaculture. UTM has access to wonderful natural marine park islands just offshore, where marine biology students can spend time studying in a natural laboratory.

Finally, we were able to visit UTM in Johor, at the southern tip of Malaysia, where there is a Department of Aeronautics, Automotive and Ocean Engineering. This department has a significant tow-tank facility, one of the largest in Asia, with wave-making capability, in which UTM have tested over 100 scale models of hulls under a variety of conditions over the past 20 years, including a maritime winged ground-effect vehicle.

These visits open collaborative opportunities to connect Europe, North America and Asia in exciting new projects and

presented us with a kaleidoscope of refreshing new experiences as we travelled around this amazing country.

But this was just the start... The tour, taking us from KL in the west, to Terengganu in the east, and then south to Johor led us to the beginning of the next chapter, in which we have begun to prepare our sailing vessel, 'Jocara' to support an expedition to the Chagos Archipelago in the middle of the Indian Ocean under a permit from the British Indian Ocean Territory administration. This is a continuation of our initiative to promote the use of small wind-powered vessels as cost-effective and ecologically sustainable platforms to support small research and surveying teams in remote marine locations. Avid readers of the Beacon may remember that Jocara supported a New Zealand maritime survey team in the remote Ha'apai islands in the Kingdom of Tonga in 2018. Following that, we sailed Jocara 5,000 n.m. west to the southern tip of Malaysia, where she has been 'trapped' for two years by the pandemic. Now, we are on a mission to 'rescue' her and prepare her to support a new expedition to the Indian Ocean to investigate marine mammal acoustics and the possibility that ancient mariners may have traversed directly across the Indian Ocean and potentially have wrecked on the sprawling and remote Chagos Archipelago. But we are not hunting for wrecks. Rather, we are hunting rats. We will explain in a subsequent article what we mean, and how this chapter of our odyssey unfolds. For now, suffice to say that the rats have launched a pre-emptive strike on our expedition, by infesting Jocara at her berth in Johor and sabotaging everything they could get their teeth into (plastic plumbing and containers, wiring, electronics, wood, fabrics, they know no limits). But we are striking back and Jocara is now undergoing emergency repairs in Langkawi to prepare her for her voyage to the Maldives, from where our expedition plans to launch.

OES Conference Calendar

Stephanie Kemna, OES Calendar Coordinator

OCEANS

OCEANS 2022 Chennai

February 21–24, 2022

Chennai, India

<https://chennai22.oceansconference.org>

OCEANS 2022 Hampton Roads

October 17–21, 2022

Hampton Roads, Virginia

<https://hamptonroads22.oceansconference.org/>

OCEANS 2023 Limerick

June 5–8, 2023

Limerick, Ireland

OTC

OTC Asia 2022

March 22–25, 2022

Kuala Lumpur, Malaysia

<https://2022.otcasia.org>

OTC 2022

May 2–5, 2022

Houston, TX, USA

<http://www.otcnet.org>

OTC Brasil

October 24–26, 2023

Rio de Janeiro, Brasil

<http://www.otcbrasil.org/>

OES Sponsored

SYMPOL 2021

In-person & Virtual, December 09–11, 2021

Kochi, India

<http://sympol.cusat.ac.in/>

Ocean Sciences Meeting (OSM) 2022

February 27–March 4, 2022
Honolulu, HI, USA
<https://www.aslo.org/osm2022/>

AUV 2022

September 19–21, 2022
Singapore
<http://auv2022.org/>

SAUVC 2022

In-Person, September 23–26, 2022
Singapore
<https://sauvc.org>

UT23

March 6–9, 2023
Tokyo, Japan
<http://www.ut23.org>

Non-OES

Please contact us if you have any information about non-OES events that OES members are involved in.

The Fifth IEEE OES Underwater Communications and Networking (UComms21) Conference

João Alves (UComms 2021 General Chair), OES AdCom member



The UComms conference series, Organised by the NATO Centre for Maritime Research and Experimentation (CMRE), is focused on working towards a deep understanding of the propagation of communication signals underwater and the performance

of necessary higher-level protocols with the objective of supporting the intelligent choice of underwater communications standards, as a foundation for interoperability.

This highly regarded, academic conference has been held every other year since 2012 and was set to have its fifth edition in early September 2020.

With the new world context imposed by the COVID-19 pandemic, on May 2020, the UComms organising team issued a survey targeted at UComms' authors and community of interest (including the technical committee members and UComms 2018 attendees). The intention of the survey was to collect the feedback of such interested parties with the ultimate goal of educating a decision for the 2020 edition of UComms.

The answers collected showed a clear preference for postponing the conference. This came with little surprise as UComms has always been highly regarded for its ability to remain specialised, attract the best researchers and promote face-to-face discussions that move the field forward.

Following such clear indication, and after close consultation with the conference sponsors, a decision was taken to postpone the conference until September 2021.

UComms Webinar 2020

In order to maintain community engagement, CMRE, the IEEE OES and the NATO Allied Command Transformation organ-

ised the first UComms Webinar series. The Webinar series, which was held between the 1st and 4th of December, 2020, consisted of four invited talks broadcast live through CMRE's social media channels. The line-up of the talks was as follows:

- Milica Stojanovic, Northeastern University (USA): “*Underwater Acoustic Communications: Is Transmit Beamforming a Possibility?*”
- Ian Akyildiz, Technology Innovation Institute (Abu Dhabi): “*Next Decade Challenges for Underwater Wireless Communication Networks*”
- Mandar Chitre, National University of Singapore (Singapore): “*Underwater Acoustics in the Age of Differentiable and Probabilistic Programming*”
- João Alves, NATO STO CMRE (Italy): “*JANUS: Why It Matters and the Critical Path into the Future*”

Thanks to the sponsoring organizations and the speakers who generously agreed to take part in this event, the webinar



Figure 1. Prof. Mandar Chitre, JOE editor-in-chief, during his invited talk at the UComms webinar.

was free and open to all. This format proved to be very effective at engaging wide participation and promoting open discussion.

All materials from the webinar (abstracts, bios and the lectures) remain available through the UComms website (www.ucomms.net), navigating to “UComms Webinar 2020”.

UComms 2021

Given the prolonged effects of the pandemic and the restrictions still in place at the time, there was no possibility to organise an in-person conference in Italy in September 2021. The conference still had a commitment to the authors to publish their manuscripts (originally submitted for the conference in 2020) and for that reason it was decided to hold a remote conference on the dates of the planned in-person event: from August 31st to September 2nd.

Just like with all UComms editions, this conference was organised in a series of structured sessions that were coordinated by key researchers in the field, aiming at gathering top quality contributions that could lead to a vibrant exchange of knowledge and increase common understanding of the state-of-the-art. The multiple sessions were handled in a single track, giving the opportunity to all participants to follow all the talks and take part in all discussions.

The session organisers took the role of inviting papers, managed the reviews, ranked and selected the final presentations in coordination with the general chairs and conducted their session at the conference.

For UComms 2021 a total of eight sessions were set up:

- “Machine Learning for Adaptive Underwater Communications” (this session was eventually dropped and papers absorbed in other sessions);
- “The Roles of Deterministic and Statistical Methods in Acoustic Propagation Modelling for Underwater Acoustic Communications Simulation and Performance Prediction”;
- “Networking, Localisation and Scheduling”;
- “Next-generation Adaptive Modem Architectures and Cognitive Networking Strategies”;
- “Interoperability and Standards”;
- “Non-Acoustic Underwater Communications”;
- “New Applications Enabled by Next-generation Underwater Acoustic Comms”;
- “Channel-aware Security and Protocol Design.”

A total of 30 short papers (strictly four pages plus references) were accepted for presentation and publication after the usual peer review process of UComms. The program was then arranged to fit a daily time window of approximately four hours to accommodate as much as possible the different time zones taking part in the remote presence conference (14:00-18:00 CEST).

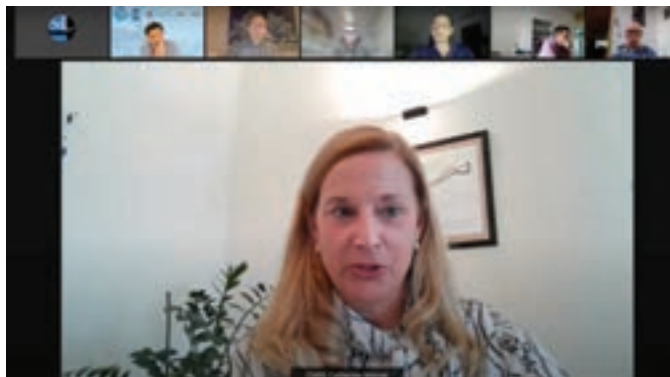


Figure 2. CMRE Director, Dr. Catherine Warner, delivering her UComms opening address.

The conference was open by CMRE’s director, Dr. Catherine Warner, and proceeded with live presentations of all accepted manuscripts with Q&A sessions moderated by the respective session organisers.

Thanks to the sponsorship structure of the conference and the reduced organizational costs when compared to in-person editions, CMRE was able to conduct UComms free-of-charge for participants and authors, contributing to a significant knowledge sharing opportunity for those interested in the field. A total of 195 delegates registered from around the globe to join the UComms technical presentations.

The book of abstracts of the conference is available in the UComms website (https://www.ucomms.net/docs/UComms21_BookOfAbstracts.pdf) and the video presentations are available in CMRE’s YouTube channel (www.youtube.com/user/PAOCMRE) for the scientific community for a-posteriori viewing.

A Special edition of the JOE will be setup with a selection of articles to be expanded and published in full article form.

Future UComms Conferences

UComms is now a well-established international biennial conference series, bringing together participants from around the globe to share their latest developments in the ever-evolving topic of underwater communications. UComms success was achieved through the recurring participation of the top scholars in the field, the strict peer review process, the focused topic, and the opportunities created for networking and discussions.

The current plan is to hold the next edition of UComms in 2022, returning to a full in-presence format for what will be its 10th anniversary. The call for papers is expected to be issued before the end of 2021.



Now Accepting Nominations



Do you know a young professional in your society who is passionate about their field of work, dedicated to industry service, and highly focused on safety in the workplace? If so, nominate that individual today and give them the recognition they've earned.

The OTC 2022 Emerging Leaders program is now open for nominations. Visit the following: <https://2022.otcnet.org/awards/otc-emerging-leaders-program>

Submit your nomination by 21 January 2022.

AUV SYMPOSIUM 2022

19-21 SEPTEMBER, 2022, SINGAPORE

Shaw Foundation Alumni House,
National University of Singapore



Important dates:

Full Paper submission: 29 Apr 2022

Final Paper Submission: 1 July 2022

Conference to be followed by

Singapore AUV Challenge,

23-26 Sep 2022

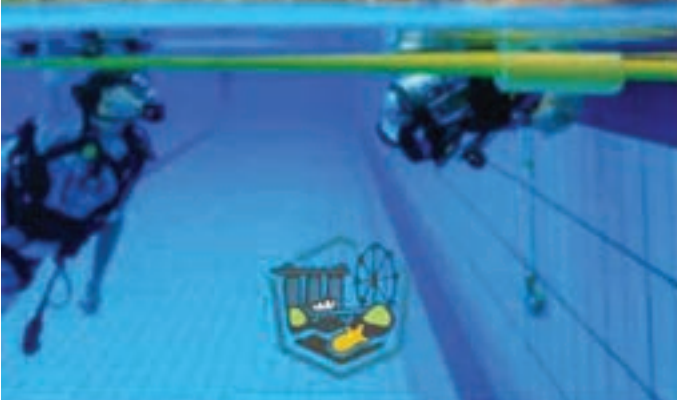




IEEE Oceanic
Engineering Society

SINGAPORE AUV CHALLENGE

is back



23-26 SEPTEMBER 2022
SINGAPORE POLYTECHNIC



DESIGN TO COMPETE.
DESTINED TO EXPLORE.



International Symposium on Underwater Technology March 6-9, 2023

In Person Meeting (with webinar option)
IIS Conference Hall “Haricot” Tokyo, Japan
– Advanced Underwater Technology for the Ocean –
URL: <http://www.ut23.org>

The University of Tokyo is delighted to welcome international experts for the International Symposium on Underwater Technology (UT23). UT23 will provide you with a thematic umbrella under which attendees will discuss the problems and potential long-term solutions that concern not only the Pacific Rim countries, but the world in general.

Important Dates

Abstracts submission page open: April, 2022
Deadline for Abstract Submission: September 16, 2022
Notification of Acceptance: October 14, 2022
Deadline for Paper Submission: December 9, 2022
Deadline for Early Registration: January 20, 2023
Symposium Dates: March 6 - 9, 2023

Organizers

IEEE Oceanic Engineering Society (IEEE/OES)
IEEE/OES Japan Chapter
Institute of Industrial Science (IIS), the University of Tokyo
Earthquake Research Institute (ERI), the University of Tokyo

Exhibition Opportunities

In conjunction with UT23, there will be a limited number of booths for technical exhibition. We hope you would take this opportunity to display your products at the symposium. There are also opportunities for supporting the symposium. For more information, please contact the secretariat at info@ut23.org

For more information about UT23, please contact:

UT23 Secretariat: info@ut23.org



A Blast from the (recent) Past! ... Face-to-Face Again!

Bob Wernli—Beacon Co-Editor-in-Chief and Stan Chamberlain

*In our last Blast, we took a look at the prior Singapore and Gulf Coast conferences, with the hope that the pandemic will be gone and we can all get together in person like we used to. Well, the OCEANS 2021 conference held its in person portion of the conference, and as you can see in the following photos, everyone was very happy to be **face-to-face again**. Cheers.*



As shown above, everyone was very happy to attend a face-to-face meeting again.

Did You Know—OCEANS Photo Gallery???

The photo gallery for the OCEANS conferences is on line in the OES website. There are decades of photos. Scan down the list, select a photo gallery, and then select View Gallery.

On the website, browse to it under Conferences >> OCEANS Conference & Exhibition >> Conference Websites >> Photo Gallery, or click the quick link in the Society News right sidebar box.

You can also access it directly here: <https://ieeeco.org/conferences/photo-gallery/>

Thanks to our official photographer, Stan Chamberlain, for taking most of the photos in the gallery.

And, below the Photo Gallery link is the Video Gallery, which contains the plenary and other presentations at the past conferences. Enjoy!

OCEANS 2021 San Diego—Porto In Person Component, San Diego Conference Report



Introduction

The OCEANS 2021 San Diego portion of the hybrid conference, held at the Town and Country Resort, provided the attendees an in-person event with exhibits and the associated social gatherings. The Porto report on the virtual portion follows. Besides the standard technical program, the conference worked with the UN to coordinate the kickoff of the United Nations’ “Decade of Ocean Science (2021–2030).” This was the 8th time the OCEANS conference has come to San Diego, a venue that has consistently provided the largest and most successful OCEANS conferences ever, and, considering the negative effect of the COVID virus, this one could be added to that list. To ensure the safety of the attendees, all state, city and facility requirements were met including temperature checks of attendees and colored wrist bands to identify the attendee’s level of desired interaction. This resulted in excellent attendee interaction without a single negative health issue arising.

In addition to the excellent technical program for which OCEANS is well known, OCEANS 2021 San Diego was structured with three key underlying categories of interest to all attendees:

“**InFocus**”—on the latest in new and emerging technologies

“**InQuire**”—on innovative research and science

“**InVest**”—investment strategies and spending priorities from high-level stakeholders and officials from the U.S. and international governments, the oil and gas industry,

Departments of Defense and Energy, local and federal regulatory agencies and a wide range of ocean industries.

The theme for OCEANS 2021 San Diego, “**Sustaining our Oceans ... Sustaining our Future**,” reflected on the critical nature and importance of our industry and its sustaining technologies, which was the focus of many of the excellent technical sessions and panels, which included plenaries with talks from our three Honorary Co-chairs, which will be discussed later. And we can give a special thanks to our local committee members who worked tirelessly to ensure a successful conference. They included:

- Allan Kenny—Chair
- Robert Wernli—Co-Chair
- Barbara Fletcher—Technical Program Chair
- David Velasco—Exhibits Chair
- Brad Fisher—Exhibits Co-Chair
- Leonard Pool—Arrangements Chair
- Kevin Hardy—Special Session Coordinator
- Bill Porto—Special Session Operations
- Vladimir Djapic—Student Poster Competition Chair

- Bonita Chamberlin—Student Volunteer Chair
- Manu Ignatius—Social Media Chair

The Fun of a Hybrid Conference

The decision to conduct a hybrid conference with Porto and San Diego sounded simple enough, but it was like doing three events, not one, or even two. You have the Porto and San Diego portions focused on virtual and in-person respectively, and then the interaction of the two events to include timing of sessions to allow some overlap such as the combined plenary on Wednesday. This also included the real time televising of all the San Diego plenaries and special sessions. However, with the help of both LOCs and our professional conference organizers, MCI, it all came together, with 862 attending in person in San Diego.

For San Diego, things kicked off on Sunday with a very successful golf tournament, organized by the local MTS Section, on a course next to the hotel. This was followed by a day of preparation on Monday that included society meetings, exhibitor move in, and the Ice Breaker reception at the hotel to some excellent hors d'oeuvres and music. The Ice Breaker was preceded by a Student Mixer reception which is done at each OCEANS to bring the students and professionals together in a relaxed environment.



Ice Breaker Reception.

Technical Program

The San Diego technical program included the standard technical paper tracks (which were not televised, but each author had to upload a short presentation for the virtual attendees). The Tuesday and Wednesday mornings started off with plenary sessions, and there were also workshops and special sessions throughout the three days, which are addressed below. And, following the morning plenaries, both societies held their annual society award meetings. The OES awards are addressed in a separate article in this issue of the Beacon. Overall, there were 92 in person technical papers given in 27 sessions and 2 technical posters. The student poster competition, discussed elsewhere in this issue, was judged virtually along with 5 in person.

Each of our Honorary Co-Chairs were invited to give a plenary presentation. These included the following:

Plenary presentation 1: Honorary Co-Chair Carly Jackson, NAVWAR Chief Technology Officer, Naval Information Warfare Center Pacific (NIWC Pacific). Title: Naval approaches to sustaining our oceans, sustaining our future.

Plenary presentation 2: Combined plenary with Porto with a presentation by Richard Santos, Minister of the Sea,



Honorary Co-Chair Carly Jackson.



San Diego—Porto Combined Plenary.



Honorary Co-Chair Dr. Vladimir Ryabinin.

Portugal, who joined via zoom. Title: Ocean Innovation on the way to 2030.

Plenary presentation 3: Honorary Co-Chair Dr. Vladimir Ryabinin, Executive Secretary of UNESCO's Intergovernmental Oceanographic Commission, who joined via Zoom. Title: The Ocean Decade: creating science for a more sustainable future.

Plenary presentation 4: Honorary Co-Chair Dr. Margaret Leinen, Director, Scripps Institution of Oceanography. Title: What will it take to have a 'smart ocean'?



Honorary Co-Chair Dr. Margaret Leinen.

There were also several Special Sessions. The first special session that followed Dr. Ryabinin's plenary presentation, continued the discussion regarding the UN Ocean Decade:

Title: The UN Ocean Decade: Sustaining our Future for the Next 10 Years and Beyond.

- Moderator (Govt and Intl Body): Craig McLean—Assistant Administrator NOAA Research & Member Decade Interim Advisory Board
- Panelist 1 IOC: Julian Barbieri—Head, Marine Policy and Regional Implementation Section IOC
- Panelist 2 (academia): Dr. Margaret Leinen—Honorary Chair of MTS San Diego Conference, Director of Scripps Institute of Oceanography & Member Decade Interim Advisory Board—virtual
- Panelist 3 (endorsed Decade Programme): Jerome Aucan—Head Pacific Community Centre for Ocean Sciences (PCCOS)
- Panelist 4 (ECOP): Hannah Toerner—Officer for Communications at the MTS ECOP Section, and the 2020's



UN Decade Panel (CW—virtual) Craig McLean, David Miller, Julian Barbieri, Jerome Aucan, Hannah Toerner; In Person—Dr. Margaret Leinen.

recipient for the Ocean News and Technology Young Professional Award

- Panelist 5 (Industry): David Millar—FUGRO Government Accounts Director, Americas

The other special sessions and workshops included:

- 1) **Panel Discussion: The Role of Marine Robotics in Supporting a Sustainable Blue Economy**
Session Convener: Jake Sobin, Sales Manager, Ocean Science Sensors and Robotics, Kongsberg Underwater Technology
- 2) **Expert Panel/Town Hall: Discussion on Justice, Equity, Diversity, and Inclusion (JEDI) in Marine Technology**
Session convener: Zdenka Willis, MTS
Session co-convener: Kristina Norman, MTS
- 3) **Workshop: Town Hall: Opportunities for Marine Technology in Offshore Wind Development**
Session convener: Ruth Perry, Shell
Session co-convener: Justin Manley
- 4) **Tech Demo: Instrument Configuration and Data Management Using RBR Ruskin software tools.**
Session convener: Daniel Nelson, RBR
- 5) **Connected Oceans with Bristlemouth: Bridging Public and Private Sector to launch Open Standard**
Session convener: Blanche Minoza, MissionC2
Co-convener: Caroline Venza, MissionC2
- 6) **Title: Expert Panel: Hadal-class UUVs (Gliders, Landers, AUV, ROV)**
Session convener: Kevin Hardy

There were also two panels that addressed the young professionals and also women in engineering:

- 1) **Early Career Ocean Professionals Career advancement: From leadership to ECOPs**
- 2) **Town Hall—Women Leadership in Ocean Science and Technology**

Exhibits

There were 60 exhibitors spread in 70 exhibit booths, less than desired due to the pandemic and travel restrictions, however, those who did exhibit were very pleased with the conference. Although in person attendance was less than originally planned



Robert Wernli, Alan Kenny, Brad Fisher and David Velasco officially open the San Diego Exhibits.



The popular exhibitor's Innovation Theater.



Exhibit Hall.

before COVID, those in attendance were generally more likely to influence the future purchases of products or support from the exhibitors. And, in the middle of the exhibit hall was the Innovation Theater, where our Patron exhibitors could present their technology to a live audience.

Gala

Regardless of the long hours in technical sessions and exhibits, the end of the day on Wednesday was a tremendous success. Plenty of Polynesian food and beverages, Hawaiian dancers and Fire Knife Entertainment.

Everyone left with a full belly and a smile on their face. **Aloha.**



Fire Knife Dancer.



Alan Kenny and Leonard Pool get their hula lessons.



Conference Chairs—Bob and Alan—and the Hawaiian Dancers.

OCEANS 2021 San Diego—Porto Virtual Component, Porto Conference Report

António Pascoal, LARSyS, IST, Portugal, Co-Chair

Eduardo Silva, INESC-TEC, ISEP, Portugal. Co-Chair

Fausto Ferreira, LABUST, UNIZG, Croatia, Technical Committee Co-chair

João Tasso de Figueiredo Borges de Sousa, LSTS, FEUP, Co-Chair



Introduction

The OCEANS 2021 San Diego—Porto virtual component included lively presentations and discussions on oceans-related issues and evoked the magic of the oceans spanning centuries of maritime history. The Porto virtual component complemented the in-person San Diego portion of this hybrid event, providing a dedicated forum for many attendees to participate in spite of travel constraints.

The Porto themes focused in two main topics:

- **Opening the Ocean Frontier: A New Age of Discoveries**
- **Ocean science and technology for the benefit of humankind.**

The innovative Porto virtual component program included technical sessions, invited sessions on specialized topics, plenary sessions, a student poster competition, outreach media sessions, and discussion panels. The Porto component was all about connecting the world-wide community with the goals of opening the ocean frontier at the dawn of a new age of discoveries for the benefit of mankind. There were new forms of participation, namely of young students and researchers from distant communities bordering the world's oceans, thus reinforcing the global dimension of the event.

OCEANS 2021 Porto virtual component was very well aligned with the surge of Portuguese interest in the oceans that comes from the recognition that Portugal harbors unique environments in the deep sea, as well as in the water column, and holds tremendous potential for the installation and operation of offshore wind/wave energy harvesting infrastructures and aquaculture farms. The conference was also very well aligned with the Atlantic International Research Centre (AIR Centre) initiative launched by the Portuguese government to foster a long-term multilateral platform for cooperation along and



across the Atlantic with an inclusive perspective on S&T and economic development.

More information about the Conference can be found at the website: <https://global21.oceansconference.org/>

OCEANS 2021 Porto Virtual Component by the Numbers

The **OCEANS 2021 Porto virtual component** had a significant number of submissions and participants:

- 428 abstract submissions
- 14 finalists of the student poster competition
- 325 abstracts accepted for oral presentation
- 16 abstracts accepted for poster presentation
- 51 abstracts accepted available on-demand only
- 36 participating countries
- 513 registrations

Oceans 2021 Porto virtual component attracted over 513 participants coming from academia, industry,

governmental organizations, research institutes and private foundations.

Technical and Poster Sessions

Thanks to the remarkable work of a committed team of 186 reviewers from Europe, Asia, and North and South America, each submitted abstract was evaluated by 3 reviewers.

In total, 325 presentations were organized in the following technical sessions covering a wide range of topics of interest to the OCEANS community:

- Access, Custody, and Retrieval of Data
- Acoustic Telemetry and Communication
- Affordable Ocean Systems and Technologies
- Aquaculture Technology
- Array Signal Processing and Array Design
- Artificial Intelligence in Ocean Science and Technology
- Automatic Control
- Autonomous Underwater Vehicles
- Buoy Technology
- Classification and Pattern Recognition (Parametric and Non-parametric)
- Exploration of Extreme Oceanic Environments
- H2020 EU Marine Robots in action
- Hydrodynamics
- Hydrography / Seafloor mapping / Geodesy
- Imaging and Vision
- Marine Education and Literacy
- Marine GIS and Data Fusion
- Marine Law, Policy, Management and Education
- Marine Life and Ecosystems
- Marine Litter: monitoring and mitigation
- Numerical Modeling and Simulation
- Ocean Economic Potential
- Ocean Energy
- Oceanographic Instrumentation and Sensors
- Oceanography: physical, geological, chemical, biological
- Offshore Structures
- Remote Sensing
- Remotely Operated Vehicles
- Sonar and Transducers
- Sonar Imaging
- Sonar Signal Processing
- Systems and Observatories
- Underwater Acoustics and Acoustical Oceanography
- Underwater Robotics Competitions
- Vehicle Design
- Vehicle Navigation

The sessions were organized in 6 parallel tracks.

Opening Session

The opening session included a welcome speech and four keynote speeches by four distinguished Portuguese leaders.

The welcome speech was delivered by the Porto Co-chairs, João Sousa, LSTS-FEUP, Portugal, Eduardo Silva, INESC-TEC-ISEP, Portugal and António Pascoal, LARSyS-IST, Portugal.

The keynote speeches were delivered by:



Figure 1. Open session speakers: Top left—Prof. Manuel Heitor; Top right—Admiral Mendes Calado; Bottom left—Prof. Miguel Miranda; Bottom right—Rear-Admiral Ventura Soares.

- Prof. Manuel Heitor, Portuguese Minister of Science and Technology and Higher Education
- Admiral Mendes Calado, Portuguese Navy Chief of Staff
- Prof. Miguel Miranda, Director Institute of the Sea and Atmosphere (IPMA)
- Rear-Admiral Ventura Soares, Director of the Portuguese Hydrographic Institute.

Plenary Sessions

OCEANS 2021 Porto virtual component included six plenaries:

Plenary 1—21st September, 10:00–11:00 am

“The challenges of deep-sea exploration”, by Pedro Madureira, Task Group for the Extension of the Portuguese Continental Shelf, Portugal

Plenary 2—21st September, 15:00–16:00 pm

“Exploring the seafloor and the midwater ocean with robots is a human adventure”, by Dana Yoerger, Senior Scientist, Dept of Applied Ocean Physics and Engineering, Woods Hole Oceanographic Institution, USA

Plenary 3—22nd September, 08:00–09:00 am

“The Post-Mediaeval Shipwreck of Gnalić (Croatia) in the light of new discoveries”, by Irena Radić Rossi, Univ. Zadar, Croatia.

“Healthy Oceans and Maritime Cultural Heritage”, by Filipe Castro, Researcher, Centre for Functional Ecology—Science for People & the Planet (CFE), Univ. Coimbra, Portugal

Plenary 4—23rd September, 08:00–09:00 am

“Challenges in Deploying Robust Autonomy for Robotic Exploration in Marine Environments”, by Stefan Williams, School of Aerospace, Mechanical and Mechatronic Engineering at the University of Sydney, Australian Centre for Field Robotics, Australia

Plenary 5—23rd September, 10:30–11:30 am

“Using integrated glider experiments to understand the scale sensitivity and variability of the Southern Ocean carbon system”, by

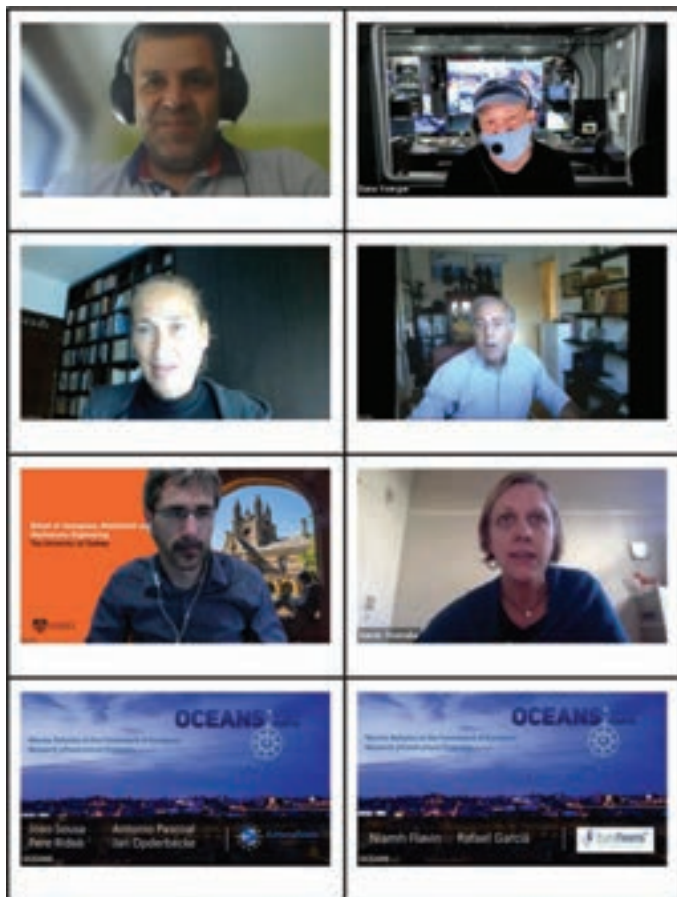


Figure 2. Plenary Sessions: Speakers. First row left—Prof. Pedro Madureira (Plenary 1); first row right—Scientist Dana Yoerger (Plenary 2); second row left—Scientist Irena Radić Rossi (plenary 3); second row right—Researcher Filipe Castro (plenary 3); third row left—Prof. Stefan Williams (plenary 4); third row right—Senior Scientist Sandy Thomalla (plenary 5); fourth row left—Marine Robotics team presentation (plenary 6); fourth row right—Eurofleets team presentation (plenary 6).

Sandy Thomalla, Principal Scientist, Southern Ocean Carbon and Climate Observatory (SOCCO), CSIR, Cape Town, South Africa.

Plenary 6—23rd September, 16:30–17:30 am

“Marine Robotics in the Framework of European Research Infrastructure Programs” by the following panel of presenters:

- Jan Opperdecke, Unit for Underwater Systems at Ifremer, France
- João Borges de Sousa, Underwater Systems and Technologies Laboratory—LSTS, FEUP, Portugal
- Pere Ridao, Underwater Robotics Lab, Univ. Girona, Spain
- António Pascoal, LARSyS, IST, Univ. Lisbon, Portugal
- Niamh Flavin, Marine Institute, Galway, Ireland
- Rafel Garcia, Underwater Vision Lab, Univ. Girona, Spain
- Agnès Robin, European Commission, EU

Special San Diego-Porto Joint Session Followed by a UN Presentation and Expert Panel Discussion

OCEANS 2021 San Diego—Porto organized a joint session that culminated with a UN presentation and a UN Decade of



Figure 3. The Portuguese Minister of the Sea, Dr. Ricardo Santos.

the Oceans Expert Panel Discussion. The first part of the joint event counted with the participation of Dr. Ricardo Santos, the Portuguese Minister of the Sea, who gave a presentation highlighting the much needed connection between marine science and technology and the economy of the sea. Dr. Ricardo Santos offered his vision of what lies ahead of us in terms of national and international programs and, based on his experience as a member of the Executive Planning Committee for the Decade, provided a soft transition to the ensuing UN Presentation / Special UN Session.

Closing Session

The OCEANS 2021 Porto virtual component closed with some final remarks by the three Co-Chairs, João Sousa, Eduardo Silva, and Antonio Pascoal, one of the Technical Committee Co-Chairs Fausto Ferreira, and Juan Carlos Luque, Univ.



Figure 4. Closing Session Speakers (Chairs and Technical Committee). First row left—Prof. Fausto Ferreira; first row right—Prof. João P. Gomes; second row left—Prof. Antonio Pascoal; second row right—Prof. Eduardo Silva; third row left—Prof. João Sousa; third row right—Prof. Anibal Matos.

Nacional De San Agustín de Arequipa, Peru on behalf of traditionally underrepresented countries.

Reaching Out to Underrepresented Countries: A Porto Initiative

A sizable number of countries continue to have reduced presence in the OCEANS conferences, notwithstanding the excellent quality of the work pursued in a large number of highly reputed national institutions. The reason for this is manifold and defies a simple analysis. We felt strongly that our community as a whole would benefit enormously from a more representative participation of such countries with a view to knowing each other better and to give impetus to cooperative actions at the scientific, technical, commercial, environmental, and societal levels. As a contribution to meeting this goal, we encouraged the participation of what, for the lack of a better word, we may call under-represented countries, as a means to engage into fruitful discussions with groups therein that are keen to broaden their horizons on marine-related affairs and have taken solid steps in this direction. In a nutshell, a small but solid step towards a more inclusive Oceans community. This is especially relevant at a time when we are witnessing the call for intensive cooperation worldwide as envisioned in the implementation plan of the UN Decade of Ocean Science for Sustainable Development, 2021–2030.

In line with the above, we warmly invited our colleagues from traditionally under-represented countries to participate actively in the virtual component of OCEANS 2021: San Diego—Porto, hosted in Portugal by attending the technical and plenary sessions remotely, and participate in round-table discussions. As a token of encouragement and appreciation for their participation, we offered to waive, in cooperation with San Diego, the registration fees for a number of attendees from



Figure 5. Prof. Juan Carlos Luque from Peru, who attended on behalf of traditionally underrepresented countries.

selected institutions from under-represented countries. The initiative attracted interest from a number of participants in Brazil, Peru, Russia, South Africa and Ivory Coast, Pakistan, and India. Some of which attended a special session aimed at analyzing the impact of the initiative and recommending further steps to increase attendance of researchers from underrepresented countries in future editions of OCEANS.

The Future

The Oceans community has been growing significantly over the last decade and is expected to continue growing at an accelerated pace. The OCEANS 2021 San Diego Porto conference explored uncharted waters in terms of hybrid formats and engagement of the worldwide community. The lessons learned from this conference and the innovative initiatives that were undertaken will certainly help shape the format of future events.

The Student Poster Competition at OCEANS 2021

Shyam Madhusudhana, OES Student Poster Competition Chair
On-Site Photographs by Stan Chamberlain

A flagship event of the MTS/OES OCEANS conferences is the Student Poster Competition (SPC), which is open to undergraduate and graduate students from colleges and universities around the world. The SPC was envisioned and created by Col. Norman Miller and was first implemented at the Seattle OCEANS conference in 1989. It has been a feature of OCEANS conferences ever since. From the pool of aspiring applicants, typically 15–20 students are selected to participate in the Competition, based on reviews (two stages) of their abstracts. The selected students get an opportunity to present, at the OCEANS conference, a poster describing their work, with their travel expenses covered.

The fusing together of this year's Porto and San Diego OCEANS conferences resulted in a single SPC event. The pandemic-induced lockdowns and travel restrictions around the globe had forced last year's OCEANS conference to be held as an entirely virtual event. In contrast, this year's event was held in a hybrid format allowing participants the option to either attend in-person or participate virtually. The final set of participants included 14 virtual and 5 in-person participants.

The hybrid format brought its own challenges to conducting the SPC. The in-person participants presented their posters in the traditional form, while the virtual participants' presentations and interactions with the judges were arranged to be held over a teleconference call - the students presented their posters virtually, one after the other, to the cohort of judges that were congregated in a hall at the conference venue. I would like to congratulate the Local Organizing Committee (LOC) for their proactive efforts in ensuring that the event was conducted at the desired expectation levels. The LOC SPC Chair, Vladimir Djapic, deserves a special mention for his commendable efforts

despite having had to relocate to Europe during the run-up to the conference. We had a total of 8 volunteers that offered to serve as judges for the Competition; their efforts and contributions to the event's success are much appreciated. I also take this opportunity to thank the sponsors—Office of Naval Research and Schmidt Ocean Institute—for their support of this year's SPC and also for their continued support for OCEANS conferences in general.

The list of participants (including the prize winners) together with their affiliation, poster title and an abstract of their poster are given below. Apologies to the virtual participants whose presentations' screenshots aren't included. We couldn't obtain the same due to IT issues during the virtual session.

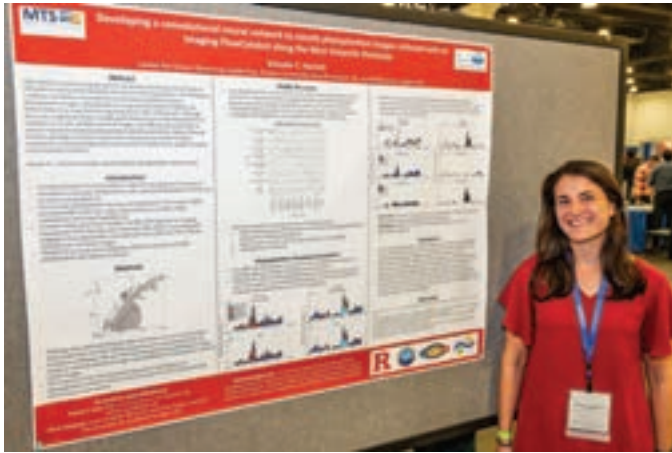
First Prize, Norman Miller Award (Certificate & \$3000 prize)

Schuyler Nardelli, Rutgers University, USA, *Developing a convolutional neural network to classify phytoplankton images collected with an Imaging FlowCytobot along the West Antarctic Peninsula*

Abstract—High-resolution optical imaging systems are quickly becoming universal tools to characterize and quantify microbial diversity in marine ecosystems. Automated detection systems such as convolutional neural networks (CNN) are often developed to identify the immense number of images collected. The goal of our study was to develop a CNN to classify phytoplankton images collected with an Imaging FlowCytobot for the Palmer Antarctica Long-Term Ecological Research project. A medium complexity CNN was developed using a subset of manually-identified images, resulting in an overall accuracy, recall, and f1-score of 93.8%, 93.7%, and 93.7%, respectively. The f1-score dropped to 46.5% when tested on a new random



Awards and certificates distribution during the Gala. Left-to-right: Vladimir Djapic (LOC SPC Chair); four of the on-site participants; Schmidt Ocean Institute rep. Jyothika Virmani (standing in front); MTS & OES Presidents; six of the judges; Society SPC Chairpersons Josh Kohut (MTS), Shyam Madhusudhana (OES) and Kristina Norman (MTS).



subset of 10,269 images, likely due to highly imbalanced class distributions, high intraclass variance, and interclass morphological similarities of cells in naturally occurring phytoplankton assemblages. Our model was then used to predict taxonomic classifications of phytoplankton at Palmer Station, Antarctica over 2017–2018 and 2018–2019 summer field seasons. The CNN was generally able to capture important seasonal dynamics such as the shift from large centric diatoms to small pennate diatoms in both seasons, which is thought to be driven by increases in glacial meltwater from January to March. Moving forward, we hope to further increase the accuracy of our model to better characterize coastal phytoplankton communities threatened by rapidly changing environmental conditions.

Second Prize (Certificate and \$2000 prize)

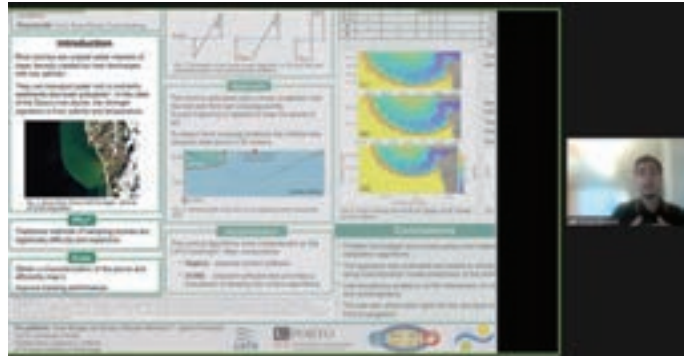
Isaac Gerg, Penn State University, USA, *A learnable image compression scheme for synthetic aperture sonar imagery*

Abstract—Synthetic aperture sonar (SAS) is an imaging modality which produces high and constant resolution images of the seafloor. These sonars are often mounted to a unmanned underwater vehicle (UUV) to autonomously collect imagery of a prescribed survey area. While a survey is underway, UUV communications back to the operator are often limited due to the use of a low-bandwidth acoustic communications (ACOM-MS) channel. Because of this, high-quality SAS imagery is rarely sent over this link due to the lack of an efficient compression scheme to send such information. Creating an efficient SAS image compression scheme provides at least two operational benefits: (1) image chips beamformed and tagged by onboard processing algorithms can be quickly communicated to operators while a survey is ongoing, and (2) cooperative UUVs can exchange salient image chips among themselves to reconcile position ambiguity and obtain a shared reference frame. In this work we propose a learned image compression scheme for SAS imagery using deep neural networks (DNNs). DNNs have already been applied to the image compression problem but almost exclusively for optical imagery. We highlight some important differences between SAS imagery and optical imagery which prevents the simple application of off-the-shelf (OTS) methods like JPEG and WebP to SAS imagery. We propose an image compression scheme which specifically addresses the domain-specific properties of SAS imagery to

obtain useful image compression performance on a real-world SAS dataset. We show that we can reduce the bitrate by up to thirty-five percent while still maintaining the same perceptual image quality as OTS codecs.

Third Prize (Certificate and \$1000 prize)

Diogo Teixeira, University of Porto—LSTS, Portugal, *3D tracking of a river plume front with an AUV*



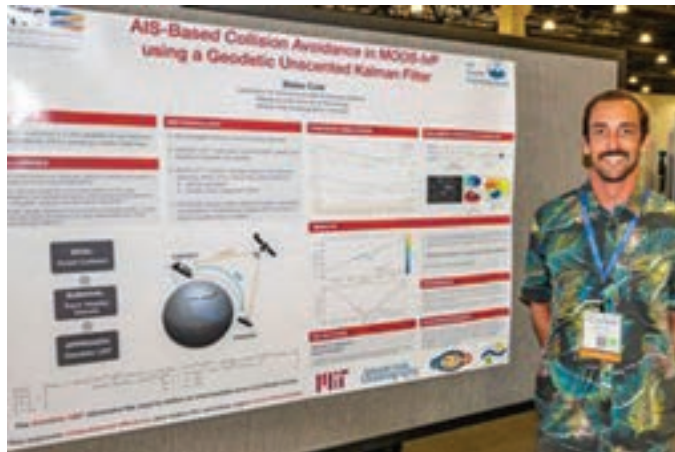
Abstract—The problem of the concurrent tracking and mapping of a river plume front with an autonomous underwater vehicle (AUV) is formulated and addressed in the framework of an interdisciplinary approach building on experience in robotics and oceanographic field studies. The problem formulation is targeted at the scientific study of the processes by which the river and the ocean interact. The approach extends previous work in AUV plume tracking to the simultaneous tracking and mapping under different ocean and meteorological conditions. This is done with the help of parameterizable motion control algorithms to enable adaptation to these time-varying conditions. The approach is evaluated in simulation with the help of a high-resolution hydrodynamic model. The test plan covers over 300 test cases exercising the most representative combinations of the ocean and meteorological conditions. Lessons learned and future operational deployments are discussed in the conclusions.

Xinwei Chen, Memorial University of Newfoundland, Canada, *A spatial-temporal ensemble network for estimating wave height from X-band marine radar image sequences*

Abstract—A spatial-temporal ensemble network is proposed to estimate significant wave heights (SWHs) from X-band marine radar image sequences. After image subarea selection, a 1024-dimension deep spatial feature vector is first extracted from each radar image using deep convolutional layers obtained from GoogLeNet. The temporal behavior of each radar image sequence can be analyzed by inputting the spatial feature vector sequence into a recurrent neural network (RNN) consisting of gated recurrent units (GRUs), followed by the regression layers that generate the estimated SWH. The network is trained using shipborne marine radar data collected during a sea trial, while simultaneous buoy measurements are used as ground truths for calibration and performance evaluation. Compared to the traditional signal-to-noise (SNR)-based method, the proposed network reduces the root mean square

error by 0.35 m and 0.36 m for image sequences collected under rainless and rainy conditions, respectively.

Blake Cole, Massachusetts Institute of Technology, USA, *AIS-based collision avoidance in MOOS-IvP using a geodetic unscented Kalman filter*



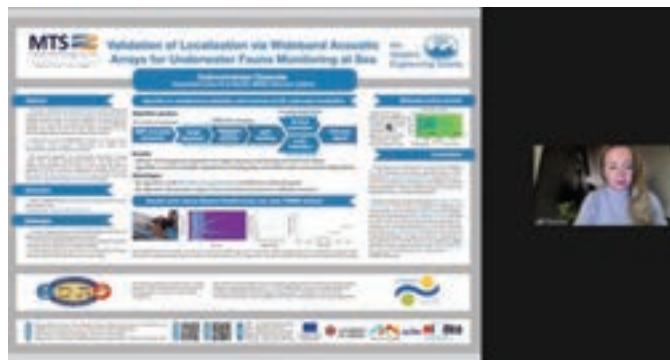
Abstract—This paper describes the design and implementation of a low-cost collision avoidance system, designed primarily for use on small and medium-sized autonomous surface vehicles (ASVs). The proposed methodology leverages real-time information broadcast via the Automatic Information System (AIS) messaging protocol, in order to estimate the position, speed, and heading of nearby vessels. The state of each target vessel is recursively estimated in geodetic coordinates using an Unscented Kalman Filter (UKF). Once identified, each vessel is avoided in accordance with the International Regulations for Preventing Collisions at Sea (COLREGs). This capability is enabled by MOOS-IvP, a behavior-based autonomy middleware that is able to make navigation decisions by weighing the relative importance of multiple competing objectives. For the purposes of collision avoidance, each target vessel produces a two-dimensional objective function which increases the cost of heading and speed combinations that will result in a collision or near-miss event. However, the primary mission behaviors remain active, allowing the IvP solver to choose an optimal combination of vessel speed and heading which drive the vehicle toward a desired state while simultaneously minimizing the risk of collision. It is shown through field testing that the proposed framework is an effective, robust means of collision avoidance.

Diogo Duarte, INESC TEC—Faculdade de Engenharia da Universidade do Porto, Portugal, *Multiple vessel detection and tracking in harsh maritime environments*

Abstract—Recently, research concerning the navigation of Autonomous Surface Vehicles (ASVs) has been increasing. However, a big scale implementation of these vessels is still held back by a plethora of challenges such as multi-object tracking. This article presents the development of a tracking model through transfer learning techniques, based on referenced object trackers for urban scenarios. The work consisted in training a neural network through deep learning techniques,

including data association and comparison of three different optimisers, Adadelata, Adam and SGD, determining the best hyper-parameters to maximise the training efficiency. The developed model achieved decent performance at tracking large vessels in the ocean, being successful even in harsh lighting conditions and lack of image focus.

Elizaveta Dubrovinskaya, Universidad Carlos III Madrid, Spain, *Validation of localization via wideband acoustic arrays for underwater fauna monitoring at sea*



Abstract—We present a technique for simultaneous detection, path tracking and accurate 3D underwater localization using wideband arrays of complex geometry based on acoustic reflections clustering. We have extended our previously proposed algorithm for 3D localization designed for arrays that do not meet typical constraints of one half-wavelength spacing between the closest array elements. Inspired by the scope of SYMBIOSIS, a hybrid opto-acoustic system for pelagic fish species monitoring, we added more functionalities that fit the needs of the project.

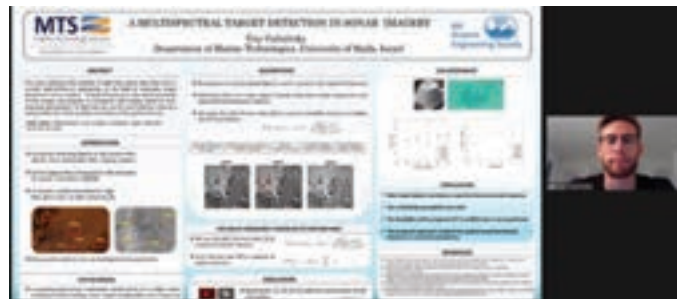
The proposed algorithm can automatically discriminate moving targets from stationary environmental features and track them to estimate their possible time of arrival to the system. We test the algorithm in several autonomous deployments including shallow and deep water. The experimental results for marine fauna monitoring have shown a good performance in various environments.

Joana Fonseca, Royal Institute of Technology KTH, Sweden, *Algal bloom front tracking using an unmanned surface vehicle: numerical experiments based on Baltic Sea data*

Abstract—We consider the problem of tracking moving algal bloom fronts using an unmanned surface vehicle (USV) equipped with a sensor that measures the concentration of chlorophyll *a*. Chlorophyll *a* is a green pigment found in plants, and its concentration is an indicator of phytoplankton abundance. Our algal bloom front tracking mission consists of three stages: deployment, data collection, and front tracking. At the deployment stage, a satellite collects an image of the sea from which the location of the front, the reference value for the concentration at this front and, consequently, the appropriate initial position for the USV are determined. At the data collection stage, the USV collects data points to estimate the local algal gradient as it crosses the front. Finally, at the front tracking stage, an

adaptive algorithm based on recursive least squares fitting using recent past sensor measures is executed. We evaluate the performance of the algorithm and its sensitivity to measurement noise through MATLAB simulations. We also present an implementation of the algorithm on the DUNE onboard software platform for marine robots and validate it using simulations with satellite model forecasts from Baltic sea data.

Guy Gubnitsky, University of Haifa, Israel, *Multispectral target detection in sonar imagery*



Abstract—Detection of underwater objects in sonar imagery is a key enabling technique, with applications ranging from mine hunting and seabed characterization to marine archaeology. Due to the non-homogeneity of the sonar imagery, the majority of detection approaches are geared towards detection of features in the spatial domain to identify anomalies in the seabed's background. Yet, when the seabed is complex and includes rocks and sand ripples, spatial features are hard to discriminate, leading to high false alarm rates. With the aim of detecting man-made objects in complex environments, we utilize, as a detection metric, the expected spectral diversity of reflections to differentiate man-made objects' reflections from the relatively flat frequency response of natural objects' reflections, such as rocks. Our solution merges a set of preregistered sonar images, each of which are obtained at a different frequency band. Using the Jain's fairness as a metric to evaluate the spectral diversity of a suspected object within a low or high resolution sonar imagery, respectively, our solution detects anomalies across the spectrum domain. We tested our algorithm over simulated data and over multispectral data obtained in a designated sea experiment. The results show that, compared to benchmark schemes, our approach obtains better performance in terms of the trade-off between false alarm rate and detection capability.

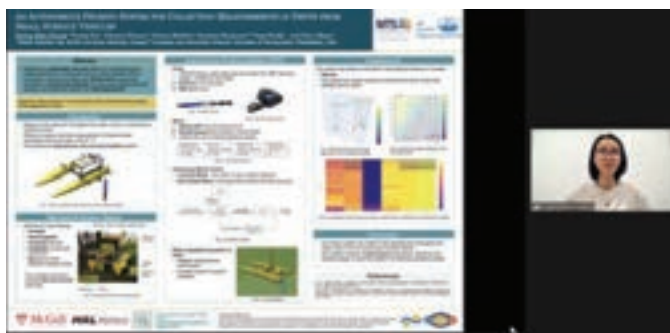
Miguel Gutierrez Gaitan, CISTER/FEUP-ISEP, Portugal, *Wireless radio link design to improve near-shore communication with surface nodes on tidal waters*

Abstract—Wireless radio links deployed over aquatic areas (e.g., sea, estuaries or harbors) are affected by the conductive properties of the water surface, strengthening signal reflections and increasing interference effects. Recurrent natural phenomena such as tides or waves cause shifts in the water level that, in turn, change the interference patterns and cause varying impairments to propagation over water surfaces. In this work, we aim at mitigating the detrimental impact of tides on the



quality of a line-of-sight over-water link between an onshore station and a surface node, targeting mission data transfer scenarios. We consider different types of surface nodes, namely, autonomous underwater vehicles, unmanned surface vehicles and buoys, and we use WiFi technology in both 2.4 GHz and 5 GHz frequency bands. We propose two methods for link distance/height design: (i) identifying a proper Tx-Rx distance for improved link quality at each point of the tidal cycle; (ii) defining the height/distance that minimizes the path loss averaged during the whole tidal cycle. Experimental results clearly show the validity of our link quality model and the interest of method (i). Analytical results confirm method (ii) and show that it outperforms, in both frequency bands, the common practice of placing onshore antennas at the largest possible height and/or surface nodes at a short but arbitrary distance.

Yuying Huang, McGill University, Canada, *An autonomous probing system for collecting measurements at depth from small surface vehicles*



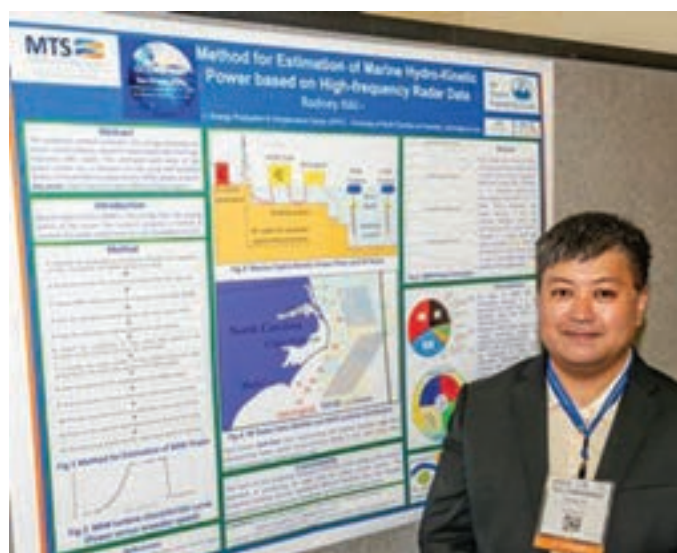
Abstract—This paper presents the portable autonomous probing system (APS), a low-cost robotic design for collecting water quality measurements at targeted depths from an autonomous surface vehicle (ASV). This system fills an important, but often overlooked niche in marine sampling by enabling mobile sensor observations throughout the near-surface water column without the need for advanced underwater equipment. We present a probe delivery mechanism built with commercially available components and describe the corresponding winch control system, and data captured from this system in a field deployment. Finally, we discuss design trade-offs and present areas for future improvement. Project details are available on our website.

Stéphane Imbert, IMT Atlantique, France, *Two-dimensional spreading waveform for adaptive rate acoustic underwater communication*



Abstract—Autonomous Underwater Vehicles (AUVs) are becoming a part of the ocean navigation ecosystem, and their applications deal with seafloor mapping, channel sounding, surveillance, submarine volcanism survey or mine warfare. During a mission, it is of great importance, through a reliable acoustic wireless communication link, that ships or surface buoys receive live data from an AUV and exchange information data with it. Furthermore, the communication range can vary during a mission. Thus, this paper addresses the challenging topic of designing a modem, to transmit information to an AUV, by emphasizing on the adaptivity and robustness of the link. The designed modem combines multi-carrier signal and 2D spreading and is called MC-SS-2D. A variable length spreading sequence combined with OFDM creates a flexible design that uses frequency diversity, time diversity and adds a processing gain to transmit at various distances. The modem was tested using rayleigh channels as well as experiments in a water tank and at sea using the IROMI platform.

Rodney Itiki, University of North Carolina at Charlotte, USA, *Method for estimation of marine hydro-kinetic power based on high-frequency radar data*



Abstract—Marine Hydro-Kinetic (MHK) is renewable energy in the moving waters of the oceans. This research proposes

a method for estimating the total MHK energy harvested by turbines spatially distributed in the ocean current. The MHK energy is variable in time and space. The method represented by an algorithm is implemented in MATLAB. It reads hourly measurements of seawater speed to estimate the power profile of the generated MHK farms. In the U.S., some speed measurements from high-frequency (HF) radars in the coastal areas are publicized on the internet by the National Oceanic and Atmospheric Administration (NOAA). The algorithm functionality is demonstrated in a case study with the NOAA radar measuring the seawater speed of the Gulf Stream off the coast of North Carolina. The peak value of the power profile sets a reference for the sizing of the MHK platform equipment and cabling. The algorithm is also useful for planning of renewables expansion of utility companies, selection of offshore site with high power output, techno-economic feasibility studies, and subsequent steps of engineering for a proposed MHK farm project. A comprehensive discussion of the implications of the proposed method for the natural, economic, social, and political environment paves the way for a myriad of potential multidisciplinary topics for future blue energy research.

Juhwan Kim, Pohang University of Science and Technology, Republic of Korea

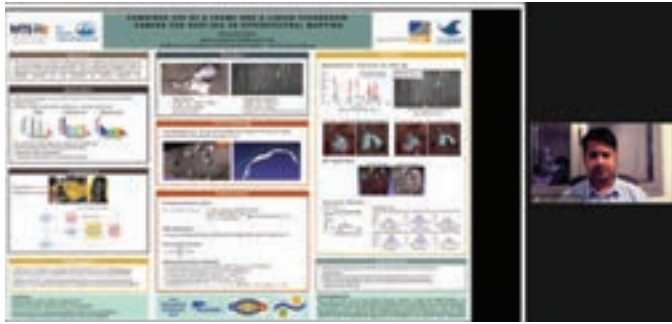
Line laser mounted small agent ROV based 3D reconstruction method for precision underwater manipulation

Abstract—We proposed a line laser based 3D reconstruction method for small agent ROV to perform precision underwater manipulation. Perception of the surrounding environment underwater is essential for manipulation. Especially for small underwater vehicles with relatively limited and weak sensors, it is very difficult to perform 3D reconstruction and manipulation of objects underwater. This paper proposed that a small agent ROV attached with a line laser performs 3D object reconstruction by rotating motion. In general, a line laser scan can be performed when an actuator moves the line laser or when the vehicle's position can be accurately known. However, in a small underwater vehicle without such an actuator and a high-performance navigation sensor, a laser scan cannot be performed smoothly. Therefore, we devised a method that performs a line laser scan by rotating the vehicle around the object only by detecting the target object with the camera. We confirmed that the target objects could be 3D scanned using the line laser scan simulator. In addition, we carried out experiments in the water tank, and 3D reconstruction of three target objects was possible. As a result, we showed that our line laser scan method could perform underwater 3D reconstruction of target objects even for small underwater vehicles with few sensors.

Peeyush Kumar, University of Bonn, Germany

Combined use of a frame and a linear pushbroom camera for deep-sea 3D hyperspectral mapping

Abstract—Hyperspectral (HS) imaging produces an image of an object across a large range of the visible spectrum, and not just the primary colors (R, G, B) of conventional cameras. It can provide valuable information for object detection, analysis of materials and processes in environmental science in the



deep-sea, especially for the study of benthic environments and pollution monitoring.

In this paper, we address the problem of camera calibration towards 3D hyperspectral mapping where GPS is not available, and the platform navigational sensors are not accurate enough to allow direct georeferencing of linear sensors, as is the case with traditional aerial platform methods.

Our approach presents a preliminary method for 3D hyperspectral mapping that uses only image processing techniques to reduce reliance on GPS or navigation sensors. The method is based on the use of standard RGB camera coupled with the hyperspectral pushbroom camera. The main contribution is the implementation and preliminary testing of a method to relate the two cameras using image information alone.

The experiments presented in this paper analyze the estimation of relative orientation and time synchronization parameters for both cameras through experiments based on epipolar geometry and Monte-Carlo simulation. All methods are designed to work with real world data.

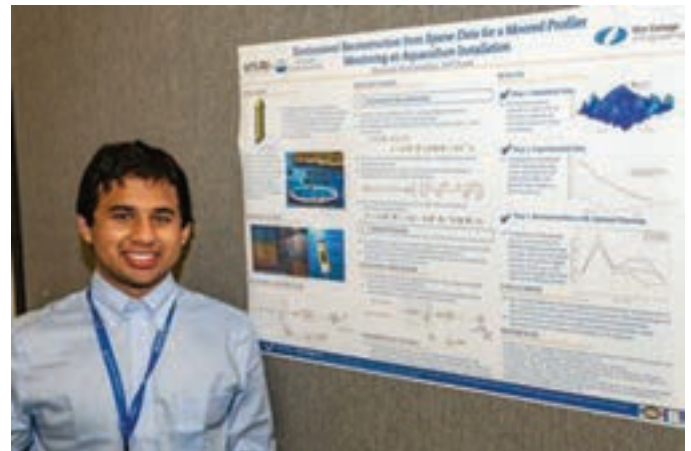
Mathilde Letard, Paris Sciences Lettres University, France, *Classification of coastal and estuarine ecosystems using full-waveform topo-bathymetric lidar data and artificial intelligence*



Abstract—Coastal and estuarine ecosystems are facing spatio-temporal changes and suffer from the effects of accelerated natural destructive processes due to climate change. Monitoring these areas is crucial to protect them and maintain the ecological balance of shorelines. In this context, full-waveform airborne topo-bathymetric lidar is a reliable tool to collect data seamlessly over land-water continuum zones, thanks to its dual wavelength configuration. It is therefore optimal for coastal habitats monitoring and mapping. However, lidar waveform processing often relies on peak detection and feature extraction that are difficult to configure and often sensitive to noise. In this article, we rather suggest not to rely on hand-

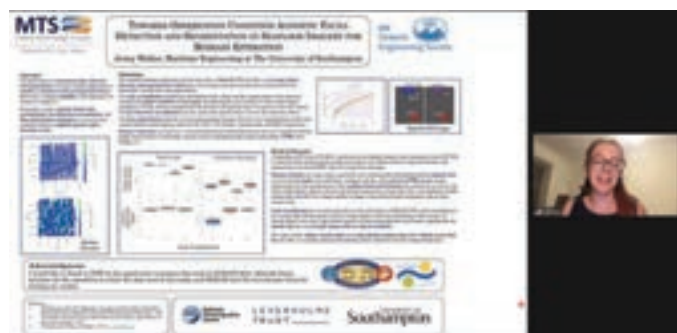
crafted features by relying on U-time, a neural network inspired by the well-known UNet convolutional neural network, to identify peaks in waveforms and classify them to discriminate coastal ecosystems efficiently. The network is tested on green waveforms and we evaluate in addition the contribution of infrared intensities. Results show equivalent performances, and obtain over 92% of accuracy when accepting a 2 samples margin of error for peaks location, which does not impact heavily waveform analysis, considering usual peaks widths. Our study shows green waveforms alone allow habitats detection with a F-score of 94%, outperforming previous methods.

Shashank Swaminathan, Franklin W. Olin College of Engineering, USA, *Optimal planning with uncertainty for a moored profiler monitoring an aquaculture installation*



Abstract—There is burgeoning global demand for marine seafood, and one proposed approach to meeting this is expanding offshore farming practices. When developing such offshore aquaculture farms, it is critical to maintain the health and safety of both the food stock and the environment. To do so, there must be consistent and thorough monitoring of the installations, with data collected over large spatial and temporal ranges, spanning up to hundreds of meters deep for weeks at a time. We focus on using a moored automatic mobile profiler (MAMP) to provide environmental data along the entire spatial range relevant to the farm. However, while MAMPs have much higher spatial range and resolution than fixed sensor arrays, an aquaculture site is dynamic. To capture the shifts in the site's state, the profiler must take quick, sparse measurements and determine the overall environment from those samples. This paper's goal is to propose an implementation of a probabilistic algorithm that enables reconstruction and prediction of the farm's state from sparse samples for use in path planning using Gaussian Regression Processes. The proposed approach is verified against experimental ocean environment data, and shows >95% accuracy in environment reconstruction while requiring only 10% of the number of data samples as the ground truth data set. It is further implemented in conjunction with a Markov Decision Process based planner to demonstrate the algorithm's use in path planning. This work indicates the high potential of the algorithm for use on dynamic environments like aquaculture farm sites.

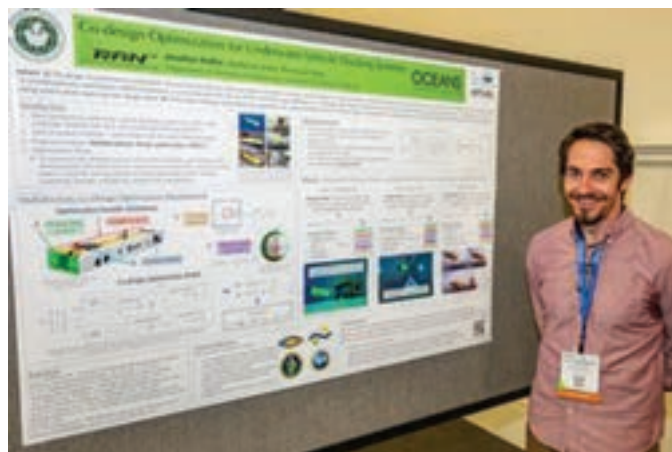
Jenny Walker, University of Southampton, UK, *Towards observation condition agnostic fauna detection and segmentation in seafloor imagery for biomass estimation*



Abstract—The performance of automated object detection and segmentation in marine imaging applications is sensitive to hardware and environmental factors that result in a large variability in the appearance of subjects in images. This paper investigates physics based scale normalisation, lens distortion normalisation, and data augmentation techniques to overcome this, working towards a condition agnostic object detection system. A total of over 700 rockfish in images taken from different altitudes using different camera equipped Autonomous Underwater Vehicles at the Southern Hydrates Ridge (depth 780 m) are used to train and test object detection and segmentation using Mask R-CNN. Images taken from low altitudes of ~2 m achieve a maximum mean average precision (mAP) score of 97.42%, and images taken from high altitudes of ~6 m achieve a maximum score of 87.4% when object detection and segmentation is trained and tested on images taken from the same altitudes. When transferring knowledge across different imaging conditions, a mAP score of 87.7% is achieved when transferring knowledge from high to low altitude datasets, and 49.6% when transferring from low to high altitudes. In both cases, significant gains in performance is seen when the images used are scale normalised. The results indicate that increasing the pixel resolution, or the size an object appears within the image, benefits learning regardless of the optical resolution images are taken at, and this should be carefully considered in

future object detection and segmentation studies. We also describe a novel method to estimate biomass distribution from the segments output by modern machine learning algorithms that can be easily adapted for different morphospecies.

Jonathan Wallen, University of Hawaii at Manoa, USA
Co-design optimization for underwater vehicle docking systems



Abstract—The design of autonomous underwater vehicles (AUVs) and their docking stations has been a popular research topic for several decades. Although many AUV and dock designs have been proposed, materialized, and commercialized, most of these existing designs prioritize the functionality of the AUV over the dock, or vice versa; there has been limited formal research in analytical optimization for AUV docking systems. In this paper, a multidisciplinary optimization framework is presented with the aim to fill this theoretical gap. We propose a co-design optimization method that optimizes multiple design parameters governing the archetype of an AUV and its docking system. Capturing the user design intents in the optimization process, the proposed method produces a set of optimal design parameters that satisfies a set of predefined bounds, constraints, and initial conditions. Three cases of design optimization are reported for different design intents. Each optimal design found in the three cases is compared to an existing system to show the validity of this design optimization framework.

Developing a convolutional neural network to classify phytoplankton images collected with an Imaging FlowCytobot along the West Antarctic Peninsula

Schuyler C. Nardelli
Center for Ocean Observing Leadership
Rutgers University
New Brunswick, NJ, USA
nardelli@marine.rutgers.edu

Patrick C. Gray
Marine Lab
Duke University
Beaufort, NC, USA
patrick.c.gray@duke.edu

Oscar Schofield
Center for Ocean Observing Leadership
Rutgers University
New Brunswick, NJ, USA
oscar@marine.rutgers.edu

Abstract—High-resolution optical imaging systems are quickly becoming universal tools to characterize and quantify microbial diversity in marine ecosystems. Automated detection systems such as convolutional neural networks (CNN) are often developed to identify the immense number of images collected. The goal of our study was to develop a CNN to classify phytoplankton images collected with an Imaging FlowCytobot for the Palmer Antarctica Long-Term Ecological Research project. A medium complexity CNN was developed using a subset of manually-identified images, resulting in an overall accuracy, recall, and f1-score of 93.8%, 93.7%, and 93.7%, respectively. The f1-score dropped to 46.5% when tested on a new random subset of 10,269 images, likely due to highly imbalanced class distributions, high intraclass variance, and interclass morphological similarities of cells in naturally occurring phytoplankton assemblages. Our model was then used to predict taxonomic classifications of phytoplankton at Palmer Station, Antarctica over 2017-2018 and 2018-2019 summer field seasons. The CNN was generally able to capture important seasonal dynamics such as the shift from large centric diatoms to small pennate diatoms in both seasons, which is thought to be driven by increases in glacial meltwater from January to March. Moving forward, we hope to further increase the accuracy of our model to better characterize coastal phytoplankton communities threatened by rapidly changing environmental conditions.

Keywords—machine learning, neural network, phytoplankton, polar science

I. INTRODUCTION

The West Antarctic Peninsula (WAP) is a highly productive marine ecosystem characterized by large summer phytoplankton blooms that support extensive krill and top predator populations [1]. The WAP is experiencing significant environmental change, threatening this unique and productive ecosystem. One of the fastest warming regions on Earth, WAP winter air temperatures and surface ocean temperatures have increased by 6°C and >1°C, respectively, over the past 50 years [2-4]. In response, 90% of marine glaciers are currently in retreat, the annual ice season has decreased by 92 days over the last 35 years, and there is no longer perennial sea ice in the northern WAP [2], [5].

Ocean warming and melting sea ice have impacted the phytoplankton community, which has implications for the entire food web. Phytoplankton biomass has significantly decreased in the northern WAP, associated with a shift from large-celled

diatoms to smaller-celled cryptophytes and mixed flagellates [6]. This shift is concurrent with an increase in low salinity meltwater [7-9]. The increased spatial coverage of low salinity surface waters associated with continued glacial and sea ice melt is predicted to increase the prevalence of smaller-celled phytoplankton communities along the WAP, with important implications for food web structure and energy transfer efficiency [10].

The Palmer Long-Term Ecological Research project (PAL-LTER) was established in 1991 to investigate how changes in sea ice structure the pelagic ecosystem and biogeochemistry along the WAP. The project has previously used High Performance Liquid Chromatography (HPLC) analysis of pigment data to characterize the taxonomic composition of phytoplankton assemblages [11]. This technique uses marker pigments of phytoplankton groups to assess their contribution to the overall abundance. However, HPLC lacks more detailed taxonomic classification and cell size information that is critical to understanding how warming and melting impacts phytoplankton communities along the WAP.

To fill this knowledge gap, in 2017 the PAL-LTER acquired an Imaging FlowCytobot (IFCB; McLane Labs, Falmouth, MA, USA). The IFCB is an automated imaging-in-flow submersible cytometer that uses a combination of video and flow cytometric technology to collect images and measure chlorophyll fluorescence and scattered light for each particle (~10-150 µm) in a 5 mL water sample [12]. These images can be analyzed to determine cell size dynamics, and sorted taxonomically to the genus or species level, thus providing much more detailed organismal information than HPLC methods.

However, the IFCB can generate more than 10,000 high-quality images every hour, which becomes an immense amount of data over the duration of a research cruise or field season. This volume of data makes manual image identification impractical, therefore, these imaging platforms are often complemented by automated detection systems that allow for rapid and precise classification of plankton communities. Currently, there are two typical machine learning approaches for IFCB images: (1) a support vector machine based on a feature selection algorithm (88% overall accuracy with 22 classes; [13]), and (2) random forest (RF) algorithms (~70% overall accuracy depending on the

model and number of classes, e.g., [14]). Following advancements in the field of computer vision through deep learning [15] the IFCB community is now transitioning to convolutional neural networks (CNNs) for improved accuracy in image classification. CNNs extract features directly from images. Starting with raw imagery and labels, semantically meaningful features are learned as the network trains on a set of images. In theory, extracted features correspond to components of the image relevant to the labels, which makes these models highly accurate and well-suited for image classification tasks.

Since 2017, the PAL-LTER has collected over 10 million images spanning four summer field seasons. The goal of our study was to develop a CNN to sort WAP phytoplankton into taxonomic groups. This would allow for taxonomic classification of entire seasons of collected phytoplankton data in a short amount of time. Additionally, the CNN could be used as a tool to characterize phytoplankton communities in the field in near-real time to inform opportunistic sampling strategies. The combination of the IFCB and a high-accuracy automated classification system would allow the PAL-LTER to learn more about shifts in phytoplankton community and size dynamics associated with rapidly changing environmental conditions.

II. METHODS

A. Phytoplankton Image Collection and Processing

IFCB data were collected along the West Antarctic Peninsula over three summer field seasons: 2017-2018, 2018-2019, and 2019-2020. Whole water samples were collected at various depths from both the January cruise along the WAP (Anvers Island in the north to Charcot Island in the south) and from seasonal (November-March) sampling at Palmer Station, Antarctica. 5 mL from each sample was analyzed with the IFCB to acquire images for each phytoplankton cell in the sample. Samples were passed through a 150 μm Nitrex screen prior to analysis to prevent large cells from clogging the IFCB's flow cell. Cells with a major axis length < 25 pixels (7.35 μm) were eliminated from the analysis as the resolution of the images was insufficient to provide clear identification.

Images were processed using methods and software from [13] (<https://github.com/hsosik/ifcb-analysis/wiki>). Image processing results in a set of 233 features describing each image including fluorescence, scattering intensity, equivalent spherical diameter, area, volume, and other morphometric parameters such as image texture and histogram of oriented gradients.

B. Model Development

Processed images, metadata, and their associated features were uploaded to the web application EcoTaxa (<https://ecotaxa.obs-vlfr.fr>) [14]. Using EcoTaxa, a subset of 18,699 images was visually inspected and manually classified into 38 living groups (taxonomic resolution ranging from genus to class) and 2 non-living groups (detritus and bubbles), with at least 100 images per group. Samples (images + features) were augmented to increase training sample size via image rotations, flips, gaussian noise, and contrast changes. Features were also randomly multiplied by a factor between 0.8 and 1.2.

After augmentation, a training dataset of 40,000 samples with 1,000 in each class was used to develop a medium complexity CNN (8 convolutional layers and 2 million parameters), and 3,740 unaugmented images, approximately evenly split across classes, were used as a validation dataset. Model precision, recall, and f1-score were calculated for the unmerged data considering all included groups, and for merged data considering only 8 general taxonomic groupings (pennate and centric diatoms, cryptophytes, prasinophytes, mixed flagellates, haptophytes, microzooplankton, and other). The "other" group includes primarily detritus with some bubbles. Precision is defined as true positives divided by the sum of true positives and false positives; it is the proportion of positive identifications that are correct. Recall is defined as true positives divided by the sum of true positives and false negatives; it is the proportion of actual positives that are identified correctly. The f1-score is the harmonic mean of precision and recall. Confusion matrices were also generated showing the percent of manually validated images predicted in each category by the CNN.

C. Model Validation

To test the model, we used it to predict on a random subset of 10,269 new images filtered by cell major axis length > 25 pixels. Additionally, we used EcoTaxa's RF algorithm to predict on the same images, using a maximum of 500 images per group. Predictions from both models were compared to manual identification of the images. Model precision, recall, and f1-score were calculated for unmerged and merged data for both the CNN and RF models, and a confusion matrix was generated for the CNN.

D. Model Application

After training and evaluation, our model was used to predict taxonomic classifications of phytoplankton collected at 0 m from Station B near Palmer Station, Antarctica over the 2017-2018 and 2018-2019 summer field seasons. CNN predictions were compared to manual validation of the images to determine the accuracy of the predicted seasonal trends.

E. Sea Ice Characterization

Sea ice data were calculated using version 3.1 of the GSFC Bootstrap sea ice concentrations. Sea ice duration is the time elapsed between day of advance and day of retreat. All sea ice metrics use the 200 km area south and west of Palmer Station. See [16] for more information.

III. RESULTS

A. Model Accuracy

The overall precision, recall, and f1-score of the model were 93.8%, 93.7%, and 93.7%, respectively. After merging the initial set of 40 classes into the 8 broader taxonomic groups, the precision, recall, and f1-score of the model all increased to 96.5%. Accuracy per group was > 95% for all groups except for microzooplankton (> 80%), mixed flagellates (> 90%), and other (> 90%).

TABLE I. CONFUSION MATRIX FOR BROAD TAXONOMIC GROUPS USING 10,269 NEW, RANDOM IMAGES

True label	Pennate diatoms (n=1577)	92.9	0.8	0.3	0.6	4.8	0.0	0.0	0.7
	Centric diatoms (n=249)	2.8	64.3	5.2	2.4	15.3	0.0	0.0	10.0
	Cryptophytes (n=2565)	9.4	1.0	65.0	4.4	19.8	0.0	0.0	0.5
	Prasinophytes (n=493)	2.6	1.6	0.4	39.6	28.0	0.0	0.0	27.8
	Mixed flagellates (n=1085)	11.6	1.5	3.9	7.4	66.2	0.0	0.3	9.2
	Haptophytes (n=1)	0.0	0.0	0.0	0.0	0.0	100	0.0	0.0
	Microzooplankton (n=6)	0.0	16.7	0.0	0.0	16.7	0.0	66.7	0.0
	Other (n=3475)	26.9	10.9	4.9	18.4	23.8	0.0	0.3	14.9
		Pennate diatoms (n=2788) Centric diatoms (n=601) Cryptophytes (n=1898) Prasinophytes (n=1040) Mixed flagellates (n=2304) Haptophytes (n=1) Microzooplankton (n=16) Other (n=803)							
		Predicted label							

Using the model to predict on the 10,269 new images resulted in unmerged and merged f1-scores of 46.5% and 47.6%, respectively. This is a 12% increase in the unmerged f1-score over EcoTaxa's random forest model (46.5% vs. 41.5%,

respectively; [14]). The model predicted most accurately for pennate diatoms (92.9%), and performed moderately well for microzooplankton (66.7%), mixed flagellates (66.2%), cryptophytes (65.0%), and centric diatoms (64.3%; Table 1). Our model was least precise predicting prasinophytes (39.6%) and other cells (14.9%; Table 1). Only one haptophyte was manually identified in the random dataset but was predicted correctly.

B. Phytoplankton Seasonal Succession at Palmer Station

Overall, the CNN captured important seasonal trends in phytoplankton dynamics. In both the 2017-2018 and 2018-2019 seasons, peak phytoplankton biovolume occurred midseason (1 January 2018 and 4 February 2019; Fig. 1). In 2017-2018, the peak was dominated by a mix of cryptophytes, prasinophytes, and mixed flagellates, while in 2017-2018 the peak was dominated by pennate diatoms. The CNN also captured early and late season peaks composed of centric diatoms in 2018-2019 (Fig. 1C-D).

However, there are several discrepancies between methods. In both seasons, but particularly 2017-2018, there were many cells manually identified as "other" that were classified as both mixed flagellates and prasinophytes by the CNN (Fig. 1). In this manner, the CNN appears to overestimate the abundance of these groups. The CNN also underestimated the abundance of cryptophytes, especially during peak biovolume in both years. Importantly, this misclassification of "other" cells also greatly overestimates the phytoplankton biovolume compared to manual validation, causing the seasonal phytoplankton peak in 2017 to appear much higher than for manual validation (Fig. 1A-B).

The CNN also captured interesting seasonal trends in the diatom community. There was less total diatom biovolume in 2017-2018 compared to 2018-2019 (Fig. 2A, 2D). In both seasons, centric diatoms shifted from a dominance of > 20 μm

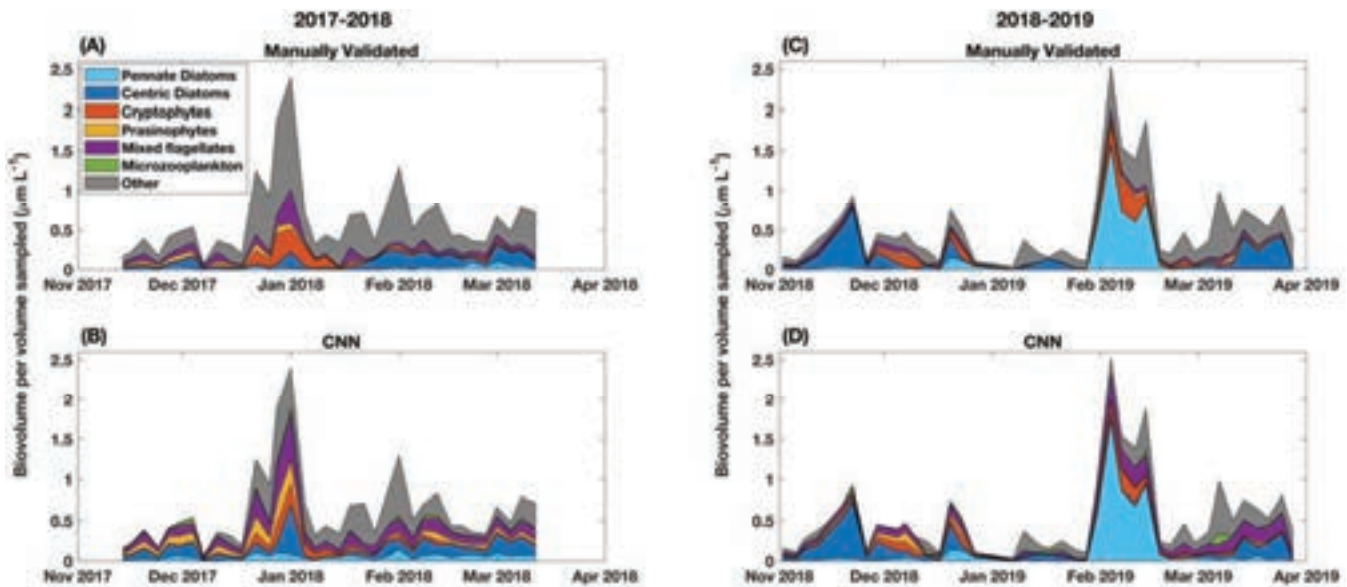


Fig. 1. Methods comparison of phytoplankton seasonal succession for the (A-B) 2017-2018 and (C-D) 2018-2019 summer field seasons, showing biovolume data from (A and C) manual validation and (B and D) CNN predictions.

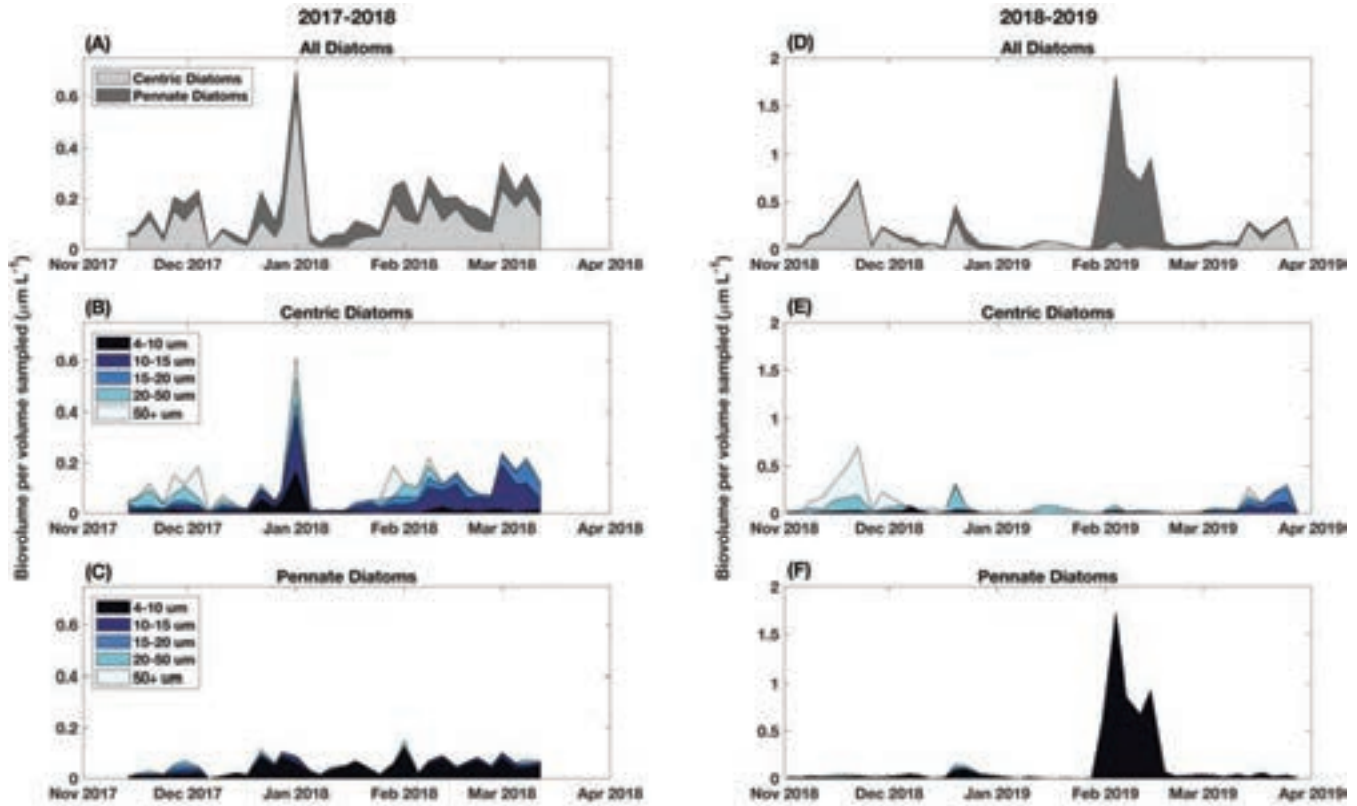


Fig. 2. Diatom seasonal diversity as predicted with the CNN for the (A-C) 2017-2018 and (D-F) 2018-2019 summer field seasons. (A and D) Total biovolume attributed to pennate and centric diatoms. (B and E) Total biovolume attributed to different size classes of centric diatoms. (C and F) Total biovolume attributed to different size classes of pennate diatoms.

cells in November and December, to a dominance of 10-15 μm cells in February and March (Fig. 2B, 2E). Pennate diatoms were consistently dominated by cells $< 10 \mu\text{m}$, with an increase in biovolume during February and March, especially in 2018-2019 (Fig. 2C, 2F). Both seasons were primarily dominated by centric diatoms, with the notable exception of a large peak in pennate diatom biovolume in 2018 (Fig. 2A, 2D).

C. Sea Ice Dynamics

2017 had lower maximum winter sea ice coverage and shorter sea ice duration than 2018, but a later sea ice retreat (Table 2 and Fig. 3). Sea ice cleared the region rapidly in 2017, dropping from 52% coverage in November, to 12% in December, and 3% in January (Fig. 3). In 2018, the sea ice retreated earlier but coverage stayed higher in the region into the summer, with 24% coverage in November, 17% coverage in December, and 10% coverage in January (Fig. 3).

TABLE II. SEA ICE CHARACTERIZATION

Year	Sea Ice Duration (days)	Date of Sea Ice Retreat
2017	132	December 3
2018	153	November 27

IV. DISCUSSION

A. Model Development: Successes and Challenges

Overall, we achieved the goal of our study: to create a CNN to accurately sort WAP phytoplankton into taxonomic categories. Our overall model achieved an f1-score of 93.7% with an increase to 96.5% for merged taxonomic groupings. This indicates that our phytoplankton imagery data can be successfully and accurately sorted with machine learning techniques, greatly reducing the time spent classifying these images manually. Absolute comparisons to classification algorithms from previous studies is challenging given different numbers of classes, data filtering schemes, and methods for determining what constitutes test data, but in general these metrics compare very favorably to other models. The development of regional and global phytoplankton classifying CNNs presents an opportunity to greatly advance our understanding of plankton diversity and ecology.

However, our model f1-score dropped dramatically from 93.7% during model development to 46.5% during model validation on a new, random dataset with a class distribution representative of that found in natural waters. We believe that this large decrease in model accuracy is a key challenge rarely addressed in the literature. One reason for this decrease is the highly imbalanced class distributions of naturally occurring phytoplankton assemblages compared to our model testing

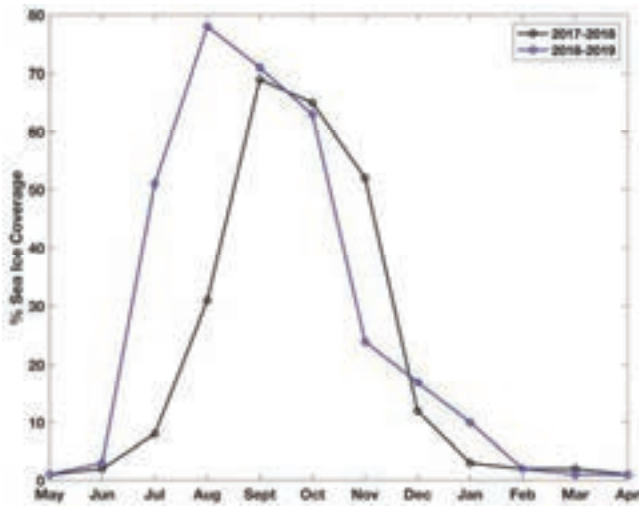


Fig. 3. Percent sea ice coverage in the 200 km area south and west of Palmer Station during the 2017-2018 season (black) and the 2018-2019 season (blue).

dataset (e.g., see n values in Table 1). Model categories such as detritus are highly abundant in our dataset, often composing up to 50% of the biovolume in a sample, while other ecologically important groups, such as large, morphologically distinct diatoms including *Corethron penatum* and *Eucampia antarctica* are encountered sporadically in our dataset. A minor misclassification of detritus as a rare class can easily overwhelm that category.

Nearly all previous studies report accuracy for a balanced and curated test dataset rather than a random sample of natural waters. During model development a balanced class distribution is necessary to ensure the model equally weights each category during training. For example, if during model development a single class composed 90% of the training dataset, the model could classify every sample as that class, ignoring all others, and be 90% accurate. The gradient descent optimization algorithm would never learn any other classes. In the few studies that do report accuracy in natural samples, our drop-off is similar (See Table 2 in [13]).

The classes being naturally highly imbalanced creates several model development choices, including whether to exclude, up-sample, or augment low incidence classes, and how specific model classifications should be (e.g., high level classes like diatoms, dinoflagellates, etc. or species level classes like *Thalassiosira* and *Gyrodinium*). We tried to strike a balance in our model setup by eliminating rare classes or merging them into broader groups while keeping groups morphologically distinct to prevent model confusion. However, there remains a degree of high intraclass variance and interclass similarity in morphology that was impossible to eliminate (e.g., 14.9% classification accuracy for “other”; Table 1). This challenge can be addressed on the other end of model development, by filtering samples where model uncertainty is high. The CNN outputs a confidence score (from the Softmax classification layer) for each prediction from 0 to 1 that can be used to filter samples below a certain threshold. While potentially increasing the model accuracy, this

could also bias the system against certain classes that are challenging to classify, and thus was not implemented in this work.

Another potential cause of reduced model accuracy is data labelling errors. Theoretically, manual identification of images should be close to perfect, but unfortunately this is not the case. In this work and most others, there is often a bias for training and test data that is easily identifiable by manual validation, which prevents test metrics from translating exactly to the wild. There are also many images with conglomerations of cells including detritus and multiple living species. While these may be manually sorted into a category labelled “multiple” and discarded from the analysis, a CNN might sort these images into the most prominent class present within each image. Additionally, morphologically ambiguous cells may be sorted more accurately by a CNN than by manual identification, as a CNN can mathematically match image attributes to potential groups. One way we attempted to eliminate a portion of these ambiguous cells was to exclude all cells with a major axis length less than 25 pixels ($7.35\ \mu\text{m}$) prior to model training. These small cells are below the quantifiable limit of detection based on instrument resolution, and thus have a high probability of being incorrectly identified. Accurately classifying these smaller cells will likely require techniques other than imaging. The issues of class imbalance can also magnify labelling errors, especially when these errors are within abundant classes such as “detritus”.

B. Phytoplankton Seasonal Succession at Palmer Station

Like other studies, we found that following a winter with low sea ice (2017), the phytoplankton community had less diatoms, and more mixed flagellates and cryptophytes, and following a winter with high sea ice (2018), the community was dominated by diatoms (Figs. 1, 3, Table 2) [9], [17]. Following trends found in previous years at Palmer Station [9], we also saw diatoms dominate in the early and late season, and higher cryptophyte concentrations in December and January.

Along the WAP, phytoplankton show strong interannual and regional variability timed with light availability and sea ice retreat. As day length increases in austral spring, solar warming and sea ice melt stabilize the upper water column allowing phytoplankton to remain near the surface in waters with high light availability [18-19]. These conditions initiate large diatom-dominated spring blooms, as we saw in 2018 [20-21]. In 2017, there was 52% sea ice coverage in November, likely inhibiting light penetration and subsequent phytoplankton growth. Dramatic reduction in sea ice coverage between November and December indicates that the ice was rapidly advected out of the region, reducing sea ice melt near Palmer Station and potentially reducing the stability of the upper mixed layer. In 2018, although sea ice retreat is six days later than in 2017, November sea ice coverage is only 24%, allowing adequate light for phytoplankton growth. Additionally, the sea ice lingers into December and January (17% and 10%, respectively), providing a stable environment for growth well into the summer. Matching our results, [22] found that rapid sea ice retreat was associated with lower proportions of centric diatoms during the spring in Ryder Bay, Antarctica (Fig. 2). Sea ice can also hold populations of ice algae, which can seed coastal regions during melting in spring [23]. It is possible that with rapid sea ice advection from the

region in 2017, less ice algae were released to the coastal region near Palmer Station than in 2018 when sea ice lingered and contributed more meltwater.

Despite differences in phytoplankton abundance and community structure between the two years, there were similar trends in the diatom community. The early season was dominated by large centric diatoms $> 20\ \mu\text{m}$ timed with sea ice retreat as described above. As both seasons progressed, centric diatoms became smaller ($< 20\ \mu\text{m}$), and the abundance of pennate diatoms $< 10\ \mu\text{m}$ increased (Fig. 3). A explanation for this size shift is the increasing amount of glacial meltwater from January to March [24]. Stronger surface stratification due to increased ice melt can reduce nutrients in surface waters, giving an advantage to smaller phytoplankton with high surface-area-to-volume ratios and reduced sinking rates [26]. Additionally, [25] experimentally exposed phytoplankton populations from Potter Cove, Antarctica to low salinity conditions (30 PSU) and found a decline in the abundance of large centric diatoms from $\sim 90\%$ on day 2 to $\sim 0\%$ on day 7, and an increase in abundance of small pennate diatoms from $\sim 0\%$ on day 4 to $\sim 95\%$ on day 8. They attribute these changes to differing osmotic stress tolerances: in large centric diatoms, a decrease in salinity caused cell size increases, compression of chloroplasts, granularization of the protoplasm, and retraction of the cytoplasm, while some small pennate diatoms (e.g., *Fragiliariopsis cylindrus*) may contain genes beneficial for adaptation to extreme environmental conditions in polar oceans and sea ice. Thus, increases in glacial meltwater in late summer could cause diatom communities to become smaller and increasingly dominated by pennate cells as we observed.

C. Conclusions and Next Steps

Our CNN is a step forward for understanding phytoplankton ecology along the WAP. However, there are still improvements to be made before it becomes a long-term tool for the community. As explained above, an important issue to address is class imbalance compounded with labelling errors of abundant classes. One potential way to better represent these undifferentiated classes (e.g., “detritus” or “multiple”) is to use unsupervised methods (e.g., non-linear dimensionality reduction, clustering, and manifold learning) to break these classes into several new groups. Defining classes purely via data rather than taxonomy could help models with potentially more easily separable decision boundaries. These techniques could also reduce manually labeled training data needs with semi-supervised classification, and in many cases unsupervised techniques may be sufficient for answering questions about phytoplankton dynamics without any need for supervised classification [27]. Another method could be to use a stage-wise approach, with a one-class-classifier or binary classification to exclude “detritus” and “multiple” images up front to limit the spread of these issues into the full output range which is exacerbated by the prevalence of these classes. In tandem to improving the classification itself, per class uncertainty estimates (sensu [13]) will be critical to unbiased extrapolation from CNN output to ecological dynamics.

With further increases in model accuracy, we hope our model will become a helpful tool for phytoplankton research. Long-term warming and sea ice declines along the WAP are

contributing to shifts to smaller and less abundant phytoplankton populations [6], and these trends are likely to continue. Understanding the seasonal and spatial dynamics of phytoplankton diversity is integral to contextualizing how communities will change in the future. Beyond the CNN’s ability to rapidly classify entire seasons of collected phytoplankton imagery, it can also be used to characterize phytoplankton communities in near-real time. Getting a snapshot of species and cell size dynamics soon after collecting a sample would aid in opportunistic sampling while still in the field. This would be invaluable, as research time in Antarctica is both limited and expensive.

Lastly, the PAL-LTER is not the only group experiencing these challenges: there is a broad IFCB user community searching for methods to automate sample classification to reduce the need for manual image validation. Various groups are independently creating phytoplankton CNNs and other models for their study sites of interest. We implore the community to begin reporting their model metrics on data with distributions representative of the natural environment, sharing labeled data openly on freely accessible platforms (e.g., EcoTaxa, IFCB Dashboard), and sharing open and reproducible code for processing and model development. As models improve, the community may be able to develop a series of regional models, freely available to download and classify a worker’s data, or even a single generalizable model usable for the world oceans. Moving forward towards this vision, it will be critical for oceanographers to collaborate with computer scientists and modelers, incorporating the best computer vision and classification techniques to these datasets to ultimately better understand phytoplankton dynamics in a changing ocean.

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Background on OCEANS 2022 Chennai

M. A. Atmanand, General Co-Chair of OCEANS 2022 Chennai



As the OCEANS 2022 Chennai, one of the long-cherished aspirations of the entire OES communities in India, is fast approaching, I shall share some of my random thoughts on the chronicle of events that led to the culmination of it from a professional perspective.

It all started with the initial visit of Dr. Jim Collins who served the IEEE OES in various capacities and who happened to visit the port of Kochi on the southwest coast of India during a vacation cruise on the Regal Princess in April, 2003. In anticipation of that visit Jim arranged to meet with Dr. P.R.S. Pillai, the only regular member of the IEEE OES in the local area. At that meeting, to discuss activities of possible mutual interest, they identified the biennial Symposium on Oceans Electronics (SYMPOL), organized by the Cochin University of Science and Technology (CUSAT), as a possible focus of cooperation with the IEEE OES. It was this initial meeting, which Dr. Jim had with Professor Pillai, that sowed the seeds for the formation of the IEEE OES Chapter in India.

I had the good fortune of getting associated with Prof. Pillai, as well as Dr. Jim, and the idea to have an IEEE OES chapter in India started gaining momentum. Jim, who has been a strong supporter of the OES communities in India, served as the link between OES members in India and the IEEE OES. This perpetual interaction and association led to the formation of the IEEE OES Chapter under the India Council, which was formally inaugurated by James McFarlane, a pioneer Ocean Technologist in 2008, and I was fortunate to get associated with this Chapter as the founder Chair. Over some time, Prof. Pillai, Prof. Bahl, Dr. Ramadass and Dr. Venkatesan were Chairs and the chapter was very active. Since the formation of the IEEE OES India Chapter, the entire OES communities in India have been working to bring one of the OCEANS to India, in the near future.

In the meantime, myself and Prof. Pillai started attending the OCEANS and our strong desire to host one of the OCEANS in India was presented at the meetings of the OES AdCom and RECON. As the AdCom was not fully confident of the success of organizing the OCEANS in India, the AdCom suggested organising first an Underwater Technology Workshop in 2013, followed by an Underwater Technology Symposium in 2015, jointly with the OES Japan Chapter to establish the competence of the OES India Chapter. Both the events were organized successfully by the OES India Chapter, in a befitting manner.

I took the initiative to hold the OCEANS conference in India with the support from the National Institute of Ocean Technology (NIOT), where I had risen to the position of Director. Our efforts to organize the OCEANS in 2018 and 2020 were not that successful, due to the commendable track record of Japan and Singapore in hosting the OCEANS. Thus, the OES India



Inauguration of IEEE OES India. Dr. Kathirolu (then Director of NIOT) speaking, on the dais—Dr. Atmanand, Dr. James Mc Farlane, Dr. Goel (then Secretary Ministry of Earth Sciences, Govt. of India), Prof. Pillai.

Chapter had no options, other than going ahead with the OCEANS 2022 Chennai, on the southeast coast of India. Meanwhile, to our surprise, the India council disbanded all chapters under them and we had to form IEEE OES under the local chapter, IEEE Madras, without our concurrence. This was also successful and this year we got approval for the same and we have Prof. Sannasiraj, a senior professor from the Ocean Engineering Department of Indian Institute of Technology, Madras as the Chair.

The event is jointly organized by the pioneers of India in the field of Ocean Technology, the Indian Institute of Technology (IIT) Madras, and the National Institute of Ocean Technology (NIOT), Chennai, and is scheduled during February 21–24, 2022, both in-person and virtual. The main theme of the conference, INSPIRE-INNOVATE-SUSTAIN, is expected to attract about 1000 delegates with 500 papers being planned for presentation along with a good number of plenary sessions with talks from leading personalities around the globe contributing to the field of Ocean Engineering and technology.

With technical paper presentations, tutorials, social and networking opportunities, professional field trips, etc. OCEANS 2022 Chennai will provide the delegates an insight on evolving technology and knowledge in the areas of:

- UN Decade of Ocean Science for Sustainable development
- Underwater Acoustics and Acoustical Oceanography
- Sonar signal/image processing and communication
- Ocean Observing Platforms; systems and instrumentation
- Remote Sensing
- Ocean Data Visualization, Modelling, and Information Management
- Marine Environment, Oceanography and Meteorology
- Optics, Imaging, Vision and EM Systems
- Marine Law, Policy, Management, and Education

- Offshore Structures and Technology
- Ocean Vehicles and Floating Structures
- Petroleum Engineering

Some of the top plenary speakers are Dr. Margaret Leinen, Director, Scripps Institute of Oceanography; Dr. Satheesh Reddy, Secretary Department of Defence R&D and Chairman DRDO; Dr. Peter Haugan, Former Chair Intergovernmental Oceanographic Commission, UNESCO; Programme Director at Institute of Marine Research, Professor at the Geophysical Institute, University of Bergen, Norway; Dr. Shailesh Nayak, Former Secretary, Ministry of Earth Sciences to name a few. A panel discussion on the current topics of interest like Global warming with leading speakers also is planned. A student poster session featuring outstanding projects from around the globe is another event. Student Hackathon competition and

other student activities will also be at the conference. Women in Engineering program and Early Career Ocean Profession program are also part of the event. A plethora of exhibitors showcasing their latest innovations will be another event.

It is my pleasure to welcome and invite all of you to register and attend the conference. Now that Covid restrictions are eased out, please attend in person. All safety precautions will be in place. For complete details visit <https://chennai22.oceansconference.org/>.



WHERE ENGINEERS MEET SCIENTISTS

IEEE Oceanic Engineering
Society (IEEE OES) Sponsored
Technical Sessions

@
OCEANS SCIENCE
MEETING 2022
(OSM22)

February 27 - March 4, 2022
Honolulu, HI, USA



Engineering and technological solutions are instrumental to study and understand the science of our oceans better. OSM 22 provides a unique opportunity for a closer interaction between ocean science and engineering communities. Realising this potential IEEE OES is sponsoring a list of scientific sessions and a Town Hall session for OSM attendees as listed below

Scientific Sessions

- OD06: Machine Learning for Oceanographic Applications.
- OD14: Digital Ocean.
- OS05: Marine Litter and Microplastic Monitoring and Understanding.
- OS11: Observing and Predicting the Global Coastal Ocean.
- OM01: Pairing autonomous monitoring with modeling to expand capacity and develop new understanding of coastal ocean systems.
- OT17: Ocean Observation for the Small Island Developing State (SIDS).
- HL24: Autonomous Sensing and Monitoring in Polar environments.

Town Hall

- Connecting Early Career Scientists with Academia and Industry Experts

SUBMIT YOUR ABSTRACTS NOW

Your contribution matters. To submit your abstract online visit the conference website by clicking on the banner below



Contact: jay.pearlman@fourbridges.org



**INSPIRE
INNOVATE
SUSTAIN**



OCEANS
CONFERENCE & EXPOSITION

February 21-24, 2022 | IIT Madras Research Park, Chennai



IEEE Oceanic Engineering Society and Marine Technology Society are presenting a special hybrid format for OCEANS 2022, Chennai. This setup combines the in-presence experience with the opportunities of on-line activities, fostering the networking and social interactions around an interesting program of selected talks and panels.

Now that the registrations are open,
kindly register and confirm
your attendance at

OCEANS 2022
Chennai (India).

The details of the various events, whether you want to join in-person or virtually, & registration categories can be found on the conference website with all the details you would want to know
<https://chennai22.oceansconference.org/>.

INDIA - one of the oldest civilisations in the world, India is a mosaic of multicultural experiences. With a rich heritage and myriad attractions, the country is among the most popular tourist destinations in the world.

CHENNAI - the capital of Tamil Nadu is one of the most popular tourist destinations in the southern fringes of the country. From the resplendent classical dance form of Bharatnatyam to the rich flavours of its iconic cuisine and from the lustrous silk sarees traded here to the gorgeous temples and churches, Chennai is the gatekeeper of South Indian art, culture and traditions.



OCEANS 2022 Hampton Roads is on the East Coast Horizon

Conference Co-Chairs—Ray Toll, Laura Rogers, Daniel Sternlicht

The OCEANS conference is returning to Hampton Roads after 10 years. The conference theme, *Resilient Coasts, Adapting Today to Secure Tomorrow*, focuses on a key priority for the 1.1 million citizens residing in the 7 municipalities that comprise the Hampton Roads region. With the significant Federal presence that exists in the region, highlighted by the largest Naval Base in the world in Norfolk, the conference will be exploring an integrated whole of government/community approach with private public partnerships to study this issue that many across the world are addressing.

See hamptonroads22.oceansconference.org.

Another key aspect to this conference is how we are promoting the mutual technologies and organizations from West Coast to East Coast, springboarding from OCEANS 2021 San Diego this past September to Hampton Roads, followed in 2023 by the Gulf Coast. For example, the US Navy's largest fleet concentration areas exist in San Diego and Norfolk, followed by the Gulf Coast. A key priority for these conferences has been



Virginia Beach Convention Center.

an attempt to link the problem areas and challenges identified in OCEANS 21 San Diego to potential solutions in OCEANS 22 Hampton Roads. The technical tracks and exhibits will therefore follow similar themes in both.

To further the whole of government/community approach, OCEANS 22 Hampton Roads is being cochaired by representa-



King Neptune on Virginia Beach.



Virginia Beach.

tives from NASA, Navy and Old Dominion University (Laura, Daniel and Ray, respectively). Similarly, the Local Organizing Committee and the MTS Hampton Roads section have reps from across the spectrum of government, academia, and business.

We therefore expect a lively and informative conference with in-water demonstrations. We look forward to seeing you October 17–21, 2022.

(Photos taken by Stan Chamberlain at OCEANS 2012 Hampton Roads)



OCEANS

CONFERENCE & EXPOSITION

October 17–21, 2022 | Hampton Roads, VA

Resilient Coasts: Adapting **Today** to Secure **Tomorrow**

2,000 ATTENDEES | 500 TECHNICAL PAPERS | 100+ EXHIBITORS | UNLIMITED OPPORTUNITIES

hamptonroads22.oceansconference.org



Who's Who in the IEEE OES

Lian Lian, an Elected AdCom Member (from 2022 to 2024), OES Shanghai Chapter Chair

I grew up in a family of teachers, having a brother who is two years older than me. In October, 1978, I started my university study at the Department of Ship Design and Manufacturing, Shanghai Jiao Tong University (SJTU), one of the top universities in China. I remember that when I was in my junior year, I fell in love with the discipline of underwater vehicles after listening to a lecture about that. Then, I decided to apply for the postgraduate study of this major. In September, 1982, my dream came true and my career in underwater vehicle research started. In January, 1985, after receiving my master's degree in engineering, I joined SJTU as a teacher and researcher. At the beginning of 1994, I was invited to Germany as a guest scientist of GKSS Research Center to participate in a Sino-German joint project. In just one year, I worked very hard and learned advanced technology, and more importantly, learned a different way of thinking, and completed my research. At the beginning of 1995, I decided to return to China as I missed my family badly, even though the German side offered me a chance to stay. I still remember my answer to "Why do you want to go back while almost everyone else is seeking for a chance to stay?" was "I love and miss my family and my country, and I want to be the master of the country not just a guest." I think this was the very reason that drives me home.

The year 1998 was an important milestone in my life, when I got the Youth Fund Project funded by the National Hi-Tech Program (863 Program), and then from hundreds of candidates I was selected as a member of Expert Group of 863 Program by the Ministry of Science and Technology at the beginning of 1999, as one of the youngest members of the expert group. For the next two years, I worked with the older experts, led by world famous physical oceanographer Prof. Jilan Su, an Academician of the Chinese Academy of Sciences, from whom I learned a lot. These two years of experience had greatly influenced my knowledge structures, scope and vision, even the project management. After that, I had been serving 863 Program for 11 years, till 2011. Therefore, since 1999, I have been engaged in the National marine strategic planning and project management while carrying out university scientific research and teaching, which was the most memorable and precious experience in my life.

As the marine technology team principal investigator, I have been leading my team and concentrating our efforts on underwater vehicles, including ROV, Smart Float, Hybrid Aerial Underwater Vehicle, sampling systems, with all these researches supported by either the National funding or Shanghai Municipal Government. Of all these research projects, what I am most proud of is the "Haima-4500" ROV, which was initiated and funded by the 863 Program at the end of 2008. In April, 2014, China's first ROV, capable of operating at a depth of 4,500 meters, underwent a successful



Lian with Haima-4500 at sea.



Lian at sea trial.



Lian with family.



Lian with daughter at campus-2.

trial in the South China Sea. This ROV was named “Haima” (sea horse in English) as 2014 was the Year of the Horse. Designed for deep-sea observation, sampling, and heavy-duty operations, “Haima-4500” had been a landmark achievement in China after “Jiaolong” (manned submersible) and signified China’s innovative capability to develop and utilize deep-sea Work-Class ROVs. Since then, “Haima” series ROV products were built, such as “Haima II”, “New Haima”, “Haima-2000” and “Haima-500”, which further consolidated my team’s leading position in ROV and its key technologies in China.

In 1998, I attended UT’98 in Tokyo, and met Prof. Ura and Harumi. It was my first IEEE/OES activity, the starting point of my engagement with IEEE OES. Now I have been an active member of OES for more than 20 years, and have been serving as the Chair of IEEE OES Shanghai Chapter since 2011. I still remember that day when Prof. Ura and Harumi came to

Shanghai from Wuxi where the UT’09 was held. They offered me a chance to bring OCEANS to Shanghai, which would be the first OCEANS in Chinese Mainland. Since then, I had worked with my team for about 7 years. In April 2016, OCEANS’16 Shanghai was held in Shanghai with total attendees about 950. The experiences of serving the society have given me a deep understanding of the fundamental goal of the society and the role we should play as the society leaders.

Now I am going to talk about the most favorite part—my family. I have a happy, loving family and a sweet daughter. My husband is always understanding and supportive at work. Recalling the road I have walked on is full of hardships, bitterness and even tears. There have been many times I want to give up, and want to escape. It was my husband who is always behind me to support me, encourage me to move forward, and even push me forward whenever I hesitate and shrink back.

Due to the needs of my work, I often go on business trips once a week, sometimes without weekends for several months. My colleagues and friends joke that I am a “flying trapeze”. I have asked many men who travel a lot whether they feel guilty about being away from their families, and the answer is “no”. EVERY time I go on a business trip, I deeply feel sorry for my family. I always believe that career and family complement each other. But you have to do your best to balance career and family, switching different roles from career woman to mother, wife, daughter and daughter-in-law. For me, my family is the main part of my life. My home will always be the harbor and haven of my work and life. Everything I put in is rewarded with my husband’s understanding and support, and my daughter’s wisdom and understanding.

I have always liked the saying that working keeps you beautiful. As a woman, only by integrating into the society and giving full inspiration to her potential, can she stay young forever. Only by loving your family and fully showing the tenderness of a woman can you be beautiful forever.



Lian with daughter at campus-1.

Member Highlights

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

Life on the Small Island

Tamaki Ura

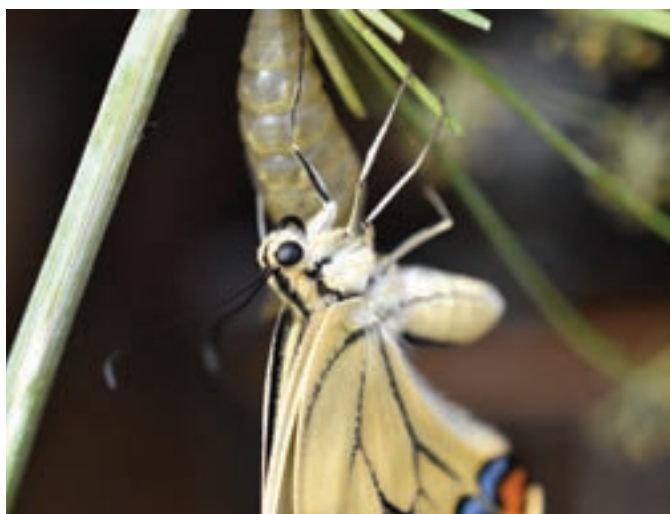
Tamaki Ura (fellow of IEEE), Prof. Emeritus of the University of Tokyo, is retired from the university and lives in a small village on Fukue Island in the Goto Islands, a tiny island on the western edge of Japan. He lives a peaceful life, waking up to the sun rising behind an offshore floating wind turbine, working on the farm and taking photographs of the insects. This summer, while working as a senior AUV engineer, he enjoyed taking care of the swallowtail butterflies (*Papilio machaon*). This morning, two swallowtails emerged from chrysalises, so he had a lot of work to do!



Swallowtail caterpillars.



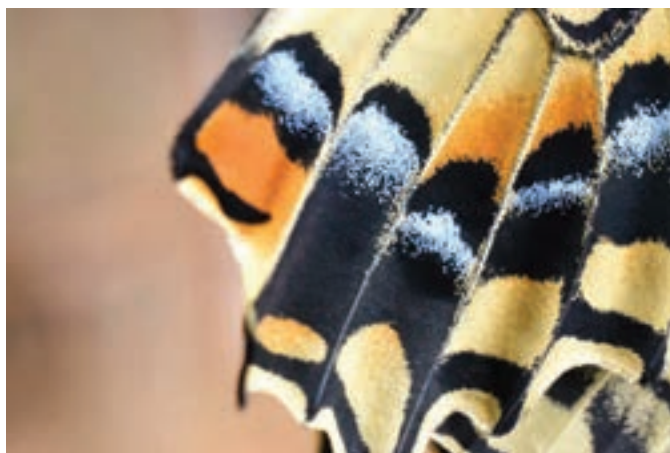
Fukue Island (red mark in the map).



Metamorphosis.



Sunrise behind the offshore floating wind turbine.



Beautiful design on the skirt.

Scribes of Scripps Ranch

Robert Wernli

Robert Wernli, Co-editor of the Beacon, was recently recognized by his local community of Scripps Ranch. Their monthly newsletter, with a distribution of over 12,000 copies, periodically includes articles on “Scribes of Scripps Ranch,” which recognizes local authors. “When I was interviewed for the article, I never thought I would make the cover of the newsletter. I felt highly honored.”

The interview, and the subsequent article, discussed how he got into writing and his approach to complete and publish his books. He is widely published in both technical books and techno-thriller fiction novels. The article can be seen on his website: wernlibooks.com.



Request for OES AdCom Nominations

Nominees for the Term 1 January 2023–31 December 2025

Jerry Carroll, Chair of IEEE/OES Nominations and Appointments Committees

The IEEE OCEANIC ENGINEERING SOCIETY is governed by an Administrative Committee of 18 members. Six are elected each year to serve three-year terms. Members are limited to two consecutive terms, although they may be reelected after a lapse of one year. This will be the thirty-eighth election to be held to determine the membership of our Administrative Committee (AdCom).

This year, the Nominations and Appointments Committee is chaired by the Senior Past President. The committee is charged with proposing a slate of nominees each year. For this election, twelve members of the OES will be nominated to fill six positions on the AdCom for the three-year term 1 January 2023–31 December 2025.

Qualifications for Administrative Committee membership are membership in the IEEE and OES, and a willingness to serve the oceanic engineering profession. The Society wishes to have the Administrative Committee characteristics to reflect characteristics of the IEEE membership. I ask that each of you identify and nominate qualified candidates for the Administrative Committee. Self-nomination is encouraged.

The nomination Packet should include a Letter of Nomination accompanied by a one-page biographical sketch of the proposed candidate with picture and one-page statement from the proposed candidate giving his or her views of the opportunities and challenges facing the Society and steps to be taken to advance the IEEE Oceanographic Engineering Society.

The election will be conducted in accordance with our Bylaws. Follow this link to read the Bylaws: <https://ieeoees.org/about-us/bylaws-of-the-ieee-oceanic-engineering-society/>. The Bylaws specify that general nominations close on *March 1*, and nominations by petition close by *April 15*.

Please submit nominations to the undersigned starting 1 January 2022. Please do not delay your efforts in finding and nominating qualified candidates. Send your nominations to:

Jerry Carroll
Chair of IEEE/OES Nominations
and Appointments Committees
SrPastPresident@ieeoees.org

Welcome New and Reinstated Members

Australia

Paul James Darwe

Canada

Matthew Cockburn

Nicolas Ewen

Chile

Gustavo Bore

Jorge Barria

Francisco Ignacio Eterovich

Bastian Daniel Munoz

Giancarlo Troni

China

Yanan Liu

Croatia

Goran Borkovic

Mak Gracic

Denmark

Simon Pedersen

France

Mohammad A Khalighi

Germany

Philip Ridder

India

Sujaatha A

Poornima B

Vaidhegi K

Priyadharshini Kumar

Kharthick Rham M

Suriya M

Lakshya Nahar

Sharvaani P

Pamila R

Prabu Kumar Venkatraman

Agritha Vijay

Israel

Avi Abu

Italy

Carlo Convevole

Lorenzo Pollini

Malaysia

Mat K Awang

Nigeria

David Adegbola Adeniran

Norway

Andrea Marinoni

Peru

Francisco Cuellar

Portugal

Jose Miguel Soares Almeida

Puerto Rico

Jobel Yometh Villafane

Pagan

Singapore

Michael Lochinvar S Abundo

Huan The Hoang

Luyuan Peng

Esther Tan

Turkey

Ali Serpenguzel

Murat Uysal

United Kingdom

Arturo Beltra Soler

Luisa Heron

Arman Khan

USA

Hameed Jimoh Ajibade

Chris A Allison

Abigail Bean

Bradford Paul Bittle

Travis Douglas Cuprak

Lisa Durbeck

James DeAndre Epkins Jr.

Peter W Furze

Philip Andrei Green

Patrick B Hall

Sam D Heron

William Frost Jenkins

Douglas McCormick

Cynthia A Palmer

Nahruma Mehzabeen Pieu

Andrew Thomas Pyzdek

Grant Rawson

Jose Rivas

Benjamin Rossmiller

Shihab Hossain Saran

Tim Snyder

Mark A Talbott-Williams

Sarah Watson

Teresa Whitmore

Eric Younkin

Report on SCHOOL Level Short Video Competition

Indian Institute of Technology Delhi (IITD) OES Student Branch Chapter

The Coronavirus (COVID-19) pandemic has caused a lot of damage and has affected the lives of millions of people, especially the school students. The impact on academic and co-curricular activities, due to school closures, resulted in social isolation and has affected all students. Keeping in mind the holistic development of the children, we planned to organize an online competitive activity to explore and keep the creative side of children running during the ongoing COVID-19 lockdown period.

We are living in the era where environmental conditions are at an alarming state. Apart of natural resources, major cause of the increasing level pollution is anthropogenic contaminants and many others. To increase the awareness among the most important link of our society chain, the school student, and to engage students in productive activities, we have organized a virtual competition where they were to produce a video highlighting the air/water/sea pollution causes/remedy/conditions. We termed it as **“SCHOOL Level Short Video Competition on Pollution and Efforts towards Promotion and Protection of Environment.”** This competition aimed to recognize the creative efforts towards promotion and protection of the environment from various kinds of pollution, with special emphasis on Air Pollution and Marine Pollution.

The competition was organized for two categories: one was for 6th to 9th class students and the second was for students of class 10th to 12th. Entries were invited from all the national wide schools. For getting a wider audience, we published our event poster through our webpages, social media, as well as our dedicated committee for communicating emails with schools. More than 50 entries in each category were received in which students had made animated videos, as well as documentary videos, on the various kinds of pollution.

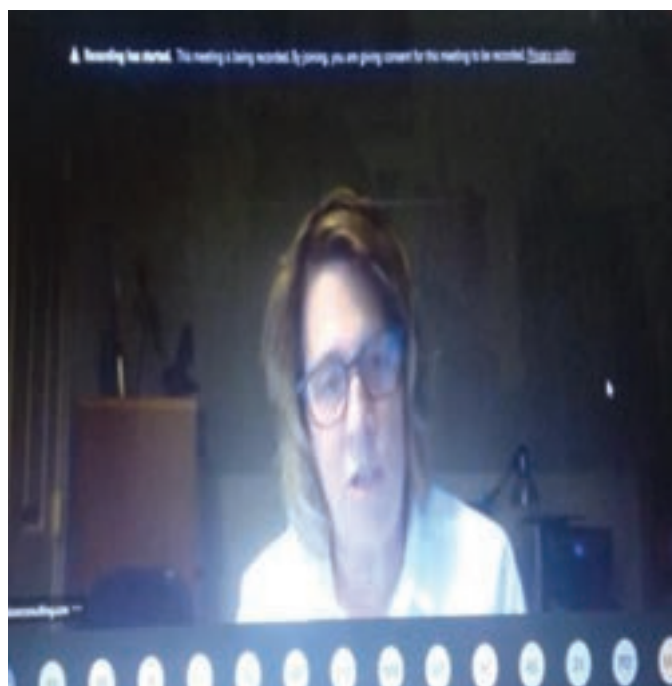
It was really difficult to shortlist the entries, but we selected a total of 15 students based on uniqueness, engagement, information, creativity and research base. On 4 July, 2021, the shortlisted students were invited in a virtual mode. The selected candidates presented their video to the chief guest, judges, and a wider audience. Judges evaluated the participants based on Communication & Presentation skills, problem definition, protective measures and how informative.

Ms. Zdenka Willis, President, Marine Technology Society, was the chief guest. She talked about the career opportunities in the marine sector, about MTS awards, scholarship funds for college graduates, undergraduates, and senior high school students who have been accepted into full-time marine-related programs. **Dr R.Venkatesan, NIOT** enlightened the students with benefits of membership as well as opportunities for students. **Prof. Monika Agarwal** talked about the advancement

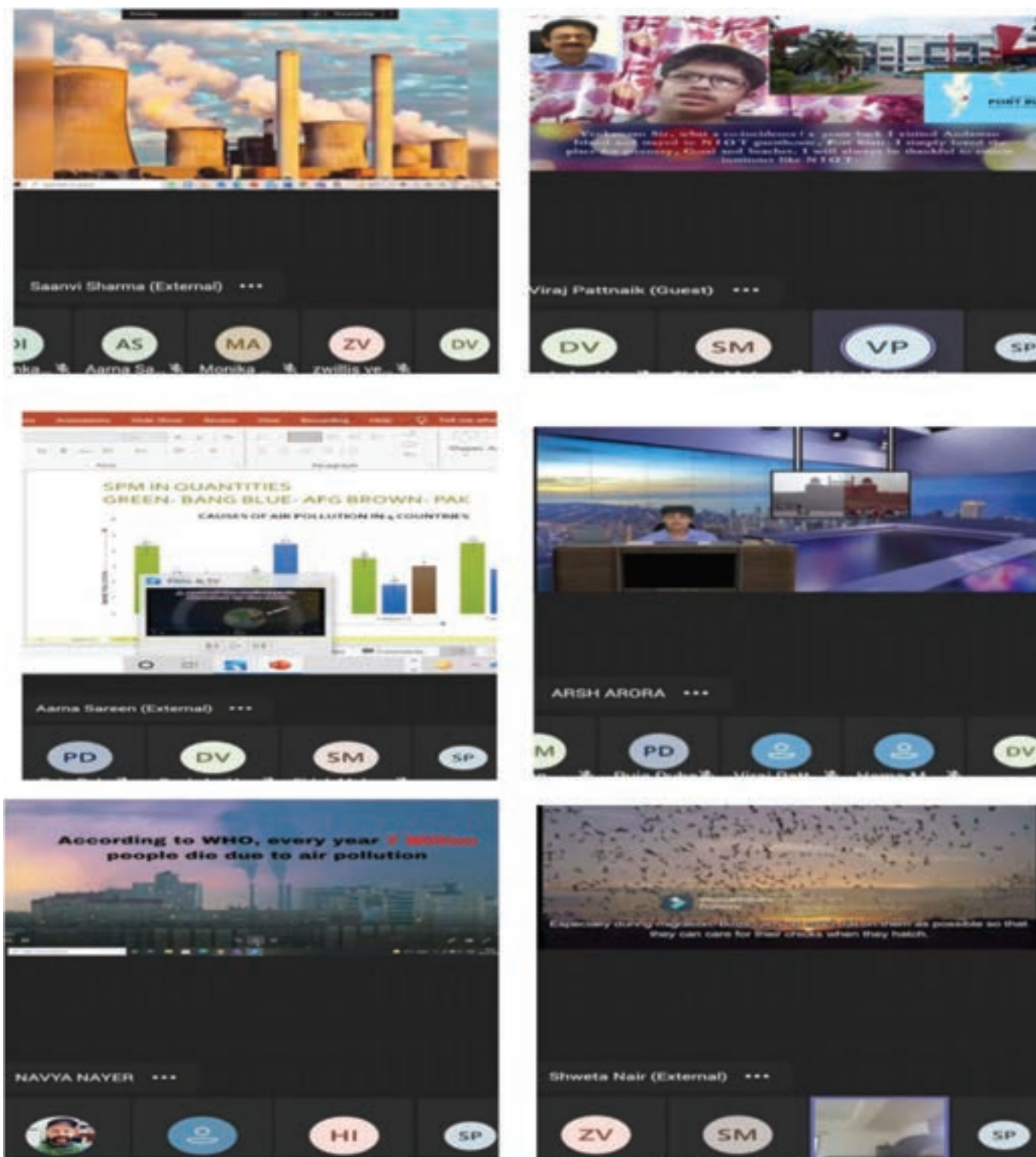
and development of the tools and procedures required to explore, study and further the responsible and sustainable use of the oceans. She facilitated a broader understanding of the



Incredible Judges Panel.



Speech By Chief Guest.



Participants Presenting their Videos.

relevance of marine technology to wider global issues by enhancing the dissemination of marine technology information. **Dr. J. Preetha Roselyn** envisaged students on the importance of communication skills and conceptual thoughts for their career development. Such skills are essential to become professional leaders in the areas of teaching, research and industrial

practice. Almost 100 enthusiastically attended the event. Even **Ms. Zdenka Willis, President, Marine Technology Society**, who initially gave 15 mins for the event, stayed for the complete two hours actively.

To encourage the selected candidate, we finally conducted another event as a **prize distribution ceremony** on 25 July,



Group photos.

2021. All the judges and Principals of the school of the top ranked participants were invited. We played most popular videos on that day as

Shweta A. Nair presented her video on less talked about pollution named Light Pollution.

Aarna Sareen gave a very informative presentation about air pollution.

Bhoomi Shukla made a presentation focused on the marine plastic pollution.

The top 3 winners from each category were awarded with the reward certificate. Best videos and winners' posters were uploaded on our website (WHAT IS THE LINK?). First rank holder from the category 1 is selected to present her video on **UN Decade Event endorsed by United Nation** going to held on 14th September.

Our team put all the efforts into conducting this event, with many meetings and coordination handled by our team so that the event can go on smoothly.



Winner List.



Prize Giving Ceremony.

Winner's list

Category 1			
Rank	Name	Class	School
1	Shweta A. Nair	VI	The Mother's International School, New Delhi
2	Namya Madan	VII	The Mother's International School, New Delhi
3	Shlok Maheshwari	VIII	The Mother's International School, New Delhi
Category 2			
Rank	Name	Class	School
1	Aarna Sareen	X	The Mother's International School, New Delhi
2	Viraj Pattnaik	X	Tagore International School, New Delhi
3	Bhoomi Shukla	XII	Kendriya Vidyalaya (A.G.C.R), New Delhi

Breaking the Surface 2021

Nadir Kapetanović, Anja Babić, Ivan Lončar, Igor Kvasić, Barbara Arbanas, Matej Fabijanić, Jura Vuković, Maja Magdalenić, Goran Borković

OCEANS 2021 Activities

In the week leading up to Breaking the Surface (BtS) 2021, our members were busy not only participating in the OCEANS 2021 conference, but also chairing some sessions. Anja chaired the session Buoy Technologies and presented her paper titled *Developing the concept of multifunctional smart buoys*. Igor presented his paper, *Diver-Robot communication using wearable sensing diver glove used in ADRIATIC project*, in the session Classification and Pattern Recognition (Parametric and Non-parametric), which he chaired. Nadir also chaired his session, Vehicle Design 1, where he presented the paper *Towards a Heterogeneous Robotic System for Autonomous Inspection in Mariculture* related to the HEKTOR project. Ivan chaired a ses-



Igor presenting his paper in the Classification and Pattern Recognition (Parametric and Non-parametric) session that he chaired.



Nadir presenting his paper 'Towards a Heterogeneous Robotic System for Autonomous Inspection in Mariculture' in the Vehicle Design 1 session.

sion about Access, Custody, and Retrieval of Data. While the virtual aspects of chairing conference sessions seemed somewhat daunting at first, our members managed with aplomb—then dived right back into final BtS preparations, this year once again taking place in-person.

BtS 2021 Workshop

Another very successful edition of the Breaking the Surface interdisciplinary field workshop on maritime robotics and applications was held in Biograd na Moru, Croatia, from 26 September to 3 October. This was the 13th year that BtS brought together experts from the fields of maritime robotics, marine biology, maritime archaeology, maritime security, and marine geology. This workshop is traditionally organized by the Laboratory for Underwater Systems and Technologies (LABUST), and some of our members are instrumental in organizing this event. Our Vice-Chair, Igor Kvasić, was the chair of the technical committee of the workshop, and our other members, Anja Babić, Nadir Kapetanović, and Ivan Lončar, formed the technical committee together with several other LABUST members.

The workshop spanned five days of lectures, tutorials, and demos. The mornings started with a series of talks, briefly interrupted by a coffee break and networking opportunity, while the afternoons were filled with many interesting tutorials, demos, and company presentations. The event was attended by many experienced professionals from both academia and industry. What is particularly interesting about this event, in addition to its highly interdisciplinary nature and the many networking opportunities, is the percentage of students who attend. This year we had the opportunity to welcome many students from different levels of education, from Bachelor and Master students to many PhD students. For them, this workshop



Group photo of all BtS participants.

is a great opportunity to network with some of the most prestigious names in their field of study. BtS supports this exchange through both the formal format of lectures and workshops and a rich program of more casual social events.

One such occasion was an event organized by our Student Branch Chapter on Monday, 27 September. We organized a casual social event with music played by our younger members by the demo pool. Attendees had the opportunity to enjoy themselves and socialize with this musical backdrop—a perfect start to the week as many new contacts were made. We particularly encourage students to introduce themselves to established people in the field, and this relaxed atmosphere certainly helped the cause. Our Chair Anja, introduced our SBC and its activities to the auditorium. We believe that organizing this type of event helps to give visibility to our activities and is also good publicity for the society as a whole.

The workshop was officially closed by a gala dinner and a ceremony led by the BtS program chair and our SBC advisor prof. Nikola Mišković. During the ceremony, the IEEE OES VP for workshops and symposia expressed his satisfaction with another great BtS edition and confirmed the OES support for the next year.

As usual, the event concluded on Saturday with an excursion. This time, participants were taken by boat to the nearby Telašćica Nature Park, where they could enjoy nature and wonderful sights. This was a perfect ending to an amazing week and we can only say that we are already looking forward to next year!



BtS field trip on Saturday.

HEKTOR Project Demo

One of the demos organized during the Breaking the Surface 2021 workshop was the demo about the results of the first half of the HEKTOR project. The demo was held on Tuesday, September the 28th, 2021. HEKTOR (Heterogeneous Autonomous Robotic System in Viticulture and Mariculture) project (<http://hektor.fer.hr/>) is looking for a solution to various issues in mariculture. Mariculture is heavily reliant on human labor, with workers generally doing arduous, repetitive, sometimes even dangerous tasks for long periods of time. Currently, divers must monitor fish farming cages for lengthy periods of time in all weather situations, even the most extreme.

The objective of the HEKTOR project in mariculture is to try for the first time in Croatia to include robotic systems (aerial, marine surface and underwater) in the process of cage fish farming for automated monitoring of fish cages. HEKTOR project proposes a heterogeneous robotic system consisting of an ROV, an ASV and a UAV for autonomous fish cage inspection missions. Based on the data fusion of the individually obtained information, the data from all three robots will be utilized for the final assessment of the fish cages.

The demo was to showcase a catamaran-shaped autonomous surface vehicle (ASV) named Korkyra, developed in-house in the scope of the HEKTOR project, and all its subsystems, namely the pan-tilt-zoom (PTZ) surveillance camera, prototype of the landing platform, mounting of the short baseline acoustic localization system, and the model of the tether management system. Moreover, the integration of the Blueye ROV with ROS2 and the ASV was presented.

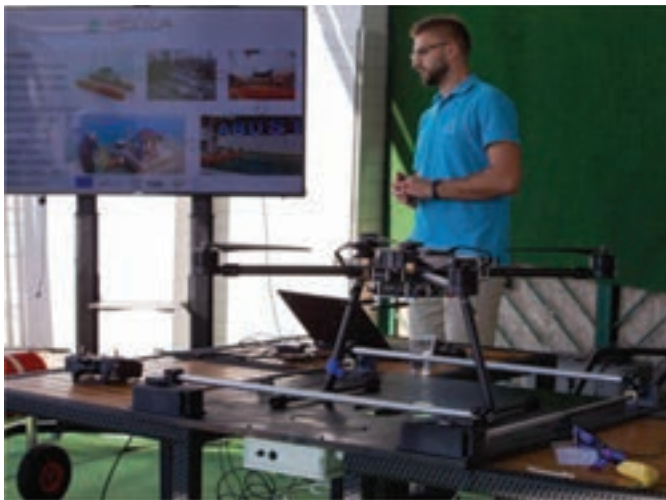
Attendees of the demo were very interested in the heterogeneous robotic system and all its subsystems. A useful discussion was started about topics ranging from visual detection and spatial map representation of biofouling, dual mode control of



IEEE OES UniZg Student Branch Chapter social event at BtS.



Nadir presenting an overview of the HEKTOR project. ASV Korkyra and Blueeye Pro ROV shown in the foreground.



Prototype of the landing platform to be mounted onto the ASV Korkyra.

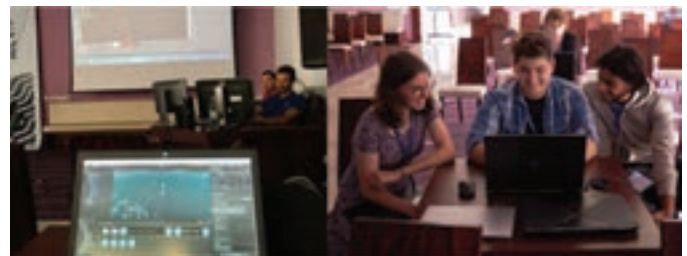
the ASV Korkyra by its 4 T200 thrusters and its booster electrical Minn Kota rear motor, mission planning, situational awareness of the ASV using its PTZ camera, to the performance of the WaterLinked Underwater GPS G2 system with the U1 Locator and future plans for the development of the small-scale tether management system and the landing platform.

Marine Simulator Tutorial

During day three of the workshop a Unity-based marine and maritime simulator developed by LABUST was showcased. The motivation for development of an in-house simulator for marine and maritime sprang from a newly funded Croatian national project, which concerns itself with developing an autonomous ship. Additionally, it is expected that other ongoing LABUST projects will benefit from the developed simulator. With the plan of open-sourcing the simulator to share the work and get constructive involvement from the community, we organized a tutorial. This event had the goal of presenting and demonstrating the simulator to the relevant community. An introductory presentation about the simulator capabilities familiarized the audience with problems encountered when



Ivan Lončar presenting an introduction to the Marine simulator tutorial.



Simulator tutorial held by Ivan Lončar, Natko Kraševac, Luka Mandić, Juraj Obradović and Vladimir Slošić.

developing marine robots and our approach in solving them. Following the lecture, the tutorial engaged participants by tasking them with creating an environment in the simulator, adding a surface vehicle with a multitude of sensors, and finally controlling it in live simulation. After the tutorial, participants gave constructive feedback and showed interest in using it in their own research projects.

BtS 2021 Workshop—Undergraduate Students' Angle

Much like during the previous years, IEEE OES UNIZG SBC tries to gather not only PhD students but also students from undergraduate and graduate studies. This year we invited our undergraduate students to the Breaking the Surface workshop so they got a chance to attend lectures about the state-of-the-art of marine robotics, but also help organize our SBC's technical and social events. Moreover, some of them also had a chance to participate hands-on in HEKTOR project experiments with the Blueeye Pro ROV. Their impressions are given below.

Matej Fabijanić: “Breaking the Surface is an international interdisciplinary field workshop of maritime robotics and applications. The 13th workshop brought together over 100 people from 39 universities and companies all around the world for 5 days of interesting lectures, useful workshops and tutorials, and hands-on demonstrations. With various topics from the fields of marine robotics, archaeology, and biology it would be quite difficult not to find something there that interests you, whether you are still a student or an international expert.

“Having worked with an underwater ROV for my third and final year as an undergraduate at University of Zagreb, specifically at the Faculty of Electrical Engineering and Computing, attending the BtS workshop was a very interesting and cool experience. I was able to catch the first two days of speeches, presentations and demonstrations before college obligations caught up.

“Hearing first-hand experiences from people in the industry, as well as researchers from around the world opened my eyes to just how diverse marine robotics are. Literally spanning from vessels designed for shallow coastal regions and swamps up to submarines designed to dive down 3800 meters to the wreck of the RMS Titanic with a 5-person crew on board. That and everything in between could be seen at BtS this year.

“On the last two days of my stay in Biograd for the workshop I worked closely with researchers and mentors from LABUST, as well as a PhD student from Italy, to test movement algorithms based on computer-vision in a realistic environment. The resort at which BtS was taking place was situated near an Olympic pool filled with seawater that could be used for various testing purposes. Only after dropping the ROV I worked with for a whole year in Zagreb into the pool did we encounter errors and faults that needed to be fixed.

“The topic of my Final Paper dealt with monitoring underwater cages in fisheries in the Adriatic Sea. While working on



Consiglio Nazionale delle Ricerche team having a demo of their SWAMP autonomous catamaran. Courtesy of Maja Magdalenic.

it I rarely had the chance to talk about it with people outside of the faculty who were also team members of the project that the topic was a part of. Coming to BtS was a chance to hear people from all over the world speak about working on closely related problems and about their experience coming up with solutions and realizing them.”

Jura Vuković: “As for underwater systems and technologies I always thought of under the sea, lakes or rivers. I haven’t read a lot about karst explorations and its importance, so I found the presentation about robots for karst exploration really interesting and new for me. Drinking water is the most important thing for humans and sometimes it can be taken for granted. A lot of it comes from underground karst and exploiting these sources under the right conditions can be quite a challenge. Because of that, we should invest into researching this area. The presentation explained how the teams explored karst with robots as, due to the great difficulties and dangers of the terrain, divers intervening means risking their life. In my opinion, there is a future in researching these vast underground horizons.

“Since I was working with underwater robots for my undergraduate project and BSc thesis and since I am generally very interested in the field of marine robotics, attending the 2021 BtS workshop was a huge pleasure. The lectures that were



Lionel Lapierre presenting the lecture titled “Robots for Karstic Exploration”. Courtesy of Goran Borković.



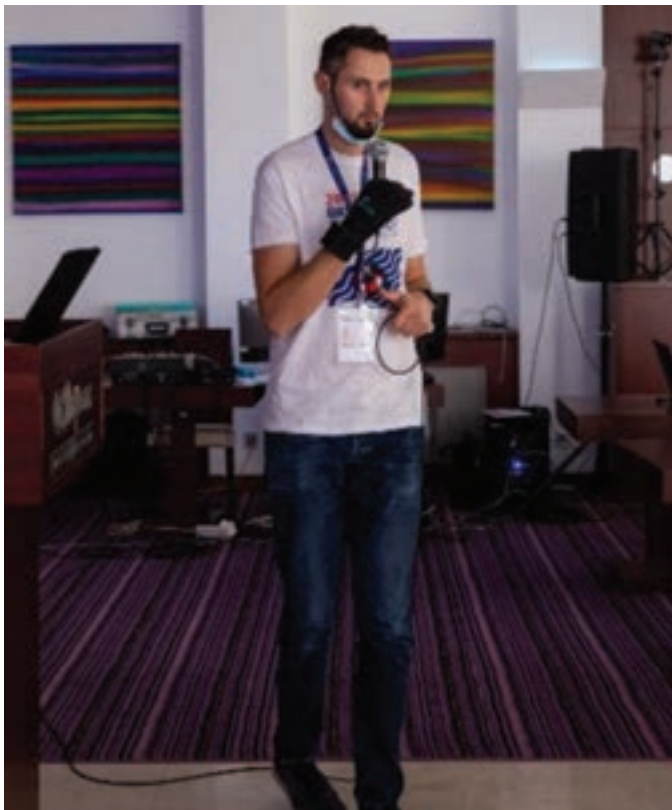
EvoLogics company demo. Courtesy of Maja Magdalenic.



*Dula Nađ presenting ADRIATIC project tutorial.
Courtesy of Maja Magdalenic.*

presented were very interesting and the research done by participants is something I thought you could only see on the Discovery channel.”

Goran Borković: “I was very intrigued by the story about how even when not using advanced, expensive robots but rather some relatively simple devices for data collection purposes, it can be very challenging when dealing with large depths and ocean conditions that are hard to predict. There were also many examples of how much marine robotics and marine research is used for solving different problems that we face today. For example, underwater robots that can be used for discovering and exploring flooded cave systems that are inaccessible to humans



Igor Kvasić introducing wearable sensors in form of a gesture recognition glove. Courtesy of Maja Magdalenic.

and are potentially large sources of much needed drinking water. Also, as mentioned before, without a special probing device it is impossible to collect sufficient amounts of data (temperature, salinity, pH) that is for example mandatory for assessing the state and dealing with global warming.”

Maja Magdalenic: “As a guest of the BtS workshop, I had the opportunity to hear and see plenty of new things that have been developed or are still being developed in the field of marine robotics. Since I am interested in marine robotics and I am also a big fan of diving, what intrigued me the most was the Adriatic project, which aims to improve communication between the diver and his robotic partner, while the ultimate goal is to improve diving safety. Communication between robots and humans in general can be a challenging task, while in underwater conditions it’s even more difficult to accomplish. The development of such underwater communication can be very useful for detecting potential danger for a diver or sending help signals. The robotic partner is very useful, especially for diving in high-risk areas, as we don’t need a live diving buddy this way.



Student attendee discovering underwater scene by controlling a virtual diver as a part of Adriatic project experiment. Courtesy of Maja Magdalenic.

“In addition to the lecture about the Adriatic project, there was also a demonstration in which I had the opportunity to go through a diving simulation with a robotic partner in the form of a game with different tasks that need to be performed. The game gives a pretty realistic view in the world of diving with the robotic partner and it also brings a lot of fun. In addition to other interesting things in the field of diving and marine robotics, I met people of the same interests, hung out with them and exchanged experiences which is also the goal of this event.”

Taking into account these testimonies from our first-time student participants, the BtS workshop is a very useful event to hear and learn new things in the field of marine robotics and robotics in general. It also presents a great opportunity to meet people with similar interests and areas of work and connect with experts in the field. And after all of the above, you can still find some free time to look around the small Croatian town of Biograd na Moru and relax in the beautiful nature that surrounds it.

ARIEL, the AUV Won First Place in Underwater Robot Convention in JAMSTEC 2021!

Kazushi Yamamoto, Sehwa Chun, Yuki Sekimori, Chihaya Kawamra

Introduction

On August 28 and 29, students and enthusiasts gathered online to take part in the Underwater Robot Convention in JAMSTEC 2021. The event, hosted by NPO Japan Underwater Robot Network, serves as a forum for participants to exchange technical ideas and build networks through presentations and the competition of underwater robots. The overview of this year's event can be found in the convention's website [1] (in Japanese), and the events in previous years are described in [2], [3], [4], and [5].

We, the authors, are masters course students in Prof. Maki's laboratory at the University of Tokyo. We participated in the AI Challenge division as team "UT Maki Lab." [Figure 1]. Our primary aim was to accumulate basic knowledge and skills related to underwater robotics in preparation for future research work. We also learned how to collaborate as a team, which is a crucial aspect in developing and operating underwater robots.

Rules

In the AI Challenge division, participants proposed a mission that combined underwater robots and Artificial Intelligence (AI). The event organizers called for "exciting" robots that are "capable of executing AI missions underwater." Each team uploaded a poster and two videos of five minutes each, one to present their robot and AI mission, and another to demonstrate its capability. The judges evaluated the overall performance based on the four criteria listed in table 1.

AI Mission

Given the freedom to choose our own AI mission, we wanted to set an exciting and technically interesting topic. Currently, the

Table 1. Criteria for AI Challenge division		
Criteria	Points	Description
Presentation	20	The overall quality of presentation, videos and poster.
Idea	30	The novelty of the AI mission.
Technical contents	30	The quality of hardware, software, algorithms, etc.
Capability	20	The performance of the robot. Maximum points for full autonomy (without tether cables).

world is under the threat of COVID-19, so we thought that a mission related to it would be attractive. Based on our slogan, "No exception to prevent infection," our mission was to identify the faces without a mask with a computer vision (CV) algorithm and cover the faces with a mask with artificial intelligence using an underwater robot. We installed three portraits and a mask station in the 8m on a side cubic water tank in the Institute of Industrial Science, the University of Tokyo [Figure 2]. One of the portraits wore a mask, and the other two did not. The funnel-shaped mask station aligns the robot, such that it can dock regardless of a small position error.

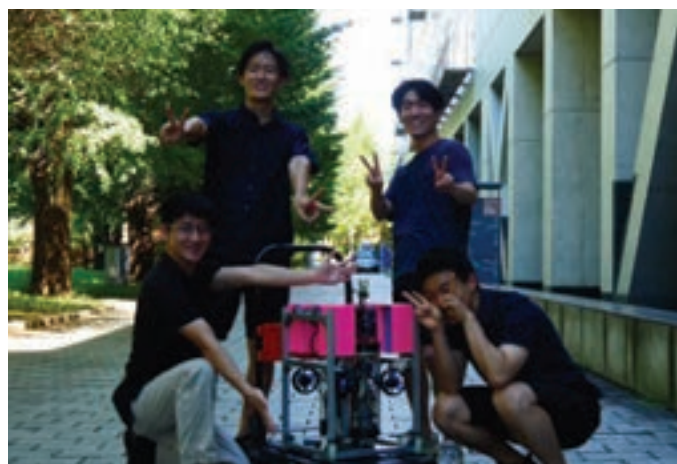


Figure 1. The group photo of "UT Maki lab" Team and the AUV, ARIEL.



Figure 2. The group photo of "UT Maki lab" at the 8m cubed water tank of the Komaba Research Campus of the University of Tokyo.

Our AI mission was to cover all the faces not wearing a mask. The robot searches and detects a maskless face within the set of submerged photograph portraits and delivers a mask from the docking station. This mission was divided into tasks: detect, catch and delivery. During the detect task, the robot hovers and searches for the portraits using the CV algorithm with the AI. If the probability of the portrait wearing the mask is low, the robot decides to transition to the next task. During the catch task, the robot aims to dock on the mask station and fetch the metallic mask with the electromagnet. During the delivery task, it delivers the mask to the portrait identified in the detect task. After the robot puts the mask on the target, it transitions back to the detect task to search for the remaining maskless portrait. If everyone is wearing a mask, the robot completes the mission, and it ascends to the surface.

AUV

To demonstrate our mission, we developed a hovering type autonomous underwater vehicle named “AI and ROS Integrated vEhicLe” (ARIEL) [Figure 3, Figure 4]. ARIEL estimates its depth using a depth sensor that measures water pressure. It estimates its position on the horizontal plane by perceiving the markers attached to the station using a camera [Figure 5]. It equips an electromagnet on the bottom to transport the masks.

ARIEL controls itself using the Raspberry Pi microcomputer and Teensy drivers. We implemented the software applications of ARIEL using the ROS, an open-source library and tools commonly used to develop robotics applications. The ROS is a powerful tool for parallel distributed processes such

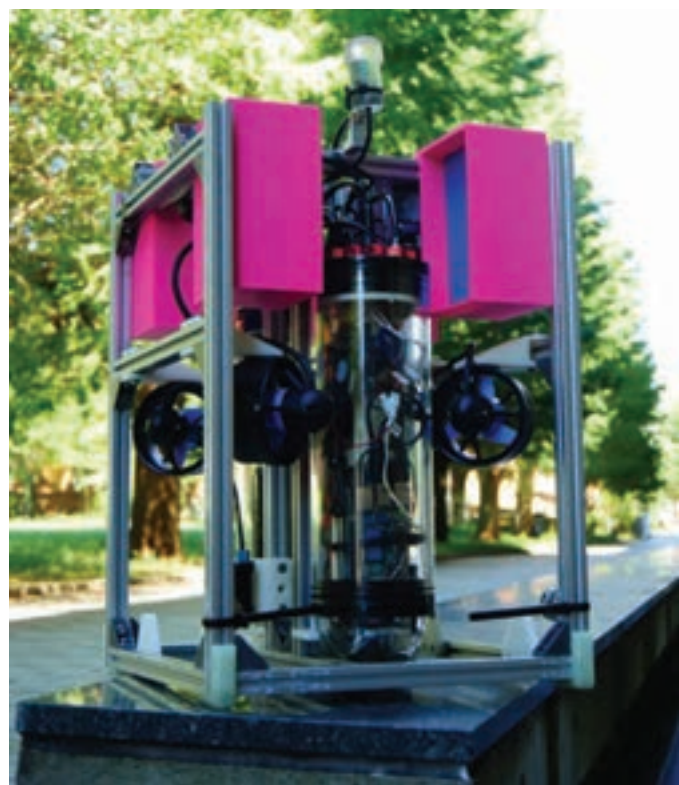


Figure 3. The hovering type autonomous underwater vehicle for AI mission named “AI and ROS Integrated vEhicLe” (ARIEL).

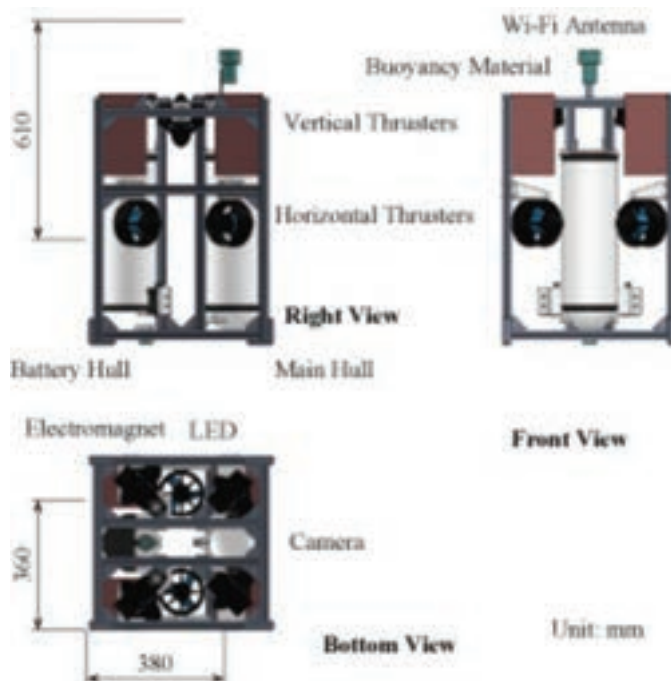


Figure 4. General arrangement of AUV ARIEL.

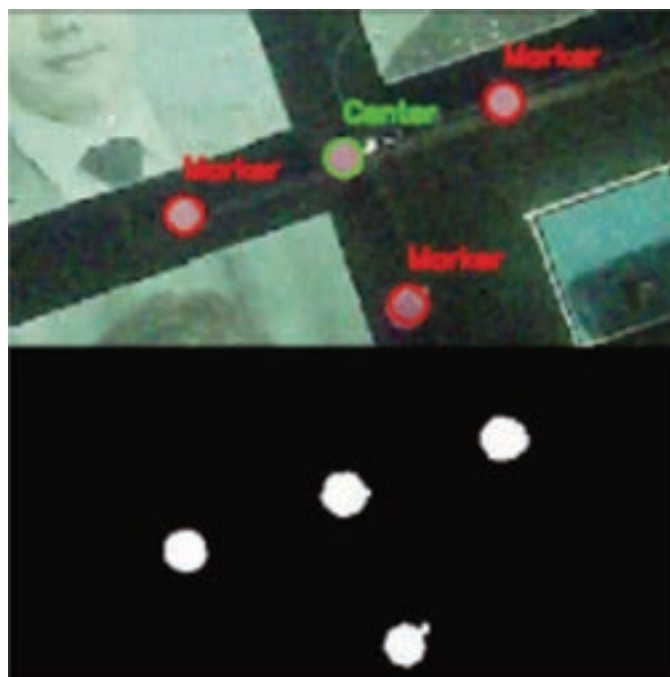


Figure 5. ARIEL estimates its location by perceiving the four pink markers on the bottom of the water tank.

as sensor and actuator signal handling. The convolutional neural network of ARIEL can estimate the position of the faces on the bottom of the water tank. Furthermore, it can calculate the probability of whether the person in the portrait is wearing a mask or not. We created the AI software based on the Tensorflow library, and we used the MobilenetV2 neural network [6] for mask recognition [Figure 6]. This software program runs swiftly and accurately on the Raspberry Pi despite its limited computational power. ARIEL decides its action based on its



Figure 6. The AI system in ARIEL detecting a non-masked person using a downward looking camera.

state and the position of the photograph. It completes the mission accurately by transitioning to an appropriate mode depending on the situation.

It was June, 2021, when we started working in earnest. With less than three months left until the date of submission on 20 August, we needed to progress efficiently. We divided the ARIEL's development process into three subprojects: hardware, system software, and AI algorithm, and we divided and conquered the subprojects. Each process was carried out in parallel by appointing a person in charge of each part. While accomplishing each part of the task, it was important to collaborate and exchange opinions as well. In July, the hardware was completed to some extent, and it was possible to operate ARIEL with manual control. In the beginning of August, we combined the system and AI that were in progress at the same time with the hardware, and the prototype of ARIEL was completed.

From August, we tested ARIEL in the water tank and made adjustments. We adjusted the center of buoyancy and the center of gravity, tuned the PID parameters, and set the parameters of the AI detector. Before the submission date, ARIEL was completed as an autonomous underwater robot and capable of judging whether a mask is on and transporting the mask by itself [Figure 7, Figure 8]. ARIEL showed 53% mission success rate by succeeding 9 times out of 17 trials.

Result

On the first day of the event, each team shared a presentation video and answered questions online. On the second day, each team shared a demonstration video likewise, and we had the awarding ceremony in the end. Our videos can be found in our laboratory YouTube channel [7], and our final score is shown in

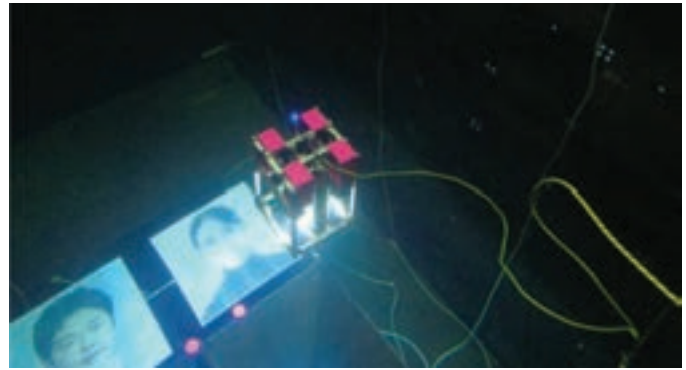


Figure 7. ARIEL during the AI mission.

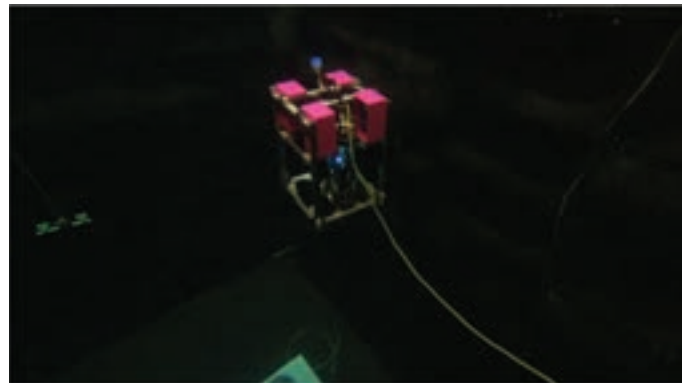


Figure 8. ARIEL in the 8 m cubic water tank.

Table 2. With an outstanding score of 91 points, we came in first place out of three teams.



[ARIEL Presentation Video]



[ARIEL Demonstration Video]

Table 2. Final scores for "Team UT Maki Lab."				
Presentation	Idea	Technical Contents	Capability	Total
18	23	29	20	91

Looking back, the Underwater Robotics Convention made us realize the difficulty of developing an underwater robot, the importance of collaboration, and connected us with people in the related industry. We have no doubt that the experiences gained throughout the intense three months of development, and the event, will be of great strength for us in future research work.

After the Event

Shortly after the Underwater Robotics Convention 2021 in JAMSTEC, "UT Maki Lab." and a team from Fukushima

Prefectural Taira Technical High School were invited to demonstrate our robots in Roboichi [8], an event that took place in Fukushima Robot Test field along with the World Robot Summit from October 8-10. ARIEL operated for over 10 hours under manual control, and did not experience any technical issues. It demonstrated the ability to detect maskless, and intervene with detected targets by placing the metallic mask on and off the portrait.

Comments

Finally, we will close this article with a short comment from each member.

Kazushi Yamamoto: Making ARIEL with my mates was great fun. It was an honor (and a relief) to come in first place.

Sehwa Chun: It's really cool to work with people with high enthusiasm, diverse talents and the same goals. It couldn't be greater if it was about underwater robots!

Yuki Sekimori: I would like to appreciate all my teammates for the outstanding enthusiasm, collaboration, and performance throughout the project. I would also like to appreciate the members of the Maki Laboratory for the pieces of advice and encouragement. Finally, I would like to thank all participants, event organizers and sponsors for providing us with the wonderful experience.

Chihaya Kawamura: This project was not only challenging but also exciting for me because it was my first time facing robot development everyday. The most striking thing I learned through this project is that haste makes waste. We found out that when ARIEL goes wrong for unknown reasons, the fastest way to fix it is to go through all the possible reasons one by one.

Acknowledgement

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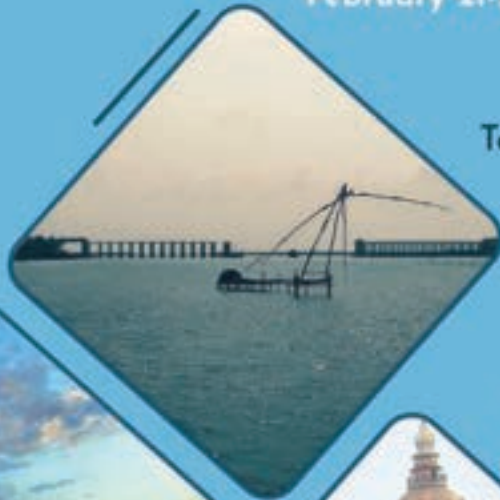
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