

## Yanwu Zhang

Email: yzhang@mbari.org

URL: <http://www.mbari.org/staff/yzhang/>

### EDUCATION

#### Massachusetts Institute of Technology (MIT)

Cambridge, MA

*Ph.D. in Oceanographic Engineering* from the Massachusetts Institute of Technology (MIT) / Woods Hole Oceanographic Institution (WHOI) Joint Program, June 2000. Thesis: "Spectral Feature Classification of Oceanographic Processes Using an Autonomous Underwater Vehicle". (Advisors: Prof. Arthur Baggeroer and Dr. James Bellingham. Thesis committee: Prof. Arthur Baggeroer (MIT), Dr. James Bellingham (MIT), Dr. Albert Williams III (WHOI), Prof. John Leonard (MIT)). GPA: 5.0/5.0

*Master of Science in Electrical Engineering and Computer Science* from MIT, and *Master of Science in Oceanographic Engineering* from the MIT/WHOI Joint Program, September 1998. Thesis: "Current Velocity Profiling from an Autonomous Underwater Vehicle with the Application of Kalman Filtering". (Advisors: Dr. James Bellingham and Prof. Arthur Baggeroer). GPA: 5.0/5.0

#### Northwestern Polytechnic University

Xi'an, Shaanxi, China

*Master of Science in Underwater Acoustics Engineering*, April 1991. Thesis: "Design and Implementation of a Multi-Beamformer of a Volumetric Sonar Array Using Digital Signal Processing (DSP) Chips". GPA: 91/100

*Bachelor of Science in Electrical Engineering*, July 1989. By early admission, selected into the elite freshmen class. Graduated No. 2 in the class. Thesis: "Adaptive Correlation Receiver of Linearly Frequency-Modulated Pulses". GPA: 91/100

### RESEARCH AND INDUSTRIAL EXPERIENCE

#### Monterey Bay Aquarium Research Institute (MBARI)

Moss Landing, CA

December 2004 – present. Senior Research Engineer.

- Principal Investigator and Program Manager of MBARI project "Targeted Sampling by Autonomous Underwater Vehicles" funded by the David and Lucile Packard Foundation.
- Co-PI in Office of Naval Research (ONR) Project "Fault Detection, Diagnosis, and Mitigation for Long-Duration AUV Missions with Minimal Human Intervention". Supervisor of a junior team member.
- Team member in MBARI Projects "Autonomous Ocean Sampling Networks", "Long-Range Autonomous Underwater Vehicles", "Controlled, Agile, and Novel Observing Network", "Soundscape Research and Education", funded by the David and Lucile Packard Foundation.

#### Aware Inc. (a worldwide leader of Asymmetric Digital Subscriber Line (ADSL) technology)

Bedford, MA

January 2001 – November 2004. Senior Digital Signal Processing (DSP) Engineer.

- Led algorithm design, C programming, and modem testing of Analog Echo Cancellers (AECs) using leading manufacturers' Analog Front End (AFE) chips.
- Enabled ISDN (Integrated Service Digital Network) compatibility of G992.1 and G992.3 in Customer Premises Equipment (CPE) modems built on Aware's StratiPHY chips.
- Devised a method to increase bit-loading capacity under noise margin constraint when inter-symbol interference (ISI) dominates over noise. Programmed this method into Aware's ADSL firmware offerings.
- Added SNR-based auxiliary pilot tone functionality to CPE modems to improve digital phase-locked loop (PLL) performance.

#### General Electric Company Research and Development Center Industrial Electronics Laboratory

Niskayuna, NY

June 2000 – December 2000. Systems Engineer.

Major team member in "Filter Design and Optimization for Stent Detection in Interventional Fluoroscopy Images", a joint project of GE R&D Center and GE Medical Systems.

- Designed and combined spatial and temporal filters to enhance interventional objects in X-ray image sequences.
- Developed a spatial spectrum analysis tool using IDL (Interactive Data Language).
- Evaluated filter performance by adaptive forced choice tests.
- Took main responsibility for biweekly reviews. Co-authored the end-of-year project report.

## **MIT Sea Grant Autonomous Underwater Vehicle (AUV) Laboratory**

Cambridge, MA

1996 – 2000. Research Assistant.

- Established the spatio-temporal mingled spectrum principle which concisely relates observations from a moving platform to the frequency-wavenumber spectrum of the surveyed stochastic process. Based on this principle, designed an AUV classifier for distinguishing between different oceanographic processes, jointly utilizing temporal and spatial information. An AUV's controllable speed tunes the separability between the mingled spectra of different processes. This property is the key to optimizing the classifier's performance. Demonstrated the AUV classifier by distinguishing between ocean convection and internal waves. Installed a SonTek acoustic Doppler velocimeter (ADV) on the Odyssey IIB AUV to measure current velocity in the Labrador Sea in 1998. Based on the vertical current velocity, the AUV classifier captured occurrence of open ocean convection in the Labrador Sea.
- Installed leading-edge Doppler sonars (RDI's ADCP and SonTek's ADV) on Odyssey IIB AUVs for 3-D current velocity measurement in the ocean. The sonar-equipped AUVs measured current velocity in the Haro Strait in 1996 and in the Labrador Sea in 1998. Also led a flow velocity measurement calibration experiment in the largest towing tank in the United States.
- Developed algorithms to extract earth-referenced current velocity from raw AUV-borne ADCP measurements. Used an Odyssey IIB AUV (installed with an RDI ADCP) to map 3-D current velocity in tidal fronts in the Haro Strait in 1996.
- Designed a method for autonomous triggering of an AUV from its underwater docking station on event detection. Wrote a real-time program in C.

## **Northwestern Polytechnic University Institute of Acoustics Engineering**

Xi'an, Shaanxi, China

1989 – 1994. Research Assistant and Teaching Assistant.

- Lead investigator in a joint project with the National Key Laboratory of Acoustics of the Institute of Acoustics of the Chinese Academy of Sciences: "Theory and Hardware Implementation of Artificial Neural Networks for Direction-Of-Arrival (DOA) Estimation of Correlated Acoustic Sources". Developed the Complex-valued Generalized Hebbian Algorithm (CGHA) for extracting principal eigenvectors in the complex domain. Applied this algorithm to DOA estimation by a sensor array.
- By applying the technique of adaptive modeling, designed short FIR filters to implement arbitrary constant phase shift in a narrow band. Designed a narrow-band sonar multi-beamformer using a bank of such FIR filters, each filter connected to one transducer. Built and tested the multi-beamformer using dual TMS320C25 DSP chips.
- Designed and built a low-cost, pocket-size, Analog-to-Digital and Digital-to-Analog conversion board plugged in personal computers. Boards were used in the Freshmen Engineering Projects Laboratory of Virginia Tech.
- Designed and built a laptop computer data acquisition system for acoustic detection of underground ancient tombs.

## **TEACHING EXPERIENCE**

### **MIT Dept. of Ocean Engineering** jointly with **Dept. of Electrical Engineering and Computer Science**

1998. Teaching Assistant in "Sonar, Radar, and Seismic Signal Processing" (high-level graduate course in both departments) offered by Ph.D. thesis advisor Prof. Arthur Baggeroer (member of the National Academy of Engineering and IEEE Fellow). Developed the entire set of solutions to a new series of problem sets and examinations, which are re-used in succeeding academic years. Graded homework. Assisted students individually on difficult problems. Led students to utilize MATLAB simulations to understand tough signal processing topics, e.g., ambiguity function, two-scale process, and beam-pattern. Students' evaluation: "TA Y. Zhang was praised as being knowledgeable and helpful"; advisor's evaluation: "Excellent job."

### **MIT Department of Ocean Engineering**

1995. Teaching Assistant in "Introduction to Geometric Modeling and Computation" (core undergraduate course) and "Transport, Fate, and Effects of Ocean Pollution" (high-level graduate course).

### **Northwestern Polytechnic University College of Marine Engineering**

Xi'an, Shaanxi, China

Lectured in "FORTRAN Programming" (core undergraduate course) and "Microprocessor Systems and Applications" (graduate course). Instructed undergraduate students in a computer laboratory. Instructed graduate students on Digital Signal Processing (DSP) system designs using Texas Instruments DSP chips.

## **PROFESSIONAL SOCIETIES AND ACTIVITIES**

- Senior Member (since 2005) of Institute of Electrical and Electronics Engineers (IEEE) Signal Processing Society and Oceanic Engineering Society.
- Member of American Geophysical Union (AGU).

- Member of Sigma Xi National Academic Honorary Society.
- Associate Editor of *Frontiers in Marine Science* in the specialty section of Ocean Observation.
- Reviewer for journals: *IEEE Journal of Oceanic Engineering*, *IEEE/ASME Transactions on Mechatronics*, *IEEE Transactions on Neural Networks*, *IEEE Robotics and Automation Letters*, *Journal of Atmospheric and Oceanic Technology*, *Journal of Geophysical Research (Oceans)*, *Deep-Sea Research I & II*, *Continental Shelf Research*, *Journal of Field Robotics*, *Frontiers in Neurorobotics*, *Progress in Oceanography*, *Marine Technology Society Journal*, *Marine Pollution Bulletin*, *Frontiers in Marine Science*, *Limnology and Oceanography*, *Ocean Engineering (Elsevier)*, *Applied Ocean Research (Elsevier)*, *Ultrasonics (Elsevier)*, *International Journal of Neural Systems*, *International Journal of Advanced Robotic Systems*, *Applied Sciences*.
- Reviewer of funding proposals to the Schmidt Ocean Institute, 2016 and 2017.
- Reviewer of funding proposals to the Directorate General for Maritime Policy (DGPM) of Portugal, 2015.
- Reviewer of funding proposal to the University of Alaska Fairbanks Coastal Marine Institute, 2014.
- Reviewer of funding proposal to the Netherlands' Technology Foundation STW Water2014 Program, 2014.
- Reviewer of funding proposals (on underwater communications) to MIT Sea Grant, 2001, 2005, and 2008.
- Reviewer of funding proposal (on an acoustic network for ocean observations) to the National Science Foundation, 2007.
- Reviewer of funding proposal (on autonomous underwater environment monitoring) to the International Science and Technology Center (partly funded the U.S. Department of State), 2005.
- Assessing progress of four projects of City University of Hong Kong State Key Lab in Marine Pollution, 2014.
- Reviewer of funding proposal (on environmental protection and sustainable use) to the King Abdullah University of Science and Technology Center Competitive Funding Program, 2013.
- Reviewer for conferences: IEEE/RSJ International Conference on Intelligent Robots and Systems (2011), and IEEE International Conference on Robotics and Automation (2015).
- Invited co-chair of Session "Advancing Discovery, Observation, and Process Studies throughout the Ocean with Robotic Technologies" at the 2016 Ocean Sciences Meeting, New Orleans, LA, February 2016.
- Invited to attend the ExxonMobil AUV Workshop, Houston, TX, October 2015.
- Invited co-chair of Session "Underwater Vehicles" at the IEEE-Cyber 2015 Conference on Cyber Technology in Automation, Control, and Intelligent Systems, Shenyang, China, June 2015.
- Invited to attend the Keck Institute for Space Studies workshop "Satellites to the Seafloor: Autonomous Science to Forge a Breakthrough in Quantifying the Global Ocean Carbon Budget" and coauthored the final report. The workshop brings together 24 robotics and earth science researchers from the international oceanographic and space science communities to develop new methods of using a coordinated network of ocean robots and satellites to autonomously interpret data and communicate sampling strategies with a focus on using these technologies to understand the global carbon budget, October 2013 and February 2014.
- Member of Technical Program Committee of the WUWNet'13 (the 8<sup>th</sup> ACM International Conference on Underwater Networks & Systems), Kaohsiung, Taiwan, China, November 2013.
- Invited session co-chair at the 2007 AGU Fall Meeting in Session "New Methods in Observational Oceanography Posters", and the 2012 AGU Fall Meeting in Session "Mesoscale Ocean Processes Posters", San Francisco, CA.
- Invited session chair at the MTS/IEEE Oceans'2010 Conference in Session "Autonomous Underwater Vehicles: Hydrodynamics", Seattle, WA, September 2010.

#### **SELECTED AWARDS AND HONORS**

- Keynote speaker (virtual), 2020 IEEE OES Autonomous Underwater Vehicle Symposium, St. John's, NL, Canada, September 2020.
- Visiting Fellowship of Antarctic Gateway Partnership from University of Tasmania, Australia, May 2018.
- Finalist for MIT *Technology Review Magazine's* TR100 (100 young innovators globally selected for the potential to make major contributions to technological innovations), June 1999.
- Student Paper Competition Award of the 10th International Symposium on Unmanned Untethered Submersible Technology, Durham, New Hampshire, September 1997.
- Certificate of Appreciation awarded by the American Society of Mechanical Engineers (ASME) "in recognition of your outstanding project 'High Precision Flow Measurement from an Autonomous Underwater Vehicle' submitted for the ASME/Ocean Engineering Division's 1998 Best Student Project Competition", September 1998.
- Autonomous Underwater Vehicle (AUV) research on display at the MIT Francis Russell Hart Nautical Museum (1998 – present) and at the New England Aquarium (1999, sponsored by the National Science Foundation).
- Profiled in *Two if by Sea*, MIT Sea Grant/WHOI Sea Grant Joint Newsletter, Spring/Summer 1999. (<http://web.mit.edu/seagrant/pubs/2ifbysea/issues/spring99/profile.html>)

- Inclusion in *Who's Who in Science and Engineering* (1999 – present) published by Marquis Who's Who, New Providence, NJ, and in *2000 Eminent Scientists of Today* (2003) published by the International Biographical Centre, Cambridge, England.
- Woods Hole Oceanographic Institution Summer Research Fellowship, summer 1997.
- Third-class prize in China University Technological Invention Competition for entry “Pocketsize Low-Cost Analog-to-Digital and Digital-to-Analog Conversion Board Used in Generic Personal Computers”, November 1992.

## SELECTED PUBLICATIONS

### Book Chapters

1. J. P. Ryan, Y. Zhang, H. Thomas, E. V. Rienecker, R. K. Nelson, and S. R. Cummings, “A High-Resolution Survey of a Deep Hydrocarbon Plume in the Gulf of Mexico during the 2010 Macondo Blowout,” (DOI: 10.1029/GM195) in *Monitoring and Modeling the Deepwater Horizon Oil Spill: A Record-Breaking Enterprise* (Editors: Y. Liu, A. MacFadyen, Z.-G. Ji, and R. H. Weisberg), Geophysical Monograph Series, Vol. 195, Washington, D.C.: AGU, 2011.
2. Y. Zhang, “Chapter 11: Complex-Valued Generalized Hebbian Algorithm and Its Applications to Sensor Array Signal Processing,” (DOI: 10.1142/9789812791184\_0011) in *Complex-Valued Neural Networks: Theories and Applications* (Edited by Prof. Akira Hirose of the University of Tokyo Department of Electrical Engineering and Information Systems), Vol. 5 in Series on Innovative Intelligence, pp. 227-250, River Edge, NJ: World Scientific Publishing Co., 2003.

### Peer-Reviewed Journal Papers

1. Y. Zhang, N. Yoder, B. Kieft, A. Kukulya, B. W. Hobson, S. Ryan, and G. G. Gawarkiewicz, “Autonomous Tracking of Salinity-Intrusion Fronts by a Long-Range Autonomous Underwater Vehicle,” *IEEE Journal of Oceanic Engineering*, DOI: 10.1109/JOE.2022.3146584
2. Y. Zhang, M. A. Godin, B. Kieft, B-Y. Raanan, J. P. Ryan, and, W. Hobson, "Finding and Tracking a Phytoplankton Patch by a Long-Range Autonomous Underwater Vehicle," *IEEE Journal of Oceanic Engineering*, Vol. 47, No. 2, pp. 322-330, April 2022, DOI: 10.1109/JOE.2021.3122195
3. Y. Zhang, P. R. McGill, J. P. Ryan, "Optimized design of windowed-sinc anti-aliasing filters for phase-preserving decimation of hydrophone data," *Journal of Acoustical Society of America*, Vol. 151, No. 3, pp. 2077–2084, 2022, DOI: 10.1121/10.0009823
4. J. P. Ryan, J. E. Joseph, T. Margolina, L. T. Hatch, A. Azzara, A. Reyes, B. L. Southall, A. DeVogelaere, L. E. Peavey Reeves, Y. Zhang, D. E. Cline, B. Jones, P. McGill, S. Baumann-Pickering, and A. K. Stimpert, “Reduction of Low-Frequency Vessel Noise in Monterey Bay National Marine Sanctuary During the COVID-19 Pandemic,” *Frontiers in Marine Science*, Vol. 8, Article 656566, pp. 1-13, 2021, DOI: 10.3389/fmars.2021.656566
5. J. B. J. Harvey, J. P. Ryan, Y. Zhang, “Influences of Extreme Upwelling on a Coastal Retention Zone,” *Frontiers in Marine Science*, Vol. 8, Article 648944, pp. 1-10, 2021, DOI: 10.3389/fmars.2021.648944
6. Y. Zhang, J. Ryan, B. Hobson, B. Kieft, A. Romano, B. Barone, C. Preston, B. Roman, B-Y. Raanan, D. Pargett, M. Dugenne, A. White, F. Henderikx Freitas, S. Poulos, S. Wilson, E. DeLong, D. Karl, J. Birch, J. Bellingham, and C. Scholin, “A System of Coordinated Autonomous Robots for Lagrangian Studies of Microbes in the Oceanic Deep Chlorophyll Maximum,” *Science Robotics*, Vol. 6, Issue. 50, pp. 1-11, January 2021, DOI: 10.1126/scirobotics.abb9138
7. Y. Zhang, B. Kieft, B. Hobson, B-Y. Raanan, S. Urmy, K. Pitz, C. Preston, B. Roman, K. Benoit-Bird, J. Birch, F. Chavez, and C. Scholin, “Persistent Sampling of Vertically Migrating Biological Layers by an Autonomous Underwater Vehicle Within the Beam of a Seabed-Mounted Echosounder,” *IEEE Journal of Oceanic Engineering*, Vol. 46, No. 2, pp. 497-508, April 2021, DOI: 10.1109/JOE.2020.2982811
8. A. E. Simonis, K. A. Forney, S. Rankin, J. Ryan, Y. Zhang, A. DeVogelaere, J. Joseph, T. Margolina, A. Krumpel, and S. Baumann-Pickering, “Seal Bomb Noise as a Potential Threat to Monterey Bay Harbor Porpoise,” *Frontiers in Marine Science*, Vol. 7, Article 142, pp. 1-9, 2020, DOI: 10.3389/fmars.2020.00142
9. Y. Zhang, B. Kieft, B. Hobson, J. Ryan, B. Barone, C. Preston, B. Roman, B-Y. Raanan, R. Marin III, T. O'Reilly, C. Rueda, D. Pargett, K. Yamahara, S. Poulos, A. Romano, G. Foreman, H. Ramm, S. Wilson, E. DeLong, D. Karl, J. Birch, J. Bellingham, and C. Scholin, “Autonomous Tracking and Sampling of the Deep Chlorophyll Maximum Layer in an Open-Ocean Eddy by a Long Range Autonomous Underwater Vehicle,” *IEEE Journal of Oceanic Engineering*, Vol. 45, No. 4, pp. 1308-1321, October 2020, DOI: 10.1109/JOE.2019.2920217
10. Y. Zhang, J. P. Ryan, B. Kieft, B. W. Hobson, R. S. McEwen, M. A. Godin, J. B. Harvey, B. Barone, J. G. Bellingham, J. M. Birch, C. A. Scholin, and F. P. Chavez, “Targeted Sampling by Autonomous Underwater Vehicles,” *Frontiers in Marine Science*, Vol. 6, Article 415, pp. 1-12, 2019, DOI: 10.3389/fmars.2019.00415
11. K. M. Yamahara, C. M. Preston, J. Birch, K. Walz, R. Marin III, S. Jensen, D. Pargett, B. Roman, W. Ussler III, Y. Zhang, J. Ryan, B. Hobson, B. Kieft, B. Raanan, K. D. Goodwin, F. P. Chavez, and C. Scholin, “In situ

- Autonomous Acquisition and Preservation of Marine Environmental DNA Using an Autonomous Underwater Vehicle,” *Frontiers in Marine Science*, Vol. 6, Article 373, pp. 1-14, 2019, DOI: 10.3389/fmars.2019.00373
12. Y. Zhang, C. Rueda, B. Kieft, J. P. Ryan, C. Wahl, T. C. O’Reilly, T. Maughan, and F. P. Chavez, “Autonomous Tracking of an Oceanic Thermal Front by a Wave Glider,” *Journal of Field Robotics*, Vol. 36, pp. 940-954, 2019, DOI: 10.1002/rob.21862
  13. A. Branch, M. M. Flexas, B. Claus, A. F. Thompson, Y. Zhang, E. B. Clark, S. Chien, D. M. Fratantoni, J. C. Kinsey, B. Hobson, B. Kieft, F. P. Chavez, “Front Delineation and Tracking with Multiple Underwater Vehicles,” *Journal of Field Robotics*, Vol. 36, No. 3, pp. 568-586, 2019. DOI: 10.1002/rob.21853
  14. H. A. Bowers, J. P. Ryan, K. Hayashi, A. L. Woods, R. Marin III, G. J. Smith, K. A. Hubbard, G. J. Doucette, C. M. Mikulski, A. G. Gellene, Y. Zhang, R. M. Kudela, D. A. Caron, J. M. Birch, and C. A. Scholin, “Diversity and Toxicity of Pseudo-nitzschia Species in Monterey Bay: Perspectives from Targeted and Adaptive Sampling,” *Harmful Algae*, Vol. 78, pp. 129-141, 2018. DOI: 10.1016/j.hal.2018.08.006
  15. B-Y. Raanan, J. Bellingham, Y. Zhang, M. Kemp, B. Kieft, H. Singh, Y. Girdhar, “Detection of unanticipated faults for autonomous underwater vehicles using online topic models,” *Journal of Field Robotics*, Vol. 35, pp. 705-716, 2018, DOI: 10.1002/rob.21771
  16. Y. Zhang, B. Kieft, M. J. Stanway, R. S. McEwen, B. W. Hobson, J. G. Bellingham, J. P. Ryan, T. C. O’Reilly, B-Y. Raanan, M. Messié, J. M. Smith, and F. P. Chavez, “Isotherm Tracking by an Autonomous Underwater Vehicle in Drift Mode,” *IEEE Journal of Oceanic Engineering*, Vol. 42, No. 4, pp. 808-817, October 2017, DOI: 10.1109/JOE.2016.2625058.
  17. J. P. Ryan, R. M. Kudela, J. M. Birch, M. Blum, H. A. Bowers, F. P. Chavez, G. J. Doucette, R. Marin III, C. Mikulski, K. Negrey, J. T. Pennington, C. A. Scholin, G. J. Smith, Y. Zhang, “Causality of an extreme harmful algal bloom in the central California Current System during the 2014-2015 northeast Pacific warm anomaly,” *Geophysical Research Letters*, Vol. 44, pp. 1-9, 2017, DOI: 10.1002/2017GL072637.
  18. Y. Zhang, “Autonomous Underwater Vehicles Lead to Scientific Discoveries in the Oceanic Wilderness,” *Journal of Engineering Studies* (Chinese journal with English abstracts), Vol. 8, No. 2, pp. 201-207, April 2016.
  19. Y. Zhang, J. G. Bellingham, J. P. Ryan, B. Kieft, and M. J. Stanway, “Autonomous 4-D Mapping and Tracking of a Coastal Upwelling Front by an Autonomous Underwater Vehicle,” *Journal of Field Robotics*, Vol. 33, No. 1, pp. 67-81, January 2016, DOI: 10.1002/rob.21617.
  20. Y. Zhang, J. G. Bellingham, J. P. Ryan, and M. A. Godin, “Evolution of a physical and biological front from upwelling to relaxation,” *Continental Shelf Research*, Vol. 108, pp. 55-64, October 2015, DOI:10.1016/j.csr.2015.08.005.
  21. J. P. Ryan, J. B. J. Harvey, Y. Zhang, and C. B. Woodson, “Distributions of invertebrate larvae and phytoplankton in a coastal upwelling system retention zone and peripheral front,” *Journal of Experimental Marine Biology and Ecology*, Vol. 459, pp. 51-60, 2014, DOI: 10.1016/j.jembe.2014.05.017.
  22. J. P. Ryan, M.A. McManus, R.M. Kudela, M. Lara Artigas, J.G. Bellingham, F.P. Chavez, G. Doucette, D. Foley, M. Godin, J.B.J. Harvey, R. Marin III, M. Messie, C. Mikulski, T. Pennington, F. Py, K. Rajan, I. Shulman, Z. Wang, and Y. Zhang, “Boundary influences on HAB phytoplankton ecology in a stratification-enhanced upwelling shadow,” *Deep Sea Research II*, Vol. 101, pp. 63-79, 2014, DOI: 10.1016/j.dsr2.2013.01.017.
  23. Y. Zhang, “Adaptive Ocean Observation,” *Advances in Earth Sciences* (Chinese journal with English abstracts), Vol. 28, No. 5, pp. 537-541, May 2013.
  24. Y. Zhang, J. P. Ryan, J. G. Bellingham, J. B. J. Harvey, and R. S. McEwen, "Autonomous detection and sampling of water types and fronts in a coastal upwelling system by an autonomous underwater vehicle," *Limnology and Oceanography: Methods*, Vol. 10, pp. 934-951, 2012, DOI: 10.4319/lom.2012.10.934.
  25. Y. Zhang, M. A. Godin, J. G. Bellingham, and J. P. Ryan, "Using an Autonomous Underwater Vehicle to Track a Coastal Upwelling Front," *IEEE Journal of Oceanic Engineering*, Vol. 37, No. 3, pp. 338-347, July 2012, DOI: 10.1109/JOE.2012.2197272.
  26. Y. Zhang, J. G. Bellingham, M. A. Godin, and J. P. Ryan, "Using an Autonomous Underwater Vehicle to Track the Thermocline Based on Peak-Gradient Detection," *IEEE Journal of Oceanic Engineering*, Vol. 37, No. 3, pp. 544-553, July 2012, DOI: 10.1109/JOE.2012.2192340.
  27. F. Cazenave, Y. Zhang, E. McPhee-Shaw, J. G. Bellingham, and T. P. Stanton, “High-resolution surveys of internal tidal waves in Monterey Bay, California, using an autonomous underwater vehicle,” *Limnology and Oceanography: Methods*, Vol. 9, pp. 571-581, 2011, DOI: 10.4319/lom.2011.9.571.
  28. Y. Zhang, R. S. McEwen, J. P. Ryan, J. G. Bellingham, H. Thomas, C. H. Thompson, and E. Rienecker, "A Peak-Capture Algorithm Used on an Autonomous Underwater Vehicle in the 2010 Gulf of Mexico Oil Spill Response Scientific Survey," *Journal of Field Robotics*, Vol. 28, No. 4, pp. 484-496, July/August 2011, DOI: 10.1002/rob.20399.

29. J. P. Ryan, A. M. Fischer, R. M. Kudela, M. A. McManus, J. S. Myers, J. D. Paduan, C. M. Ruhsam, C. B. Woodson, and Y. Zhang, "Recurrent frontal slicks of a coastal ocean upwelling shadow," *Journal of Geophysical Research (Oceans)*, 115, C12070, December 2010, DOI:10.1029/2010JC006398.
30. Y. Zhang, R. S. McEwen, J. P. Ryan, and J. G. Bellingham, "Design and Tests of an Adaptive Triggering Method for Capturing Peak Samples in a Thin Phytoplankton Layer by an Autonomous Underwater Vehicle," *IEEE Journal of Oceanic Engineering*, Vol. 35, No. 4, pp. 785-796, October 2010, DOI: 10.1109/JOE.2010.2081031.
31. Y. Zhang, J. G. Bellingham, and Y. Chao, "Error Analysis and Sampling Strategy Design for Using Fixed or Mobile Platforms to Estimate Ocean Flux," *Journal of Atmospheric and Oceanic Technology*, Vol. 27, No. 3, pp. 481-506, March 2010, DOI: 10.1175/2009JTECHO700.1.
32. Y. Zhang and J. G. Bellingham, "An Efficient Method of Selecting Ocean Observing Locations for Capturing the Leading Modes and Reconstructing the Full Field," *Journal of Geophysical Research (Oceans)*, 113, C04005, April 2008, DOI: 10.1029/2007JC004327.
33. Y. Zhang, A. B. Baggeroer, and J. G. Bellingham, "The Total Variance of a Periodogram-Based Spectral Estimate of a Stochastic Process with Spectral Uncertainty and Its Application to Classifier Design," *IEEE Transactions on Signal Processing*, Vol. 53, No. 12, pp. 4556-4567, December 2005, DOI: 10.1109/TSP.2005.859346.
34. Y. Zhang, A. B. Baggeroer, and J. G. Bellingham, "Spectral-Feature Classification of Oceanographic Processes Using an Autonomous Underwater Vehicle," *IEEE Journal of Oceanic Engineering*, Vol. 26, No. 4, pp. 726-741, October 2001, DOI: 10.1109/48.972115.
35. J. S. Willcox, J. G. Bellingham, Y. Zhang, A. B. Baggeroer, "Performance Metrics of Oceanographic Surveys with Autonomous Underwater Vehicles," *IEEE Journal of Oceanic Engineering*, Vol. 26, No. 4, pp. 711-725, October 2001, DOI: 10.1109/48.972114.
36. Y. Zhang, K. Streitlien, J. G. Bellingham, and A. B. Baggeroer, "Acoustic Doppler Velocimeter Flow Measurement from an Autonomous Underwater Vehicle with Applications to Deep Ocean Convection," *Journal of Atmospheric and Oceanic Technology*, Vol. 18, No. 12, pp. 2038-2051, December 2001, DOI: 10.1175/1520-0426(2001)018<2038:ADVFMF>2.0.CO;2.
37. Y. Zhang and Y. Ma, "CGHA for Principal Component Extraction in the Complex Domain," *IEEE Transactions on Neural Networks*, Vol. 8, No. 5, pp. 1031-1036, September 1997, DOI: 10.1109/72.623205.
38. Y. Zhang and Y. Ma, "An Efficient Architecture for Real-Time Narrowband Beamforming," *IEEE Journal of Oceanic Engineering*, Vol. 19, No. 4, pp. 635-638, October 1994, DOI: 10.1109/48.338400.
39. Y. Zhang, G. Xiao, X. Shi, and Y. Ma, "Hardware Design of a Signal Processing Module Composed of TMS320C25 Chips," *Journal of Data Acquisition and Processing* (Chinese journal with English abstracts), Vol. 7, No. 4, pp. 273-278, December 1992.
40. Y. Zhang and Y. Ma, "Software Design of a Multi-Beamformer Implemented by TMS320C25 Chips," *Applied Acoustics* (Chinese journal with English abstracts), Vol. 11, No. 4, pp. 22-25, July 1992.
41. Y. Zhang, "Performance and Applications of Dual-Port RAM Chips IDT7132 and IDT7142," *Microcomputer and Applications* (Chinese journal with English abstracts), No. 10, pp. 40-41, October 1991.
42. Y. Zhang, "An Often-Made Mistake in Using the A/D Converter AD7574," *Applications of Microelectronics Techniques* (Chinese journal with English abstracts), No. 2, pp. 14, February 1991.
43. Z. Zhu, X. Ning, and Y. Zhang, "High-Speed Multi-Channel Synchronous Sampling Using DMA," *Microelectronics and Computer* (Chinese journal with English abstracts), Vol. 9, No. 5, 1992.
44. Y. Zhang and Y. Ma, "A Novel Approach for Designing Digital Phase Shifter," *Journal of Northwestern Polytechnic University* (Chinese journal with English abstracts), Vol. 11, No. 3, pp. 320-324, July 1993.

#### **Conference Presentations, Proceedings, and Other Publications**

1. B. Hobson, B. Kieft, B-Y. Raanan, Y. Zhang, J. Birch, J. P. Ryan, and F. P. Chavez, "An Autonomous Vehicle Based Open Ocean Lagrangian Observatory," *Proc. IEEE AUV'2018*, pp. 1-5, Porto, Portugal, November 2018.
2. J. Birch, B. Barone, E. DeLong, G. Foreman, K. Gomes, B. Hobson, S. Jensen, D. Karl, B. Kieft, R. Marin III, T. O'Reilly, D. Pargett, C. Preston, B. Roman, A. Romano, J. Ryan, C. Scholin, W. Ussler, K. Yamahara, and Y. Zhang, "Autonomous Targeted Sampling of the Deep Chlorophyll Maximum Layer in a Subtropical North Pacific Eddy," *Proc. MTS/IEEE Oceans '18*, pp. 1-5, Charleston, SC, U.S.A., October 2018.
3. Y. Zhang, M. Messié, J. Ryan, B. Kieft, M. J. Stanway, B. Hobson, T. O'Reilly, B-Y. Raanan, J. Smith, and F. Chavez, "Water-column stratification observed along an AUV-tracked isotherm," *2016 Ocean Sciences Meeting, Abstract 92906*, New Orleans, Louisiana, U.S.A., February 2016.
4. J. M. Birch, D. Pargett, S. Jensen, B. Roman, C. M. Preston, W. Ussler, K. Yamahara, Roman M. III, B. Hobson, Y. Zhang, J. P. Ryan and C. A. Scholin, "Towards a Mobile Ecogenomic sensor: the Third Generation Environmental Sample Processor (3G-ESP)," *2016 Ocean Sciences Meeting*, New Orleans, Louisiana, U.S.A., February 2016.

5. K. Yamahara, C. M. Preston, D. Pargett, S. Jensen, B. Roman, K. Walz, J. M. Birch, B. Hobson, B. Kieft, Y. Zhang, J. P. Ryan, F. Chavez, and C. A. Scholin, "Development and Applications of a Mobile Ecogenomic Sensor," *2016 Ocean Sciences Meeting*, New Orleans, Louisiana, U.S.A., February 2016.
6. Y. Zhang, B. Kieft, R. McEwen, M. J. Stanway, J. Bellingham, J. Ryan, B. Hobson, D. Pargett, J. Birch, and C. Scholin, "Tracking and Sampling of a Phytoplankton Patch by an Autonomous Underwater Vehicle in Drifting Mode," *Proc. MTS/IEEE Oceans '15*, pp. 1-5, Washington D.C., U.S.A., October 2015.
7. B.-Y. Raanan, J. Bellingham, Y. Zhang, B. Kieft, M. J. Stanway, R. McEwen, B. Hobson, "A Real-time Vertical Plane Flight Anomaly Detection System for a Long Range Autonomous Underwater Vehicle," *Proc. MTS/IEEE Oceans '15*, pp. 1-7, Washington D.C., U.S.A., October 2015.
8. D. M. Pargett, J. M. Birch, C. M. Preston, J. P. Ryan, Y. Zhang, and C. A. Scholin, "Development of a Mobile Ecogenomic Sensor," *Proc. MTS/IEEE Oceans '15*, pp. 1-6, Washington D.C., U.S.A., October 2015.
9. Y. Zhang, J. P. Ryan, J. B. Harvey, and J. G. Bellingham, "Autonomously Targeted Observation and Sampling of Coastal Marine Ecological Features by Autonomous Underwater Vehicles," *2014 Joint Aquatic Sciences Meeting, Abstract 13937 (oral presentation)*, Portland, OR, U.S.A., May 2014.
10. Y. Zhang, J. G. Bellingham, J. P. Ryan, B. Kieft, and M. Stanway, "Three-Dimensional Structure and Dynamics of an Upwelling Front in Monterey Bay as Mapped and Tracked By an Autonomous Underwater Vehicle," *2014 Ocean Sciences Meeting, Abstract 15003 (oral presentation)*, Honolulu, HI, U.S.A., February 2014.
11. M. Stanway, Y. Zhang, and J. G. Bellingham, "Interpolating through Time and Space with Empirical Orthogonal Functions," *2014 Ocean Sciences Meeting, Abstract 17892*, Honolulu, HI, U.S.A., February 2014.
12. J. G. Bellingham, F. P. Chavez, C. A. Scholin, Y. Zhang, and E. E. McPhee-Shaw, "Measuring Scales of Variability of Dynamic Processes in the Coastal Ocean With Coordinated AUVs," *2014 Ocean Sciences Meeting, Abstract 17270*, Honolulu, HI, U.S.A., February 2014.
13. J. B. Harvey, J. P. Ryan, Y. Zhang, M. P. McCann, and R. C. Vrijenhoek, "Adaptive Sampling of Marine Zooplankton and Contextual Environment with an Autonomous Underwater Vehicle," *2014 Ocean Sciences Meeting, Abstract 15216*, Honolulu, HI, U.S.A., February 2014.
14. Y. Zhang, J. G. Bellingham, J. P. Ryan, B. Kieft, and M. J. Stanway, "Two-Dimensional Mapping and Tracking of a Coastal Upwelling Front by an Autonomous Underwater Vehicle," *Proc. MTS/IEEE Oceans '13*, pp. 1-4, San Diego, CA, U.S.A., September 2013.
15. D. Thompson, D. Caress, D. Clague, D. Conlin, J. Harvey, E. Martin, J. Paduan, C. Paull, J. Ryan, H. Thomas, and Y. Zhang, "Dorado AUV's Scientific Results," *Proc. MTS/IEEE Oceans '13*, pp. 1-9, San Diego, CA, U.S.A., September 2013.
16. P. B. Sujit, Y. Zhang, A. J. Healey, and J. B. Sousa, "Multi-AUV Fault Tolerant Adaptive Sampling," Workshop on Robotics for Environmental Monitoring at the RSS (Robotics: Science and Systems) 2013 Conference, Berlin, Germany, June 2013.
17. Y. Zhang, J. P. Ryan, M. A. Godin, and J. G. Bellingham, "Observing Coastal Upwelling Front Dynamics by AUV Tracking, Remote Sensing, and Mooring Measurements," *AGU 2012 Fall Meeting, Abstract OS31H-04 (oral presentation)*, San Francisco, CA, U.S.A., December 2012.
18. M. A. Godin, J. P. Ryan, Y. Zhang, and J. G. Bellingham, "Localization and Tracking of Submerged Phytoplankton Bloom Patches by an Autonomous Underwater Vehicle," *AGU 2012 Fall Meeting, Abstract OS43E-1869*, San Francisco, CA, U.S.A., December 2012.
19. B. Hobson, J. G. Bellingham, B. Kieft, R. McEwen, M. Godin, and Y. Zhang, "Tethys-Class Long Range AUVs - Extending the Endurance of Propeller-Driven Cruising AUVs from Days to Weeks," *Proc. IEEE AUV'2012*, pp. 1-8, Southampton, U.K., September 2012.
20. J. Harvey, Y. Zhang, and J. P. Ryan, "AUVs for Ecological Studies of Marine Plankton Communities – Intelligent Algorithms on Dorado and Tethys AUVs Enable Precise Water Sampling for Plankton Research," *Sea Technology*, Vol. 53, No. 9, pp. 51-54, September 2012.
21. J. P. Ryan, J. Harvey, Y. Zhang, and C. B. Woodson, "Aggregation of plankton: perspectives from a thinking / sampling AUV," *59<sup>th</sup> Annual Eastern Pacific Ocean Conference*, Timberline Lodge, Mt. Hood, OR, U.S.A., September 2012.
22. J. B. J. Harvey, J. P. Ryan, and Y. Zhang, "Autonomous, robotic collection and molecular detection of invertebrate larvae from surface waters of Monterey Bay, California," *10<sup>th</sup> Larval Biology Symposium*, Berkeley, CA, U.S.A., July 2012.
23. Y. Zhang, J. Ryan, J. Harvey, M. Godin, J. G. Bellingham, M. Messie, T. Pennington, and F. Chavez, "The Monterey Bay Upwelling Shadow Frontal Complex: Results from an Ecosystem Process Study," *2012 Ocean Sciences Meeting, Abstract 9899*, Salt Lake City, UT, U.S.A., February 2012.
24. J. B. J. Harvey, J. P. Ryan, Y. Zhang, R. Marin III, K. Rajan, J. G. Bellingham, M. McManus, G. Doucette, F. Chavez, and C. Scholin, "An Interdisciplinary, Multi-Scale Approach to Monitoring the Development and

- Succession of Harmful Algal Bloom Communities in the Monterey Bay,” *2012 Ocean Sciences Meeting, Abstract 10008*, Salt Lake City, UT, U.S.A., February 2012.
25. B. Hobson, J. G. Bellingham, M. Godin, B. Kieft, T. Hoover, R. McEwen, J. Erickson, and Y. Zhang, “Capabilities and Field Experience of MBARI’s Tethys Long Range AUV,” *2012 Ocean Sciences Meeting, Abstract 12517*, Salt Lake City, UT, U.S.A., February 2012.
  26. Y. Zhang, J. P. Ryan, J. G. Bellingham, J. Harvey, R. McEwen, F. Chavez, and C. Scholin, “Classification of Water Masses and Targeted Sampling of Ocean Plankton Populations by an Autonomous Underwater Vehicle,” *AGU 2011 Fall Meeting, Abstract OS21A-1609*, San Francisco, CA, U.S.A., December 2011.
  27. Y. Zhang, M. Godin, J. G. Bellingham, and J. P. Ryan, “Ocean Front Detection and Tracking by an Autonomous Underwater Vehicle,” *Proc. MTS/IEEE Oceans’11*, pp. 1-4, Kona, HI, U.S.A., September 2011.
  28. M. Godin, Y. Zhang, J. P. Ryan, T. Hoover, and J. G. Bellingham, “Phytoplankton Bloom Patch Center Localization by the Tethys Autonomous Underwater Vehicle,” *Proc. MTS/IEEE Oceans’11*, pp. 1-6, Kona, HI, U.S.A., September 2011.
  29. J. B. J. Harvey, J. P. Ryan, R. Marin III, J. Robidart, C. Preston, N. Alvarado, Y. Zhang, R. McEwen, F. Py, J. G. Bellingham, K. Rajan, F. Chavez, C. Scholin, R. Vrijenhoek, “Two robotic platforms for molecular detection of marine zooplankton, phytoplankton, bacterioplankton and HAB phycotoxins: A multi-trophic level approach,” ASLO Aquatic Sciences Meeting, San Juan, Puerto Rico, February 2011.
  30. Y. Zhang, R. S. McEwen, J. P. Ryan, J. G. Bellingham, J. Harvey, and R. Vrijenhoek, “Acquiring Peak Samples from Phytoplankton Thin Layers and Intermediate Nepheloid Layers by an Autonomous Underwater Vehicle with Adaptive Triggering,” *AGU 2010 Fall Meeting, Abstract OS51C-1334*, San Francisco, CA, U.S.A., December 2010.
  31. J. P. Ryan, Y. Zhang, H. Thomas, E. Rienecker, R. Nelson, and S. Cummings, “High-resolution AUV mapping and sampling of a deep hydrocarbon plume in the Gulf of Mexico,” *AGU 2010 Fall Meeting, Abstract OS41D-07*, San Francisco, CA, U.S.A., December 2010.
  32. J. G. Bellingham, C. Scholin, Y. Zhang, M. A. Godin, B. Hobson, and S. Frolov, “Adaptive Observatories for Observing Moving Marine Organisms,” *AGU 2010 Fall Meeting, Abstract IN34A-01*, San Francisco, CA, U.S.A., December 2010.
  33. Y. Zhang, J. G. Bellingham, M. Godin, J. P. Ryan, R. S. McEwen, B. Kieft, B. Hobson, and T. Hoover, “Thermocline Tracking Based on Peak-Gradient Detection by an Autonomous Underwater Vehicle,” *Proc. MTS/IEEE Oceans’10*, pp. 1-4, Seattle, WA, U.S.A., September 2010.
  34. J. G. Bellingham, Y. Zhang, J. E. Kerwin, J. Erikson, B. Hobson, B. Kieft, M. Godin, R. McEwen, T. Hoover, J. Paul, A. Hamilton, J. Franklin, and A. Banka, “Efficient Propulsion for the Tethys Long-Range Autonomous Underwater Vehicle,” *Proc. IEEE AUV’2010*, pp. 1-6, Monterey, CA, U.S.A., September 2010.
  35. Y. Zhang, J. G. Bellingham, and Y. Chao, “Optimizing Deployment of Moorings and Autonomous Underwater Vehicles for Ocean Flux Estimation,” *2010 Ocean Sciences Meeting, Abstract PO35L-18*, Portland, OR, U.S.A., February 2010.
  36. J. G. Bellingham, B. Hobson, M. A. Godin, B. Kieft, J. Erikson, R. McEwen, C. Kacey, Y. Zhang, T. Hoover, and E. Mellinger, “A Small, Long-Range AUV with Flexible Speed and Payload,” *Ocean Sciences Meeting, Abstract MT15A-14*, Portland, OR, U.S.A., February 2010.
  37. Y. Zhang, R. S. McEwen, J. P. Ryan, and J. G. Bellingham, “An Adaptive Triggering Method for Capturing Peak Samples in a Thin Phytoplankton Layer by an Autonomous Underwater Vehicle,” *Proc. MTS/IEEE Oceans’09*, pp. 1-5, Biloxi, Mississippi, U.S.A., October 2009.
  38. J. G. Bellingham, Y. Zhang, R. E. Davis, and M. Godin, “Improving AUV-Based Coastal Observing Systems,” *Eos Trans. AGU*, 89 (36), Ocean Sciences Meeting Suppl., Session 100, March 2008.
  39. Y. Zhang, J. G. Bellingham, R. E. Davis, D. Fratantoni, and S. Ramp, “Reconstruction of Coastal-Scale Ocean Fields in an Upwelling Region,” *Eos Trans. AGU*, 88 (52), Fall Meeting Suppl., Abstract OS51B-0475, December 2007.
  40. Y. Zhang and J. G. Bellingham, “Synoptic Chemical Sampling with Distributed Mobile Systems: a Possibility?” *Arctic/Subarctic Ocean Fluxes Newsletter*, No. 5, pp. 11&18, April 2006.
  41. Y. Zhang, J. G. Bellingham, R. E. Davis, and F. Chavez, “Error Analysis and Sampling Design for Ocean Flux Estimation,” *Eos Trans. AGU*, 87 (52), Fall Meeting Suppl., Abstract OS33A-1683, December 2006.
  42. Y. Zhang and J. G. Bellingham, “Selective Sampling of an Oceanographic Field Utilizing Principal Empirical Orthogonal Functions,” *Eos Trans. AGU*, 87 (36), Ocean Sciences Meeting Suppl., Abstract OS36G-17, February 2006.
  43. Y. Zhang, J. G. Bellingham, R. E. Davis, and Y. Chao, “Optimizing Autonomous Underwater Vehicles’ Survey for Reconstruction of an Ocean Field that Varies in Space and Time,” *Eos Trans. AGU*, 86 (52), Fall Meeting Suppl., Abstract IN21B-1178, December 2005.



44. J. G. Bellingham and Y. Zhang, "Observing Processes that Vary in Time and Space with Heterogeneous Mobile Networks," *Proc. International Workshop on Underwater Robotics*, pp. 9-16, Genoa, Italy, November 2005.
45. Y. Zhang and J. S. Willcox, "Current Velocity Mapping Using an AUV-Borne Acoustic Doppler Current Profiler", *Proc. 10<sup>th</sup> International Symposium on Unmanned Untethered Submersible Technology*, pp. 31-40, Durham, New Hampshire, U.S.A., September 1997.
46. J. S. Willcox, Y. Zhang, J. G. Bellingham, and J. Marshall, "AUV Survey Design Applied to Oceanic Deep Convection," *Proc. MTS/IEEE Oceans'96*, pp. 949-954, Ft. Lauderdale, Florida, U.S.A., September 1996.
47. Y. Zhang and Y. Ma, "Estimating Direction of Arrival with One-Dimensional Spectral Analysis," *Proc. MTS/IEEE Oceans '95*, pp. 845-848, San Diego, California, U.S.A., October 1995.
48. Y. Zhang and Y. Ma, "A Novel Beamforming Approach Based on DSP Chips," *Proc. 14th International Congress on Acoustics*, LP-7, Beijing, China, September 1992. Also in *ACUSTICA*, Vol. 76, Supplement to No. 4, May 1992.
49. Y. Zhang and Y. Ma, "Design of Digital Phase Shifter Based on Adaptive Modeling," *Proc. 4th National Conference on Signal Processing*, pp. 55-58, Chengdu, China, April 1992.
50. Y. Zhang and Y. Ma, "Dual-Role Design for Off-Chip RAM of TMS320C25 in Master-Slave Systems," *Proc. 10th National Conference on Circuits and Systems*, pp. 29-31, Hangzhou, China, May 1992.

### INVITED TALKS

1. Y. Zhang, B. Kieft, B. Hobson, T. O'Reilly, and J. Ryan, "Targeted Sampling Enhanced by Multi-Vehicle Collaboration", National Science Foundation Workshop on Underwater Wireless Infrastructure, Washington, D.C., November 2018.
2. J. Ryan and Y. Zhang, "Oceanographic Feature Recognition and Response with AUVs"
  - ICRA'2018 Workshop on Informative Path Planning and Adaptive Sampling, Brisbane, Australia, May 2018.
  - University of Tasmania, Launceston and Hobart, Australia, May 2018.
3. Y. Zhang, "AUV Autonomy for Marine Ecology Studies,"
  - Woods Hole Oceanographic Institution, Woods Hole, MA, September 2017.
  - California Institute of Technology Pasadena, CA, September 2017.
4. Y. Zhang and C. Scholin, "Intelligent and Persistent Ocean Observation Using Autonomous Underwater Vehicles - on the Way toward Packard's Vision", the 2015 International Conference on Underwater Sciences, Technology, and Education, City University of Hong Kong, Hong Kong, China, August 2015.
5. Y. Zhang, "Targeted Observation of Oceanographic Features Using Autonomous Underwater Vehicles in Flight and Drifting Modes", Chinese Academy of Sciences Shenyang Institute of Automation, Shenyang, China, June 2015.
6. Y. Zhang, J. Bellingham, and J. Ryan, "Mobile Intelligent Ocean Observation by Autonomous Underwater Vehicles", the Second Chinese Conference on Ocean Observation, Xiamen, China, November 2014.
7. Y. Zhang, J. Bellingham, and J. Ryan, "Adaptive Sampling of Coastal Processes by Autonomous Underwater Vehicles", Nanjing University, Nanjing, China, May 2014.
8. Y. Zhang, J. Ryan, and J. Bellingham, "Using Autonomous Underwater Vehicles to Enable Autonomous Detection and Targeted Sampling of Oceanographic Features", State Key Laboratory in Marine Pollution, City University of Hong Kong, Hong Kong, China, January 2014.
9. Y. Zhang, J. Ryan, and J. Bellingham, "Using Autonomous Underwater Vehicles for Targeted Sampling in a Coastal Upwelling Ecosystem", the First Xiamen Symposium on Marine Environmental Sciences, Xiamen, China, January 2014.
10. Y. Zhang, "Unmanned Exploration of the Ocean", Experts Forum Lecture, University Town of Shenzhen, Shenzhen, China, April 2013.
11. Y. Zhang, J. G. Bellingham, J. P. Ryan, J. Harvey, M. Godin, and R. McEwen, "Autonomous Underwater Vehicles Drive Intelligent Ocean Observation", Tsinghua University Shenzhen Graduate School, Shenzhen, China, April 2013.
12. Y. Zhang, "Introduction to the U.S. Ocean Observatories Initiative (OOI) and the Scientific Applications of the Regional Scale Nodes (RSN)", Tongji University, Shanghai, China, April 2013.
13. Y. Zhang, J. G. Bellingham, and J. P. Ryan, "Adaptive Ocean Observation Using Fixed Platforms and Autonomous Underwater Vehicles", the First Chinese Conference on Ocean Observation, Shanghai, China, November 2012.
14. Y. Zhang, J. G. Bellingham, J. P. Ryan, J. Harvey, M. Godin, and R. McEwen, "Using an Autonomous Underwater Vehicle to Adaptively Sample and Track Oceanographic Processes", Chinese Academy of Sciences Shenyang Institute of Automation, Shenyang, China, November 2012.
15. Y. Zhang, J. G. Bellingham, J. P. Ryan, J. Harvey, M. Godin, R. McEwen, F. Chavez, and C. Scholin, "Autonomous Detection, Tracking, and Targeted Sampling of Oceanographic Features by AUVs", the Second Chinese Symposium on Deep Sea and Earth Sciences, Shanghai, China, July 2012.

16. Y. Zhang, J. G. Bellingham, J. P. Ryan, J. Harvey, M. Godin, R. McEwen, F. Chavez, and C. Scholin, "Autonomous Detection and Targeted Sampling of Oceanographic Features by AUVs", the 2012 IFAC (International Federation of Automatic Control) Workshop on Navigation, Guidance, and Control of Underwater Vehicles, Porto, Portugal, April 2012.
17. Y. Zhang, J. G. Bellingham, J. P. Ryan, J. Harvey, R. McEwen, and M. Godin, "Adaptive Sampling in Ocean Observation", the Second International Workshop on Seafloor Observation, Shanghai, China, November 2011.
18. Y. Zhang, J. Ryan, H. Thomas, E. Rienecker, R. McEwen, and J. G. Bellingham, "Running an AUV for High-Resolution Survey and Targeted Sampling of a Deep Oil Plume in the 2010 Gulf of Mexico Oil Spill", AUV-Based Technologies in Offshore Oil & Gas Monitoring Workshop, Stavanger, Norway, September 2011.
19. Y. Zhang, J. Ryan, H. Thomas, E. Rienecker, R. McEwen, and J. G. Bellingham, "Using an Autonomous Underwater Vehicle to Map and Sample a Subsurface Oil Plume in the 2010 Gulf of Mexico Oil Spill," Marine Technology Society (MTS) TechSurge Workshop, Sarasota, FL, April 2011.
20. Y. Zhang, J. G. Bellingham, E. Massion, C. Dawe, S. Etchemendy, and C. Scholin, "Towards a Synergistic Ocean Observing System in Monterey Bay", Zhejiang University (in Hangzhou, China) and Shanghai Jiao Tong University (in Shanghai, China), March 2011.
21. Y. Zhang, J. G. Bellingham, E. Massion, C. Dawe, S. Etchemendy, and C. Scholin, "The MARS Deep-Sea Observatory in Monterey Bay", Tongji University, Shanghai, China, January 2011.
22. "Capturing the Key Oceanographic Signals with Autonomous Underwater Vehicles", Northwestern Polytechnic University, Xi'an, China, November 2010.
23. "Enabling Better Process Experiments through Quantitative Design and Improved Platforms", Office of Naval Research (ONR) Unmanned Maritime Systems Technology Review, Orlando, FL, February 2009.
24. "Exploring the Ocean Using Autonomous Underwater Vehicles", IEEE Monterey Bay Subsection and IEEE Vehicular Technology Society Santa Clara Valley Section, Scotts Valley, CA, June 2007.
25. "Using Fleets of Robots to Unravel Ocean Processes", University of California at Santa Cruz Department of Applied Mathematics and Statistics, Santa Cruz, CA, April 2007.
26. "Synoptic Chemical Sampling with Distributed Mobile Systems: a Possibility?", the 5<sup>th</sup> International Scientific Steering Group Meeting of Arctic Subarctic Ocean Flux Studies (ASOF), Villefranche-sur-mer, France, November 2005.
27. "Sampling the Ocean with Autonomous Underwater Vehicles", University of Miami Rosenstiel School of Marine and Atmospheric Science, Miami, FL, February 2005.
28. "Spectral Feature Classification of Oceanographic Processes Using an Autonomous Underwater Vehicle"
  - University of California Scripps Institution of Oceanography Marine Physical Laboratory, La Jolla, CA, May 2000.
  - Monterey Bay Aquarium Research Institute, Moss Landing, CA, May 2000.
  - Woods Hole Oceanographic Institution Department of Applied Ocean Physics and Engineering, Woods Hole, MA, March 2000.
29. "Signal Processing in an Autonomous Underwater Vehicle," General Electric Company Research and Development Center Industrial Electronics Laboratory, Niskayuna, NY, December 1999.
30. "Current Velocity Profiling Using an AUV-Borne Acoustic Doppler Current Profiler," Woods Hole Oceanographic Institution Department of Applied Ocean Physics and Engineering, Woods Hole, MA, July 1997.
31. "Theory and Hardware Implementation of Artificial Neural Networks for Direction-Of-Arrival (DOA) Estimation of Correlated Acoustic Sources," National Key Laboratory of Acoustics, Institute of Acoustics of the Chinese Academy of Sciences, Beijing, China, March 1994.

#### **AUTONOMOUS UNDERWATER VEHICLE (AUV) FIELD EXPERIENCE**

1. Hawaii: Using Aku and Opah long-range AUVs for autonomous sampling and survey of an open ocean deep chlorophyll maximum layer, 2018.
2. Monterey Bay, CA: running the peak-capture algorithm on the Dorado AUV to autonomously acquire peak-rhodamine water samples in a rhodamine dye patch, 2014.
3. Monterey Bay, San Pedro Bay, and Bodega Bay, CA: running the peak-capture algorithm on the Dorado AUV to acquire peak-chlorophyll water samples in phytoplankton patches for studies of harmful algal blooms and near-coast zooplankton, 2009 ~ 2014.
4. Monterey Bay, CA: running a 4-D front-tracking algorithm on the Tethys AUV to track an upwelling front for 5.5 days, May/June 2013. Led the algorithm design and mission script programming.
5. Monterey Bay, CA: running the Dorado AUV to autonomously and accurately detect an upwelling front and acquire targeted water samples in different water types across the front, June 2011 and May/June 2012. Led the algorithm design and wrote the C++ code.

6. Monterey Bay, CA: testing an algorithm on the Tethys AUV for autonomously classifying different water columns and acquiring targeted water samples across an upwelling front, April 2011. Led the algorithm design and code writing (in C++).
7. Monterey Bay, CA: testing an algorithm on the Tethys AUV for autonomously tracking the thermocline, August 2010. Led the algorithm design and code writing (in C++).
8. Gulf of Mexico: Deepwater Horizon Oil Spill Response Scientific Survey (organized by NOAA), May and June 2010. Developed and implemented an algorithm for the Dorado AUV's gulpers to capture peak-CDOM-signal water samples.
9. Monterey Bay, CA: testing an adaptive triggering method for the Dorado AUV's 10 water samplers ("gulpers") to capture peak fluorescence water samples in a thin phytoplankton layer, October 2009. Led the design, code writing (in C++), and implementation of the algorithm.
10. Monterey Bay, CA: running the Dorado AUV to track the thermocline in a tide-driven internal wave field, November 2005, May and August 2007. Wrote the AUV C++ code and the mission scripts.
11. Monterey Bay, CA: Synoptic Internal Tide Experiment, September 1999. Installed an RDI Acoustic Doppler Current Profiler (ADCP) on an Odyssey IIB AUV to measure current velocity over a long distance (10 km) in the topographically hostile Monterey Canyon. Planned AUV missions.
12. Massachusetts Bay, MA: Coastal Ocean Predictive Skill experiment, September 1998. Tested bottom-tracking functionality of an RDI Doppler Velocity Log (DVL) installed on an Odyssey IIB AUV.
13. Labrador Sea open ocean convection experiment, January 1998. Installed a SonTek Acoustic Doppler Velocimeter (ADV) on an Odyssey IIB AUV for high-precision current velocity measurement.
14. Cape Cod Bay, MA: AUV docking experiment, May 1997. Measured current velocity using a SonTek Acoustic Doppler Velocimeter (ADV) to support AUV docking operations.
15. Haro Strait, British Columbia, Canada: Autonomous Oceanographic Sampling Network experiment, June 1996. Used an Odyssey IIB AUV (installed with an RDI ADCP) to map 3-D current velocity in tidal fronts.
16. Buzzards Bay, MA: AUV docking experiment, March 1996. Participated in AUV launches and recoveries.