Chris Murphy

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Research Interests

Applied research in autonomous marine robotics, particularly communication, networking and reliable command of multiple submerged and surface-bound marine vehicles. Specific topics of research include data compression and networking for unreliable channels, governance and coordination of multiple vehicles, human-computer interfaces for autonomous underwater vehicles, machine vision, and geodesy.

Education

PhD *Candidate – Completion January 2012*. Electrical Engineering and Computer Science, MIT / WHOI Joint Program in Oceanography, Cambridge, MA. Thesis Topic: "Progressively Communicating Rich Telemetry from Autonomous Underwater Vehicles via Relays" Advisor: Hanumant Singh

S.M. Electrical Engineering and Computer Science, MIT / WHOI Joint Program in Oceanography, Cambridge, MA, 2008. Thesis: "Lossy Compression and Real-Time Geovisualization for Ultra-Low Bandwidth Telemetry from Untethered Underwater Vehicles." Advisor: Hanumant Singh

B.S. Electrical and Computer Engineering, Franklin W. Olin College of Engineering, Needham, MA, 2006. Senior Capstone: "Stereo Vision on an FPGA for Field Robotics" with John Deere.

Experience

2006- **Graduate Research Fellow**, *Deep Submergence Lab, WHOI.* One of two primary software developers responsible for SeaBED AUV platform, currently numbering 8 vehicles worldwide. Led training of NOAA employees and other users on platform. Extensive ocean-going experience with deep sea vehicles, including under-ice in both polar regions. Comfortable in leadership, operational, and research and development roles.

2005 **Summer Student Fellow**, *Deep Submergence Lab, WHOI.* Authored paper evaluating novel method for range-only localization. Processed and mosaicked imagery for underwater archaeological expedition.

2004-2005 **Summer Technical Intern**, *The MITRE Corporation*. In team, designed and developed prototype emergency contact system. Principle author and presenter of conference paper on this work. Led purchasing and initial evaluation of 802.11b tracking and security system. Developed in Java and .NET to attain enterprise goals.

Honors & Awards

2006 NSF Graduate Research Fellowship Program Honorable Mention
2005 WHOI Summer Student Fellowship
2002 Franklin W. Olin Scholarship – Full Undergraduate Tuition + Room Scholarship for 4 years
2001 Virtual Olin Partner – Franklin W. Olin College of Engineering
– Eagle Scout

Software Background

Extensive background in GNU/Linux for desktops, servers and embedded systems. Well versed in TCP/IP networking and serial communication. Fluent in Python, C, C++, and MATLAB. Contributor to several open-source software packages, including Goby acoustic communications libraries. Developer of Python Probabilistic Robotics toolkit. Packaged Python PROJ.4 bindings for Ubuntu. Familiar with programming languages including

Assembly, Verilog, Java, C#, JavaScript, PHP, and with libraries ranging from numerics to user interface design.

Professional Activities

2010-2011	Member, Strategic Planning Committee, MIT / WHOI Joint Program in Oceanography
2011-	Member, American Society for Engineering Education (ASEE)
2006-	Member, Institute of Electrical and Electronics Engineers (IEEE)
2006-	Alumni Website Administrator, OlinAlumni.org
2001-2004	Founding Member, CORe Executive Board

Oceanographic Expeditions

2012	SeaBED AUV survey of LNG Tanker Grounding on reef with UPRM in Puerto Rico, on R/V Sultana
2011	SeaBED AUV under-ice surveys in Weddell and Bellinghausen Seas, Antarctica, on RRS James C. Ross
2010	Lucille AUV Fisheries surveys with NOAA in the Pacific Northwest, on R/V Pacific Storm
2010	Lucille AUV Fisheries surveys with NOAA in Guam, Rota, and Saipan, on R/V Oscar Elton Sette
2009	Mola-Mola AUV Coral Reef surveys and training with NIUST in Bahamas, on R/V Liberty Star
2009	SeaBED AUV Operations and Training in Taiwan with National Sun Yat-Sen University
2009	Lucille AUV Operations Training with NOAA in Hawaii, on local small boat
2008	SeaBED AUV Coral Reef surveys with UPRM in Puerto Rico, on R/V Cape Hatteras
2008	Puma / Jaguar AUV Southern Mid-Atlantic Ridge Expedition and Engineering tests, on R/V Knorr
2007	Puma / Jaguar AUV Hydrothermal Vent Expedition in the Arctic Circle, on R/V Oden
2005	SeaBED AUV Deep Water Archaeology off of Chios, Greece with HCMR, on R/V Aegaeo
-	Near-shore operations out of Woods Hole aboard R/V Tioga (60' boat) and small boats as necessary

Journal Publications

1. C. Murphy, J. M. Walls, T. Schneider, R. M. Eustice, M. Stojanovic, and H. Singh, "CAPTURE: A Communications Architecture for Progressive Transmission via Underwater Relays with Eavesdropping," *IEEE Journal of Oceanic Engineering*, In Review.

2. C. Kunz, C. Murphy, H. Singh, C. Willis, R. A. Sohn, S. Singh, T. Sato, C. Roman, K. Nakamura, M. Jakuba, R. Eustice, R. Camilli, and J. Bailey, "Toward Extraplanetary Under-Ice Exploration: Robotic Steps in the Arctic," *Journal of Field Robotics,* vol. 26, no. 4, 2009.

3. M. Jakuba, C. Roman, H. Singh, C. Murphy, C. Kunz, C. Willis, T. Sato, and R. A. Sohn, "Long-baseline acoustic navigation for under-ice AUV operations," *Journal of Field Robotics,* vol. 25, no. 11, 2008.

4. R. A. Sohn, C. Willis, S. Humphris, T. M. Shank, H. Singh, H. N. Edmonds, C. Kunz, U. Hedman, E. Helmke, M. Jakuba, B. Liljebladh, J. Linder, C. Murphy, K. Nakamura, T. Sato, V. Schlindwein, C. Stranne, M. Tausenfreund, L. Upchurch, P. Winsor, M. Jakobsson, and A. Soule, "Explosive volcanism on the ultraslow-spreading Gakkel ridge, Arctic Ocean" *Nature*, no. 453, pp. 1236-1238, 2008.

Conferences + Workshops

1. M. V. Jakuba, J. C. Kinsey, D. R. Yoerger, R. Camilli, C. Murphy, D. Steinberg, and A. Bender, "Exploration of the Gulf of Mexico Oil Spill with the Sentry Autonomous Underwater Vehicle," *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) – Workshop on Robotics for Environmental Monitoring,* San Francisco, 2011.

2. C. Murphy and H. Singh, "Wavelet Compression with Set Partitioning for Low Bandwidth Telemetry from AUVs," Fifth *ACM International Workshop on UnderWater Networks (WUWNET) Conference*, Woods Hole, 2010.

3. C. Murphy, R.Y. Wang, and H. Singh, "Seafloor Image Compression with Large Tilesize Vector Quantization," *Proceedings of IEEE AUV Conference,* Monterey, 2011.

4. C. Murphy and H. Singh,"Rectilinear Coordinate Frames for Deep Sea Navigation," *Proceedings of IEEE AUV Conference*, Monterey, 2010.
5. S. E. Webster, R. Eustice, C. Murphy, H. Singh, and L. L. Whitcomb, "Toward a platform-independent acoustic communications and navigation system for underwater vehicles," IEEE/MTS OCEANS, Biloxi, MS, 2009.
6. C. Kunz, C. Murphy, R. Camilli, H. Singh, J. Bailey, R. Eustice, C. Roman, M. Jakuba, C. Willis, T. Sato, K. Nakamura, and R. Sohn, "Deep sea underwater robotic exploration in the ice-covered Arctic ocean with AUVs," *Proceedings of IEEE IROS Conference,* Nice, 2008.
7. C. Murphy and H. Singh, "Human-Guided Autonomy for Acoustically Tethered Underwater Vehicles," *Proceedings of IEEE OCEANS Conference*, Quebec City, 2008.
8. R. A. Sohn, H. N. Edmonds, S. Humphris, T. M. Shank, H. Singh, E. Helmke, M. Jakuba, C. Kunz, B. Liljebladh, J. Linder, C. Murphy, K. Nakamura, T. Sato, V. Schlindwein, M. Tausenfreund, L. Upchurch, C. Willis, and P. Winsor, "Scientific scope and summary of the Arctic Gakkel vents (AGAVE) expedition," *EOS, Transactions of the AGU,* vol. 88, 2007.
9. C. Murphy, C. Aquilina, D. Phair, "MITRE Crisis Response System: A Multi-Modal Decision Support Architecture for Crisis Response," *Proceedings of Information Systems for Crisis Response and Management (ISCRAM),* Brussels, 2005.

Other Publications

1. H. Singh, R. Eustice, S. Humphris, M. Jakuba, C. Kunz, C. Murphy, K. Nakamura, R. Reves-Sohn, C. Roman, T. Sato, T. Shank, C. Willis, "Towed and AUV Technologies for Arctic Operations". *American Geophysical Union*, Fall Meeting, Poster, 2007.
2. C. Murphy, D. Lindquist, A.M. Rynning, T. Cecil, S. Leavitt, M.L. Chang. "Low-cost Stereo Vision on an FPGA," *IEEE Symp. on Field-Programmable Custom Computing Machines (FCCM),* Poster, 2007.