Hanumant Singh

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Research Interests

My interests include system architecture and algorithms for high resolution acoustic, optical and chemical sensing; underwater vehicle (AUV and ROV) system architectures for navigation, docking and power; and the interactions between these subsystems.

Education

Ph.D., Massachusetts Institute of Technology/Woods Hole Oceanographic Institution Joint Program, 1995.
B.S., Computer Science, George Mason University, 1989. *Distinguished Graduate*
B.S., Electrical Engineering, George Mason University, 1989. *Distinguished Graduate*

Professional Experience

2001-Present, Associate Scientist, Woods Hole Oceanographic Institution
1997-2001, Assistant Scientist, Woods Hole Oceanographic Institution
1995-1997, Post-doctoral Investigator, Woods Hole Oceanographic Institution

Professional Activities

Organizer, Fourth Annual Centre for Subsurface Sensing and Imaging Systems Retreat, 2003
Editor, IEEE Journal of Oceanic Engineering, Special issue on Underwater Image and Video Processing, 2003
Organizer, First Annual Centre for Subsurface Sensing and Imaging Systems Retreat, 2000
Member, Management Board, Engineering Research Center on Subsurface Sensing and Imaging

Institute Advisory Committee, Deep Ocean Exploration Institute, 2004-2007
Member, WHOI Information Technology Advisory Committee
Member, WHOI Alumni/ae Committee, 2000-2005
Seminar Coordinator, Dept. of AOPE, WHOI 1996-2000
Organizer, WHOI AUV Summer Seminar Series, 1998
Member, Task Force on International Arrivals, 1993-1995
Student Representative, MIT-WHOI Joint Program, 1993-1994

Member, IEEE
Member, American Geophysical Union
Member, Eta Kappa Nu, National Honor Society for Electrical Engineering
Member, Alpha Chi, National Honor Society

Invited Seminars / Talks

Mitsubishi Electric Research Laboratory, MA, 2004
Stanford University,CA, 2004
NCKU, Tainan, Taiwan, 2004
Biological and Chemical Sensors Workshop sponsored by OLI, WHOI, 2003
Korean Research Institute of Ships and Ocean Engineering, 2003
Alfred Wegener Institute, Bremen, Germany, 2003
Monterey Bay Aquarium and Research Institute, 2003
National Science Foundation, OCE Division, 2002
The Mathworks Inc, 2001
Lamont Doherty Earth Observatory, 2001
Speaker / Panelist, ICRA Workshop on Concurrent Mapping and Localization, March 2000
Department of Electrical Engineering, Northeastern University
Robotics Institute, Carnegie Mellon University, 2001
Department of Aerospace and Mechanical Engineering, Boston University, 2001
Rensselaer Polytechnic Institute, NY, 2000
Panel on Methodology and Technique, The First Conference on Archaeology and Technology in the Deep Sea, Massachusetts Institute of Technology, Cambridge, MA, January 1999
Sarnoff Research Laboratories, Princeton, NJ, 1999
Naval Underwater Warfare Center, RI, 1997
George Mason University, 1996
Massachusetts Institute of Technology, 1996

Public Outreach

Funded Collaboration with Cheyney University (an HBCU), for minority participation in the Ocean Sciences, 2004-2007

Numerous Talks for the Trustees and Members of the Corporation, WHOI

My Photomosaics were featured in National Geographic Magazine
1. *Roman Shipwrecks*, pp 32-41, April, 1998.
2. *Ancient Ashkelon*, pp 62-92, January 2001.
3. *What's Destroying Titanic*, pp 96-114, December 2004.
and accompanying National Geographic Television Documentaries.

Significant coverage of my work has appeared in the popular media including National Public Radio, the Discovery Channel and at the American Museum of Natural History.

Students

Current
Dennis Evangelista, Graduate Student, Multiple AUV Applications, 2004 - onwards
Chris Roman, Doctoral Candidate, Multibeam Surveys Underwater, 1999 - onwards
Ryan Eustice, Doctoral Candidate, Visually Augemented Navigation, 1999 - onwards
*Qiao Hu, Doctoral Candidate, Pattern Recognition, 2000 - onwards
***Sacha Wichers, Graduate Student, Modelling Hydrothermal Fluid Flow, 2002 - onwards

Past
Oscar Pizarro, Ph.D, 2004.
Zachary Berkowitz, Summer Student Fellow, In-situ Chemical Sensors Underwater, 2004
Celeste Fowler, Graduate Student, Color Imaging Underwater, 2003-2004
Jordan Pekor, Summer Student Fellow, LED array design for underwater imaging, 2003
Nicole Nichols, Summer Minority Trainee, A Design for a Depth Upgrade to SeaBED, 2002 and 2003
Rajesh Nadakuditi, Summer Student Fellow, Automated mosaicking of optical imagery, 2000
**Jane Canulette, Summer Student Fellow, Architectural issues in AUV design, 1999
Gregory Fries, Summer Student Fellow, Docking for Ocean Sampling Networks, 1998
**Lt Erik Burian, USN, Master's Thesis, Gradient following with ABE, 1996-1997
**Frank Weyer, Graduate Student, Stereo imaging with ABE, 1995-1996
**Lt Cmdr Phil LeBas, USN, Master's Thesis, Control of an AUV at low speeds, 1995-1996
**Ralf Bachmayer, Undergraduate Thesis, Bottom following with ABE, 1995

*Co-advised with Cabell S. Davis
**Co-advised with Dana R. Yoerger
***Co-advised with Rob Sohn

Postdocs

Ali Can (currently at GE Medical Systems Research Center), AOPE Post-doctoral Fellow, Color Correction Underwater, 2003-2004
Brian Binghan (currently Assistant Professor at Olin College), Post-doctoral Investigator, Underwater Vehicles, 2004
Brendan Foley, Post-doctoral Fellow, Deep Water Archaeology, 2004-continuing
Rich Camilli, DOEI Post-doctoral Fellow, In-situ Chemical Sensing, 2004-continuing
Oscar Pizarro, Post-doctoral Investigator, Optical Imaging Underwater, 2004-continuing

Refereed Publications

1. Stewart, W.K., Chu, D., Malik, S., Lerner, S., Singh, H., Quantitative Seafloor Characterization Using a Bathymetric Sidescan Sonar, *IEEE Journal of Oceanic Engineering*, Vol. 19, No. 4, pp. 599-610, October 1994.
2. Goff, J., Stewart, W.K., Singh, H., Tang, X., Quantitative Analysis of Sea Ice Draft. 2.

Application of Stochastic Modeling to Intersecting Topographic Profiles, *Journal of Geophysical Research*, Vol. 100, No. C4, pp. 7705-7018, April 1995.

3. Yoerger, D., Bradley, A., Singh, H., Bachmayer, R., Surveying a Subsea Lava Flow Using the Autonomous Benthic Explorer (ABE), *International Journal of Systems Science*, vol. 29, No.10, pp. 1031-1044, 1998. *Also published as* Yoerger, D.R., Bradley, A., Walden, B., Singh, H., Bachmayer, R., Surveying a Subsea Lava Flow Using the Autonomous Benthic Explorer (ABE), *Journal of the Japan Society for Marine Surveys and Technology*, Vol. 9, No. 1, pp. 43-60, March 1997 (in Japanese).
4. Ballard, R.D., McCann, A., Yoerger, D., Whitcomb, L., Mindell, D., Oleson, J., Singh, H., Foley, B., Adams, J., Piechota, D., The Discovery of Ancient History in the Deep Sea Using Advanced Deep Submergence Technology, *Deep-Sea Research* Part I, Vol. 47, pp. 1591-1620, 2000.
5. Singh, H., Whitcomb, L., Yoerger, D., Pizarro, O., Microbathymetric Mapping from Underwater Vehicles in the Deep Ocean, *Journal of Computer Vision and Image Understanding*, Vol. 79, No. 1, pp. 143-161, 2000.
6. Singh, H, Adams, J., Foley, B.P. Mindell, D., Imaging for Underwater Archaeology, *American Journal of Field Archaeology*, pp. 319-328, vol 27, no 3, Fall 2000.
7. Singh, H., Bellingham, J.G., Hover, F., Lerner, S., Moran, B.A., von der Heydt, K., Yoerger, D., Docking for an Autonomous Ocean Sampling Network, *IEEE Journal of Oceanic Engineering*, pp. 498-514, vol 26, no 4, 2001.
8. Bradley, A., Feezor, M. D., Singh, H., Sorrell, F.Y., Power Systems for AUVs, *IEEE Journal of Oceanic Engineering*, pp. 526-538, vol 26, no 4, 2001.
9. Webster, S., Pizarro, O., Singh, H.,"Photomosaicking in Underwater Archaeology", *INA Quarterly*, pp 22-26. vol 28, no 3, 2001.
10. Ballard, R., Stager, L., Master, D., Yoerger, D., Mindell, D., Whitcomb, L., Singh, H., Piechota, D., Iron Age Shipwrecks in Deep Water off Ashkelon, Israel, American Institute of Archaeology. pp.151-168. vol 106, no 2. 2002.
11. Pizarro, O., Singh, H. "Towards Large Area Mosaicing for Underwater Scientific Applications", *IEEE Journal of Oceanic Engineering, Special Issue on Underwater Image and Video Processing*, pp. 651-672, vol 28, no 4, 2003.
12. Singh, H., Howland, J., Pizarro, O., Large Area Photomosaicking Underwater, *IEEE Journal of Oceanic Engineering*, pp. 872-886, vol 29, no 3, 2004.
13. Singh, H., Armstrong, R., Gilbes, F., Eustice, R., Roman, C., Pizarro, O., Torres, J., "Imaging Coral I: Imaging Coral Habitats with The SeaBED AUV", The Journal for Subsurface Sensing Technologies and Applications, pp. 25-42, vol 5, no 1, 2004.
14. Cleveland, R., Cohen, A.,Roy, R., Singh, H., Szabo, T., "Imaging Coral II: Advances in Imaging of Coral Skeletons using Ultrasound", The Journal for Subsurface Sensing Technology and Applications, pp 43-61, vol 5, no 1, 2004.
15. D.A. Mindell, H. Singh, D. Yoerger, L.Whitcomb, J.Howland, "Precision mapping and imaging of underwater sites at Skerki Bank using robotic vehicles," in A.M. McCann and J.P. Oleson, eds., Deep-water Shipwrecks off Skerki Bank: the 1997 Survey, *Journal of Roman Archaeology*, Suppl. Series, pp 25-30, no 58, 2004.
16. Armstrong, R., Singh, H., Torres, J., Riggs, L., Garcia-Moliner, G., Can, A., Eustice, R., Roman, C., "Quantitative Assessment of the Deep Coral Reef Habitat of the Hind Bank MCD (US Virgin Islands) using the Seabed AUV", submitted to *Deep Sea Research Part I: Oceanographic Research Papers*.

17. Can, A., Singh, H., "Methods for Correcting Lighting Pattern and Attenuation in Underwater Imagery", submitted to the *IEEE Journal of Oceanic Engineering*
18. Narasimha-Iyer, H., Can, A., Singh, H., Roysam, B., Tanenbaum, H.L., "Automated Analysis of Longitudinal Changes in Color Retinal Fundus Images for Monitoring Diabetic Retinopathy", submitted to *the IEEE Transactions on Medical Imaging.*

Other Journals, Book Chapters

19. Tivey, M., Yoerger, D., Bradley, A., Catanach, R., Duester, A., Liberatore, S., Singh, H., Autonomous Underwater Vehicle Maps Seafloor, *EOS*, Transactions of the American Geophysical Union, Vol. 78, No. 22, pp. 229-230, June 1997. *Also selected for publication in a journal for high school teachers and students*, Tivey, M., Yoerger, D., Bradley, A., Catanach, R., Duester, A., Liberatore, S., Singh, H., Autonomous Underwater Vehicle Maps Seafloor, *Earth in Space*, No. 10, pp. 10-14, 1997.
20. Whitcomb, L., Yoerger, D., Singh, H., Mindell, D., Towards Precision Robotic Maneuvering, Survey, and Manipulation in Unstructured Undersea Environments, *Robotics Research - The Eighth International Symposium*, Ch. 2, pp. 45-54, Springer-Verlag Publications, London, 1998.
21. Howland, J., Singh, H., Marra, M., Potter, D., Digital Mosaicking of Underwater Imagery, *Sea Technology*, pp. 65-69, June 1999.
22. Singh, H., Pizarro, O., Duester, A., Howland, J.C., Optical Imaging from the ABE AUV, *Sea Technology*, pp. 39-43, April 2000.
23. Whitcomb, L.L., Yoerger, D.R., Singh, H., Howland, J., Advances in Underwater Robot Vehicles for Deep Ocean Exploration: Navigation, Control, and Survey Operations, *Robotics Research - The Ninth International Symposium*, pp. 439-448, Springer-Verlag Publications, London, 2000.
24. Singh, H, Can, A., Eustice, R., Lerner, S., McPhee, N., Pizarro, O., Roman, C., "Seabed AUV Offers New Platform for High-Resolution Imaging", *EOS, Transactions of the AGU*, vol 85, no 31, pp 289,294-295, August, 2004.

Refereed Conference Publications

25. Singh, H., Yoerger, D., Bradley, A., Issues in AUV Design and Deployment for Oceanographic Research, *Proceedings of the 1997 IEEE International Conference on Robotics and Automation*, Vol. 3, pp. 1857-1862, April 1997. (Invited Paper)
26. Whitcomb, L., Yoerger, D., Singh, H., Advances in Doppler-based Navigation of Underwater Robotic Vehicles, *Proceedings of the IEEE International Conference on Robotics and Automation*, Vol. 1, pp. 399-406, May 1999.
27. Singh, H., Pizarro, O., Whitcomb, L., Yoerger, D.R., In-situ Attitude Calibration for High Resolution Bathymetric Surveys with Underwater Robotic Vehicles, *Proceedings of the IEEE International Conference on Robotics and Automation*, pp. 1767-1774, April 2000.
28. Pizarro, O., Singh, H., Lerner, S., "Towards Image-based characterization of Acoustic Navigation", *Proceedings of the 2001 IEEE/RSJ Conference on Intelligent Robots and Systems* Maui, HI, pp.1519-1524, Nov 2001.
29. Eustice, R., Salgian, G., Singh, H., Mandelbaum, R., "Sensor fusion of Structure from

Motion, Bathymetric and Acoustic Navigation Modalities Underwater", *Proceedings of the 2002 International Conference on Robotics and Automation*, pp. 4024-4031, May 2002.

30. Pizarro, O., Eustice, R., Singh, H., ""Relative Pose Estimation for Instrumented, Calibrated Imaging Platforms", *Proceedings of the VIIth Digital Imaging Computing, Technologies and Applications Conference*, pp. 601-612, Sydney, December, 2003.
31. Eustice, R., Pizarro, O., Singh, H., "Visually Augmented Navigation in an Unstructured Environment Using a Delayed State History", *Proceedings of the 2004 International Conference on Robotics and Automation*, pp. 25-32, vol. 1, New Orleans, LA, USA, April 2004.
32. Eustice, R., Singh, H., Leonard, J., "Exactly Sparse Delayed State Filters", accepted by *The 2005 International Conference on Robotics and Automation*.

Other Conference Publications

33. Singh, H., Yoerger, D., Bachmayer, R., Bradley, A., Stewart, W.K., Sonar Mapping with the Autonomous Benthic Explorer (ABE), *Proceedings of the 9th International Symposium on Unmanned, Untethered Submersible Technology*, pp. 367-375, Durham, New Hampshire, September 1995.
34. Burian, E., Yoerger, D., Bradley, A., Singh, H., Gradient Search with Automomous Underwater Vehicles Using Scalar Measurements, *Proceedings of the AUV 96 IEEE Conference*, pp. 86-97, Monterey, California, June 1996.
35. Singh, H., Catipovic, J., Eastwood, R., Freitag, L., Henrikson, H., Hover, F., Yoerger, D., Bellingham, J.G., Moran, B.A., An Integrated Approach to Multiple AUV Communications, Navigation and Docking, *Proceedings of the Oceans '96 Conference*, pp. 59-64, Fort Lauderdale, Florida, September 1996.
36. Singh, H., Stewart, W.K. An Entropic Framework for Sensor Modelling, *Proceedings of the Oceans 96 MTS/IEEE Conference*, pp. 211-215, Ft. Lauderdale, Florida, September 1996.
37. Singh, H., Bowen, M., Hover, F., LeBas, P., Yoerger, D.R., Intelligent Docking for an Autonomous Ocean Sampling Network, *Proceedings of the Oceans '97 Conference*, Vol. 2, pp. 1126-1131, Halifax, Nova Scotia, October 1997.
38. Singh, H., Howland, J., Whitcomb, L., Yoerger, D., Quantitative Photomosaicking of Underwater Imagery, *Proceedings of the Oceans '98, IEEE/OES Conference*, Vol. 1, pp. 263-266, Nice, France, September/October 1998.
39. Singh, H., Lerner, S., von der Heyt, K., Moran, B., An Intelligent Dock for an Autonomous Ocean Sampling Network, *Proceedings of the Oceans '98, IEEE/OES Conference*, pp. 1459-1462, Nice France, September/October 1998.
40. Whitcomb, L.L., Yoerger, D., Singh, H., Howland, J., Advances in Underwater Robot Vehicles for Deep Ocean Exploration: Navigation, Control and Survey Operations, *Proceedings of the Ninth International Symposium of Robotics Research*, Snowbird, Utah, October 1999.
41. Singh, H., Weyer, F., Howland, J., Duester, A., Yoerger, D., Bradley, A., Quantitative Stereo Imaging from the Autonomous Benthic Explorer (ABE), *Proceedings of the Oceans '99 MTS/IEEE Conference*, Vol. 1, pp. 52-57, Seattle, Washington, September 1999.

42. Whitcomb, L., Yoerger, D.R., Singh, H., Combined Doppler/LBL Based Navigation of Underwater Vehicles, *Proceedings of the 11th International Symposium on Unmanned Untethered Submersible Technology*, Durham, New Hampshire, August 1999.
43. Yoerger, D., Bradley, A., Singh, H., Walden, B., Cormier, M-H., Ryan, W., Multisensor Mapping of the Deep Seafloor with the Autonomous Benthic Explorer, *Proceedings of the 2000 International Symposium on Underwater Technology*, pp. 248-253, Tokyo, Japan, May 2000.
44. Singh, H., Roman, C., Whitcomb, L., Yoerger, D., Advances in Fusion of High Resolution Underwater Optical and Acoustic Data, *Proceedings of the 2000 International Symposium on Underwater Technology*, pp. 206-211, Tokyo, Japan, May 2000.
45. Roman, C., Pizarro, O., Eustice, R., Singh, H., A New Autonomous Underwater Vehicle for Imaging Research, *Proceedings of the 2000 MTS/IEEE Oceans Conference*, Providence, Rhode Island, Vol. 1, pp. 153-156, September 2000.
46. Eustice, R., Singh, H., Howland, J., Image Registration Underwater for Fluid Flow Measurements and Photomosaicking, *Proceedings of the 2000 MTS/IEEE Oceans Conference*, Providence, Rhode Island, Vol. 3, pp. 1529-1534, September 2000.
47. Howland, J., Singh, H., Simulation of the Deep Sea Mosaicking Process, *Proceedings of the 2000 MTS/IEEE Oceans Conference*, Providence, Rhode Island, Vol. 2, pp. 1353-1357, September 2000.
48. Roman, C., Singh, H., "Estimation of Error in Large Area Underwater Photomosaics Using Vehicle Navigation Data", Proceedings of the 2001 MTS/IEEE Oceans 2001 Conference.
49. Singh, H., Eustice, R., Pizarro, O., "U-WIT: The Underwater Imaging Toolkit for photomosaicking and image based navigation", Proceedings of the UT2002 Underwater Technology Conference, pp 141-145, April 2002.
50. Singh, H., Eustice, R., Pizarro, O., Roman, C., "The SeaBED AUV- A platform for high resolution imaging", Invited presentation, 2002 UUVS Conference, Southampton, UK.
51. Camilli, R., Bingham, B., Jakuba, M., Singh, H., Whelan, J., "Integrating In-situ Chemical Sampling with AUV Control Systems", accepted for the *IEEE 2004 Oceans Conference*.
52. Pizarro, O., Eustice, R., Singh, H., "Large Area 3D Reconstructions from Underwater Surveys", accepted for the *IEEE 2004 Oceans Conference*.
53. Roman, C., Singh, H., "Micro-bathymetric mapping using acoustic range images", accepted for the *IEEE 2004 Oceans Conference*.

Posters / Abstracts

54. Yoerger, D., Bradley, A., Bachmayer, R., Catanach, R., Duester, A., Liberatore, S., Singh, H., Walden, B., Tivey, M.A., Near Bottom Magnetic Surveys of the Coaxial Ridge Segment Using the Autonomous Benthic Explorer Survey Vehicle, *1995 Ocean Sciences Meeting of the American Geophysical Union*, San Francisco, California.
55. Bradley, A., Yoerger, D., Walden, B., Singh, H., The Autonomous Benthic Explorer, an Instrument for Deep Ocean Survey, *1996 Ocean Sciences Meeting of the American Geophysical Union*, San Diego, California.
56. Yoerger, D., Singh, H., Howland, J., Whitcomb, L., Lerner, S., High Resolution Optical and Microbathymetric Mapping using the Jason ROV, *1998 Fall Meeting of the American Geophysical Union*, San Francisco, California.

57. Stein, S., Lin, J., Stein, C., Bradley, A., Von Herzen, R., Yoerger, D., Singh, H., An Autonomous Seafloor Heat Flow Measurement System, *1998 Fall Meeting of the American Geophysical Union*, San Francisco, California.
58. Yoerger, D., Singh, H., Whitcomb, L., Catteau, J., Adams, J., Foley, B., Mindell, D., High Resolution Mapping for Deep Water Archaeology, *1998 Annual Meeting of the Society of Historical Archaeology*, Atlanta, Georgia.
59. Cormier, M-H., Ryan, W.B.F., Jin, W., Shah, A., Bradley, A., Yoerger, D.R., Singh, H., Sinton, J., Batiza, R., Rubin, K., Building of the Extrusive Crust of the EPR at 17°28'S Through Fissure-fed Inflationary Lava Flows, *Fall 1999 Meeting of the American Geophysical Union*, San Francisco, California.
60. Ryan, W.B.F., Cormier, M-H., Bradley, A.M., Yoerger, D.R., Singh, H., Branching and Confluence of Axially-fed Lava Channels on the Crest of the East Pacific Rise at 17°28'S, *Fall 1999 Meeting of the American Geophysical Union*, San Francisco, California.
61. Cormier, M-H., Ryan, W.B.F., Jin, W., Shah, A., Bradley, A.M., Yoerger, D.R., Singh, H., Inflationary Lava Flows Fed by a Large Fissure Eruption on the Crest of the East Pacific Rise at 17°28'S, *European Geological Society 2000 Meeting*, Nice, France.
62. Singh, H., Pizarro, O., Eustice, R., Roman, C., "Advances in High Resolution Optical Imaging Underwater", the 5th Underwater Science Symposium, Southampton, U.K., March 2001.
63. Eustice, R., Singh, H., Pizarro, O., "UWIT – The Imaging Toolbox", Censsis Industrial Conference, December, 2001.
64. Roman, C., Singh, H., "Multiscalar, Multisensor Search and Survey with Hovering AUVs", *2nd MIT Conference on Technology, Archaeology, and the Deep Sea, MIT, April, 2002.* Invited Presentation.
65. Paganetti, H., E. Rietzel, A. Can, H. Singh, G. T. Y. Chen, "Real Four-Dimensional Monte Carlo Dose Calculation for Double-Dynamic Systems (Time-Dependent Delivery Under Organ Motion)," *Medical Physics*, vol. 30, page 1451 (Abstract), San Diego, CA, August 2003.
66. Paganetti, H., E. Rietzel, A. Can, H. Singh, G. T.Y. Chen, "Simulation of four-dimensional effects in radiation therapy: The dose in intensity modulated beam delivery under organ motion," *International Journal of Radiation Oncology, Biology, and Physics*, Salt Lake City, Utah, October 2003.
67. Yoerger,D.R., Duester, A., Sellers, C., Bradley, A., Complementary Fine-Scale Multibeam Acoustic Bathymetry and Photomosaicking from an Autonomous Underwater Vehicle, *Fall 2003Meeting of the American Geophysical Union*, San Francisco, California.
68. Hanumant Singh, Roy Armstrong, Ali Can, Yasmin Detres, Graciela Garcia-Moliner, Kenneth Foote, Liane Guild, James Lindholm, Rick Nemeth, Page Valentine, The SeaBED AUV and its use in Habitat Characterization, *the 2004 ASLO/TOS Meeting*, Honolulu, HI.
69. Fowler, C., Nichols, N., Stone, A., Singh, H., Towards a three dimensional understanding of Coral Growth, *the 2004 ASLO/TOS Meeting*, Honolulu, HI.
70. Singh, H., "The Seabed AUV: A Platform for High Resolution Coastal Imaging", *the NE/SE Meeting of Geological Society of America*, vol 36, no 2, Tysons Corner, VA, March 2004.
71. Cormier, M., Driscoll, N., Weissel, J., Singh, H., "Mapping Fluid Expulsion Structures Offshore Virgina/North Carolina (USA) Using the Autonomous Underwater Vehicle "Seabed": Preliminary Results", *the 32nd International Geological Congress*, Florence,

Italy, August 2004.

72. Hill, J.C., Driscoll, N., Weissel, J., Kastner, M., Singh, H., Cormier, M., Camilli, R., Eustice, R., Lipscomb, R., McPhee, N., Newman, K., Robertson, G., Solomon, E., Tomanka, K., "A Detailed Near-bottom Survey of Large Gas Blowout Structures Along the US Atlantic Shelf Break Using the Autonomous Underwater Vehicle (AUV) SeaBED", *Fall 2004 Meeting of the AGU, San Francisco, 2004.*
73. Newman, K., Driscoll, N., Weissel, J., Kastner, M., Singh, H., Cormier, M., Camilli, R., Eustice, R., Lipscomb, R., McPhee, N., Hill, J.C., Robertson, G., Solomon, E., Tomanka, K., "A Potential Link between Fluid Expulsion and Slope Stability: Geochemical Anomalies Measured in the Gas Blowouts along the U.S. Atlantic Margin Provide New Constraints on their Formation", *Fall 2004 Meeting of the AGU, San Francisco, 2004.*
74. Singh, H., Yoerger, D., "A Universal Docking Methodology for Multiple AUVs With Differing Geometries", *Fall 2004 Meeting of the AGU, San Francisco, 2004*.
75. Camilli, R., Bingham, B., Singh, H., Whelan, J., "In-situ Chemical Exploration and Mapping using an Autonomous Underwater Vehicle", *Fall 2004 Meeting of the AGU, San Francisco, 2004.*

Oceanographic Cruises

2004 Seabed AUV Coral Habitat Mapping off of Puerto Rico aboard the *R/V Cape Hatteras*, *Chief Scientist*
2004 Archaeological Research for Persian fleet off of Mt Athos, Greece, aboard *R/V Aegaeo*
2004 Seabed AUV Investigations of Gas Blowout Structures off of North Carolina, *R/V Cape Hatteras*
2003 Archaeological Research for Persian fleet off of Mt Athos, Greece, aboard *R/V Aegaeo*
2003 Deep Water Archaeology at Skerki Bank off of Sicily on the R/V *Knorr*
2003 SeaBED AUV deep water coral mapping off of US Virgin Islands on R/V *Chapman*
2003 SeaBED AUV mapping of the shipwreck USS Monitor of the R/V *Cape Fear*
2003 SeaBED AUV habitat mapping of the Stellwagen Bank on the R/V *Oceanus, Chief Scientist*
2002 SeaBED AUV deep water coral mapping off of Bermuda on the R/V *Weatherbird II*
2002 SeaBED AUV deep water coral mapping transects off of Puerto Rico.
2001 DSL120A evaluation trials off of Bermuda on the R/V *Atlantis*
2001 AUV APOGEE engineering trials off of Bermuda on the R/V *Weatherbird II*
2000 SeaBED AUV engineering trials off of Woods Hole
1999 Forensic examination of the wreckage of Egypt Air Flight EA990 off theSSV *Carolyn Chouest*
1999 Evaluation of doppler based navigation for the DSV Alvin aboard the R/V *Atlantis*
1999 The Ashkelon99 Deep Ocean Archaeological Expedition to the Mediterranean using the Jason ROV aboard the M/V *Northern Horizon*
1999 SITE99 Experiment conducted out of the Monterey Bay Aquarium and Research Institute demonstrating docking with the Odyssey AUV aboard the R/V *Shana Rae*
1998 Docking demonstration for Navoceano with the Odyssey AUVs from the R/V *Gyre*
1998 AOSN/LOOPS cruise in Mass Bay with the Odyssey AUVs from the R/V *Oceanus*
1998 High Resolution Mapping at a hydrothermal vent area using the Jason ROV from the R/V *Atlantis*

1998 Labrador Sea AOSN deployment with the Odyssey AUVs from the R/V *Knorr*
1997 Deep Water Archaeology in the Mediterranean from the SSV *Carolyn Chouest*
1997 Docking and power transfer trials in Cape Cod Bay with the Odyssey AUV aboard the R/V *Cape Hatteras*, Co-Chief Scientist
1997 Docking and power transfer trials in Cape Cod Bay with the Odyssey AUV aboard the R/V *Diane G*, Co-Chief Scientist.
1996 Stereo and Magnetic surveys with ABE and JASON operations in the Juan de Fuca region aboard the R/V *T.G. Thompson*
1996 Buzzards Bay docking trials with the Odyssey class AUVs aboard the R/V *Diane G*
1995 Magnetic Surveys in the Juan de Fuca region with the ABE AUV and Alvin aboard the *R/V Atlantis II*
1994 Shallow water mapping exercises with the JASON ROV off the Woods Hole Oceanographic Institution dock
1993 Jason IV, Guaymas Basin aboard the SSV *Laney Chouest*
1991 Deep Water Dump Site 106, JASON, DSL120 Towed Sonar, M/V *Betty Chouest*