

# Underwater vehicle



## Research Projects

Rebuilding ecosystem resilience: Assessment of management options to minimise formation of 'Barrens' habitat by the long-spined sea urchin (*Centrostephanus rodgersii*) in Tasmania, University of Tasmania, Craig Johnson, 2007-2010, Partner Institution(s): DPIPWE

Autonomous Exploration and Characterization of Benthic Habitats Linked to Oceanographic Processes, University of Sydney, Stefan Williams, 2008-2010, Funding: ARC Discovery Project

Autonomous repeatable surveys for long term monitoring of marine habitats, University of Sydney, Stefan Williams, Oscar Pizarro, Michael Jakuba, 2010-2013, Partner Institution(s): Thales Australia Pty. Ltd., Funding: ARC Linkage Project

Machine Assisted, Multi-scale Spatial and Temporal Observation and Modelling of Marine Benthic Habitats, University of Sydney, Stefan Williams, Maria Bryne, Will Figueria, Neville Barrett, 2010-2013, Partner Institution(s): University of Tasmania, Funding: ARC Super Science Fellowship

Cost-effective autonomous systems for large scale monitoring of marine protected areas, University of Sydney, Oscar Pizarro, Stefan Williams, Michael Jakuba, Ryan Eustice, Louis Whitcomb, 2010-2014, Partner Institution(s): University of Michigan, Johns Hopkins University, Funding: ARC Discovery Project, QEII Fellowship

Stress, virulence and bacterial disease in temperate seaweeds: the rise of the microbes, University of New South Wales, Peter Steinberg, S Kjelleberg, T Thomas, S Egan, M Coleman, 2010-2013, Funding: ARC Linkage Project

Establishment of a cost-effective monitoring program to detect changes in the structure of benthic invertebrate and macroalgae assemblages in the West Coast Bioregion, University of Western Australia, University of Sydney, D Smale, Gary Kendrick, E Harvey, 2010-2013, Funding: West Australian Marine Science Institution

Scientific Support for Managing Australia's Marine Biodiversity - a National Marine Biodiversity Hub, University of Tasmania, Nicholas Bax, Chris Austin, R Babcock, Neville Barrett, Mark Bravington, Brendan Brooke, J Caley, Piers Dunstan, Karen Edyvane, Peter Harris, Sarah Jennings, Gary Kendrick, Tim O'Hara, Sean Pascoe, Bob Pressey, Wendy Proctor, Tony Smith, Chris Wilcox, 2011-2015, Partner Institution(s): AIMS, CDU, CSIRO, GA, Museum Victoria, JCU, UTas, UWA, Funding: National Environmental Research Program (NERP)

Effects of climate change on temperate benthic assemblages on the continental shelf in eastern Australia, University of Tasmania, Craig Johnson, Neil Holbrook, Neville Barrett, Peter Steinberg, 2011-2014, Partner Institution(s): University of New South Wales, Funding: ARC Super Science Fellowship

Image-based automated macrobenthic species identification, counting and sizing, University of Sydney, Commonwealth Scientific Industrial Research Organisation, University of Tasmania, Stefan Williams, Oscar Pizarro, R Babcock, M Dunabin, Neville Barrett, 2011-2014, Funding: SIEF Fellowship

## Postgraduate Research Projects

Doctor of Philosophy (PhD), Large-Scale Multi-Sensor 3D Reconstructions and Visualisations of Unst ... , University of Sydney; Matthew Johnson-Robertson, 2005-2009, Supervisor(s): Stefan Williams, Oscar Pizarro

Doctor of Philosophy (PhD), Bathymetric simultaneous localisation and mapping, University of Sydney; Stephen Barkby, 2007-2011, Supervisor(s): Stefan Williams, Oscar Pizarro

Doctor of Philosophy (PhD), Variability in mesophotic coral reef communities along the Great Barrier Reef, Australia, James Cook University; Tom Bridge, 2007-2011, Supervisor(s): Scott Smithers, Jody Webster, Robin Beaman, Terry Done

Doctor of Philosophy (PhD), Non-extractive monitoring of biodiversity on temperate Australian deepwater reefs: Using advanced vision-processing techniques to develop and test reliable biodiversity metrics, University of Tasmania, Commonwealth Scientific Industrial Research Organisation; Jan Seiler, 2008-2011, Supervisor(s): Neville Barrett, Alan Williams, Neil Holbrook

Doctor of Philosophy (PhD), Water Column Current Profile Aided Localisation for Autonomous Underwa ... , University of Sydney; Lashika Medagoda, 2008-2012, Supervisor(s): Stefan Williams, Michael Jakuba

Doctor of Philosophy (PhD), Learning Predictive Habitat Models using Bathymetry, Seabed Terrain Fe ... , University of Sydney; Nasair Ashan, 2009-2013, Supervisor(s): Stefan Williams, Oscar Pizarro, Michael Jakuba

Doctor of Philosophy (PhD), Rugosity, Slope and Aspect from Bathymetric Stereo Image Reconstructio ... , University of Sydney; Ariell Friedman, 2009-2013, Supervisor(s): Stefan Williams, Oscar Pizarro

Doctor of Philosophy (PhD), Autonomous habitat classification using Gaussian Mixture Models, University of Sydney; Daniel Steinberg, 2009-2013, Supervisor(s): Stefan Williams, Oscar Pizarro, Michael Jakuba

Doctor of Philosophy (PhD), Adaptive Exploration Of Benthic Habitats Using Gaussian Processes, University of Sydney; Asher Bender, 2009-2013, Supervisor(s): Stefan Williams, Michael Jakuba

Doctor of Philosophy (PhD), Light Field Processing and its Application to Autonomous Underwater Ve ... , University of Sydney; Donald Dansereau, 2010-2014, Supervisor(s): Stefan Williams, Oscar Pizarro

Doctor of Philosophy (PhD), Heterogeneous Multiple Agent Planning for Autonomous Underwater Operat ... , University of Sydney; Lachlan Toohey, 2010-2014, Supervisor(s): Stefan Williams, Michael Jakuba

Doctor of Philosophy (PhD), In-Situ Hyperspectral Imaging using Autonomous Underwater Vehicles for ... , University of Sydney; Daniel Bongiorno, 2011-2015, Supervisor(s): Stefan Williams, Oscar Pizarro

## Book

### Book Chapters

Williams, S, Pizarro, O, Mahon, I, Johnson-Robertson, M 2009, Simultaneous localisation and mapping and dense stereoscopic seafloor reconstruction using an AUV, in G Pappas, V Kumar, O Khatib (eds.), *Experimental Robotics XI: The Eleventh International Symposium*, Springer, Berlin, pp.407-416

Williams, S, Pizarro, O, Jakuba, M, Barrett, N 2010, AUV benthic habitat mapping in South Eastern Tasmania, in A Howard, K Lagnemma (eds.), *AUV benthic habitat mapping in South Eastern Tasmania*, Springer, Berlin, pp.275-284

## Community White Papers / Technical Papers

## Conference Proceedings

Johnson-Robertson, M, Pizarro, O, Williams, S 2007, Towards Three-Dimensional Heterogeneous Imaging Sensor Correspondence and Registration for Visualization, Proceedings of the IEEE Oceans 2007 Conference, Aberdeen, May 2007, Aberdeen

Williams, S, Pizarro, O, Mahon, I, Johnson-Robertson, M 2008, Simultaneous Localisation and Mapping and Dense Stereoscopic Seafloor Reconstruction using an AUV, Proceedings of the International Symposium on Experimental Robotics 2008, Athens, Greece, Athens

Pizarro, O, Colquhoun, J, Rigby, P, Johnson-Robertson, M, Williams, S 2008, Towards Image-based Marine Habitat Classification, Proceedings of the IEEE Oceans 2008 Conference, Quebec, Canada, September 2008, Quebec City

Williams, S, Pizarro, O, Webster, J, Beaman, R, Johnson-Robertson, M, Mahon, I, Bridge, T 2008, AUV-assisted Surveying of Relic Reef Sites, Proceedings of the IEEE Oceans 2008 Conference, Quebec, Canada, September 2008, Quebec City

Williams, S, Pizarro, O, How, M, Mercer, D, Powell, G, Marshall, J, Hanlon, R 2009, Surveying Nocturnal Cuttlefish Camouflage Behaviour using an AUV, Proceedings of the IEEE 2009 International Conference on Robotics and Automation Kobe, Japan, May 2009, Kobe

Barkby, S, Williams, S, Jakuba, M 2009, An efficient approach to bathymetric SLAM, Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, St. Louis

Williams, S, Pizarro, O, Jakuba, M, Barrett, N 2009, AUV benthic habitat mapping in south eastern Tasmania, Proceedings of the 7th International Conference on Field and Service Robotics, Cambridge

Rao, D, Williams, S 2009, Large-scale path planning for underwater gliders in ocean currents, Proceedings of the 2009 Australasian Conference on Robotics and Automation, Sydney

Pizarro, O, Williams, S, Colquhoun, J 2009, Topic-Based Habitat Classification Using Visual Data, Proceedings of the MTS/IEEE Oceans 2009, Bremen, Germany, May 2009, Bremen

Williams, S, Pizarro, O, Jakuba, M, Mahon, I, Ling, S, Johnson, C 2010, Repeated AUV surveying of urchin barrens in North Eastern Tasmania, Proceedings of the IEEE 2010 International Conference on Robotics and Automation Anchorage, USA, May 2010, Anchorage

Steinberg, D, Pizarro, O, Williams, S, Jakuba, M 2010, Dirichlet process mixture models for autonomous habitat classification, Proceedings of the IEEE Oceans 2010, Sydney, Australia, May 2010, Sydney

Jakuba, M, Pizarro, O, Williams, S 2010, High resolution, consistent navigation and 3D optical reconstructions from AUVs using magnetic compasses and pressure-based depth sensors, Proceedings of the IEEE Oceans 2010, Sydney, May 2010, Sydney

Barrett, N, Seiler, J, Anderson, T, Williams, S, Nicol, S, Hill, N 2010, Using an autonomous underwater vehicle to inform management of biodiversity in shelf waters, Proceedings of the IEEE Oceans 2010 Conference, Sydney, May 2010, Sydney

Medagoda, L, Jakuba, M, Pizarro, O, Williams, S 2010, Water column current profile aided localisation for autonomous underwater vehicles, Proceedings of the IEEE Oceans 2010 Conference, Sydney, May 2010, Sydney, Presenter: Lashika Medagoda

Steinberg, D, Williams, S, Pizarro, O, Jakuba, M 2010, Towards autonomous habitat classification using Gaussian Mixture Model, Intelligent Robots and Systems (IROS), 2010 IEEE/RSJ International Conference, Taipei

Johnson-Robertson, M, Pizarro, O, Williams, S 2010, Saliency ranking for benthic survey using underwater images, Proceedings of the 11th International Conference on Control, Automation, Robotics and Vision, ICARCV 2010, Singapore

Medagoda, L, Williams, S 2011, Water Column Current Profile Aided Localisation combined with View-based SLAM for Autonomous Underwater Vehicle Navigation, Proceedings of the IEEE 2010 International Conference on Robotics and Automation Anchorage, USA, May 2010, Anchorage, Presenter: Donald Dansereau

Dansereau, D, Williams, S 2011, Seabed Modeling and Distractor Extraction for Mobile AUVs Using Light Field Filtering, Proceedings of the IEEE 2010 International Conference on Robotics and Automation Anchorage, USA, May 2010, Anchorage, Presenter: Donald Dansereau

Medagoda, L, Williams, S, Pizarro, O, Jakuba, M 2011, Localisation combined with view-based SLAM for Autonomous Underwater Vehicle navigation, Proceedings of the IEEE 2009 International Conference on Robotics and Automation Kobe, Japan, May 2009, Kobe

Beall, C, Dellaert, F, Mahon, I, Williams, S 2011, Bundle adjustment in large-scale 3D reconstructions based in underwater robotic surveys, Proceedings of IEEE/OES Oceans 2011, Santander, Spain 6-9 June 2011, Santander

Fang, C, Williams, S 2011, Probabilistic resurvey mission planning, Proceedings of the 2010 Australasian Conference on Robotics and Automation, Brisbane, Presenter: C Fang

Mahon, I, Pizarro, O, Jakuba, M 2011, Reconstructing Pavlopetri: Mapping the World's Oldest Submerged Town using Stereo-vision, Proceedings of the IEEE 2010 International Conference on Robotics and Automation Anchorage, USA, May 2010, Anchorage, Presenter: Lashika Medagoda

## In Press

## Journals

Mahon, I, Williams, S, Pizarro, O, Johnson-Robertson, M 2008, Efficient view-based SLAM using visual loop closures, IEEE Transactions on Robotics, vol. 24, no. 5, pp. 1002-1014, doi:10.1109/TRO.2008.2004888

Webster, J, Beaman, R, Bridge, T, Davies, P, Bryne, M, Williams, S, Manning, P, Pizarro, O, Thornborough, K, Woolsey, E 2008, From Corals to Canyons: Exploring the Great Barrier Reef Margin, EOS Transactions, vol. 89, no. 24, pp. 217-218, doi:10.1029/2008EO240002

Williams, S, Pizarro, O, Webster, J, Beaman, R, Mahon, I, Johnson-Robertson, M, Bridge, T 2010, AUV-assisted surveying of drowned reefs on the shelf edge of the Great Barrier Reef, Australia, Journal of Field Robotics, vol. 27, no. 5, pp. 675-697, doi:10.1002/106.20356

Johnson-Robertson, M, Pizarro, O, Williams, S, Mahon, I 2010, Generation and visualization of large scale three-dimensional reconstructions from underwater robotic surveys, Journal of Field Robotics, vol. 27, no. 1, pp. 21-51, doi:10.1002/rob.20324

Bridge, T, Done, T, Beaman, R, Friedman, A, Williams, S, Pizarro, O, Webster, J 2010, Topography, substratum and benthic macrofaunal relationships on a tropical mesophotic shelf margin, Great Barrier Reef, Australia, Coral Reefs, vol. 30, no. 1, pp. 143-153, doi:10.1007/s00338-010-0677-3

Steinberg, D, Bender, A, Friedman, A, Jakuba, M, Pizarro, O, Williams, S 2010, Toward Selection of a Propulsion Method for a Long Range Benthic Imaging AUV, Marine Technology Society Journal, vol. 44, no. 2, pp. 46-55, doi:10.4031/MTSJ.44.2.3

Steinberg, D, Bender, A, Friedman, A, Jakuba, M, Pizarro, O, Williams, S 2010, Analysis of propulsion methods for long range AUVs, Marine Technology Society Journal, vol. 44, no. 2, pp. 46-55, doi:10.4031/MTSJ.44.2.3

Rigby, P, Williams, S, Pizarro, O 2010, Towards Adaptive Benthic Habitat Mapping using Gaussian Process Classification, Journal of Field Robotics, vol. 27, no. 6, pp. 741-758, doi:10.1002/rob.20372

Stachniss, C, Williams, S, Neira, J 2010, Editorial: Visual navigation and mapping outdoors, Journal of Field Robotics, vol. 27, no. 5, pp. 509-510, doi:10.1002/106.20358

Bridge, T, Done, T, Friedman, A, Beaman, R, Williams, S, Pizarro, O, Webster, J 2011, Variability in mesophotic coral reef communities along the Great Barrier Reef, Australia, *Marine Ecology Progress Series*, vol. 428, pp. 63-75, doi:10.3354/meps09046

Barkby, S, Williams, S, Pizarro, O, Jakuba, M 2011, A featureless approach to efficient bathymetric SLAM using distributed particle mapping, *Journal of Field Robotics*, vol. 28, no. 1, pp. 19-39, doi:10.1002/06.20372

## Reports

## Thesis

## Public Seminars

Williams, S; Marine Life through the eyes of a remote operated, deep sea, autonomous vehicle; SIMS Open Day, 15/03/2009 - 15/03/2009, Sydney Institute for Marine Science, Sydney, Presenter(s): Stefan Williams

Williams, S; Simultaneous Localisation and Mapping and Dense Stereoscopic Seafloor Reconstruction using an AUV; University of Southern California Open Forum, 01/04/2010 - 01/04/2010, Los Angeles, Presenter(s): Stefan Williams

Jakuba, M; Invited seminar for Deep Submergence Lab; Woods Hole Oceanographic Institute Seminar, Woods Hole Oceanographic Institute, Woods Hole, Presenter(s): Michael Jakuba

Jakuba, M, Williams, S; Simultaneous Localisation and Mapping and Dense Stereoscopic Seafloor Reconstruction using an AUV; Centre for Marine Studies and Centre for Remote Sensing and Spatial Information Science Seminar, University of Queensland, Brisbane

Williams, S; Simultaneous Localisation and Mapping and Dense Stereoscopic Seafloor Reconstruction using an AUV; Monterey Bay Aquarium Research Institute Seminar, Monterey Bay Aquarium Research Institute, Moss Landing, Presenter(s): Stefan Williams

## Conferences, Symposia or Workshops

### Conference Oral Presentation

Johnson-Robertson, M, Pizarro, O, Williams, S, Rees, M; Identifying novel benthic habitats in high resolution AUV imagery; Australian Marine Science Association Conference, 09/07/2007 - 13/07/2007, University of Melbourne, Melbourne

Williams, S, Pizarro, O, Johnson-Robertson, M, Mahon, I, Rigby, P, Barkby, S; IMOS—Integrated Marine Observing System: Integrating IMOS with underwater cultural heritage research; New Ground: Australian Archaeological Conference, 21/09/2007 - 26/09/2007, Sydney

Johnson-Robertson, M, Mahon, I, Pizarro, O, Williams, S; Generating Visually Consistent Benthic Surface Meshes Using Visual Features Matthew; OCEANS 2007 MTS/IEEE, 29/09/2007 - 04/10/2007, Vancouver

Rigby, P, Pizarro, O, Williams, S, Colquhoun, J; Effective Benthic Surveying with Autonomous Underwater Vehicles; OCEANS 2007 MTS/IEEE, 29/09/2007 - 04/10/2007, Vancouver

Pizarro, O, Seiler, J, Bridge, T, Colquhoun, J, Barrett, N, Williams, S; Towards image-based habitat classification; GeoHab 2009, 05/05/2008 - 08/05/2009, Trondheim

Williams, S, Pizarro, O, Mahon, I, Johnson-Robertson, M; Habitat mapping using AUVs; Australia-Japan Marine Science Forum, 27/10/2008 - 30/10/2008, Australian Institute of Marine Science, Townsville

Johnson-Robertson, M, Pizarro, O, Williams, S; Towards Large Scale, Integrated Optical And Acoustic AUV Survey; Underwater Acoustic Measurements (UAM): Technologies and Results, 3rd International Conference, 21/06/2009 - 26/06/2009, Nafpilon, Presenter(s): Stefan Williams

Jakuba, M, Johnson-Robertson, M, Pizarro, O, Williams, S; Co-registered multibeam acoustic and photographic mapping of benthic environments with an AUV; Australian Marine Science Association Conference, 05/07/2009 - 09/07/2009, Adelaide

Barkby, S, Williams, S, Pizarro, O, Jakuba, M; Incorporating prior bathymetric maps with distributed particle bathymetric SLAM for improved AUV navigation and mapping; OCEANS 2009 MTS/IEE Biloxi Conference and Exhibition, 26/10/2009 - 29/10/2009, Biloxi

Pizarro, O, Colquhoun, J, Moore, C, Radford, B, Williams, S, Jakuba, M, Heyward, A; Automated Benthic Habitat Classification from Optical Imagery; Ocean Sciences Meeting, 22/02/2010 - 26/02/2010, Portland

Ashan, N, Williams, S, Jakuba, M, Pizarro, O, Radford, B; Predictive habitat models from AUV-based multibeam and optical imagery; OCEANS 2010 MTS/IEEE , 20/09/2010 - 23/09/2010, Seattle

Bender, A, Williams, S, Pizarro, O, Radford, B; Adaptive exploration of benthic habitats using gaussian processes; OCEANS 2010 MTS/IEEE , 20/09/2010 - 23/09/2010, Seattle

### Conference Poster

Bridge, T, Bongaerts, P, Englebert, N, Sampayo, E, Ridgway, K, Rodriguez-Lanetty, M, Williams, S, Pizarro, O, Webster, J, Hoegh-Guldberg, O; Scleractinian Corals and their associated Symbiodinium on Mesophotic Coral Ecosystems of the Great Barrier Reef; 11th International Coral Reef Symposium, 07/07/2008 - 11/07/2008, Fort Lauderdale

Bridge, T, Webster, J, Beaman, R, Abbey, E, Williams, S, Pizarro, O, Woolsey, E, Thornborough, K, Done, T; Hexacoral and Octocoral Communities on the Unexplored Great Barrier Reef Shelf-Edge; Deepsea Coral Symposium 2008, 01/12/2008 - 05/12/2008, Wellington

Johnson-Robertson, M, Pizarro, O, Williams, S; Large Scale Optical and Acoustic Sensor Integration for Visualization; IEEE Oceans 2009, 11/05/2009 - 14/05/2009, Bremen

Williams, S, Pizarro, O, Jakuba, M, Mahon, I, Johnson-Robertson, M; Australia's Integrated Marine Observing System Autonomous Underwater Vehicle Facility; OceanObs'09 Conference, 21/09/2009 - 25/09/2009, Venice

Friedman, A, Pizarro, O, Williams, S; Rugosity, slope and aspect from bathymetric Stereo image reconstructions; IEEE Oceans 2010, 24/05/2010 - 27/05/2010, Sydney

Medagoda, L, Jakuba, M, Pizarro, O, Williams, S; Water column current profile aided localisation for autonomous underwater vehicles; IEEE Oceans 2010, 24/05/2010 - 27/05/2010, Sydney

Ashan, N, Jakuba, M, Pizarro, O, Williams, S, Radford, B; Learning Predictive Habitat Models using Bathymetry, Seabed Terrain Features and Optical Imagery; OCEANS 2010 MTS/IEEE , 20/09/2010 - 23/09/2010, Seattle

Bender, A, Williams, S, Pizarro, O, Jakuba, M; Adaptive Exploration Of Benthic Habitats Using Gaussian Processes; OCEANS 2010 MTS/IEEE , 20/09/2010 - 23/09/2010, Seattle

### Meeting Presentation

Williams, S, Pizarro, O; High Resolution Optical Surveying using an AUV; Australasian Hydrographic Society and The Society for Underwater Technology Technical Seminar - AUVs: Future Technologies & Emerging Markets, 30/10/2008 - 30/10/2008, Perth

Steinberg, P; IMOS AUV Facility Update; NSW-IMOS Node Meeting, 21/05/2010 - 21/05/2010, Sydney Institute for Marine Science, Sydney, Presenter(s): Peter Steinberg

## **Symposium Presentation**

Steinberg, D, Bender, A, Friedman, A; Analysis of propulsion methods for long range AUVs; International Symposium on Unmanned Untethered Submersible Technology (UUST), 23/08/2009 - 26/08/2009, Durham

Williams, S; Autonomous Underwater Vehicle Support for Marine Science Projects around Australia; Society for Underwater Technology and Australian Hydrographic Office Autonomous Underwater Vehicle Symposium, 28/10/2010 - 28/10/2010, Perth, Presenter(s): Stefan Williams

Radford, B, Pizarro, O, Colquhoun, J, Moore, C, Williams, S, Jakuba, M, Cooper, T, Heyward, A, Sexton, M, Burq, S; Predictive habitat mapping of deep water coral reefs using data from Multibeam and AUV machine auto-classified data and an Ecological Modelling approach; Euro ISRS Symposium, 13/12/2010 - 17/12/2010, Wageningen

Radford, B; Predictive habitat mapping of deep lagoonal reefs using data collected by multibeam sonar and autonomous underwater vehicle; Euro ISRS Symposium, 13/12/2010 - 17/12/2010, Wageningen, Presenter(s): B Radford

## **Workshop Presentation**

Johnson-Robertson, M, Pizarro, O, Williams, S, Mahon, I; Large Scale 3D Reconstruction and Visualization of Stereo Surveys; GeoHab 2009 Video Workshop, 03/05/2009 - 04/05/2009, Trondheim

Williams, S, Pizarro, O, Jakuba, M, Mahon, I, Johnson-Robertson, M, Rigby, P, Barkby, S; Autonomous Marine Systems for Navigation, Mapping and Data Interpretation; GeoHab 2009 Video Workshop, 03/05/2009 - 04/05/2009, Trondheim

Pizarro, O; Simultaneous Localisation and Mapping and Dense Stereoscopic Seafloor Reconstruction using an AUV; Office of Naval Research Workshop on Machine Intelligence, 07/10/2009 - 08/10/2009, Lerici, Presenter(s): Oscar Pizarro

Williams, S, Pizarro, O, Jakuba, M, Steinberg, D, Friedman, A, Ashan, N; Autonomous Underwater Vehicle monitoring of benthic reference sites; IEEE/RSJ International Conference on Intelligent Robots and Systems, 11/10/2009 - 15/10/2009, St. Louis, Presenter(s): Stefan Williams