

# Pablo Valdivia y Alvarado

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Center for Environmental Sensing and Modeling

Singapore-MIT Alliance for Research and Technology

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## RESEARCH AND ACADEMIC INTERESTS

- **Bio-inspired design:** Design of mechanisms, actuators, sensors, and power sources using physical principles inspired by biological systems. Modeling and design methodologies for chemical and soft mechanisms and structures.
  - **Field robotics:** Control approaches for long-term field deployments of robots and autonomous systems. Locomotion, sensing, and sustainability approaches for environmental studies in marine, urban, and disaster zones.
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## EDUCATION

Massachusetts Institute of Technology

Cambridge, MA

*Doctor of Philosophy in Mechanical Engineering, 2007.*

Thesis: "Design of Biomimetic Compliant Devices for Locomotion in Liquid Environments"

Committee: Kamal Youcef-Toumi, Woodie Flowers, Michael Triantafyllou, and Julio Guerrero

Massachusetts Institute of Technology

Cambridge, MA

*Master of Science in Mechanical Engineering, 2001.*

Thesis: "Design, Analysis, and Control of an Autonomous Conveyance Module for Well Exploration"

Supervisor: Samir Nayfeh, Ph.D.

Massachusetts Institute of Technology

Cambridge, MA

*Bachelor of Science in Mechanical Engineering, 1999.*

Thesis: "Modeling and Identification for Control of a Holonomic Variable-Footprint Wheelchair"

Supervisor: Haruhiko H. Asada, Ph.D.

## PROFESSIONAL EXPERIENCE

Singapore-MIT Alliance for Research and Technology.

Singapore & Cambridge, MA

September 2010 - Present. Research Scientist. Conducting and supervising research on novel robots, controls, and sensors for exploration of marine environments. Work on bio-inspired soft robots was recognized with a TR35 young investigator award for SE Asia, Australia, and New Zealand.

Nomadron Inc.

Cambridge, MA

January 2010 - December 2010. VP of Mechatronic Systems. Directed research efforts to implement novel robotics and automation tools for dynamic pick-up and delivery hubs.

**Energid Technologies.**

Cambridge, MA

January 2010 - August 2010. Principal Robotic Systems Engineer. Established and managed research collaborations with Research Hospitals (Mass General, Brigham and Women's in Boston MA) and University research laboratories (MIT, University of Toronto).

February 2007 - December 2009. Senior Robotic Systems Engineer. Won and managed four research grants (totalling \$1,880,000) in the areas of Mechatronics, Robotics, and Biomedical Engineering.

**Alpine Pharmaceuticals Inc.**

Boston, MA

August 2002 - June 2006. Design consultant. Developed devices for hair care, electro-mechanical gardening tools, and infant nutrition products. One patent granted (US 7,055,528).

**Schlumberger Ltd.**

Cambridge UK, Ridgefield CT, Rosharon TX

June - August 2000. Robotics intern at Cambridge UK Research Center. Designed and built an autonomous rover for oil well exploration.

June 1999 - January 2000. Robotics Intern at Doll Research Center. Developed a new autonomous propulsion module to transport downhole logging tools.

June - August 1998: Intern at Schlumberger Perforating and Testing. Developed models of the dynamic behavior displayed by well perforating guns during accidental drops.

June - August 1997: Intern at Schlumberger Perforating and Testing. Assisted in the development of new techniques for the manufacture of perforating devices (Shape charges).

**MIT**

Cambridge, MA

September 1998 - May 1999. Undergraduate Researcher at the D'Arbeloff Laboratory.

Fall 1996 - Fall 1998. Undergraduate Researcher in the Ocean Engineering Towing Tank.

**TEACHING EXPERIENCE****MIT Mechanical Engineering Department**

Cambridge, MA

Fall 2006: Teaching Assistant for *Advanced System Dynamics and Controls* (2.151), 30 students.

Fall 2004, 2002, 2001, 2000: Teaching Assistant for *Elements of Mechanical Design* (2.72), 50 students.

Spring 2000: Teaching Assistant for *System Dynamics and Control* (2.004), 100 students.

**STUDENTS ADVISED****Graduate Thesis (MIT)**

Audren Cloitre M.S. Mechanical Engineering, 2013. Ph.D. Mechanical Engineering, 2017 (expected).

**Undergraduate Thesis (MIT)**

Sean Mellott B.S. Mechanical Engineering, 2009.

Anirban Mazumdar B.S. Mechanical Engineering, 2007.

Adam Kaczmarek B.S. Mechanical Engineering, 2006.

**Undergraduate Research Projects (MIT)**

Grace Kane B.S. Mechanical Engineering, 2011.

Bonnie Blackburn B.S. Mechanical Engineering, 2011.

Stephanie Chin Steele B.S. Mechanical Engineering, 2010.

Winston Larson B.S. Mechanical Engineering, 2010.

Fiona Yuen B.S. Mechanical Engineering, 2009.

## PUBLICATIONS

### Books and Book Chapters:

**P. Valdivia y Alvarado** and Kamal Youcef-Toumi, “Soft-Robot Fish”. In *Bio-inspired Fishlike Underwater Robots*. (ed. R. Du, Z. Li, K. Youcef-Toumi, and P. Valdivia y Alvarado), Springer, 2015.

### Refereed Journal Articles:

**P. Valdivia y Alvarado** and K. S. Sekar, “Modeling Wake Topology and Thrust Production in Batoid-inspired Oscillating Fins”, *In preparation*.

**P. Valdivia y Alvarado**, V. Subramaniam, and S. Bath, “Whisker-like Flow Sensors with Soft Tunable Follicles”, *In preparation*.

**P. Valdivia y Alvarado**, “Design of soft batoid-like underwater robots”, *In preparation*.

**P. Valdivia y Alvarado** and K.S. Sekar, “Design of a Constrained Bi-Layer Flapper for Bio-inspired Fins”, *In preparation*.

M. Asadnia, A.G.P. Kottapalli, A. Cloitre, **P. Valdivia Y Alvarado**, J. Miao, and M. Triantafyllou, “MEMS sensors for assessing flow-related control of an underwater biomimetic robotic stingray”, *Accepted for Publication: Bioinspiration and Biomimetics*.

B. Epps, **P. Valdivia y Alvarado**, K. Youcef-Toumi, and A. Techet, “Swimming Performance of a Biomimetic Compliant Fish-like Robot”, *Experiments in Fluids*, **47**(6), pp:927-939, 2009.

Y.J. Lim, **P. Valdivia y Alvarado**, C.Y. Chang, and N. Tardella, “MR Fluid Haptic System for Regional Anesthesia Training Simulation”, *Stud. Health Technol. Inform.* **132**, pp:248-253, 2008.

**P. Valdivia y Alvarado**, and K. Youcef-Toumi, “Design of Machines with Compliant Bodies for Biomimetic Locomotion in Liquid Environments”, *ASME Journal of Dynamics Systems Measurement and Control*, **128**, pp:3-13, 2006.

### Refereed Conference Papers:

K. S. Sekar, M. Triantafyllou, and **P. Valdivia y Alvarado**, “Flapping Actuator Inspired by Lepidotrichia of Ray-Finned Fishes”, *Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, September 14-18, Chicago, IL, 2014.

A. Cloitre, B. Arensen, N. Patrikalakis, K. Youcef-Toumi, and **P. Valdivia y Alvarado**, “Propulsive Performance of an Underwater Soft Biomimetic Batoid Robot”, *Proc. the 24th International Ocean and Polar Engineering Conference (ISOPE)*, Busan, Korea, Jun. 2014.

**P. Valdivia y Alvarado**, and S. Bhat, “Whisker-like sensors with tunable follicle sinus complex for underwater applications”, *Proc. of SPIE Bioinspiration, Biomimetics, and Bioreplication IV conference*, March 9-12, 2014, San Diego, CA, USA.

**P. Valdivia y Alvarado**, V. Subramaniam, and M. Triantafyllou, “Performance Analysis and Characterization of Bio-Inspired Whisker Sensors for Underwater Applications”, Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), November 3-7, 2013, pp:5956-5961, Tokyo Big Sight, Japan.

A. Cloitre, V. Subramaniam, N. Patrikalakis, and **P. Valdivia y Alvarado**, “Design and Control of a Field Deployable Batoid Robot”, Proc. IEEE International Conference on Biomedical Robotics and Biomechatronics (BioRob), Jun. 2012, pp:707-712, Rome, Italy.

**P. Valdivia y Alvarado**, “Hydrodynamic Performance of a Soft Body Under-actuated Batoid Robot”, Proc. IEEE International Conference on Robotics and Biomimetics (ROBIO), Dec. 2011, pp: 1712-1717, Phuket Island, Thailand.

H. Hans, J. Miao, **P. Valdivia y Alvarado**, and M. Triantafyllou, “Chemical Composition and Physical Features of Harbor Seal (*Phoca Vitulina*) Vibrissae for Underwater Sensing Applications”, Proc. IEEE International Conference on Robotics and Biomimetics (ROBIO), Dec. 2011, pp:1439-1443, Phuket Island, Thailand.

**P. Valdivia y Alvarado**, S. Chin, W. Larson, A. Mazumdar, and K. Youcef-Toumi, “A Soft Body Under-actuated Approach to Multi Degree of Freedom Biomimetic Robots: A stingray example”, Proc. IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob), Sept. 2010, pp: 473-478, Tokyo, Japan.

**P. Valdivia y Alvarado**, C.Y. Chang, and K. Hynynen, “Design of a Manipulator System for Hemorrhage Detection and Treatment using High Intensity Focused Ultrasound (HIFU)”, Proc. IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Oct. 2009, pp:4529-4534, St. Louis, MO.

Y.J. Lim, T. Le, **P. Valdivia y Alvarado**, C.Y. Chang, and N. Tardella, “A Regional Anesthesia Training Simulation System”, Proceedings of Medicine Meets Virtual Reality (MMVR) 17, Long Beach, CA., Jan, 2009.

Y.J. Lim, T. Le, **P. Valdivia y Alvarado**, N. Tardella, and K. Curley, “Simulation-Based Military Regional Anesthesia Training System”, 26th Army Science Conference, Orlando, FL, December, 2008.

A. Mazumdar, **P. Valdivia y Alvarado**, and K. Youcef-Toumi, “Maneuverability of a Robotic Tuna with Compliant Body”, Proc. IEEE International conference on robotics and automation (ICRA), 2008, pp:683-688, Pasadena, CA.

**P. Valdivia y Alvarado**, and K. Youcef-Toumi, “Performance of machines with flexible bodies designed for biomimetic locomotion in liquid environments”, Proc. IEEE International conference on robotics and automation (ICRA), May 2005, pp:3324-3329, Barcelona, Spain.

**P. Valdivia y Alvarado**, and K. Youcef-Toumi, “Modeling and design methodology for an efficient underwater propulsion system”, Proc. IASTED International conference on Robotics and Applications, 2003, pp:161-166, Salzburg, Austria.

#### **Contributed Papers and Abstracts:**

**P. Valdivia y Alvarado** and K.S. Sekar, “Effects of Deformation Kinematics on Underwater Fin Locomotion”, Proceedings of the 7th Symposium on Adaptive Motion of Animals and Machines AMAM 2015, June 21-25, Cambridge MA, USA (to appear).

**P. Valdivia y Alvarado**, “Modeling and Control of Soft Body Underwater Fin Locomotion”, ICRA 2015 Workshop on Soft Robotics: Actuation, Integration, and Applications, May 30 2015 (to appear).

M. Asadnia, J. Miao, A.G.P. Kottapalli, **P. Valdivia Y Alvarado**, and M. Triantafyllou, “Self-powered Micro-sensors to Improve Control and Maneuvering of a Robotic Stingray”, Proc. IEEE SENSORS, Nov. 2014, pp:458-461, Valencia, Spain.

**P. Valdivia y Alvarado**, S. Bhat, and K. Sekar, “Soft Tunable Whisker-like Sensors”, Workshop on Advances on Soft Robotics, Robotics Science and Systems (RSS) Conference, July 13, 2014, Berkeley CA.

**P. Valdivia y Alvarado**, K. Srivatsa, and M. Triantafyllou, “A Simple Analytical Model for Batoid Wakes and Thrust”, *Bulletin of the American Physical Society DFD* 58, 2013.

**P. Valdivia y Alvarado**, V. Subramaniam, and M. Triantafyllou, “Design of a Bio-Inspired Whisker Sensor for Underwater Applications”, Proc. IEEE SENSORS, Oct. 2012, pp:1-4, Taipei, Taiwan.

N. Patrikalakis, G. Weymouth, H. Kurniawati, **P. Valdivia y Alvarado**, T. Taher, R. Khan, J.C. Leighton, and G. Papadopoulos, “Modeling and Inspection Applications of a Coastal Distributed Autonomous Sensor Network”, Proc. of the ASME 31st International Conference on Ocean, Offshore, and Arctic Engineering (OMAE), Jul. 2012, pp:319-325, Rio de Janeiro, Brazil.

**P. Valdivia y Alvarado**, G. Weymouth, D. Thekoodan, and N. Patrikalakis, “Wake topology of under-actuated rajiform batoid robots”, Bulletin of the American Physical Society DFD 56, 2011.

H. Hans, **P. Valdivia y Alvarado**, D. Thekoodan, M. Jianmin, and M. Triantafyllou, “A whisker sensor: role of geometry and boundary conditions”, Bulletin of the American Physical Society 56, 2011.

**P. Valdivia y Alvarado**, T. Taher, H. Kurniawati, G. Weymouth, R.R. Khan, J. Leighton, G. Papadopoulos, G. Barbastathis, and N. Patrikalakis, “A Coastal Distributed Autonomous Sensor Network”, Proc. MTS/IEEE OCEANS’11, Sept. 2011, pp:1-8, Kona, Hawaii.

## INVITED TALKS

- “Under-actuated Soft Robots and Sensors for Marine Applications”, Coastal and Ocean Fluid Dynamics group (COFDL) Seminar, Woods Hole Oceanographic Institution, September 12 2014.
- “Under-actuated Soft Robots and Sensors”, Mechanical Engineering Departmental Seminar, U. Mass, Amherst, September 8 2014.
- “Models for Bio-inspired Unsteady Fin Locomotion and Sensing in Fluid Environments”, Controls Instrumentation and Robotics (CIR) Seminar, Mechanical Engineering Department, MIT, September 4 2014.
- “Multi-functional Field Robotic Devices: Vehicles and Sensors”, Mechanical Engineering Seminar, Stony Brook University, April 25, 2014.

- “New Technologies for Ocean Observation and Monitoring”, Maritime and Science Innovation Workshop, Singapore July 3 2013.
- “Making Better Robots”, National University of Singapore, Ignite talks, February 6 2013.
- “Underwater Biomimetic Sensing”, IEEE OES-TMSI Workshop, Nov. 2012.
- “Vehicles and Sensors for a Robust Coastal Distributed Autonomous Sensor Network”, Temasek Laboratories, Oct. 2011.
- “A Coastal Distributed Autonomous Sensor Network”, Project STARFISH: 6th Workshop on Autonomous Underwater Vehicles, National University of Singapore, Aug. 2011.
- “A Soft Body Under-actuated Approach to Multi-Degree of Freedom Biomimetic Robots”, Keynote talk for 3rd International Conference on Underwater System Technology, USYS '10, Cyberjaya, Malaysia, Nov. 2010.

## HONORS AND AWARDS

- Winner of MIT’s Technology Review 2012 TR35 Young Innovator Award for South East Asia, Australia and New Zealand for work on soft robots for long-term exploration of harsh environments.
- Design of biomimetic compliant devices (my doctoral work) featured in the permanent exhibition, “A Journey Through Creativity”, at the ARTSCIENCE Museum in Singapore.
- Finalist, Best Conference Paper, IEEE Robotics and Biomimetics (ROBIO) 2011: **P. Valdivia y Alvarado**, “Hydrodynamic Performance of a Soft Body Under-actuated Batoid Robot”.

## PATENTS

- Bi-directional fixating transvertebral body screws and posterior cervical and lumbar interarticulating joint calibrated stapling devices for spinal fusion. US Patent No. 9,005,293. Filed May 16 2011, Issued Apr. 14 2015.
- Bi-directional fixating/locking transvertebral body screw/intervertebral cage stand-alone constructs having a central screw locking lever, and pliers and devices for spinal fusion. US Patent No. 8,734,516. Filed May 22 2009, Issued May 27 2014.
- Artificial cervical and lumbar discs, disc plate insertion gun for performing sequential single plate intervertebral implantation enabling symmetric bi-disc plate alignment for interplate mobile core placement. US Patent No. 8,535,379. Filed Nov. 20 2007, Issued Sept. 17 2013.
- Bi-directional fixating transvertebral body screws and posterior cervical and lumbar interarticulating joint calibrated stapling devices for spinal fusion. US Patent No. 8,353,913. Filed Apr. 11 2011, Issued Jan. 15 2013.
- Posterior cervical and lumbar interarticulating joint staples, stapling guns, and devices for spinal fusion. US Patent No. 8,257,370. Filed May 22 2009, Issued Sept. 4 2012.

- Bi-directional fixating/locking transvertebral body screw/intervertebral cage stand-alone constructs and posterior cervical and lumbar interarticulating joint stapling guns and devices for spinal fusion. US Patent No. 7,972,363. Filed Mar. 24, 2008, Issued Jul. 5 2011.
- Bi-directional fixating transvertebral body screws and posterior cervical and lumbar interarticulating joint calibrated stapling devices for spinal fusion. US patent 7,942,903 B2. Filed Aug. 21, 2007, Issued May 17, 2011.
- Mechanical fish robot exploiting vibration modes for locomotion. US patent 7,865,268 B2. Filed Jun. 23, 2005, Issued Jan 4 2011.
- Applicator. US patent 7,055,528. Filed Mar. 27, 2003, Issued Jun. 6, 2006.
- Flexible Robotic Manipulation Mechanism Pub. No: US 2009/0293442 A1 (Patent Application Publication). Filed May 5 2009.
- Citrus Harvester U.S.S.N.: 61/126,382 (Provisional US patent application). Filed May 5 2008.

## FUNDING

- DSO National Laboratories, Singapore - \$160,000  
Principal Investigator, 05/2014 - 05/2015  
“Adaptation of batoid-fin technology to AUVs and its performance”
- Department of Defense, U.S. Army Medical Research and Materiel Command - \$779,915  
Principal Investigator, 11/2009 - 11/2011  
“Autonomous Airway Management”
- Department of Defense, U.S. Army Medical Research and Materiel Command- \$99,999  
Principal Investigator, 4/2010 - 11/2010  
“Actively Compliant Parallel End-Effector Mechanism for Medical Interventions”
- Department of Defense, U.S. Army Medical Research and Materiel Command - \$69,998  
Principal Investigator, 2/2009 - 8/2009  
“Autonomous Airway Management”
- Department of Defense, U.S. Army Medical Research and Materiel Command - \$849,929  
Principal Investigator, 8/2006 - 1/2009  
“Robotic High Intensity Focused Ultrasound (HIFU) Manipulator System for Critical Systems Transport (CSTAT)”
- U.S. Department of Agriculture - \$80,000  
Coauthor with PI James English (Energid Technologies), 5/2008 - 12/2009  
“Robotic Mass Removal of Citrus Fruits”

## PUBLICITY

**Robot fish set to be deployed to rescue sea life:** International Business Times, April 21 2015.

**Drones of the deep and the skies:** Straits Times, March 29 2015.

**Whisker-like flow sensors:** Featured on Zaobao, 2013.

**Biomimetic Robotic Fish:** Featured on: National Geographic Magazine, February 2010; NATURE blogs, 2009; MIT News, Technology Review, VOL 112, No 6. 2009; CNN.com/Technology, August 2009; Discovery Channel, Discovery News, 2009; CNET, 2009; Gizmodo, 2009; WIRED News, 2009; Emerging Technologies (MIT Technology Review) article 2005.

## **SERVICE ACTIVITIES**

- Chairman (Nov. 2012 to Nov. 2013) and Vice Chairman (Nov. 2011 to Nov. 2012) IEEE Ocean Engineering Society (OES) Singapore Chapter.
- Technical reviewer for: IEEE Robotics and Automation Magazine; Journal of Fluids and Structures; IEEE Transactions on Mechatronics; IEEE Transactions on Aerospace and Electronic Systems; IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS); IEEE International Conference on Robotics and Automation (ICRA); IEEE Conference on Decision and Control (CDC).

**LANGUAGES:** Spanish (Native Proficiency), English (Bilingual Proficiency), French (Bilingual Proficiency), Italian (Limited working proficiency).

## **PROFESSIONAL AFFILIATIONS**

American Society of Mechanical Engineers (ASME)  
Institute of Electrical and Electronic Engineers (IEEE)  
American Physical Society (APS)

**VISA STATUS:** US Legal Permanent Resident (green card holder).