

Roberto Shu

rshum@cmu.edu

5000 Forbes Ave., EDSH 120, Pittsburgh PA 15213 • C:(734) 355-8757 • www.robortoshu.com

EDUCATION	Carnegie Mellon University , Pittsburgh, PA Ph.D., Robotics – <i>Advisor: Dr. Ralph Hollis</i> (expected) December 2021 <i>Thesis:</i> Development of an Agile and Dexterous Balancing Mobile Manipulator M.S., Robotics – <i>Advisor: Dr. Koushil Sreenath</i> May 2016 <i>Thesis:</i> Design and Analysis of a Biped Leg to Survive High-Impact Falls University of Michigan , Ann Arbor, MI May 2014 B.S., Mechanical Engineering <i>Minor: Multidisciplinary Design</i> B.S., Aerospace Engineering <i>Minor: Mathematics</i>
INDUSTRY EXPERIENCE	Amazon.com, Robotics & AI group May 2020 – Aug. 2020 <i>Applied Scientist Intern</i> <ul style="list-style-type: none">• Developed and implemented a novel variable compliant controller in C++ for a torque controllable robot manipulator to further Amazon’s warehouse automation efforts• Validated the new controller over the existing controllers implemented with experiments on the robot hardware, code was merged into the production branch of the organization’s code base• Implemented and deployed a task space admittance controller based on a joint torque observer to estimate Force/Torque acting at the end-effector
RESEARCH EXPERIENCE	Microdynamic Systems Laboratory , <i>Carnegie Mellon University</i> Sep. 2016 – Present <i>Advisor: Dr. Ralph Hollis</i> <ul style="list-style-type: none">• Researching whole-body planning and control for dynamically balancing mobile robots, currently working on the CMU ballbot humanoid, a 200 lb human size robot that balances on a single ball and has a pair of 7-DOF arms and multi-DOF hands• Devised a centroidal based optimal whole-body planning and control framework to perform simultaneous locomotion and manipulation tasks, trajectory optimization generates whole-body motion plans offline and are tracked online with a whole-body MPC on the real robot• Designed and built a pair of lightweight compliant 7-DOF anthropomorphic arms capable of lifting 20 kg for the ballbot, including the full software stack to control the arms. Actuation with BLDC + Harmonic Drive• Performed system identification and developed 2D, 2.5D and 3D dynamic simulations of the CMU ballbot with 7-DOF arms in Matlab, V-REP and PyBullet for cross validation• Contributed to the writing of a successful USD 1.5 million NSF research grant Hybrid Dynamic Robotics Lab , <i>Carnegie Mellon University</i> Aug. 2016 – May 2018 <i>Advisor: Dr. Koushil Sreenath</i> <ul style="list-style-type: none">• Designed human size robotic leg with active damping via M.R. damper and non-linear spring element to withstand the high impact force of landing high jumps (> 3 m), performed FEA analysis and created custom BLDC + Harmonic Drive + Belts actuation unit• Simulated leg design in SimMechanics and implemented and used CMAE-ES to solve for the optimum control gains, damping, and joint profiles for save landing• Created a real-time simulink communication interface and LQR position control for Nano Quadcopter Crazyflie Biological Inspired Robotics And Dynamical Systems , <i>U of M</i> May 2013 - May 2014 <i>Advisor: Dr. Shai Revzen</i> <ul style="list-style-type: none">• Designed, built, and tested new generation of self-assembling modular robotics with expandable polyurethane foam named FoamBots and implemented controllers in python• Redesigned autonomous foam reagents mixing device and peristaltic pump manufactured only with a laser cutter that assembles without screws or permanent joints

TEACHING EXPERIENCE	16-264 Humanoids, CMU Robotics Institute Spring 2019 Instructor: Dr. Chris Atkeson 16-711 Kinematics, Dynamic Systems and Control, CMU Robotics Institute Fall 2018 Instructor: <i>Dr. Hartmut Geyer</i>	
SKILLS	Software & OS: PTC Creo/Pro E, SolidWorks, Gazebo, PyBullet, Pinocchio, CasADi, OSQP, IPOPT, QuadProg ROS, QNX, Linux(Ubuntu) Programming: C/C++, MATLAB/Simulink/SimMechanics, Python Robots & Hardware Ballbot, Bi-manual 7DOF arms, Kinova Gen3, CrazyFile Quad-rotor, Intel RealSense, IMUs (VectorNav), Hokuyo LIDAR, BLDC, Harmonic Drive Manufacturing: Mill, Lathe, CNC Router, CNC Mill, Rapid Prototyping (3D printing, Laser cutter)	
PUBLICATIONS	<ol style="list-style-type: none"> 1. R. Shu, and R. L. Hollis. "Momentum based Whole-Body Optimal Planning for a Single-Spherical-Wheeled Balancing Mobile Manipulator." <i>2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)</i>, IEEE, 2021 (to appear). 2. R. Shu and R. L. Hollis, "Development of a Humanoid Dual Arm System for a Single Spherical Wheeled Balancing Mobile Robot," <i>2019 IEEE-RAS 19th International Conference on Humanoid Robotics (Humanoids)</i>, IEEE, 2019. 3. F. Sonnleitner, R. Shu and R. L. Hollis, "The Mechanics and Control of Leaning to Lift Heavy Objects with a Dynamically Stable Mobile Robot," <i>2019 International Conference on Robotics and Automation (ICRA)</i>, IEEE, 2019, (pp. 9264-9270). 4. Shu, R., Siravuru, A., Rai, A., Dear, T., Sreenath, K., Choset, H.. "Optimal control for geometric motion planning of a robot diver." In <i>2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)</i> IEEE, 2016, (pp. 4780-4785). 5. Shu, R., A. Siravuru, and K. Sreenath. "On the utility of active damping leg for safe landing from a free fall." <i>Dynamic Walking Conference</i> (2015). 6. Li, X., Geraldo, D., Weng, S., Alve, N., Dun, W., Kini, A., Patel, K., Shu, R., Zhang, F., Li, G., Jin, Q., Fu, J.. "Desktop aligner for fabrication of multilayer microfluidic devices." <i>Review of Scientific Instruments</i> 86.7 (2015): 075008. 	
PRESENTATIONS	<ol style="list-style-type: none"> 1. Shu, R.. "Building a Robotic Leg for High Impact Landing" <i>Bipedal Locomotion Seminar - Carnegie Mellon Univeristy.</i> (February 2016) 2. Hollis, R., Shu, R.. "Ballbot: A single-wheeled balancing robot" <i>Carnegie Colloquium on Digital Governance and Security - Carnegie Endowment for International Peace</i> (October 2016) 	
AWARDS AND HONORS	Scholarships: Uber Presidential Fellowship Carnegie Mellon University (USD 42,500) University of Excellence Scholarship for graduate studies (USD 150,000) University of Excellence Scholarship for undergraduate studies (USD 130,000) Awards: 2014 Dean's Rev. Dr. Martin Luther King Jr. Spirit Award 2013 Stellar Multicultural Performance Award Society of Hispanic Professional Engineers (while U of M chapter president) 2013 National Chapter of the Year 2013 Region 6 Chapter of the Year 2013 Blue Chip Award 2012, 2013, 2014 Undergraduate Achievement Award 2013 1st place Case Study - National Institute for Leadership Advancement	