Rana Soltani Zarrin

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PROFESSIONAL SUMMARY

- Research experience in robotics, control, optimization, and motion planning. Resulted in 1 pending patent, 1 international research excellence award from National Academy of Engineering, 13 peer-reviewed conference/journal publications
- Strong background in control systems including classical and modern controls, optimal control, force control, and optimization. Experience with design and implementation of control algorithms on real-time embedded controllers
- Strong track record and hands-on experience in kinematic/dynamic modeling and analysis, and designing control, optimization, ML, and motion planning algorithms for autonomous multi-DoF robotic arms and wheeled robots

EDUCATION

Texas A&M University (TAMU), College Station	Jan. 2015-Dec. 2019
Ph.D. in Mechanical Engineering – Robotics and Control	
GPA: 4.00	
Advisor: Dr. Reza Langari	
Dissertation: Improving Human-Robot Interaction in Upper-limb Rehabilitation Exoskeletons	
University of Central Florida (UCF), Orlando	Aug. 2011-Dec. 2013
Master of Science in Mechanical Engineering- Mechanical Systems track	
Advisor: Dr. Suhada Jayasuriya	
Thesis: Constrained Directions: a Novel Path Planning Method for Wheeled Robots using Reach	able Direction Analysis
University of Tabriz, Tabriz	Sep. 2006- Sep. 2010
Bachelor of Science in Electrical Engineering - Control track	
Thesis: Intelligent Path Planning for Rescue Robots using Decision Analysis	

AWARDS

Research Excellence Award for Societal/Technical Impact, National Academy of Engineering, 2017 Global Grand Challenges Summit. International Research Poster Competition	Jul. 2017
Willemain, Guyonnot, Liagre 99 Academic Excellence Award, TAMU	May 2018
Southerland Aggie Leader Scholarship Award, TAMU	May 2018
Society of Iranian American Women for Education, TAMU	May 2018
Society of Women Engineers Scholarship, TAMU	May 2018
Emil Buehler Aerodynamic Analog Fellowship, for academic excellence, TAMU	Sep. 2017
2017 Fran O'Sullivan Women in Lenovo Leadership Scholarship, selected among 1800 applicants for	May 2017
outstanding academic achievement as well as strong engineering skills, Society of Women Engineers	-
Rapid Fire Research Competition Finalist, 2017 Society of Women Engineers National Conference, Austin	Oct. 2017
Society of Women Engineers Scholarship, TAMU	Apr. 2017
Ethel Ashworth-Tsutsui Memorial Award for Mentoring, Women in Science and Engineering, TAMU	Nov. 2016
Austin L. Grogan Memorial Scholarship for academic excellence, UCF	Aug. 2013
Forough B. Hosseini scholarship, UCF	Aug. 2012

SKILLS

Technical Skills:

• <u>Control Systems:</u> Linear and modern controls, Optimal control, Nonlinear control, Impedance/Admittance controls, Force Control, Adaptive control, Robust control, Model Predictive control

• Robotics: Kinematic and dynamic modeling and analysis, Motion planning and control algorithm development and implementation, Hands-on experience in electromechanical design and integration of robotic systems, Experience with sensor and actuator selection, Software development

- Optimization: Numerical and Heuristic optimization algorithms, Operations research
- Modeling/Computational Tools: Simulink, Real-time control (LabVIEW C-Rio embedded controller) •
- Software/Programming: C++/C, MATLAB, LabVIEW, ROS
- Technology Commercialization: Intellectual Property Formulation, Business Model Development, Customer Discovery

Transferable Skills: Attention to details, Collaboration, Communication, Experience working in multi-disciplinary teams, Leadership, Mentorship, Problem-solving, Strong work ethic

RESEARCH EXPERIENCE

Research Assistant/Fellow, Laboratory for Control, Robotics, and Automation, TAMU Spring 2015-present

- Control development
 - Development and implementation of a new minimal intervention progress-based assist-as-needed control algorithm 0 based on admittance/impedance controls and arms redundancy resolution to achieve autonomous upper-limb rehabilitation exoskeletons with improved human-robot interaction.
- Path generation algorithm development
 - Human-like path generation for exoskeletons based on human motor control approaches using differential (Riemannian) and analytic geometries, optimization, and robot kinematics.
 - Model verification using human movement data captured by Vicon Mocap system 0
 - Development of a novel geometric inverse kinematics method for exoskeletons to improve computation cost 0
- Kinematic design and analysis of a new 8 DoF upper-limb exoskeleton (CLEVERarm) to comply with the human upperlimb biomechanics.
 - Worked with therapists and physicians to define and verify design requirements. 0
 - Increased workspace and dexterity while reducing volume through design optimization. 0
 - Improved human-robot interaction by reducing interaction forces through the developed kinematic design. 0
- Exoskeleton software development in MATLAB/LabVIEW for motion planning, real-time control, and data acquisition.
- Electromechanical design/testing and integration of the CLEVERarm exoskeleton.
- Conducting clinical trials to evaluate the effectiveness of CLEVERarm exoskeleton in stroke rehabilitation.

Research Assistant, Intelligent Systems Lab, UCF and Drexel University

- Studying human-robot collaboration in semi-autonomous systems
- Development and implementation of efficient motion planning and control algorithms for autonomous wheeled mobile robots subject to hard input constraints using reachable direction analysis
- Kinematic and dynamic modeling and analysis of wheeled mobile robots

Undergraduate Researcher, Robotics Lab of University of Tabriz

Development of a path planning and mission scheduling algorithm for autonomous robots based on artificial potential field, multi-criteria decision analysis, and resource allocation

Off-line programming and control of a small-scale industrial production line using WALLI3 (Workcell Amalgamated Logical Linguistic Instructions) Software as a simulated environment for robot programming and control

TEACHING EXPERIENCE

Teaching Assistant, Undergraduate Research (ENGR491, ENGR 485)	Fall 2016-Fall 2018
Teaching Assistant, Performance Enhancement of Dynamic Systems course, Drexel University	Fall 2014
Lab Instructor, Dynamic Systems Laboratory, Drexel University	Spring 2014
Teaching Assistant, Dynamics course, University of Central Florida	Spring 2012
Teaching Assistant, Feedback Control course, University of Central Florida	Fall 2011

MENTORING ACTIVITIES

Aggie-Challenge Program, TAMU

Mentored 70 undergraduate engineering students (freshman to senior levels) working in teams on multidisciplinary grand

Fall 2016- Fall 2018

Spring 2012-Fall 2014

Spring2009-Spring2010

challenge research projects including virtual and augmented reality game development, and analysis of EMG and EEG signals

Aggie Research Scholars, TAMU Mentored 10 undergraduate students from multidisciplinary engineering majors working on rehab	Fall 2016 – Summer 2017 pilitation game development
2017 VEX-U Robotics competition, Women in Engineering, TAMU Mentored the Mechanical sub-team (10 students). The team won the 4_{th} place.	Spring 2016-Spring 2017
AUVSI RoboSub competition, Women in Engineering, TAMU Mentored the Mechanical sub-team (8 students). Qualified for semifinals.	Fall 2016-Spring2017
SAE Supermileage competition, Women in Engineering, TAMU Performed regular design reviews for the mechanical team	Fall 2016-Spring2017

ENTREPRENEURSHIP EXPERIENCES

National Science Foundation's Southwest Regional I-Corps ProgramSummer 2017Selected to participate and successfully completed the NSF Southwest Regional I-Corps Program. Got endorsement for the
national phase competition.Summer 2017

Summer 2017

2017 Summer NSF I-Corps Site program, TAMU

Selected as the top team among 12 participating teams.

SELECTED PUBLICATIONS

Journal Articles

- [1]. **R. Soltani-Zarrin**, R. Langari, "Compliant Upper-limb Rehabilitation Exoskeletons via a Variable Admittance-based Controller", (under review).
- [2]. **R. Soltani-Zarrin**, A. Zeiaee, A. Eib, R. Langari, "CLEVERarm: A Novel Light-weight Upper-limb Exoskeleton for Home-based Rehabilitation", (under review).
- [3]. R. Soltani-Zarrin, A. Zeiaee, R. Langari, "Human-like Path Generation in Upper-limb Exoskeletons", (under review).
- [4]. A. Zeiaee, **R. Soltani-Zarrin**, R. Langari, R.Tafreshi, "Kinematic Design Optimization of an 8 Degree of Freedom Upper-Limb Exoskeleton", *Robotica*, vol. 37, no. 12, pp. 2073-2086, 2019.
- [5]. S. Khanmohammadi, **R. Soltani Zarrin**, "Intelligent Path Planning for Rescue Robots", *International Journal of Electrical and Computer Engineering*, Vol. 5, No. 7, pp. 844-849, 2011.

Peer-Reviewed Conference Papers

- [6]. **R. Soltani-Zarrin**, A. Zeiaee, A. Eib, R. Langari, and R. Tafreshi, "CLEVERarm: A Novel Exoskeleton for Rehabilitation of Upper Limb Impairments", *IEEE proceedings of International Symposium on Wearable & Rehabilitation Robotics (WeRob)*, Houston, 2017.
- [7]. R. Soltani-Zarrin, A. Zeiaee, R. Langari, and R. Tafreshi, "A Computational Approach for Human-like Motion Generation in Upper Limb Exoskeletons Supporting Scapulohumeral Rhythms", *IEEE proc. of International Symposium* on Wearable & Rehabilitation Robotics (WeRob), Houston, 2017.
- [8]. R. Soltani-Zarrin, A. Zeiaee, R. Langari, N. Robson, "Reference Path Generation for Upper-Arm Exoskeletons Considering Scapulohumeral Rhythms", Proc. of IEEE 15th International Conference on Rehabilitation Robotics (ICORR), pp.753-758, London, 2017.
- [9]. A. Zeiaee, **R. Soltani-Zarrin**, R. Langari and R. Tafreshi, "Design and kinematic analysis of a novel upper limb exoskeleton for rehabilitation of stroke patients," *Proc. of IEEE 15th International Conference on Rehabilitation Robotics (ICORR)*, London, 2017, pp. 759-764.
- [10]. A. Zeiaee, R. Soltani-Zarrin, F. Fontes, R. Langari, "Constrained Directions Method for Stabilization of Mobile Robots with Input and State Constraints", Proc. of American Control Conference (ACC), pp. 3706 – 3711, Seattle, 2017.
- [11]. A. Zeiaee, **R. Soltani-Zarrin**, R. Langari, "A novel approach for tracking control of differential drive robots subject to hard input constraints," *Proceedings of American Control Conference (ACC)*, Boston, MA, 2016, pp. 2098-2103.
- [12]. A. Zeiaee, R. Soltani-Zarrin, S. Jayasuriya, R. Langari. "A uniform control for tracking and point stabilization of differential drive robots subject to hard input constraints", *Proc. of ASME Dynamic Systems and Control Conference* (DSCC), pp. V001T04A005, Columbus, 2015.
- [13]. R. Soltani-Zarrin, A. Zeiaee, S. Jayasuriya, "Pointwise Angle Minimization: A Method for Guiding Wheeled Robots

Based on Constrained Directions", Proc. of ASME Dynamic Systems and Control Conference (DSCC), pp. V003T48A004, San Antonio, 2014.

[14]. **R. Soltani-Zarrin**, S. Jayasuriya, "Constrained Directions as a Path Planning Algorithm for Mobile Robots under Slip and Actuator Limitations", *Proc. of IEEE Int. Conf. on Intelligent Robots and Systems (IROS)*, pp. 2395-2400, 2014.

Patent

[15]. R. Soltani-Zarrin, A. Zeiaee, R. Langari, R. Tafreshi, "Robotic Upper-Limb Rehabilitation Device", US Patent App. 16/298,777, 2019.

Other Publications

[16]. **R. Soltani-Zarrin**, A. Zeiaee, R. Langari, "Moving Exoskeletons from Sci-Fi into Medical Rehabilitation and Therapy", The Conversation, July 2016.

TALKS/ INTERVIEWS/PRESENTATIONS

Invited Talks

- [1]. "Development and Control of Human-Friendly Robots for Upper-Limb Rehabilitation", Invited Speaker, *NSF Workshop* on Human-Friendly Robots, University of Texas at San Antonio, May 2019.
- [2]. "Development and Control of Compliant Upper-limb Exoskeletons for Stroke Rehabilitation", California Polytechnic State University (Cal Poly), Apr. 2019.
- [3]. "Development and Control of Compliant Upper-limb Exoskeletons for Stroke Rehabilitation", Worcester Polytechnic Institute (WPI), Mar. 2019.
- [4]. "Compliant Upper-limb Rehabilitation Exoskeletons for Stroke Rehabilitation", West Virginia University, Mar. 2019.
- [5]. "CLEVERarm: A New Upper-Limb Exoskeleton for Rehabilitation of Stroke Patients", UT San Antonio, Apr. 2018
- [6]. "Design and control of a new upper-limb exoskeleton: kinematic design, reference path generation, and progress-based control development", University of Texas at El Paso, Mar. 2018
- [7]. "Design and Control of CLEVERarm", ASME Northwest Houston Section, Dec. 2017
- [8]. "A Novel Upper-Limb Exoskeleton for Stroke Patients", ASME South Texas Section, Oct. 2017

Media Interviews

- [1]. "Stroke Patient Recovery via Robotics", Texas A&M College of Engineering YouTube channel, June 2018.
- [2]. "An Exoskeleton Assists the Road to Recovery", ASME Magazine, Apr. 2017
- [3]. "Robotics based Intelligent Therapy for Stroke Victims", Texas A&M College of Engineering Newsletter, May 2016

Poster Presentations

- [1]. "Kinematic Design and Optimization of an Upper-limb Exoskeleton for Rehabilitation of Neurological Impairments", 2018 Robotics Science Systems (RSS) Conference, Jun. 2018.
- [2]. "Reference Path Generation for Upper-Limb Exoskeletons Considering Scapulohumeral Rhythms", 2017 International Symposium on Wearable and Rehabilitation Robotics (WeRob), Nov. 2017.
- [3]. "A Novel Compact and Low-weight Upper-limb Exoskeleton for Rehabilitation of Stroke Patients", 2017 Global Grand Challenge Summit, D.C., Jul. 2017.
- [4]. "Novel Exoskeleton for Upper-limb Stroke Rehabilitation", 2017 Robotics Science Systems Conference, Jul. 2017
- [5]. "Design and Control of a Novel Compact and Low-weight Upper-limb Exoskeleton for Rehabilitation of Stroke Patients", 2017 Student Research Week, TAMU, Mar. 2017.
- [6]. "Design and Control of a Novel Compact and Low-weight Upper-limb Exoskeleton for Rehabilitation of Stroke Patients", *Society of Women Engineers poster competition*, selected as the top presenter, TAMU, Mar. 2017.
- [7]. "A Novel Upper-limb Exoskeleton for Rehabilitation of Stroke Patients", 2017 SWE Region C Conference, Feb. 2017
- [8]. "Design of a Novel Compact and Low-weight Upper-limb Exoskeleton for Rehabilitation of Stroke Patients", 5th Arizona State University Rehabilitation Robotics Workshop, Feb. 2017.
- [9]. "A Uniform Control for Stabilization and Tracking of Differential Drive Robots Subject to Hard Input Constraints", *Texas Systems' day*, University of Austin, Apr. 2016.
- [10]. "A Novel Method for Control of Differential Drive Robots Subject to Input Constraints", Student Research Week, Texas A&M University, Mar. 2016.

[11]. "A framework for Capturing Human States in Cooperative Robotics", Graduate Research Week, UCF, Mar. 2013

Oral Presentation

- [1]. "A Novel Upper-Limb Robotic Arm for Providing Automated Therapy to Stroke Patients", Rapid Fire Finalist, SWE17 Conference, among the top 10 selected finalists, Oct. 2017.
- [2]. "CLEVERarm", NSF I-Corps Regional program, Oct. 2017.
- [3]. "CLEVERarm A Rehabilitation Exoskeleton", NSF I-Corps Site program, Aug. 2017.
- [4]. "Constrained Directions as a Path Planning Algorithm for Mobile Robots under Slip and Actuator Limitations", *IEEE/RSJ International Conference on Intelligent Robots and Systems (RSS)*, Sep. 2014.

PROFESSIONAL AND VOLUNTEER ACTIVITIES

Chair, Graduate Society of Women Engineers (GradSWE), TAMU	2017-2018
Technical Program Committee, 2017 SWE Region C Conference,	Fall 2016
Research Poster Competition, and Lunch Sessions Organizer	
Session Chair, Unmanned Ground & Surface Robotics Track, ASME Dynamic Systems & Control Conference	Oct. 2014
Technical Program Committee, 2014 ASME Dynamic Systems & Control Conference	
Reviewer, IEEE Robotics and Automation Letters	
Reviewer, Recent Patents on Mechanical Engineering	
Reviewer, IEEE Transactions on Industrial Electronics	
Reviewer, IEEE Transactions on Aerospace and Electronic Systems	
Reviewer, European Journal of Control	
Reviewer, Journal of Intelligent and Fuzzy Systems	
Reviewer, American Control Conference	
Reviewer, Elsevier, Engineering Science and Technology (JESTECH)	
Reviewer, IEEE International Conference on Rehabilitation Robotics	
Reviewer, IEEE Int. Conference of Engineering in Medicine and Biology Society	
Reviewer, IEEE International Conference on Robotics and Automation	
Reviewer, ASME Dynamic Systems and Control Conference	
Reviewer, Elsevier Journal of Robotics and Autonomous Systems	
Judge, 2017 Texas Junior Science and Humanities Symposium	
Judge, 2015 Engineering Summer Undergrad Research Symposium	

CERTIFICATES

Academy for Future Faculty, Center for Teaching Excellence, TAMUApr. 2018Aggie Research Leader, Aggie Research Leadership ProgramFall 2016-Spring 2017Aggies Professional Development Certificate (Intermediate)Spring 2017Mentoring Undergraduate ResearchersMay & Sept. 2016

MEMBERSHIPS

ASME- IEEE- IEEE Robotics and Automation Society- IEEE Women in Engineering- Society of Women Engineers-Honor Society of Phi Kappa Phi- Golden Key International Honor Society