Amir Yazdani

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SUMMARY

I am a researcher and a PhD candidate in robotics with the goal of improving human-robot interaction (HRI) through developing new algorithms for robot perception and planning. My current research includes *probabilistic perception and planning in HRI* and covers human state estimation, ergonomics & safety optimization, teleoperation, risk-aware motion & manipulation planning, and inverse reinforcement learning.

I am also interested in online and reactive motion planning for human-robot & robot-robot co-existence and spent a summer internship at the OMRON Research Center of America (ORCA) on this topic.

SKILLS

Human-Robot Interaction	Ergonomics and safety in HRI, Human-aware perception & planning, Human factors
AI	State estimation & SLAM, POMDP, HMM, Bayes filters, Smoothing, Prediction
Planning	Optimal & search-based motion planning, MPC, A*, RRT, PRM, MIQP, Convex Opt.
Software	Python, C++, ROS, Gazebo, OpenCV, OpenNI, OpenPose, KDL, DART
	PyTorch, skorch, Tensorflow, Keras, MATLAB Simulink, Gurobi Optimization
Hardware	Robots (Baxter, KUKA iiwa & lbr4, Omron Cobra & Viper, iRobot Create 2), Haptic robots (Quanser HD^2, Phantom Omni, Phantom Premium, Novint Falcon), Sensors (RGB cameras, Kinect Azure & v2, Laser range finders, Motion capture)

EXPERIENCES

Reactive Trajectory Planning for Fixed Robots
Robotics Research Intern, Supervisors: John Drinkard

Omron Research Center of America, San Ramon, CA
Summer 2019

- I researched on reactive trajectory planning for industrial robots and successfully implemented a reactive trajectory planning approach on a robot-robot co-existence scenario.

Human-Robot Interaction / Robot Perception *LL4MA Lab & Ergonomics and Safety Lab, University of Utah*
Research Assistant, Supervisors: Tucker Hermans, Andrew Merryweather, Jake Abbott   *Jan. 2016 - present*

- I am working on 3D posture estimation of infants from single-view videos and utilizing inverse reinforcement learning to understand the cruising motion skills of infants to be transferred into robots. This project is funded by DARPA.
- I am developing a framework for postural optimization in teleoperation w.r.t. teleoperation task type including both derivative-based and derivative-free optimizations
- I developed a full teleportation simulation environment in Gazebo including leader and follower robots as well as the human teleopereator. The teleoperator model includes a receding horizon online motion planner that performs the teleoperation based on observing the motion of the follower robot, as well as applying postural correction.
- I learned a neural network model for RULA risk assessment tool using skorch with 95% accuracy to be used in our derivative-based postural optimization approach.
- I developed a new algorithm for probabilistic human posture estimation in teleoperation that infers posture solely from the trajectory of the leader robot without any vision system. Comparing to a MoCap system, our approach has almost 5 deg of deviation in joint angles. The risk assessment using the estimated posture from our approach results in the same interpretation in RULA score for more than 84.37% of the trials a human-subject study, when compared to the risk assessment for the posture from a MoCap system.
- I collaborated on developing a probabilistic risk-aware decision making for a patient assistant mobile robot that leverages the predictive models of patient motion, and manipulation planning to minimize the risk of patient falls in the hospital rooms, by providing supporting objects during ambulation.

- I developed a haptic guidance algorithm including virtual fixtures and synthetic fixtures to guide the user through a maze using a Quanser HD2 haptic robot
- I implemented safety parameters into an optimal motion planning algorithm using MPC for serial robots to improve the safety and productivity of the task in a shared autonomy
- I collaborated on developing a mobile manipulation planning algorithm based on MPC and convex optimization to push/pull legged objects. The results are published in IROS 2018 and submitted to IJRR.
- I developed an algorithm for push planning of objects by mobile robots using a mixture of A* and RRT-connect and the simulation results prove the performance of our approach.
- I collaborated in implementing and benchmarking several optimization techniques for solving inverse kinematics and trajectory optimization of robot arms as a optimization mini course
- I collaborated on implementing visual SLAM using RGB-D and monocular cameras on a mobile robot.
- I collaborated on a project to control an under-actuated wearable arm-swing rehabilitator for gait training.
- I collaborated in designing and developing an under-actuated robotic hand for grasping legged objects with various leg diameters.

Motion Planning / Parallel Robots
TaarLab, The University of Tehran, Tehran, Iran
Research Associate, Supervisor: Mehdi Tale Masouleh, Mohammad Bagher Menhaj   *Dec. 2011 - Dec. 2015*

- I developed a fault-tolerant optimal collision-free motion planning algorithm based on convex optimization and MPC for robot arms and implemented on a developed 4-DOF planar & redundant serial robot.
- I collaborated on developing an optimal collision-free motion generation algorithm based on convex optimization and MPC and implementing it on various mobile, serial and parallel robots.
- I collaborated on developing PGNGN, a neural gas network algorithm for finding the singularity-free workspace of planar parallel robots.
- I designed and developed several parallel robots including a 6-DOF pneumatic Gouph-Stewart, a 4-DOF Quattro-based, a 3-DOF and a 2-DOF spherical, and a 3-DOF Cartesian parallel robot and collaborated in dynamic modeling and computed torque control of them.

Haptic Robots / Driving Simulators
Virtual Reality Lab, K. N. Toosi University of Technology, Tehran, Iran
Research Assistant & Lab manager, Supervisor: Ali Nahvi   *July 2008 - Sep. 2011*

- I designed and developed VirSense, a 6-DOF haptic device with fixed-base actuators and 95% passive gravity compensation using linear springs.
- I designed a novel 4-DOF serial-parallel robot for real-size urban bus driving simulators and collaborated in development and kinematic analysis of the mechanism.

EDUCATION

University of Utah, Salt Lake City, UT   *JAN 2016 - Present*
PhD in Mechanical Engineering (Robotics Track), Thesis: *"Haptic Posture Estimation and Guidance to Improve Ergonomics in Telemanipulation"*
AmirKabir University of Technology, Tehran, Iran   *FEB 2013 - JUN 2015*
MSc in Mechanical Engineering, Thesis: *"Optimal Trajectory Planning and Fault-Tolerant Control of Redundant Planar Serial Manipulators"*
K. N. Toosi University of Technology, Tehran, Iran   *SEP 2005 - SEP 2010*
BSc in Mechanical Engineering, Thesis: *"Design and Development of VirSense: A Novel Haptic Device With Fixed-Base Actuators and Gravity Compensation"*

SELECTED COURSES

Artificial Intelligence	Robot Learning	Machine Learning	Motion Planning
3D Computer Vision	Neural Networks	Haptics and Physical HRI	Intro to Robot Control

RELATED PEER-REVIEWED PUBLICATIONS

1. **A.Yazdani**, R. SabbaghNovin, A. Merryweather, T. Hermans, "Postural Optimization for Ergonomically Intelligent Teleoperation Systems", Submitting to *Transaction on Robotics*.

2. **A.Yazdani**, R. SabbaghNovin, A. Merryweather, T. Hermans, "Posture Estimation and Optimization in Ergonomically Intelligent Teleoperation Systems", In Companion of the *HRI 2021*.

3. **A.Yazdani**, R. SabbaghNovin, A. Merryweather, T. Hermans, "Is The Leader Robot an Adequate Sensor for Posture Estimation and Ergonomic Assessment of A Human Teleoperator?", Submitted to *ICRA 2021*, Available on *arXiv*.

4. R. SabbaghNovin, **A.Yazdani**, A. Merryweather, T. Hermans, "Risk-Aware Decision Making in Service Robots to Minimize Risk of Patient Falls in Hospitals", Submitted to ICRA 2021.

5. R. SabbaghNovin, **A.Yazdani**, A. Merryweather, T. Hermans, "A model predictive approach for online mobile manipulation of nonholonomic objects using learned dynamics", *International Journal of Robotics Research (IJRR), 2020*.

6. R. SabbaghNovin, **A.Yazdani** , T. Hermans, and A. Merryweather, "Dynamics model learning and manipulation planning for objects in hospitals using a patient assistant mobile (PAM) robot." *IROS 2018*, Madrid, Spain.

7. R. SabbaghNovin, M. Tale Masouleh, and **M.Yazdani**. "Optimal motion planning of redundant planar serial robots using a synergy-based approach of convex optimization, disjunctive programming and receding horizon." *Proceedings of the Institution of Mechanical Engineers, Part I: Journal of Systems and Control Engineering* 230, no. 3 (2016): 211-221.

8. R. SabbaghNovin, M. Tale Masouleh, **M.Yazdani** and B. Danaei. "Optimal motion planning of a 3-DOF decoupled parallel robot using convex optimization and receding horizon concept." *Modares Mechanical Engineering* (2015).

9. R. SabbaghNovin, A. Karimi, **M.Yazdani**, and M. Tale Masouleh. "Optimal motion planning for parallel robots via convex optimization and receding horizon." *Advanced Robotics*, 30, no. 17-18 (2016): 1145-1163.

10. **M.Yazdani**, R. SabbaghNovin, M. Tale Masouleh, M. Menhaj, and H. Abdi. "An experimental study on the failure tolerant control of a redundant planar serial manipulator via pseudo-inverse approach." *ICRoM 2015*, Tehran, Iran.

11. A. Mashayekhi, A. Nahvi, **M.Yazdani**, M. Mohammadi Moghadam, M. Arbabtafti, and M. Norouzi. "VirSense: a novel haptic device with fixed-base motors and a gravity compensation system." *Industrial Robot* (2014).

12. R. SabbaghNovin, M. Tale Masouleh, and **M.Yazdani**. "A new neural gas network approach for obtaining the singularity-free workspace of 3-DOF planar parallel manipulators.", *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science* (2016).

PRESENTATION & ABSTRACTS

1. **A.Yazdani**, R. SabbaghNovin, A. Merryweather, and T. Hermans. "Human posture estimation and ergonomics analysis solely from the robot in physical human-robot interaction." *17th Annual Regional National Occupational Research Agenda (NORA) Young/New Investigators Symposium*. April 2019, Salt Lake City, UT.

2. **A.Yazdani**, and A. Merryweather. "Changing perceptions of robotics in industry: recent accomplishment in safety and injury risk reduction." *National Occupational Research Symposium (NOIRS)*, October 2018, Morgantown, WV.

3. **A.Yazdani**, R. SabbaghNovin, and A. Merryweather. "Improvement of human safety in fault-tolerant human and robot collaboration using convex optimization and receding horizon control." *Expanding Research Partnership: State of The Science Conference*, June 2017, Aurora, CO.

4. A. Merryweather, R. SabbaghNovin, **A.Yazdani**, "Optimal motion and mobility aid manipulation planning to enable personal activity monitoring and facilitate safer sit-to-walk transitions", *5th International Conference on Ambulatory Monitoring of Physical Activity and Movement (ICAMPAM)*, June 2017, Bethesda, MD.

PATENTS

- 4-degree of freedom industrial-researching parallel robot with free singularity workspace, No.91977 issued by Iranian Organization of Patents Registration. *2016*

- Pneumatically Actuated 6-DoF Gough-Stewart Parallel Robot, No.446327 issued by Iranian Organization of Patents Registration. *2015*
- Design and Development of a Haptic Robot with Fixed-Based Actuators and Automatic Gravity Compensation, No.75817 issued by Iranian Organization of Patents Registration. *2013*
- Mechanism for Rapid Video Recording, No.78963 issued by Iranian Organization of Patents Registration. *2013*

AWARDS & HONORS

- Dr. Paul Richard's Safe Workplace Scholarship by WCF Insurance *2017, 2018 & 2019*
- American Society of Safety Engineering Foundation Scholarship *2018, 2019*
- Graduate Student Travel Assistance award, Graduate School, The University of Utah *2018*
- Pilot Project Research Training (PPRT) Award from National Institute of Occupational *2016* Safety and Health (NIOSH), Award number: T420H008414-10
- 1st place in Senior Demo league in Robocup IranOpen *2014*

PEER REVIEW ACTIVITIES

- SAGE: Journal of Systems and Control Engineering
- IEEE: RA-L, RSS, ICRA, IROS, Humanoinds, ICROM
- ACM: HRI
- ELSEVIER: Medicina
- MDPI: Sensors, Robotics, Applied Science, Technologies