

# Amir Yazdani

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## SUMMARY

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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. Recently, I was selected as one of the HRI Pioneers 2021 cohort, for my research on Ergonomically Intelligent Teleoperation Systems.

## EDUCATION

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**University of Utah, Salt Lake City, UT** JAN 2016 - Present

PhD in Mechanical Engineering (Robotics Track), Thesis: "*Posture Estimation and Optimization to Improve Ergonomics in Teleoperation*"

**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*"

## SKILLS

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<b>HRI</b>	Human-aware planning, Posture Estimation, Ergonomics, Safety, Human factors, Motion Analysis
<b>AI &amp; ML</b>	State estimation & SLAM, (PO)MDP, HMM, Bayes filters, Smoothing, Prediction
<b>ML Packages</b>	PyTorch, sklearn, skorch, Tensorflow, Keras
<b>Planning</b>	Optimal & search-based motion planning, MPC, A*, RRT, PRM, MIQP, Convex Opt.
<b>Software</b>	Python, C++, ROS/ROS2, Gazebo, OpenCV, OpenPose, KDL, DART, Gurobi
<b>Hardware</b>	Robots (Baxter, KUKA iiwa & Ibr4, Omron Cobra & Viper; iRobot Create 2), Haptic robots (Quanser HD <sup>2</sup> , Phantom Omni, Phantom Premium, Novint Falcon), Sensors (RGB cameras, Kinect Azure & v2, Laser range finders, Motion capture)

## EXPERIENCES

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**Reactive Trajectory Planning for Fixed Robots** Omron Research Center of America, San Ramon, CA

Robotics Research Intern, Supervisors: John Drinkard Summer 2019

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

**HRI, Planning, Perception** LL4MA Lab & Ergonomics and Safety Lab, University of Utah

Research Assistant, Supervisors: Tucker Hermans, Andrew Merryweather, Jake Abbott Jan. 2016 - present

- Currently working on developing a pipeline for 3D posture estimation of infants from uncalibrated single-view videos, analyzing the infant lateral locomotion, and utilizing inverse reinforcement learning to understand the cruising motion skills of infants to be transferred into common sense for robots. This project is funded by DARPA in collaboration with psychologists from NYU and AI scientists from OSU.
- Currently developing a framework for postural optimization in teleoperation w.r.t. teleoperation task types including both derivative-based and derivative-free optimizations.
- Explored mixture of model-based and model-free reinforcement learning for robot planning.

- Developed a full teleportation simulation environment in Gazebo including leader and follower robots as well as the human teleoperator. The human 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.
- Learned a continuous and differentiable neural network model for RULA risk assessment tool using PyTorch and skorch with 99.7% accuracy, to be used in our derivative-based postural optimization approach.
- Proposed 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, our approach has median of 5deg 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 MoCap.
- 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.
- Developed a haptic guidance algorithm including virtual fixtures and synthetic fixtures to guide the user in teleoperation through a maze using a Quanser HD2 haptic robot
- Collaborated on developing a mobile manipulation planning algorithm based on MPC and convex optimization to push/pull legged objects.
- Designed an algorithm for collision-free push planning of objects by mobile robots in simulation, using a mixture of A\* and RRT-connect algorithms.
- 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.
- Collaborated on a project to control an under-actuated wearable arm-swing rehabilitator for gait training.
- Collaborated on 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*

- 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.
- Collaborated on developing and implementing an optimal collision-free motion generation algorithm based on convex optimization and MPC and implementing it on various mobile, serial and parallel robots.
- Collaborated on creating PGNGN, a neural gas network algorithm for finding the singularity-free workspace of planar parallel robots.
- Designed and developed several parallel robots including a 6-DOF pneumatic Gough-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*

- Designed and developed VirSense, a 6-DOF haptic device with fixed-base actuators and 95% passive gravity compensation using linear springs.
- 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. More than 2000 bus drivers in Iran were trained on that.

### RELATED PEER-REVIEWED PUBLICATIONS

1. **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?", *IEEE CASE 2021*.

2. **A.Yazdani**, R. SabbaghNovin, "Posture Estimation and Optimization in Ergonomically Intelligent Teleoperation Systems", In Companion of the *HRI 2021*.
3. R. SabbaghNovin, **A.Yazdani**, A. Merryweather; T. Hermans, "Risk-Aware Decision Making in Service Robots to Minimize Risk of Patient Falls in Hospitals", *ICRA 2021*, Xi'an, China.
4. 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.
5. 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.
6. 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.
7. 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).
8. 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.
9. **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.
10. 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).
11. 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).
12. M. ZamaniFekri, M. Zareei, M. Tale Masouleh, and **M.Yazdani**. "Optimal design and fabrication of a 4-DOF quattrotaar parallel robot with singularity-free workspace by ABC and PSO algorithms.", *Modares Mechanical Engineering*, (2016): Vol 16 No 6, 149-158.
13. **M.Yazdani**, M. Tale Masouleh, M. Hasanvand, I. Yahyapour, and M. Ghafouri Tabrizi. "Inverse dynamic problem of two parallel manipulators with identical limbs structures.", *Modares Mechanical Engineering*, Vol 15 No 13, 281-290 (2015).
14. A. Jaber, A. Nahvi, M. Hasanvand, M. Tale-Masouleh, M. Arbabtafti, and **M.Yazdani**. "Design and kinematic analysis of a 4-DOF serial-parallel manipulator for a driving simulator." *International Journal of Robotics (Theory and Applications)* Vol.4, No. 3, 29-37 (2015).
15. E. Rostami Jame Bozorgi, I. Yahyapour, A. Karimi, M. Tale Masouleh, and **M.Yazdani**. "Design, development, dynamic analysis and control of a 2-DOF spherical parallel mechanism." *ICRoM 2014*, Tehran, Iran.
16. I. Yahyapour, **M.Yazdani**, M. Tale Masouleh, and M. Ghafouri Tabrizi. "Dynamic modeling and computed torque control of a 3-DOF spherical parallel manipulator." *ICRoM 2014*, Tehran, Iran.
17. R. SabbaghNovin, **M.Yazdani**, M. Tale Masouleh, and M. Menhaj. "Workspace determination of planar parallel robots via progressive growing neural gas network." *ICRoM 2014*, Tehran, Iran.
18. A. Jaber, A. Nahvi, M. Hasanvand, M. Tale Masouleh, M. Arbabtafti, **M.Yazdani**, M. Lagha, M. Hemmatabadi, and S. Samiezadeh. "Design and kinematic analysis of a 4-DOF serial-parallel manipulator for urban bus driving simulator." *ICRoM 2013*, Tehran, Iran.
19. I. Yahyapour, M. Hasanvand, M. Tale Masouleh, **M.Yazdani**, and S. Tavakoli. "On the inverse dynamic problem of a 3-PRRR parallel manipulator; the Tripteron." *ICRoM 2013*, Tehran, Iran.

## PRESENTATION & ABSTRACTS

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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

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- 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

## TEACHING ASSISTANTSHIP

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- Probability and Statistics, Introduction to Product Safety and Engineering Ethics, Introduction to Industrial Safety, Computer-based Problem Solving for Eng. Sys., *University of Utah, 2016-2019*  
Intro to Design for Eng. Sys., Engineering Design I, CAD Lab
- Advanced Robotics, Parallel Robots, Statics and Strength of Materials *University of Tehran, 2012-2013*

## AWARDS & HONORS

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- IEEE/ACM Human-Robot Interaction Pioneer 2021
- 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 Safety and Health (NIOSH), Award number: T420H008414-10 2016
- 1<sup>st</sup> place in Senior Demo league in Robocup IranOpen 2014

## Academic Service

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- US General Chair, IEEE/ACM HRI Pioneers 2022
- Student Volunteer, IEEE/ACM HRI 2021
- Peer Review: RA-L, RSS, ICRA, IROS, HRI, Humanoids, CASE, Sensors, Applied Science, ICROM

## MEMBERSHIPS

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- Student member of IEEE
- Student member of Robotic & Automation Society (RAS)
- Student member of American Society of Safety Engineering (ASSE)