Keyvan Majd

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PRINCIPAL INTERESTS

Safe Autonomous Systems, Machine Learning, Imitation and Reinforcement Learning, Formal Requirements and Testing, Robotics, Verification and Repair of Deep Neural Networks, and Control Theory.

EDUCATION

Arizona State University Aug. 2019 - Present
Doctor of Philosophy in **Computer Science** - *GPA: 4/4*
Research area: certifiably safe human-robot control & interaction, verification and repair of Deep Neural Networks (DNNs).
Advisor(s): Heni Ben Amor (ASU) and Georgios Fainekos (Toyota Research in NA)

North Carolina A&T State University Jan. 2017 - Jun. 2019
Master of Science in **Electrical Engineering** - *GPA: 4/4*
Thesis: Kinematic-based Trajectory Planning Framework for Autonomous Ground Vehicles.
Advisor: Abdollah Homaifar (NCAT)

Ferdowsi University of Mashhad Jan. 2011 - Jun. 2015
Bachelor of Science in **Electrical Engineering** - *GPA: 3.56/4*
Thesis: A Model Predictive Controller (MPC) Design for the Curing Process of Wind Turbine Blades.

RESEARCH EXPERIENCES & PROJECTS

Graduate Research Assistant Aug. 2019 - Present
Arizona State University, Tempe, AZ

- Guaranteeing Neural Network Safety through Expansion: Developed a safety-aware growing neural network method aimed at expanding neural networks such that the added units only respond to faulty behavior.
- Safe Robot Learning with Predictive Models: Designed a two-step supervised learning approach for safety-aware robot learning, using predictive models to enforce safety constraints with applications in mobile robot navigation and prosthetic control.
- Informative Planning: Developed a joint communication and motion planning framework to take into account the imperfect perception of humans about robot movements.
- Deep Neural Networks Repair & Verification: Developed a neural network repair framework for training policies with hard safety constraints using Mixed-Integer Programming (MIP).
- Autonomous Vehicle (AV) Simulators: Compared the technical suitability of AV simulators: SVL, Carla, and Webots in the context of requirements-driven adversarial testing, *Collaboration with Toyota TRI-NA*.
- Risk-bounded Control: Developed a probabilistic risk-bounded motion planner for the Toyota HSR robot in densely occupied dynamic spaces using Control Barrier Functions, *Collaboration with Toyota TRI-NA*.

Course Projects Aug. 2019 - Present
Arizona State University, Tempe, AZ

- Conformal Mapping: Implemented Spherical Conformal Mapping algorithm in Python on triangular meshes represented by Halfedge data structure, *Advanced Computer Graphics course.*
- Loop Subdivision: Implemented loop subdivision algorithm in Python on triangular meshes represented by Halfedge data structure, *Advanced Computer Graphics course.*
- AI in Battleship: Compared the performances of a random agent, a Deep Q-Learning Agent, and a Particle Filtering Agent in finishing the game of Battleship with the minimum number of shots, *Planning and Learning Methods in AI course.*
- Storm Event Application: Designed an application in C for the storm event data management using max-heap, hash table, and binary search tree data structures, *Algorithms and Data Structure course.*
- Graph Algorithms: Represented sea ice concentration as a graph and captured small-world graph trough capturing the high degree of local clusters and the small number of long-range connections (programmed in C), *Algorithms and Data Structure course.*

Graduate Research Assistant Jan. 2017 - Jun. 2019
North Carolina A&T State University, Greensboro, NC

- Kinematic-based Trajectory Planning: Proposed a globally exponentially stable optimal analytical solution to the classical car-like robot kinematic model trajectory tracking and control problem.

Course Projects Jan. 2017 - Jun. 2019
North Carolina A&T State University, Greensboro, NC

- Fuzzy-logic Controller: Implemented a Generalized Sugeno controller to approximate an optimal control law by learning from a family of optimal trajectories, *Fuzzy Logic with Applications course.*
- Lane Detection and Tracking: Lane detection by converting the images into a bird-eye plot using the prospective analysis, segmentation, and feature extraction, and then testing on the prerecorded image and video data, *Digital Image Processing course.*
- Robust Model Predictive Control (MPC): Designed a Constrained Robust MPC for the classical angular positioning problem with uncertainty on the system model, *Model Predictive Control course.*

SPECIAL ACHIEVEMENTS

Awards

- *Received a Best Paper Award*, NeurIPS'22 Robot Learning Workshop. (2022)
- *CIDSE Doctoral Fellowship Award*, Arizona State University. (2020)
- *CIDSE Doctoral Fellowship Award*, Arizona State University. (2020)
- *Dean of University Award*, Ferdowsi University of Mashhad. (2016)
- *Dean of College of Engineering Award*, Ferdowsi University of Mashhad. (2015)

Professional Activities

- Session chair of "*Motion and Path Planning VI*" in 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). (2021)
- Member of Toyota Human Support Robot (HSR) Developer Community. (2019 - Present)
- Conference/Journal Reviewer (selection):
  - IEEE Conference on Decision and Control (CDC)
  - International Conference on Robotics and Automation (ICRA)
  - IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

  - American Control Conference (ACC)
  - IEEE/ASME Transactions on Mechatronics
  - IEEE Robotics and Automation Letters (RA-L)
  - IEEE Transactions on Intelligent Vehicles
  - IEEE Transactions on Vehicular Technology
  - IEEE Transactions on Visualization and Computer Graphics
  - IET Radar, Sonar & Navigation
- President of Iranian Student Association in Greensboro, NC. (2017-2018)

PROFESSIONAL & ACADEMIC EXPERIENCE

- Research assistant at Arizona State University. (2019 - Present)
- Teaching assistant for *Introduction to Theoretical Computer Science* at Arizona State University. (2020)
- Teaching assistant for *Introduction to Mobile Robotics* at Arizona State University. (2019)
- Research assistant at North Carolina A&T State University. (2017-2019)
- Teaching assistant for *Stochastic Process and Random Variables* at North Carolina A&T State University. (2017)
- Summer internship at *MONIRAN* power engineering consultant company, Iran. (2014)

SELECTED COURSES

AI, Machine Learning, & Robotics: Neural Networks, Statistical Machine Learning, Advances in Robot Learning, Planning\Learning Methods in AI, Topics in RL.

Probability and Statistics: Probability and Stochastic Processes, Multivariate Statistics.

Algorithm and Complexity: Theory of Computation, Data Structure and Algorithms, Combinatorial Algorithms.

Control Systems: Model Predictive Control, Optimal Control, Nonlinear Control, Adaptive Control.

SKILLS

Programming/OS: Python, C/C++, MATLAB, Git, LaTeX, Linux, Windows, MacOS.

Machine Learning/AI/Statistics Tools: TensorFlow, Keras, PyTorch, R, SAS (Statistical Analysis System), OpenAI Gym.

Robotic/AV Simulation and Control Platforms: SVL, Apollo, Gazebo, ROS.

Optimization Tools/Libraries: Gurobi, Pyomo, CPLEX, YALMIP.

Languages: Farsi (Native), English (Fluent)

PUBLICATIONS

Under review & Preprints

1. Majd K., Clark G., Fainekos G., and Ben Amor A. (2023). "Safety-aware Neural Network Repair for Robotic Systems with Predictive Models," *Robotics and Automation Letters (RA-L).* ***(Under revision)***
2. Majd K., Zhou S., Ben Amor H., Fainekos G., and Sankaranarayanan S. (2021). "Local Repair of Neural Networks Using Optimization," *arXiv:2109.14041.*

Conferences & Workshops

3. [**IROS'23**] Majd K., Fainekos G., and Ben Amor A. (2023)."Safety-aware Expansion for Neural Network Repair," *IEEE/RSJ International Conference on Intelligent Robots and Systems (iROS) - Workshop on Formal methods techniques in robotics systems.*
4. [**NeurIPS'22**] Majd K., Clark G., Khandait T., Zhou S., Sankaranarayanan S., Fainekos G., and Ben Amor H. (2022). "Certifiably-correct Control Policies for Safe Learning and Adaptation in Assistive Robotics," *Neural Information Processing Systems (NeurIPS) - Robot Learning Workshop.* **(Received the Second Best Paper Award)**
5. [**CoRL'22**] Majd K., Clark G., Khandait T., Zhou S., Sankaranarayanan S., Fainekos G., and Ben Amor H. (2022). "Safe Robot Learning in Assistive Devices through Neural Network Repair," *Conference on Robot Learning (CoRL).*
6. [**ICRA'21**] Dadvar M., Majd K., Oikonomou E., Fainekos G., and Srivastava S. (2021). "Joint Communication and Motion Planning for Cobots," *IEEE International Conference on Robotics and Automation (ICRA).*
7. [**IROS'21**] Majd K., Yaghoubi S., Yamaguchi T., Hoxha B., Prokhorov D., and Fainekos G. (2021), "Safe Navigation in Human Occupied Environments Using Sampling and Control Barrier Functions," *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS).*
8. [**IV'18**] Majd K., Razeghi-Jahromi M., and Homaifar A. (2018), "Optimal Kinematic-based Trajectory Planning and Tracking Control of Autonomous Ground Vehicle Using the Variational Approach," *Intelligent Vehicles Symposium (IV).*

Journals

9. [**L-CSS'20**] Yaghoubi S., Majd K., Fainekos G., Yamaguchi T., Prokhorov D., and Hoxha B. (2020), "Risk-bounded Control using Stochastic Barrier Functions," *IEEE Control Systems Letters.*
10. [**IEEE-JAS'19**] Majd K., Razeghi-Jahromi M. and Homaifar A. (2019), "A stable analytical solution method for car-like robot trajectory tracking and optimization," *IEEE/CAA Journal of Automatica Sinica.*