Farnoosh Faraji

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Experienced in deep learning, computer vision, and reinforcement learning, with a growing interest in large language models. I thrive in collaborative environments and on innovative projects.

Professional Experiences and Recent Publications

Uncertainty-aware hybrid paradigm of nonlinear MPC and model-based RL for off-road navigation:Exploration of transformers in the predictive model (ICRA2024)

- I contributed to a project aimed at enhancing off-road navigation through a hybrid approach combining nonlinear MPC and model-based RL. Building on BADGR, a baseline framework for self-supervised navigation, the project involved developing an improved image-based predictive model by replacing BADGR's LSTM modules with transformers, resulting in enhanced environmental modeling. A dataset of 20,982 samples with 9 event types was collected and annotated, while epistemic uncertainty was addressed by training an ensemble of 5 models. Results demonstrated that transformers outperformed LSTMs, particularly in predicting future events and heading angle estimation, leveraging self-attention mechanisms to filter critical information. Integrating transformers into an uncertainty-aware hybrid planner with MPC reduced uncertainty and effectively balanced the speed-accuracy trade-off in the reward function, achieving robust vehicle control across diverse scenarios.

Constrained Robotic Navigation on Preferred Terrains Using Large Language Models and Speech Instruction (ISER2023)

- During my Ph.D. studies, I worked on a project enhancing robotic navigation by leveraging Large Language Models (LLMs) and vision-language models for terrain-aware navigation using speech commands. Adverb-modified instructions, such as "move cautiously on slippery terrain," were processed using GPT-3.5, a transformer-based LLM, to extract adverbial cues and map them to constrained optimization parameters (e.g., speed limits, safety margins). These parameters enabled nonlinear Model Predictive Control (MPC) to dynamically adjust robot behavior based on terrain constraints. A curated dataset of 15,000 terrain-labeled samples and speech commands was used to fine-tune the Language-driven Segmentation (LSEG) model via contrastive learning, aligning textual and visual embeddings for terrain classification. The resulting embeddings integrated into the control framework enabled real-time navigation adjustments. Results demonstrated improved precision and adaptability in dynamic terrains, effectively bridging high-level linguistic instructions with low-level robotic control policies for robust terrain-aware navigation.

Drowsiness Detection Based On Driver Temporal Behavior Using a New Developed Dataset 2020

- For my Master's thesis, I worked on a project aimed at detecting driver drowsiness by leveraging YOLOv3 CNN for facial feature extraction and LSTM neural networks for sequence classification of driver behavior. I contributed to developing a novel dataset consisting of 1042 labeled images for CNN training and a time-series dataset for LSTM training, considering variations in lighting, head pose, and facial expressions. The dataset was augmented with existing datasets like DDD to improve robustness. Using transfer learning, YOLOv3 was fine-tuned on our dataset for real-time facial feature extraction, while LSTM was employed to analyze blinking and yawning patterns over time. A multi-thread framework was implemented to run CNN and LSTM in parallel, ensuring efficient drowsiness detection. I implemented Deep CNNs and LSTM networks for the drowsiness detection prototype and deployed the system on NVIDIA Jetson AGX Xavier and Jetson Nano platforms.

Please refer to the link for more publications

Programming Skills

Languages	Python, C++, Matlab and Simulink, Git, LaTeX.
Libraries	TensorFlow, Pytorch, Keras, TensorRT, Scikit-learn, Numpy, Pandas, Matplotlib, OpenCV, ROS

Education

PhD student in Computer Science, *McGill University, Mila (Montreal, Canada)* 2023–Now

During my PhD journey, I have worked on underwater robotics, offroad navigation, and integrating Large Language Models (LLMs) into robotics applications. I am now focusing on exploring multi-modal learning for robotic in-hand manipulation.

Master of Science, Electrical Engineering *K. N. Toosi University of Technology (Tehran, Iran)* 2016–2019

I developed and implemented Convolutional Neural Networks (CNNs) and Long Short-Term Memory (LSTM) networks for driver assistance systems.

Bachelor of Science, Aerospace Engineering *K. N. Toosi University of Technology (Tehran, Iran)* 2012–2016

I applied classic control methods to design and simulate quadcopter control systems in the MATLAB Simulink environment.

Presentations for Conference and Attended Events

- **2023, 2024** International Conference on Robotics and Automation (ICRA), Oral and poster presentation of an accepted paper
- **2023, 2024** National Canadian Robotics Network (NCRN) annual meeting. Poster presentation
- **2023** NCRN Robotic field trial in the UoT camp site, Working on offroad Navigation project, Tutorial on Ramius(underwater robot) for new students *(Toronto, Canada)*
- **2023, 2024** NCRN Robotic field trial in McGill Blairs institute, Working on diver tracking project *(Holetown, Barbados)*.
- **2023** Deep and Reinforcement Learning Summer School at Mila, Quebec AI institute *(Montreal, Canada)*
- **2023** Scuba Diving Course, Certified scuba diver, a required qualification for operating underwater robots *(Holetown, Barbados)*.

Honors and Awards

- **2023-2027** Graduate Research Enhancement and Travel Awards by McGill University, $0.74K *(Canada)*
- **2023-2027** Natural Sciences & Engineering Research Council of Canada Graduate Fellowship $60K *(Canada)*
- **2023-2027** Differential Fee Waiver Award by McGill University, $45K *(Canada)*
- **2023-2027** Grad Excelence Award by McGill University, $18K *(Canada)*.
- **2019** Awarded honorary admission to the PhD program in Mechanical Engineering as a reward for having high academic records and achievements *(Iran)*
- **2016-2019** Governmental fellowship (full tuition waiver) for M.Sc. studies *(Iran)*.
- **2016** Top 3% among roughly 30,000 participants in National University Entrance Examination for Graduate Schools among all students in Mechanical Engineering *(Iran)*.
- **2016** Awarded honorary admission to the M. Sc. program in Mechanical Engineering as a reward for having high academic records and achievements *(Iran)*
- **2016** Ranked 6th, in terms of cumulative GPA among students of Mechanical Engineering, K. N. Toosi University of Technology *(Iran)*
- **2012** Governmental fellowship (full tuition waiver) for B.Sc. studies *(Iran)*
- **2012** Top 0.2% among roughly 500,000 participants, ranked 2016th in National University Entrance Examination among all students in Mathematics and Physics Discipline *(Iran)*

Languages

English	Professional
French	Intermediate