

# Golnaz Raja

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## SUMMARY

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First-year PhD student in Machine Learning and Robotics at Tampere University, funded by the Finnish Doctoral Program Network in AI (AI-DOC). My research focuses on uncertainty-aware safe autonomous navigation on challenging terrains.

Working on uncertainty-aware navigation has made me increasingly aware of the critical role of probabilistic methods in my field. While I have started exploring probabilistic machine learning, I am eager to build a deeper foundation in Bayesian inference, latent variable models, and variational inference to enhance decision-making in robotics. My goal is to effectively integrate probabilistic approaches into my research to improve the reliability and safety of autonomous systems.

Attending the Nordic Probabilistic AI School 2025 will provide me with the necessary theoretical and practical tools to apply probabilistic modeling in robotics, advancing my work in uncertainty-aware navigation

## EXPERIENCE

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### Doctoral Researcher

Tampere University

August 2024 - Present, Tampere, Finland

- PhD topic: Uncertainty-aware Safe Autonomous Navigation on Rough Terrain.
- Designing probabilistic traversability maps for safe autonomous navigation on rough terrain. (ongoing)
- Designing risk-aware planners on rough terrain (ongoing)
- Supervisors: Prof. Reza Ghabcheloo, Prof. Joni Pajarinen, Prof Karel Zimmermann, and Prof. Arun Kumar Singh
- Funded by the Finnish Doctoral Program Network in AI (AI-DOC) (Acceptance rate 3%)

### Researcher

Tampere University

December 2023 - August 2024, Tampere, Finland

- Designed and implemented a novel sensor-agnostic perception-based navigation system in CARLA Simulator.
- Investigated and implemented a rough terrain model in CARLA simulator and Unreal Engine.
- Conducted an exhaustive literature review on rough terrain mapping for autonomous navigation, and identified key trends and gaps.

### Research Assistant

Tampere University

November 2021 - December 2023, Tampere, Finland

- Designed and implemented a novel vision-based obstacle avoidance controller using CBF in CARLA simulator and on an industrial mobile robot.
- Designed and implemented optimization-based controllers on an industrial mobile robot.
- Implemented an end-to-end vision-based navigation system (BADGR) in Unity game engine.
- Implemented RGB and RGBD based semantic segmentation.
- Designed and Integrated advanced learning-based solutions such as Generative Adversarial Networks (GANs) with safe controllers.
- Integrated learning-based solutions such as segmentation in robotics experiments using sensor models such as Microsoft Azure RGBD camera.
- Conducted an extensive research and development on CARLA simulator in various research projects.

### Thesis Worker (Master's Thesis)

Vision-based Cost Maps for Safe Autonomous Navigation : Design and Evaluation of Vision-based Control Barrier Functions (V-CBF)

July 2023 - October 2023  
, Tampere, Finland

- Designed and implemented three vision-based cost maps for V-CBF safe controller.
- Designed and implemented a scenario-based evaluation system for V-CBF safe controller in CARLA simulator.
- Conducted an extensive analysis of V-CBF safe controller based on a custom-designed metrics system.
- Implemented V-CBF safe controller on an industrial mobile robot.
- Supervisors: Prof. Reza Ghabcheloo, Dr. Nataliya Strokina.

### Researcher

ARAS (Advanced Robotics and Automated System) Group

October 2019 - September 2021, Tehran, Iran

- Developed online simulation of ARASH: ASiST robot for the eye surgeries training system using Mixed Reality in Unity game engine and Sofa framework.
- Implemented the evaluation system of the eye surgery simulation using reinforcement learning.
- Supervisors: Prof. Hamid D. Taghirad and Dr. Alireza Norouzzadeh.

### Thesis Worker (Bachelor's Thesis)

K. N. Toosi University

March 2019 - May 2019, Tehran, Iran

- Implemented marker-based and image-based Augmented Reality (AR) software using Computer Vision.
- Supervisor: Prof. Behrouz Nasihatkon.

## PROJECTS

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### Simulation Twin 1 & 2 & 3

Tampere University · July 2022 - August 2024

- Researched on simulators with realistic rendering for mobile robots.

- Conducted an extensive research and development on CARLA and AirSim simulators.
- Designed and developed scenario-based evaluation system for autonomous navigation systems based on ISO standards.
- Conducted extensive research on design and importation of custom maps for CARLA simulator.
- Integrated various software and frameworks for scenario generation such as Mathwork's RoadRunner, CARLA ScenarioRunner, and OpenSCENARIO files.

### **NSF and AoF SafeRL in Non-Stationary Environments with Fast Adaptation and Disturbance Prediction**

Tampere University • January 2022 - August 2024

- Designed and Developed Vision-based Control Barrier Function (V-CBF).
- Integrated the state-of-the-art vision-based techniques such as segmentation and mapping to safe controllers.
- Implemented semantic segmentation models such as YOLO, and SAM.

### **Tristan**

Tampere University • October 2023 - December 2023

- Researched on implementation and application of probabilistic occupancy grid maps in safe autonomous navigation in CARLA simulator.

### **AI Hub Tampere Workshop on Numerical Optimal Control**

Tampere University • [research.tuni.fi/aihubtampere/blog/event-recap-numerical-optimization-workshop/](https://research.tuni.fi/aihubtampere/blog/event-recap-numerical-optimization-workshop/) • April 2023 - August 2023

- Developed and demonstrated obstacle avoidance controllers on an industrial mobile robot.
- Designed and developed optimization-based safe controllers such as Model Predictive Control (MPC), Control Barrier Function (CBF), and Control Lyapunov Function (CLF).
- Integrated various libraries such as Qpsolvers, PyTorch, Tensorflow, and CasADi for implementation of novel optimization-based controllers.

### **AI Hub Tampere Workshop on Simulators for Mobile Robot Applications**

Tampere University • [research.tuni.fi/aihubtampere/event/two-events-in-march-children-and-ai-and-simulation/](https://research.tuni.fi/aihubtampere/event/two-events-in-march-children-and-ai-and-simulation/)

- January 2023 - March 2023
- Conducted an extensive research on suitable simulators for mobile robots.
- Demonstrated capabilities of CARLA simulator for development of autonomous driving systems.

### **Pedestrian Detection using Image Processing and Computer vision Techniques**

April 2018 - June 2018

- Developed a software for detection of pedestrians in RGB images using techniques such as HOG transform, RANSAC, and SIFT.

## **EDUCATION**

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### **Doctoral Studies in Automation Science and Engineering**

Tampere University • Tampere, Finland • 2027

### **Master of Science in Signal Processing and Machine Learning**

Tampere University • Tampere, Finland • 2023 • 4.6

- Awarded a full tuition fee wavier scholarship

### **Bachelor of Science in Computer Engineering**

K. N. Toosi University of Technology • Tehran, Iran • 2019 • 3.44

- Ranked 5th among all of computer engineering students
- Awarded full tuition fee wavier scholarship

## **PUBLICATIONS**

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- Abdi, H., Raja, G. and Ghabcheloo, R., 2023, May. Safe Control using Vision-based Control Barrier Function (V-CBF). In 2023 IEEE International Conference on Robotics and Automation (ICRA) (pp. 782-788). IEEE.

- Raja, G., 2023. VISION-BASED COST MAPS FOR SAFE AUTONOMOUS NAVIGATION.

- Raja, G., Mökkönen, T., Ghabcheloo, R., Safe Autonomous Navigation using Control Barrier Functions and Mapping -- In Prepration

## **SKILLS**

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Selected Libraries: PyTorch, ROS2, OpenCV, Scikit-learn, Tensorflow, Keras, Matplotlib

Simulators: CARLA, Unreal Engine, Unity, Sofa