Alireza Falah

AI Researcher and Software Developer

al.r.falah@gmail.com | alirezafalah.github.io/ | linkedin.com/in/alireza-falah-5560b5116/

"Transforming Ideas into Reality: Engineering Excellence"

Personal Profile

Interdisciplinary researcher with a background in both mechanical engineering and computer science, specializing in robotics. My experience spans **simulations, reinforcement learning and AI techniques** for autonomous systems to **computer vision** and **end-to-end system design** for intelligent manufacturing. I am seeking a challenging R&D role where I can collaborate with interdisciplinary experts to advance the state-of-the-art in intelligent systems.

Work Experience

HUMDA Lab Nonprofit Ltd. *Budapest, Hungary*

AI Researcher and Simulation Engineer *Feb 2024 - Present*

- Developed a high-fidelity vehicle dynamics model of the **Super Formula Dallara SF23** in **MuJoCo MJX** and **Brax** to optimize lap time performance on the Yas Marina circuit. Applied **Reinforcement Learning** to discover optimal, dynamically-feasible trajectories which was successfully used at the **A2RL 2025 Sim Challenge**.
- Adapted the company's autonomous software (developed in **C++**, **ROS2**, and **Python**) to interface seamlessly with new simulation platforms, such as **automotive-grade simulator aiSim (Stellantis)** or **Aspire's Autonoma Autoverse**, requiring varied adapter configurations.
- Led the integration of **aiSim (Stellantis)** for complex autonomous driving simulations, developing custom **ROS clients** (C++/Python) and engineering **virtual sensors for synthetic data generation.**
- Engineered the **data pre-processing pipeline** for raw LiDAR and Radar sensors, delivering clean, high-quality point clouds that were **used for training** the team's successful vehicle detection and tracking model, utilized in the **A2RL 2025 Multi Vehicle Test Sessions**.
- Maintained a complete **DevOps pipeline** using **GitHub Actions**, **Docker**, and **Azure VMs**. This pipeline automated the validation of the core autonomous software by running **Pytest-based** quality gate scenarios (e.g., tunnel passing, time trials) within a containerized simulation, ensuring continuous integration and robust performance for every commit.
- Contributed to the **A2RL** competition by verifying vehicle behavior in **simulators** using **C++** and **ROS**, helping the team achieve a competitive standing among top international teams.
- **Technical Skills:** C++, Python, Simulations, ROS2, JAX, MuJoCo, Brax, Reinforcement Learning, Vehicle Dynamics, Docker, Pytest, DevOps, CI/CD, OpenCV, PyTorch, GitHub Actions, Azure, Git, Linux, Foxglove, Sensor Integration.
- **Soft Skills:** Strategic Problem-Solving, Team Collaboration, Analytical Thinking, Innovation, Adaptability, High Stress Tolerance.

Deep Learning Center of Iran *Tehran, Iran*

AI Researcher *Jan 2020 - Aug 2022*

- Researched high-performance computer vision perception modules for autonomous racing vehicles (object detection, recognition, tracking) using **C++**, **Python**, and **ROS2**.
- Presented research findings on perception systems to stakeholders and engineering teams, contributing to the organization's knowledge base in autonomous technologies.
- **Technical Skills:** C++, Python, ROS2, Linux, Computer Vision, Machine Learning, Algorithm Development, Sensor Integration, Simulated Test Environments, Data Analysis.
- **Soft Skills:** Team Collaboration, Innovative Thinking, Effective Communication, Problem-Solving, Analytical Rigor.

Mapna Turbine Engineering and Manufacturing Company *Karaj, Iran*

Mechanical Engineer (Simulation & Analysis) *Sep 2018 - Nov 2020*

- Engineered and validated the thermo-mechanical performance of Air Cooled Condensers (ACCs) by developing detailed **Finite Element (FEA) simulation** models in **Ansys**.
- Validated thermo-mechanical performance using **Ansys FEA**, which involved numerically solving the governing **Partial Differential Equations (PDEs)** for nonlinear stress analysis and stiff systems of **ODEs** for transient thermal dynamics.
- Modeled and optimized complex S-CO2 power cycles using **Aspen Plus** for large-scale **process simulation**, analyzing overall system efficiency and performance.
- **Technical Skills:** Ansys (FEA), Autodesk Inventor, Aspen Plus, Matlab, Simulink, Computational Analysis, Thermal & Structural Analysis, 3D Modeling, Process Simulation.

Education

Eötvös Loránd University (ELTE) *Budapest, Hungary*

Ph.D. in Computer Science *Sept 2024 - Present*

- **Stipendium Hungaricum Scholarship** recipient.
- **Research Focus: System Design and Computer Vision for Industry 4.0.** Designing autonomous optical inspection systems, focusing on: (1) High-fidelity **CNC tool condition monitoring** pipelines, and (2) **Autonomous 3D reconstruction** of manufactured parts for **CAD model retrieval**.
- Spearheaded the creation and publication of the **ELTE-TCM-46k dataset**, a novel collection of 46,000+ high-resolution images for CNC tool condition monitoring

Eötvös Loránd University (ELTE) *Szombathely, Hungary*

M.S. in Mechanical Engineering (Specialization: Automation and Industry 4.0) *Sep 2022 - Jul 2024*

- **Stipendium Hungaricum Scholarship** recipient.
- **Thesis: Vision-Based System Design for Tool Monitoring.** Executed the end-to-end design of a monitoring prototype, integrating industrial hardware (Basler cameras, VS Technology lenses) with custom image processing algorithms to quantify tool condition incycle. (Published in *Discover Applied Sciences*).
- Received training from industry experts at **Schaeffler** and **TDK**. Key courses: Microcontroller Based Device Development, **Embedded Systems Programming (Assembly/Low-Level CPU-Specific)**, Industrial Communications, Digital Manufacturing, CNC Programming, Digital Factory.
- Gained foundational, hands-on experience in embedded systems through coursework in **Microcontroller Development** and **low-level Assembly programming**.
- **GPA:** 4.43/5.00

Semnan University *Semnan, Iran*

B.S. in Mechanical Engineering *Sep 2013 - Jul 2018*

- **Thesis:** Simulation based on 'Mobile Offset Progressive Deformable Barrier: A New Approach to Cover Compatibility and Offset Testing' (Supervisor: Dr. Amir Najibi)
- Gained expertise in 3D Modeling, Solid Properties, Control and Automation, Heat Transfer, and Thermodynamics.

Publications & Scientific Contributions

Journal Articles

Tool Condition Monitoring in CNC Systems: A Hybrid Computer Vision and Signal Processing Approach
Alireza Falah, Mátyás Andó, Bálint J. Szekeres
The International Journal of Advanced Manufacturing Technology (2025). 2025

Novel and Cost-Effective CNC Tool Condition Monitoring Through Image Processing Techniques
Alireza Falah, Mátyás Andó
Discover Applied Sciences (2025). 2025

Conference Proceedings

Autonomous Racing Competitions: A Review of Platforms, Software Development, and Sustainability Contributions
Zalán Demeter, Alireza Falah, Levente Puskás

Datasets

ELTE-TCM-46k: A CNC Tool Condition Image Dataset
Alireza Falah, Soninkhuu Baatarchuluun, Mátyás Andó, Béla Szekeres
2025

Achievements & Honors

Abu Dhabi Autonomous Racing League (A2RL) *Yas Marina Circuit, Abu Dhabi, UAE*
5th Place – International Autonomous Racing Competition *April 2024*

- Achieved **5th Place** globally with the HUMDA Lab team, competing for a **$2.5 Million prize pool** against elite research universities (e.g., TUM, UNIMORE).
- Executed critical **simulation-based validation** of vehicle behavior, ensuring control strategy safety and stability for the **Dallara Super Formula SF23** prior to track deployment.

Scientific Student Association (TDK) *Eötvös Loránd University, Hungary*
2nd Place (University Level) – National Finalist *Nov 2023*

- Awarded **2nd Place** for Master's thesis in the Informatics section, securing qualification for the **National Scientific Students' Associations Conference (OTDK)**.
- Thesis selected for publication in the university's academic journal based on research excellence.

TechTogether Automotive Hungary Competition *Budapest, Hungary*
StudentTechLab – ELTE *May 2023 & Oct 2023*

- Secured **2nd Place** overall in both Spring and Autumn 2023 editions, solving real-world **industrial robotics** challenges from **Kuka**, **Schaeffler**, **Fanuc**, and **SMC**.
- Led the team to **2nd Place** specifically in the **Fanuc** industrial robotic optimization challenge.
- Awarded a special university scholarship for **consistent high performance** in competitive engineering events.

Projects

Industrial IoT: VFD Communication & SCADA Prototype *Szombathely, Hungary*
Eötvös Loránd University *Feb 2023 - Apr 2023*

- Engineered a Python-based control interface for Variable Frequency Drives (VFDs), implementing the **Modbus RTU** protocol over RS485 for robust industrial communication.
- Developed a real-time dashboard (Tkinter) to visualize telemetry data and execute motor control commands, simulating an industrial SCADA environment.
- **Tech Stack:** Python, PyModbus, Industrial Comms (RS485), GUI Development.

Embedded Control: Self-Balancing Robot *Szombathely, Hungary*
Eötvös Loránd University *Mar 2023 - Apr 2023*

- Prototyped an inverted pendulum system using an **Arduino** microcontroller, implementing a closed-loop **PID controller** to stabilize unstable non-linear dynamics.
- Executed the mechanical design (CAD/3D Printing) and integrated IMU sensors (Gyro/Accelerometer) for real-time state estimation.
- **Tech Stack:** C++, Embedded Systems, Control Theory (PID), Sensor Fusion.

Skills

Programming	Python, C/C++, Linux, ROS2, Git, Matlab, LaTeX (Overleaf)
ML/AI Libraries	JAX, PyTorch, TensorFlow, NumPy, OpenCV, Scikit-learn, Pandas, Hugging Face Transformers
Tools & Platforms	Docker, GitHub Actions, CI/CD, MuJoCo, Brax, Nvidia Isaac Sim, aiSim, Azure, Foxglove
Soft Skills	Adaptability, Communication, Creativity, Critical Thinking, Presentation Skills

References available upon request.