Karan Shah

M.Sc. Computer Science, Technical University of Munich
Research Engineer, German Aerospace Centre

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PROFESSIONAL SUMMARY

Research Engineer in Systems Engineering and Simulation with over three years of experience at the intersection of control theory, real-time software and physical systems. My work spans the design, implementation and maintenance of software that models, simulates and controls different physical systems ranging from traffic simulation and autonomous-mobility systems to the modelling and control of nonlinear dynamical systems. I have built physics-informed models and reinforcement-learning-based controllers that interface with simulated and real hardware, with an applied focus on correctness, determinism and graceful degradation under fault.
Beyond applied ML, my research interests include dynamical systems, number theory, the distribution of primes and the Goldbach's conjecture.

Tools & Frameworks for ML, Simulation, and Control: Python, C++, C# | PyTorch, TensorFlow, Unity3D, OpenAI Gym | ROS, Docker, JAX, | RAG, CNNs, Physics Informed NNs

EXPERIENCE

Research Engineer - Systems Engineering and Simulation
German Aerospace Centre (DLR) - Institute Systems Engineering for Future Mobility
03/2024 – present — Oldenburg, DE

- Conducting faster-than-real-time simulations on Maritime Traffic Simulation Software and a bridge simulator to test human pilot behavior in surface-vessel scenarios.
- Designing and training large language models (LLMs) and reinforcement learning agents to learn autonomous navigation behavior for surface vessels in complex marine environments.
- Integrating LLM-driven perception with environment-aware control policies to simulate real-time decision-making.

Research Assistant - Autonomous Driving
TUM - Chair of Traffic Engineering and Control
09/2022 – 02/2024 — Munich, BY, DE

- Built a 3D digital twin of Ingolstadt, DE using Blender, ArcGIS, and Unity3D for urban mobility modeling.
- Integrated SUMO to simulate heterogeneous traffic dynamics and AV testing environments.
- Conducted human-in-the-loop studies using high-fidelity driving simulators to analyze safety and perception.

Internship - Business Analyst
BMW Group
03/2022 – 07/2022 — Munich, BY, DE

- Designed big data pipelines for customer feedback clustering using NLP models; cut processing time by 15%.
- Maintained and monitored deployed pipeline components in production, investigating and resolving performance regressions and data-quality issues.
- Contributed to successful launch of BMW 7 Series (2022), improving customer satisfaction across markets.

Research Assistant - Reinforcement Learning
TUM - Chair of Computational Modelling and Simulation
03/2021 – 03/2022 — Munich, BY, DE

- Developed a scalable simulation + RL framework combining Unity ML Agents with OpenAI Gym.
- Modeled complex agent-environment interactions and collected over 1M data points for training RL policies.
- Achieved 20% improvement in learning stability through domain-aware modeling.

EDUCATION

M.Sc. Computer Science
Technische Universität München | Technical University of Munich 2019 - 2023
Computer Vision, Machine Learning, Motion Planning for Autonomous Vehicles,
Crowd Modelling & Simulation, Autonomous Driving, Math for Imaging and Visualization

B.E. Computer Engineering
Mumbai University 2015 - 2019
Analysis of Algorithms, Data Structures, Machine Learning, Structured Programming Approach,
Software Engineering, Operations Research, Artificial Intelligence, Cloud Computing

PROJECTS

Master-Thesis: Physics-Informed Deep Learning for Control of Dynamical Systems
Keywords: Control Theory, Differential Calculus, Deep Learning, PyTorch, Python
- Modeled nonlinear systems using neural differential equations in PyTorch, integrating control theory for predictive state-space learning.
- Work parallels challenges in magnetic field modeling and accelerator system forecasting.

Crowd Modelling and Simulation of the extended SIR model using OpenAI and Unity3D
Keywords: Unity3D, Dynamical Systems, Linear Algebra, C#, Reinforcement Learning, OpenAI, Gym
- Created a compartmental model in Unity3D implementing an extended SIR model (with vital dynamics + biological factors)
- Modeled different urban environments and simulated movement of population in different scenarios
- Used OpenAI Gym to train a RL-model to get the agents in the environment to learn social distancing

Trajectory Extraction and Pose Estimation of moving traffic using Detectron2 (Meta)
Keywords: Object Detection, Tracking, Computer Vision, Python, Detectron2, Trajectory Extraction, C++
- Configured and Trained a deep learning model (detectron v2) for object detection and tracking (trajectories of cars, buses, trucks, motorcycles, bicycles and unknown objects)
- Ran benchmark tests on the Munich Highlight Tower Dataset with state-of-the-art accuracy
- Added a trailer/double-detection processor to improve generated trajectories for vehicles with trailers and container cargo based on relative position and velocity.

Seminar – Deep Learning in Physics
- Implemented and presented the paper “Deep learning and the Schrödinger equation” (Mills et al.)
- Trained a CNN to predict ground-state energies of electrons in random 2D electrostatic potentials.
- Achieved chemical accuracy (MAE ~1.49 mHa) on non-analytic potentials.
- Explored predictions of kinetic and excited-state energies, translating quantum observables into ML models

PUBLICATIONS

P. Sonawane, K. Shah, P. Patel, S. Shah and J. Shah, "Speech To Indian Sign Language (ISL) Translation System," 2021 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS), Greater Noida, India, 2021, pp. 92-96, doi: 10.1109/ICCCIS51004.2021.9397097.

Shah, Karan & Kelpin, Rene & Steinmetz, Alexander. (2026). Stress-Aware Urban Mobility: Predicting User Comfort with Physiological and Geo-Semantic Features. 10.54941/ahfe1007076.