MOHAMED KHALID M JAFFAR

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PROFESSIONAL SUMMARY

Robotics and autonomy researcher with a decade of experience across diverse platforms, including ground, aerial, and legged robots, UAVs, and rockets. Expertise in motion planning, control, optimization, and learning-based methods for **safety-critical autonomous systems**, translating theory into real-world deployments. Focused on advancing reliable, intelligent autonomy through rigorous research, engineering, and system-level integration.

EDUCATION

University of Maryland, College Park, USA — **Expected Jun 2026**
Doctor of Philosophy (PhD) in Aerospace Engineering — **GPA: 3.62/4**

Indian Institute of Technology Madras, India — **2013 – 2018**
Dual Degree (B.Tech & M.Tech) in Aerospace Engineering — *Class Rank* **1**
Minor in Robotics — **GPA: 9.06/10**

SKILLS AND EXPERTISE

- **Planning & Control**: Trajectory optimization, Kinodynamic planning, MPC, LQR, Behavior planning, A*/RRT*
- **Navigation & Perception**: Kalman filters, EKF, Sensor fusion (IMU, LiDAR, RGB-D camera), Semantic mapping
- **Machine Learning & AI**: Gaussian process, LLM/VLM integration for Physical AI, scikit-learn, PyTorch, CLIP
- **Languages & Tools**: Python, C++, MATLAB, C, ROS/ROS2, CasADi, CVXPY, Gurobi, Simulink, SolidWorks

WORK EXPERIENCE

Research Scientist Intern | Mitsubishi Electric Research Labs (MERL) — **2025–present**
*Project: Adaptive spatio-temporal monitoring using a heterogeneous mobile robot team — **US patent pending***

- Developed a multi-robot monitoring system using **12+** aerial and ground vehicles; implemented robust estimation and optimal task allocation while satisfying motion, battery, and collision-avoidance constraints
- Integrated data-driven learning with multi-agent coordination via Gaussian processes and integer programming
- Reduced monitoring effort by **85%** over non-learning baselines while enforcing hard uncertainty thresholds

Graduate Research Assistant | Motion and Teaming Lab, University of Maryland — **2018–25**
PhD Thesis: Real-time feedback motion re-planning of mobile robots in dynamic spaces

- Designed uncertainty-aware motion planning algorithms with formal Lyapunov-based safety guarantees for mobile robots in obstacle-cluttered environments, achieving robust replanning speeds of **50+ Hz**
- Released `computeSOSFunnels`, a MATLAB toolbox for invariant reachable set synthesis across **4** robot platforms
- Developed fault-tolerant control strategies for multirotor aerial vehicles with **up to 3** complete rotor failures

Visiting Researcher | U.S. Army Research Lab & GAMMA Lab, University of Maryland — **Summer 2024**
Project: Long-range navigation of legged robots in unstructured outdoor environments

- Field-deployed quadruped autonomous navigation (**>200 m**) in unmapped terrain with trees, tall grass, and mud
- Built multi-level costmaps from LiDAR and RGB camera sensor fusion for terrain-aware planning; used CLIP for semantic scene understanding and GPT-4o/Gemini for behavior-rule guided traversability estimation

Systems Lead | Airbrake subteam, Terrapin Rocket team | Spaceport America Cup — **2021–24**
Project: Real-time altitude regulation of a competition rocket via deployable aerodynamic braking flaps

- Engineered an airbrake avionics system, integrating sensors (IMU, barometer, magnetometer), MCU, and telemetry
- Implemented an MPC and EKF-based closed-loop control in C++, reducing apogee error from **2000 ft to 70 ft**
- Led a 6-student team over two years; placed **2nd in category** in 2023 and **1st overall** in 2024, out of **150 teams**

Master's Research | RAFT Lab & Robotics Lab, IIT Madras **2017–18**
Thesis: Onboard maneuver control of quadrotors in tight indoor spaces

- Benchmarked 4 nonlinear controllers; integral SMC outperformed alternatives in robustness against wind gusts
- Conducted **70+ hours** of hardware-in-the-loop tests for system identification and evaluation of control strategies

Principal Investigator | Innovative Projects Scheme | IC&SR, IIT Madras **Fall 2017**
Project: Autopilot flight controller board for multirotor UAVs

- Designed and fabricated a custom embedded autopilot board for real-time flight stabilization
- Achieved **<10 ms** end-to-end control latency through RTOS and assembly-level programming

Aerostructures Lead | Nimbus, IIT Madras competition team | SAE Aero Design **2016–17**
Project: Design and fabrication of IC-engine fixed-wing unmanned aircraft

- Analyzed aerodynamic characteristics, stability, and flight performance; designed the airplane using SolidWorks and manufactured using composites, achieving a payload fraction of **34%**
- Placed **12th worldwide** and **4th in India**, out of **75 teams globally**

Autonomy Lead | Team Noctua, DeTect Technologies | Tech startup **2015–16**
Product: Aerial robot operations for infrastructure inspection in oil and gas industrial plants

- Founding-stage member of a seed-funded startup, leading technology development and operations; the company has since grown to a **$138M valuation** (Series B)
- Developed localization and control algorithms for aerial robots to autonomously inspect pipelines and chimneys in petrochemical plants, reducing inspection time by **80%** compared to manual methods

Undergraduate Research Intern | IIT Madras & Defense R&D Organisation (DRDO) **Fall 2015**
Project: Autonomous target-tracking multirotor unmanned aerial vehicle (UAV)

- Implemented guidance & control strategies for a VTOL UAV to track reference trajectories with **0.2 m accuracy**

SELECTED PUBLICATIONS

Journal and Peer-Reviewed Conference Articles

- **M.K.M. Jaffar**, S. Di Cairano, A. Vinod. "Adaptive spatio-temporal monitoring using constrained mobile robots." *Conference on Decision and Control* (under review)
- **M.K.M. Jaffar** and M. Otte. "Online feedback motion re-planning in dynamic spaces using invariant funnels." *International Journal of Robotics Research* (preprint)
- G. Seneviratne, M Elnoor, V. Rajgopal, H. Varatharajan, **M.K.M. Jaffar**, J. Pusey, D. Manocha. "Cross attention-based multimodal representation fusion for parametric gait adaptation in complex terrains." *IROS* **(2025)**
- M. Elnoor, K. Weerakoon, G. Seneviratne, R. Xian, T. Guan, **M.K.M. Jaffar**, V. Rajagopal, D. Manocha. "Robot navigation using physically grounded vision-language models in outdoor environments." *ICRA* **(2025)**
- K. Weerakoon, M. Elnoor, G. Seneviratne, V. Rajagopal, S. Arul, J. Liang, **M.K.M. Jaffar**, D. Manocha. "Behavioral rule guided autonomy using LLMs and VLMs for robot navigation in outdoor scenes." *ICRA* **(2025)**
- H. Yang, **M.K.M. Jaffar**, M. Otte. "Trajectory tracking while stabilizing an inverted pendulum on a quadcopter using adaptive model predictive control." *AIAA SciTech* **(2024)**
- E. Bregin and **M.K.M. Jaffar**. "Development of a drag-modulating feedback system to control a rocket's ascent." *AIAA SciTech* **(2024)**
- J. Cho, C. Kim, **M.K.M. Jaffar**, M. Otte, and S. Kim. "Low-level controller in response to changes in quadrotor dynamics." *ICRA* **(2023)**
- **M.K.M. Jaffar** and M. Otte. "PiP-X: Funnel-based online feedback motion planning in dynamic environments." *Algorithmic Foundations of Robotics* [***best paper consideration***] **(2022)**
- E. Carrillo, S. Yeotikar, S. Nayak, **M.K.M. Jaffar**, S. Azarm, J. Herrmann, M. Otte, and M. Xu. "Communication-aware multi-agent metareasoning for decentralized task allocation." *IEEE Access* **(2021)**
- S. Nayak, S. Yeotikar, E. Carrillo, E.R. Cohen, **M.K.M. Jaffar**, R. Patel, S. Azarm, J. Herrmann, M. Xu, M. Otte. "Experimental comparison of decentralized task allocation algorithms under imperfect communication." *IEEE RA-L* **(2020)**

- **M.K.M. Jaffar**, M. Velmurugan, and R. Mohan. "A novel guidance algorithm and comparison of nonlinear control strategies applied to an indoor quadrotor." *Indian Control Conference* **(2019)**

Open-source Software Releases

- **M.K.M. Jaffar**. "`computeSOSFunnels`: A MATLAB framework for invariant funnel synthesis using sum-of-squares optimization." *v1.0.0 - GitHub* **(2025)**

15+ peer-reviewed publications in ICRA, IROS, RA-L, CDC. A complete list is available on my **Google Scholar**.

AWARDS AND HONORS

- Ann G. Wylie **Dissertation Fellowship** for pursuing *6-month* academic research (Fall 2024)
- **Dean's Fellowship** from the University of Maryland, College Park (2019)
- **Gold Medalist** for **best overall academic record** in Dual Degree Aerospace Engineering (2018)
- **NTU-India Connect Scholarship** from NTU, Singapore; *1 among 20 students from India* (2016)
- E. G. Tulapurkara **Institute Merit Prize** for best academic performance in Junior year (2015-16)
- Within *top 30 ranks in State* (Tamil Nadu, India) in **Regional Mathematics Olympiad** (2010)

TEACHING AND MENTORSHIP

- **Head Instructor, CAD Lab**: Taught **150+** undergraduate students core computer-aided design concepts through hands-on SolidWorks training; managed and supervised 4 teaching fellows at UMD College Park **Spring 2025**
- **Mentored 5+ undergraduates** in Motion & Teaming Lab, Department of Aerospace, UMD **2022–24**
  Students mentored: Matthew Nam, Han Yang, Rishi Parikh, Robert Baratta, Matthias Kim
- **Teaching Assistant** for courses: *Flight Controls & Simulation* and *Gas Dynamics.* Conducted lab sessions, lectures and evaluated reports, final papers **2017–18**

PROFESSIONAL SERVICE AND LEADERSHIP

- **Academic Chair** of Graduate Student Advisory Committee, Aerospace Department, UMD **2021–22**
- **Student representative** on the **Executive Committee** of Maryland Robotics Center **2020–21**
- **Chief Strategist and Mentor** for student teams in **Robotics**, **Electronics**, and **Aero Clubs** at the Centre for Innovation (CFI), IIT Madras **2016–18**