

Shivaram Kumar Jagannathan

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Research Interests

Robotics | Autonomous Systems | SLAM | Sensor Fusion | Multi-Agent Reinforcement Learning | Real-time Perception | Graph Neural Networks | Machine Learning for Robotics

Education

Manipal Institute of Technology

Bachelor of Technology in Information Technology, CGPA: 8.5/10

Bangalore, India

Expected Graduation: 2026

- Relevant Coursework: Modern Robotics, Embedded Systems, Computer Vision, Control Systems, Machine Learning, Kinematics and Dynamics

Research Experience

Nanyang Technological University, Singapore

Researcher

Jan. 2026 - Present

Singapore

- Working at the Algorithmic Robotics Group, under Dr. Yoonchang Sung
- Co-authoring Mani-Imagine, a task and motion planning algorithm that leverages 3d reconstruction to inform novel object search
- Built the complete end-to-end 3d reconstruction pipeline, with object localization and wrote a smooth torque control system for controlling the Franka FR3
- Core tech stack - SAM3D, FoundationStereo, FoundationPose, Qwen2.5 VL, PyBullet, LibFranka (C++)
- Researching optimizations on general purpose task and motion planning algorithms for robotic manipulation
- Designing algorithms using analogous theoretical computational algorithms and neural networks
- Currently working on applying Minimum Constraint Removal problem with priors from a Graph Neural Network

Centre of Excellence in Autonomous Mobility, MIT Bangalore

Technical Lead

Jan. 2025 - Present

Bangalore, India

- Wrote a custom Unscented Kalman Filter to fuse IMU with GNSS readings accounting for RTK corrections
- Applied RandLA-Net for real-time 3D semantic segmentation, improving localization speed by 35%
- Wrote a bespoke IMU preintegration layer for pure LiDAR-IMU SLAM, and utilized the semantic segmentation layer for enabling bundle adjustment with feature recognition.

IIT Bombay Robotics Lab

Research Project Lead

Nov. 2022 - Jan. 2023

Mumbai, India

- Designed and implemented a warehouse automation project, where I led a team of 3 individuals
- The project
- Integrated MoveIt for motion planning for the UR5, wrote a forward kinematics algorithm to automate repetitive pick-and-place tasks.
- Complemented autonomous delivery with a simple rover, hooked up to a 2D laser rangefinder and ultrasonics
- Implemented cartographer for mapping the warehouse, and used AMCL for localization, which led me to tackle the kidnapped robot problem
- Developed an automated warehouse logistics system employing ArUco marker-based pick-and-place strategies

Technical Projects

AToM: Adaptive Teleoperation Middleware for Humanoid Manipulation

Lead Developer

Oct. 2025 – Oct. 2025

- Developed a complete ROS2-based teleoperation middleware in one week, enabling full-body humanoid control through real-time human pose tracking and inverse kinematics solving across multiple degrees of freedom
- Implemented a **multi-threaded teleoperation controller** using PyKDL, TF2, and adaptive motion scaling to synchronize operator limb motion with robotic arms and neck joints, achieving near real-time performance (\approx **20 ms delay per movement**)
- Designed a **Neck Tracker Node** with quaternion-to-Euler mapping, TF2-based head-following, and clamped trajectory generation for smooth visual tracking with live camera feedback and recording

- Integrated KDL-based **inverse kinematics solvers (LMA)** for bilateral arm and neck kinematic chains with reach-projection, exponential smoothing (EMA), and retry-based convergence, reaching **99% IK solve success rate**
- Developed adaptive projection and relative motion scaling for out-of-reach targets, enhancing operator-to-robot motion fidelity under constrained kinematic limits
- Built a **real-time joint trajectory publisher** leveraging ROS2 action interfaces and MultiThreadedExecutor for deterministic, low-latency motion control across concurrent IK, TF, and vision pipelines
- Integrated a **vision subsystem** using OpenCV and CvBridge for continuous image streaming, recording, and teleoperation monitoring to support safety and behavior analysis
- Focused on natural human–robot motion mirroring, constraint-aware control, and low-latency teleoperation suitable for humanoid and remote manipulation research platforms

Vision-Based Quadcopter Autonomous Navigation System

Aug. 2025 - Present

Lead Developer

- Achieved **stable autonomous flight with $\pm 0.1\text{m}$ positional accuracy** across all axes using pure control theory and vision-based pose estimation, eliminating reliance on IMU or odometry sensors
- Designed and implemented a **Linear Quadratic Regulator (LQR)** controller with full-state feedback for optimal trajectory tracking, outperforming traditional PID approaches in stability and convergence speed
- Developed a complete **ROS2 action-based waypoint navigation system** with service-client architecture, enabling sequential autonomous flight through multiple 3D coordinates with real-time feedback
- Integrated **WhyCon visual marker tracking** for high-frequency pose estimation (80–100 Hz update rate), implementing coordinate frame transformations between Gazebo simulation and controller reference frames
- Built a **multi-threaded state estimation pipeline** using Kalman filtering with sensor processing, measurement updates, and prediction steps for robust pose tracking under visual noise
- Implemented **adaptive stability monitoring** with sphere-constraint validation, requiring continuous presence within tolerance bounds and dual validation against both raw and filtered position data
- Developed an **RC command mixer** with thrust linearization, attitude control mapping, and real-time saturation handling to translate LQR control outputs into PWM commands for quadcopter actuators
- Created comprehensive **diagnostic and logging infrastructure** with CSV export, real-time performance metrics (Lyapunov stability, control energy, cross-coupling), and multi-layer system analysis for controller tuning
- Demonstrated vision-only autonomous navigation without traditional sensor fusion, proving viability of camera-based control for resource-constrained aerial platforms

Autonomous Mobile Manipulation Platform

Oct. 2022 - Present

Lead Developer

- Integrating ROS2-based navigation stack with a custom 6-DOF robotic arm for indoor object manipulation
- Implementing sensor fusion between 3D LiDAR, depth cameras, and IMUs to achieve sub-centimeter positional accuracy
- Developing custom inverse kinematics solver with collision avoidance capabilities for confined spaces
- Currently achieving 92% pick success rate in cluttered environments through deep reinforcement learning approaches

LoRA + 8-bit Fine-Tuning for Extreme Multi-Label Retrieval Retrieval

Jan. 2025 – Feb. 2025

Systems Researcher

- Ported mpnet-base retriever to parameter-efficient LoRA ($r = 8$) and bitsandbytes 8-bit optimiser on a single RTX 3060 Max Q.
- Cut peak VRAM from 8 GB \rightarrow 3 GB and boosted throughput $1.8 \times$ while maintaining recall@100 (-0.4 pt).
- Delivered reproducible Jupyter notebook, timing script, and 1-page cost–speed trade-off brief.
- **Trade-offs:** slight recall drop (-0.4 pt) and library-version tight-coupling; future work includes QLoRA + FlashAttention-2 to reach $2.5 \times$ throughput on full Amazon-670 K.

Grants & Awards

IIT Bombay eYantra Robotics Competition

Nov. 2022 - Present

Lead Researcher - Top 1% among participants

Mumbai, India

- Led a team to develop advanced autonomous navigation algorithms with real-time SLAM implementation

AWS DeepRacer Scholarship

Jul. 2022 - Dec. 2022

Excellence in Reinforcement Learning

Bangalore, India

- Recognized for excellence in reinforcement learning for self-driving models

Publications & Research Output

- **Mani-Imagine: 3D Occlusion Aware Task and Motion Planning for Novel Object Search**
Antareep Singha, Shivaram Kumar Jagannathan, Yoonwoo Kim, Yoonchang Sung
Target: ICRA 2027
- **VLM enabled Semantic Soft-Collision Manipulation**
Shivaram Kumar Jagannathan, Yoonchang Sung
Bachelor's Thesis

Professional Experience

Virya Autonomous Technologies

Jun. 2025 – Dec. 2025

Robotics Systems Engineer Intern

Bangalore, India

- Developed a **global localization system** for autonomous industrial mobile robots (AMRs), achieving **0.05 m Absolute Trajectory Error (ATE)** against GNSS ground truth and an average **0.006 m Relative Pose Error (RPE)** across evaluation sequences.
- Implemented a **GNSS-based fallback relocalization mechanism** using the **CUAV UM982 RTK chipset**, automatically engaging when LiDAR and camera localization pipelines failed, leveraging RTK fixes for centimeter-level global accuracy.
- Designed a **feature detection and relocalization pipeline** leveraging **Visual Bag-of-Words (BoW)**, **Bayesian hypothesis generation**, and **TF-IDF likelihood scoring** for robust feature association and graph node matching within the SLAM backend.
- Introduced a **safety-critical covariance confidence metric**, published at high frequency, to quantify localization certainty across the entire SLAM chain (*feature extraction* → *hypothesis generation* → *likelihood ratio* → *feature matching* → *6-DoF coarse alignment* → *ICP refinement* → *graph optimization*); enabling low-level controllers to autonomously trigger emergency stops or recovery maneuvers under uncertain localization states.
- Implemented an **Optical Flow-based odometry module** as a fallback to feature-based matching, ensuring reliable motion estimation under low-light, high-glare, or texture-deprived visual conditions.
- Advanced the perception pipeline by fusing data from the **Ouster OS-1 (128-channel) LiDAR** and **Intel RealSense RGB-D camera** via reprojection-based sensor fusion and extrinsic calibration—replacing the legacy 16-channel LiDAR system for enhanced spatial fidelity.
- Parallelized the **DLIO odometry engine** using **OpenMP** to exploit multi-core CPU architectures, achieving real-time SLAM updates and reduced odometry latency.
- Evaluated and benchmarked both **G2O** and **GTSAM iSAM2** as core optimization backends, analyzing convergence behavior, runtime performance, and incremental pose-graph update characteristics for large-scale maps.
- Integrated **Vertigo** for robust graph optimization to dynamically handle outlier loop closures and inconsistent spatial constraints, replacing static error thresholds with adaptive switchable factors for stable long-term mapping.
- Performed a comprehensive comparison of modern **SLAM frameworks** (Cartographer, FAST-LIO, LIO-SAM, RTAB-Map) under noisy industrial environments with frequent sensor outages, dynamic obstacles, and spurious LiDAR reflections.
- Extended RTAB-Map's modular framework to support heterogeneous odometry and sensor sources, integrating visualization and diagnostic telemetry in **Foxglove Studio**.
- Conducted **multi-session SLAM experiments** spanning **over 6 km of robot trajectories**, generating merged maps covering **approximately 3 km²** through cross-session loop closures and global pose-graph alignment.
- Developed an internal **environment-authoring toolkit** enabling large-scale map visualization, lane and safety-zone definition, behavior annotation (docking, charging, pausing), and automatic generation of optimized waypoint graphs functioning as a global planner for autonomous robots.
- Engineered a high-performance **point-cloud rendering subsystem** using OpenGL optimizations, achieving **loading and visualization of 30 million points in under 5 seconds** to support large-scale environment inspection and workflow design.
- Integrated perception, planning, and visualization modules into a unified, extensible interface allowing operators to author navigation pipelines directly from mapped environments, significantly improving tooling efficiency and deployment workflows.

Exponent Energy

Jun. 2023 - Jul. 2023

Software Engineer Intern

Bangalore, India

- Deployed Kubernetes-based backend systems, reducing operational overhead by 30%
- Developed Apache Superset dashboards for real-time analytics benefiting 50+ stakeholders
- Led version control initiatives for a team of 20+ engineers, improving deployment efficiency by 25%

- Created a cloud-based EV charging station locator, boosting user engagement by 25%

Exponent Energy

Embedded Systems Engineer Intern

Jul. 2023 - Aug. 2023

Bangalore, India

- Improved CAN-based communication reliability by 15% in EV charging networks
- Designed adaptive error detection mechanisms, increasing charging performance by 20%
- Optimized microcontroller performance, enhancing data processing throughput by 25%

Leadership & Extracurricular Activities

IEEE RAS Society, Manipal Institute of Technology

Chair

Jan. 2025 - May 2025

Bangalore, India

- Organized robotics workshops and led interdisciplinary research collaborations
- Coordinated an annual robotics symposium with 100+ participants from various institutions
- Mentored junior robotics enthusiasts and contributed to open-source robotics projects

References

Dr. Yoonchang Sung

Assistant Professor, Algorithmic Robotics Group

Nanyang Technological University

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