

ANIKET SHIRSAT

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Summary

- *5+ years* of prototyping & testing experience on developing level 2 autonomy solutions for edge based decision making on low compute IoT devices using *OpenCV*, *C++*, *Python 3*.
- *3+ years* of hands-on experience using *Linux*(Ubuntu), standard template library (C++ STL) for developing robotics applications.
- Demonstrated expertise in leading teams & contributing to peer-reviewed and scalable codebases in collaborative and fast-paced environments.

Core Competencies

- Embedded control design and implementation with C++ and Python.
- Hands on experience in developing, deploying image processing algorithms for aerial robot navigation, on low power embedded architectures.
- Proficient in *Software-In-The-Loop (SITL)* testing and debugging using *ROS2* & *Gazebo*.
- Worked in collaborative applied research and development teams on patentable innovative research.
- Multi-robot system design, simulation & implementation utilizing *ROS*, *OpenCV*.
- Fluent in formulating estimation algorithms for ADAS using *camera*, *radar*, IMU.

Technical Skills

- Hardware: Experienced in deploying control & navigation algorithms on Raspberry Pi 4, Nvidia Jetson Nano, UP board, Arduino.
- Coding: Adept in developing software applications using *ROS2*, *Gazebo* for control, mapping with *OpenCV* in C++, Python 3.
- Tools: Docker for test & deployment; Git, Jira for code review

Education

Ph.D., Mechanical Engineering (GPA:4.0/4.0)

Arizona State University, Tempe, AZ, USA.

Aug'16 - May'22

Relevant Courses: Multi-Robot systems, Computer Image Understanding & Pattern Analysis.

Research Focus: Navigation & Control of Multi-robot systems, Swarm Consensus, Multi-view Geometry.

Advisor: Prof. Spring Berman, spring.berman@asu.edu

M.S., Mechanical Engineering (GPA:3.43/4.0)

Arizona State University, Tempe, AZ, USA.

Aug'12 - May'15

Relevant Courses: Feedback Systems; Linear Systems; Linear Algebra; Advanced System Modeling

Research Focus: Model-based control design for non-aggressive flight in a quadrotor UAV.

B.E., Mechanical Engineering (GPA:~ 3.77/4.0)

University of Mumbai, India

July'06 - May'10

Research Focus: Design & implementation of a prototype Assembly Line.

Patents

1. **Aniket Shirsat** and Spring Berman. Systems and methods for decentralized multi-target tracking with multiple robots using a phd filter, May 2024. Filed Aug. 18, 2022
2. **Aniket Shirsat**, Shatadal Mishra, Wenlong Zhang, and Spring Berman. Systems and methods for probabilistic consensus on feature distribution for multi-robot systems with markovian exploration dynamics, Pending. Filed Sept. 11, 2023

Relevant Work Experience

Senior Robotics Engineer

BGarage, San Jose, CA

Aug'23- Present

- Improved fleet management efficiency by 20-30% by code optimization with *Python3*, *networkx* and *Google OR-Tools* framework.
- Implement optimal multi-agent path planning strategies that minimize travel costs with *networkx* and generate collision-free paths.
- Developed simulation frameworks for testing drone control strategies in Software in the Loop with *PX4* and *ROS2* middleware.
- Developed & implemented a novel glass window detection algorithm with *LIDAR* sensor for *obstacle avoidance*.
- Implemented weighted costmap based *Octomap* generation for path planning in unknown environments.
- Lead the recruitment and training of interns, strategically aligning program goals with key robotics and system initiatives.

Postdoctoral Researcher

Arizona State University, Tempe, AZ

Feb'23- Aug'23

- Developed & deployed communication strategy enabling co-operative behavior strategies on mobile sensor networks using *ZeroMQ*.
- Formulated multi-robot consensus algorithm to merge multi-view point clouds from monocular cameras & *VO*.
- Formulated multi-robot image feature matching using consensus strategies.

Application Engineer

Uhnder Inc., San Jose, CA, USA.

Jun'22 - Feb'23

- Developing software applications in *ROS 2* for next-generation automotive radar to facilitate the adoption of the product and enable sensor debugging through *rosbag's*, *rosllog's* data files.
- Data collection & analysis of several radar KPI's to test radar performance for adaptive cruise control, cross-traffic alert applications.
- Automated testing & analysis of radar interference characterization to improve *DCM* radar robustness, using *NumPy*, *Matplotlib* in *Python 3*.

Flight Controls Intern

Intel GmBH, Munich, DE

May'19 - Aug'19

- Implemented *Software-In-Loop (SIL)* algorithm for testing performance of *semi-direct visual odometry (SVO)* on a simulated multirotor in *Gazebo*.
- Performed flight analysis of longitudinal controls of proprietary aerial platform in *MATLAB*.
- Tested & integrated *visual odometry* algorithm using *Intel Realsense T265* for egomotion estimation.

Relevant Research & Academic Projects

Distributed Point Cloud Fusion with Intel Realsense D435i (Work In Progress)

- Image feature extraction (*ORB* features) from image sequence for estimating *pose* using *C++ STL, OpenCV, ROS 2*.
- Implementing a *GM-PHD* Filter to detect and track regions of interest using semantic map information obtained by lidar and camera integration.

Decentralized Multi-Target tracking with Quadrotor Swarm

Jan'20 - May'20

- Formulated & simulated a Markov chain based distributed multi quadrotor exploration strategy for tracking multiple static targets in *MATLAB*.
- Implemented *Gaussian Mixture Probability Hypothesis Density (GM-PHD)* filter framework for estimating target locations in *MATLAB* and in *C++* with *ROS*.

- Designed and simulated an Image-Based Visual Servo (IBVS) scheme with color detection for quadrotor waypoint navigation using *ROS* and *Gazebo* in *C++*.
- Implemented the *IBVS* controller in *ROS* and *Python* on a Parrot Bebop 2 quadrotor using *ArUco* markers.

Research Publications

1. **Aniket Shirsat**, Shatadal Mishra, Wenlong Zhang, and Spring Berman. Probabilistic Consensus on Feature Distribution for Multi-Robot Systems with Markovian Exploration Dynamics. *IEEE Robotics and Automation Letters*, 7(3):6407–6414, 2022. doi:10.1109/LRA.2022.3171905(**Patent Pending**)
2. **Aniket Shirsat** and Spring Berman. Decentralized Multi-target Tracking with Multiple Quadrotors using a PHD Filter. AIAA Scitech, 2021. doi:10.2514/6.2021-1583 (**US Patent App. 17/820,823 2023**)
3. Karthik Elamvazhuthi, Zahi Kakish, **Aniket Shirsat**, and Spring Berman. Controllability and Stabilization for Herding a Robotic Swarm Using a Leader: A Mean-Field Approach. *IEEE Transactions on Robotics*, 37(2):418–432, 2021. doi:10.1109/TRO.2020.3031237
4. **Aniket Shirsat**, Karthik Elamvazhuthi, and Spring Berman. Multi-robot Target Search using Probabilistic Consensus on Discrete Markov Chains. In *2020 IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR)*, pages 108–115, 2020. doi:10.1109/SSRR50563.2020.9292589
5. **Aniket Shirsat**. Modeling and Control of a Quadrotor UAV. doi:10.31219/osf.io/5dwsc, 2015

Personal Robotics Projects

Autonomous Drone Path Planning & Exploration using 2D Lidar

Sep'23 - Feb'24

- *Octomap* based *costmap* computation using a custom smoothing function to enable identification of the safe navigation zone for drones.
- *Point Cloud Library (PCL)* based ground plane rejection scheme for generating robot level 2D costmap for path planning.
- *Frontier* based waypoint generation enabling A^* path planning, using k nearest neighbors.
- Formulated algorithmic process for drift minimization in egomotion estimates by using simple *Kalman* filter approach odometry fusion from tracking sensor, range finder, *IMU* data.

Consensus Controller for Markov Random Walkers

Aug'18 - Apr'19

- Developed a decentralized *consensus* based Markov random walk framework tolerant to communication network failures.
- Experimentally validated the convergence guarantees with simulated quadrotors in *ROS* & *Gazebo*.

Herding a swarm of ground vehicles with an aerial observer

May 2018 - July 2018

- Developed a *graph traversal* in *Python3* for navigating the discretized environment.
- Implemented a *detect-move* scheme using *IBVS* control architecture for trajectory generation on *Parrot Bebop 2* drone using *ArUco* markers in *Python* and *ROS*.
- Developed a *Region of Interest (ROI)* based ground robot detection and counting scheme using *ArUco* markers and *OpenCV* in *Python*.

Formation Control for a Heterogeneous Group of Robots

Aug'16 - Dec'16

- Developed a *Leader-Follower* architecture for a team of ground robots (followers) and aerial robot (*leader*) to co-operatively execute a path tracking objective in *MATLAB*.
- Generated a trajectory tracking controller for the *leader* robot using *PID* architecture.
- Implemented a *leader-follower* consensus protocol in *Webots* simulator using built in interfaces in *Simulink* for communication and execution.

- Developed, analyzed, simulated, and implemented complex *nonlinear mathematical models* for quadrotor UAV dynamics in *MATLAB* and *Simulink*.
- Model linearization for different flight conditions to aid in analysis and model-based control design.
- Conducted control-relevant trade-offs for understanding and optimizing closed-loop performance and control system design.

Design of 3-DOF Robotic Manipulator Using LEGO MindStorms

Aug 2013 - Dec 2013

- Nonlinear multi-input multi-output (*MIMO*) mathematical model generated using Denavit-Hartenberg parameters and forward and inverse kinematics using *MAPLE*.
- Performed dynamic analysis and optimized space utilization using force and velocity ellipsoids to identify and avoid singular configurations in simulation with *MATLAB*.
- Designed & implemented 3 inner loop PID controller & outer-loop based trajectory planning using way-point tracking guidance algorithm
- Conceptualized, simulated and implemented *trajectory planning* and *waypoint tracking* using *LEGO Mindstorms NXT*.

Low Level Control design for Quadrotor with Arduino Mega

Jan 2013 - Apr 2013

- Formulated and implemented discrete linear model for quad-rotor hover using *MAPLE* and *MATLAB* on *Arduino Mega 2560* micro-controller.
- *Adafruit IMU* measurements acquisition over *I2C* protocol on the *Arduino Mega 2560* and using Arduino IO Package for Matlab rapid prototyping tool.
- *Complimentary filter* based Euler angle (*roll, pitch*) computation for accelerometer and gyroscope provided angles for maintaining hover.