

Rishab Balasubramanian

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About Me

I'm a first year MS student at Oregon State University, advised by Prasad Tadepalli. Currently I'm working on Combinatorial Bandit Problems, and previously I've worked on computer vision and machine learning with a specific focus on 3D vision, reconstruction, and detection. I previously worked on control, robotics, vision-based path-planning, SLAM, and Shape-from-Motion

[Personal Website](#) [Github](#) [Google Scholar](#)

Education

2021 - Present	MS in Artificial Intelligence <i>Oregon State University, USA,</i>	CGPA- 3.89/4.0
2016 - 2020	B.Tech - Instrumentation And Control Engineering <i>National Institute of Technology, Tiruchirapalli (NIT Trichy),</i> First Class, Department Rank : 20/91	CGPA- 8.42/10
2016	Higher Secondary Examination (CBSE) <i>Maharishi Vidya Mandir, Chennai,</i>	94%
2014	Secondary Examination (CBSE) <i>Padma Seshadri Bala Bhavan, Chennai,</i>	10/10.

Technical Strengths

Programming Languages: *Embedded C, C, C++, Python, MATLAB, HTML, Assembly Language, SQL, L^AT_EX, Scratch, Shell Programming.*

Software Packages Used: *ROS, Gazebo, OpenCV, Keras, PyTorch, Arduino, Tina, Pygame, MATLAB & Simulink, Ardupilot, Px4, SITL.*

Research Work/Internships

June 2022 - Present	<u>Attacks on Combinatorial Multi Arm Bandits</u> <i>Research Dr. Huazheng Wang.</i> <ul style="list-style-type: none">Working on theoretical methods for attacking combinatorial banditsExtension of present attacks to Online Influence Maximization
April 2022 - June 2022	<u>Contrastive Learning for Object Detection and OOD Detection</u> <i>Course project with Prof. Stefan Lee.</i> <ul style="list-style-type: none">Used ranking to incorporate human knowledge into contrastive learning frameworkVerified on Object Classification, detection, and OOD detectionAnalyzed shortcomings of our approach and described possible improvements
October 2021 - March 2022	<u>3D Object Mesh Reconstruction from Images</u> <i>PhD Research at Oregon State University with Prof. Prasad Tadepalli.</i> <ul style="list-style-type: none">Working on algorithms to generate mesh representation of objects from image inputs.Implementing topologically-aware networks that can remove faces from reconstructed meshes to modify topology.Incorporating multi-view reconstruction for non-symmetric objects.

- January 2021 - **Computer Vision Data Scientist**
 April 2021 *Research Engineer at **EndovisionAI**.*
- Working on developing an API for 3D reconstruction of the human anatomy using endoscope images.
 - Developed a model for unsupervised learning of depth from RGB endoscopy images using a U-Net based architecture.
 - Used Phong reflection model to generate Lambertian images, and cleaned them using inpainting techniques.
 - Used Shape-from-Shading methods to create 3D point clouds from RGB images.
- June 2020 - **Risk Averse Submodular Optimization for the Multi-Objective Travelling Salesman Problem**
 November 2020 *Research project with **Prof. P.B.Sujit**, IISER Bhopal, and **Prof. Pratap Tokekar**, University of Maryland, Accepted to International Conference on Robotics and Automation (ICRA) 2021.*
- Objective: To develop an approximation algorithm for the multi-objective Travelling Salesman Problem to determine optimal paths given the risk level.
 - Developed a risk aware greedy algorithm to maximize the Conditional Value at Risk (CVaR) using a submodular function over a matroidal constrained system.
 - Proved the algorithm has polynomial runtime and approximation factor is proportional to the optimal solution along with an additive term.
- June 2020 - **Autonomous Mapping And Safe Footfall Planning For Hexapods**
 November 2020 *Research project with **Prof. Guillaume Sartoretti**, MARMOT Lab, National University of Singapore.*
- Objective: To develop algorithms to facilitate legged locomotion on uneven terrain.
 - Used RTABMap to generate a global map with teleoperated controls
 - Developed an elevation map from input images, by fusing localization data with an octomap.
 - Computed gradients and safe foot positions by applying a sobel filter to the input pointcloud data.
 - Working on closed loop footstep planning using a Central Pattern Generator.
- June 2020 - **Domain Decomposition Using Reinforcement Learning for Multi-Agent Search**
 November 2020 *Research project with **Prof. Guillaume Sartoretti**, MARMOT Lab, National University of Singapore.*
- Objective: To develop an algorithm to decompose the environment into small modules to simplify multi-agent search given information estimation and robot positions.
 - Used Asynchronous Actor Critic (A3C) to learn the optimal generator placements, and create a Voronoi diagram using these to decompose the map.
 - Analyzing the effect of communication restrictions and uncertainty of sensors on the efficiency of the search.
 - Working on integrating the decomposition with search algorithms to verify the performance.
- May 2019 - May 2020 **A Cooperative Framework for Autonomous Landings of Quadrotors using Vision on a Moving UGV**
- Summer Research Internship under **Prof. P.B.Sujit**, IIIT-Delhi, Accepted to American Institute of Aeronautics and Astronautics SciTech 2021.*
- Objective: To develop a control algorithm for guaranteed UAV landing on a moving ground target using only vision from onboard camera
 - Used State Dependent Ricatti Equation (SDRE) for the problem
 - Applied homographic transformations on the visual data from camera feed to detect and determine the target's position
 - Used a Kalman Filter to estimate the target's position and velocity
 - Proved robustness and stability of proposed controller
 - Developed strategies for multi-agent coordinated landing for high-speed targets.
- February 2020 - **Formation Control And Collision Avoidance For Multi-Agent Systems**
 April 2020 *Undergraduate Research Thesis under **Prof. Umapathy**, Department of Instrumentation And Control Engineering, NIT-Trichy.*
- Objective: To develop a framework for multi-agent formation control without collisions.
 - Developed CAD files for omni-directional robots, and packages to spawn multiple robots.
 - Used Optimal Reciprocal Collision Avoidance (ORCA) for implementing collision avoidance and PID control for waypoint following.
 - Compared the results with Potential field and histogram based collision avoidance.

- November 2018 - January 2019 **Efficient Geometric Algorithm for the Multi-Player Pursuit Evasion Game**
Winter Research Internship under Prof.P.B.Sujit, Department of Electronics And Communication Engineering,IIIT-Delhi.
- Objective: To develop a novel algorithm for the guaranteed capture of a single evader by multiple pursuers with equal or lesser speed in a bounded environment with circular or cylindrical obstacles.
 - Investigated Voronoi Tessellation-based strategy for the pursuers and their proof for definitive capture.
 - Developed a unique algorithm based on a fractional relationship between the attributes of the polygon formed by all players in the game, specifically its area, perimeter and centroid.
 - Applied Virtual Potential Fields for the motion of the evader and for obstacle avoidance.
 - Simulated the algorithms using Pygame.
- May 2018 - July 2018 **Real-Time American Sign Language To Text Conversion Using Convolutional Neural Networks**
Summer Research Internship under Dr.Ramasubba Reddy, Department of Applied Mechanics, Indian Institute of Technology - Madras.
- Objective: To develop a system to aid speech or hearing impaired people to communicate with others by translating American Sign language into text and vice versa in real-time
 - Used Haar-Cascade Face Detection Algorithm to detect the face and extract the skin color from four distinct points on it.
 - Used the detected skin color as a mask to localize the position of hands in the incoming video feed.
 - Applied Background Subtraction, Thresholding and Morphological transformations for noise removal.
 - Used a combination of Google Inception and YOLO architecture in Keras, with lesser convolutional layers and more pooling and normalization layers.
 - Achieved a validation accuracy of 84%.

Projects

- July 2018 - Present **Ballbot.**
- Objective: To develop a five degree of freedom, stable ball-balancing robot.
 - Worked on developing a functional simulation in Gazebo-ROS using cascaded PID controller, and developed go-to-goal algorithm for the robot
 - Implemented minimal balancing on hardware using DC motors
- December 2017 - February 2018 **Snakebot.**
- Objective: To develop a snake-like robot that can move through different terrains for the purpose of surveillance
 - Designed the snakebot using six servo motors which were independently actuated using Arduino Uno.
 - Developed the robot to traverse different terrains, using three different gaits - caterpillar, rotatory and sidewinding.
- August 2017 - September 2017 **Two Degree of Freedom Planar Robotic Arm.**
- Objective: To develop a simple two-link arm mechanism to write any alphabet given as input.
 - Used two servos to actuate the motion, and Arduino Uno micro-controller for processing.
 - The input letter from the user is split into several points (co-ordinates) through which the end-effector of the arm has to pass
 - Applied inverse kinematics to determine the angles of rotation for each servo motor, when a co-ordinate in the plane was given

Achievements and Extra-Curricular Activities

- Was among the top 1% of students graduating from high school in 2016
- Member of the Workshops team at **Sensors'17, '18**, which conducts two day workshop for teaching young students
- Lecturer in **Genesis'17, '18, '19** - four day annual workshops for tutoring first years on the basics of micro-controllers, robotics, electronics and mechanics
- Member of **Robotics And Machine Intelligence (RMI)**, the official robotic research club of NIT-Trichy.
- Selected twice for regional **AMTI (Association of Maths Teachers of India)** examination
- Participant in the **National Service Schemes (NSS)**

Relevant Courses

- Machine Learning (Oregon State University)
- Algorithms (Oregon State University)
- Causal Inference (Oregon State University)
- Machine Learning by Prof.Andrew Ng (Coursera) - 94% : Certificate
- Control Of Mobile Robots (Coursera) - 94.2% : Certificate
- Deep Learning Specialization by Prof.Andrew Ng (Coursera)
- Artificial Intelligence - MIT OCW
- Probability And Statistics - Edx
- Data Structures And Algorithms - MIT OCW