Akshay Raman

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Education

Carnegie Mellon University Expected graduation date: May 2024
M.S. Research in Mechanical Engineering Robotics ***GPA: 3.9/4.0***
Relevant Courses: Machine Learning and AI (24-787), Planning For Robots (16-782), Optimal Control and RL (16-785), Computer Vision (16-720), Estimation and Detection (18-752)

University of Illinois at Urbana Champaign Graduated: Dec. 2019
B.S. in Aerospace Engineering with Minor in Computer Engineering ***GPA: 3.3/4.0***
Relevant Courses: UAV Navigation Control (AE 483), Introduction to Robotics (ECE 470), Digital Systems Lab (ECE 385)

Skills

Languages:

Python, C++, MATLAB, C, CMake, Bash, C#, Java, JavaScript, HTML, CSS

Technologies & Tools:

Git, GitLab, Linux, Docker, OpenCV, Pytorch, NX-10, SolidWorks, Latex, Optitrack, Microsoft Office, CI/CD

Experience

Sandia National Laboratories | *Software R&D Intern* May 2023 - Present

Segmentation Based Airplane Contrail Detection *Python, Computer Vision, GitLab, Bash*

- Developed a Python-based pipeline for real-time analysis of GOES (GeoStationary Environmental Satellite) imagery, extracting pixel intensity data from NetCDF4 files to accurately predict contrail formation.
- Engineered a sophisticated filter response system by convolving multiple kernels over satellite images and using k-means clustering, resulting in a segmented NumPy image dictionary. Employed Euclidean distance calculations on the predicting image to map similar features and create an accurate 'wordmap' of clusters.
- Integrated Hough Transform algorithm with a Gradient Detection algorithm to identify and classify thin straight-line clusters in images, effectively distinguishing contrails from other atmospheric phenomena.

C++ HDF5 Satellite Frame Data Converter *C++, CMake, Docker, GitLab, Bash*

- Designed and implemented a comprehensive HDF5 C++ package for WFOV satellite imagery processing, comprising of dedicated classes for data reading, format conversion, and file writing into FRM product.
- Integrated Sandia's in-house libraries to double the efficiency of the format conversion process and employed CMake for efficient build and dependency management.
- Optimized data processing by segmenting single WFOV frame images into 60x60 fast frame segments for FRM product, significantly enhancing data processing for real-time tracking applications.
- Created test cases to validate data conversion integrity, adhering to CI/CD principles.

Mechanical and AI Lab Research | *Prof. Amir Farimani - Carnegie Mellon* Sept. 2022 - Present

Autonomous Multi Agent Task Planning Charging Stations *Python, Computer Vision, Motion Planning, SolidWorks*

- Goal: Develop a multi-agent Crazyflie wireless charging ecosystem to enable large-scale aerial operations with limited battery resources. Leverage laser positioning systems, vision-based AI, and advanced planning algorithms to dynamically guide multiple drones to charging stations while ensuring continuous aerial coverage.
- Custom-designed a drone frame with enhanced 2S motors and integrated a crazyflie 'bolt' flight controller for increased payload capacity.
- Utilized a calibrated stationary camera and strategically placed April Tags to precisely determine open charging pads' locations within 5cm. This method effectively facilitated the translation of pad coordinates into the drone's navigation system for precise landing guidance.

Precognition of Low Battery and Position Error Mitigation During Low Battery *Python, AI, Git, Bash*

- Goal: Applied advanced AI methodologies to proactively predict Crazyflie drone battery levels, ensuring timely charging. Simultaneously utilized AI to accurately forecast drift errors associated with decreasing battery levels.
- Compiled and analyzed a comprehensive dataset encompassing 35 key features to predict position drift error as battery levels depleted. For enhanced model training on battery life prediction, additional data was collected to include samples of drone battery depletion until complete discharge.
- Leveraged t-SNE and Random Forest Regressor methods to identify critical features affecting drone position error. Implemented an ANN regression model with an aggregated loss function, reducing drift errors from 12cm to under 1cm for low battery (<25%) scenarios.
- Innovatively developing a transformer-based model to predict drone battery life remaining with the goal of classifying if a drone can reach a charging pad given its current location. Actively refining model accuracy through iterative testing.

Boeing Aerospace
April 2020 - Aug. 2022

Electrical and Navigation Systems Engineer *Python, C#, Bootstrap, Microsoft Office*

- Developed python scripts to test multiple Inertial Measurement Units and GPS Receivers to debug 'Could Not Duplicate' field failures and validate functionality.
- Conducted experiments to evaluate and enhance GPS receiver performance; Integrated C# codebase (software) with vector modulators (hardware) to simulate a jamming environment on raw live sky RF signals.
- Collected GPS receiver 'Carrier to Noise' data, Anti-Jam performance data, and kalman filter performance data over a GPS jamming plane to analyze GCU (Guidance Control Unit) performance.
- Supported flight test cards: monitored navigation data including satellite acquisition, tracking, and Carrier to Noise Ratio data to enhance GCU performance.
- Designed a test method to solve a power dissipation issue with GPS receivers during production testing.

Projects

Multi-Robot Motion Planning for Quadrupeds
Nov. 2023 - Dec. 2023

Course Project - Carnegie Mellon *C++, ROS, CMake, Bash, Linux, Git, Motion Planning*

- Developed and implemented three innovative algorithms for quadruped multi-robot motion planning: Sequential RRT-Connect, Joint State-Space RRT-Connect, and Conflict-Based Search.
- Conducted extensive simulations on the Quad-SDK system using Gazebo, analyzing algorithm effectiveness in generating kino-dynamically feasible and collision-free trajectories in diverse terrains. Integrated changes into an existing ROS-based quadruped framework, contributing to an open-source project with substantial code development.
- Conducted an ablation study revealing that the Conflict-Based Search algorithm outperformed the other two methods, achieving a 17.5% shorter average path length compared to the Sequential RRT-Connect and 10.3% shorter path length compared to the Joint State-Space RRT-Connect Planner while having the fastest planning time.

Live Motion Direction Estimation
April. 2023

Course Project - Carnegie Mellon *Python, Computer Vision, AI*

- Collaborated on the development of a real-time camera 'motion direction estimation system', employing advanced image processing and machine learning. Compiled a diverse dataset of 4000 images across multiple platforms to ensure robust model training and avoid overfitting.
- Utilized innovative feature extraction techniques, including pixel change analysis and disparity map generation using CV2.stereoSGBM_create, to develop a robust training dataset. This dataset was instrumental in categorizing motion into five categories: forward, backward, turning left, turning right, and stationary.
- Evaluated various models for image-based motion direction detection, achieving accuracies of 74.7% with Naive Bayes, 83% with Linear Neural Networks, and 94.6% with CNN, highlighting CNN's effectiveness in this domain.

License Plate Detection Ablation Study
Nov. 2022 - Dec. 2022

Course Project - Carnegie Mellon *Python, Computer Vision, AI*

- Trained a YOLOv5 neural network to accurately identify and extract the bounding box of license plates from vehicle images.
- Implemented image contouring and k-means unsupervised clustering to segment characters in license plate images, facilitating individual character recognition.
- Conducted comparative analysis of machine learning algorithms on the EMNIST dataset for character recognition, achieving best results with FNN (88% accuracy), followed by CNN and KNN.

Forest Fire Burn Size/Direction Prediction Model
Sep. 2021

Course Project - UCLA Extension *Python, AI*

- Integrated a Random Forest feature selection model with a Bayesian regression algorithm (GridSearch tuned), reaching a burn size prediction accuracy of about 60 percent.
- Performed an ablation study on various FNN models to determine the optimal burn direction prediction model.

UAV Control Systems Project
Oct. 2019 - Dec. 2019

Course Project - Univ. of Illinois Urbana-Champaign *C, MATLAB, Control Systems*

- Implemented C code, on Visual Studio, to parse sensor data from a quad-copter to estimate its current state.
- Integrated IMU force measurements and implemented a hard weighting between motion capture data and IMU sensor data to reduce overall sensor noise and bias leading to improved stability of quad-roter.