Tharun V Puthanveettil

240-791-1188 | tvpian@umd.edu | tvpian.github.io | linkedin.com/in/tvpian | github.com/tvpian

Research Intrests : *Pattern Recognition| Human-Robot Interaction| Multi-Modal Networks| Machine Vision| Cognitive Science*

Education

University of Maryland Aug. 2022 – May 2024
Master of Engineering in Robotics (GPA:3.88/4.0) *Maryland, USA*

Vellore Institute of Technology Jul. 2014 – Apr 2018
Bachelor of Technology in Electronics and Communication (GPA:8.59/10.0) *Vellore, India*

Experience

Robotics Intern Feb 2023 – Present
CATT Labs *Maryland, USA*

- Developing Multi-Modal anomaly detectors to report behaviors that deviate from the robot's normal baseline nature.
- Formulating functional and behavioral attacks to model the baseline behavior of the autonomy stack.
- Developing a metric to parameterize the safety of robots and cyber-physical systems.
- Developed LSTM-based sequential model with 91% accuracy for detecting anomalies in temporal Robot system call data.
- Designed targeted Data Flooding attacks on ROS-based autonomy stacks running on Lidar input.
- Modelled a GCN+LSTM+Autoencoder-based spatiotemporal robot anomaly detector with 86% accuracy and F1 score.
- Orchestrated an MITM attack, effectively disabling and intercepting ROS node communication with minimal traceability.
- Established a dynamic web interface for real-time tracking and control of robots on the global map.
- Engineered a robust Flask-based web app for seamless waypoint navigation for an autonomy stack.

Graduate Research Assistant Nov 2022 – Jan 2023
Perception and Robotics Group, UMD *Maryland, USA*

- Worked on *"Human-Robot Interaction using Multi-Modal interaction schemes"* under **Dr.Yiannis Aloimonos**.
- Implemented an Imitation Learning-based policy to teach robot, actions from human demonstration, speech & gestures.

Robotics Research Intern June 2021 – Dec 2021
Indian Institute of Science *Banglore, India*

- Implemented a robotic manipulator based *Precision Weeding Robot* to optimize pesticide usage in indoor farms.
- Developed YoloR-based crack detection algorithm with 94% accuracy for asset inspection challenge at IROS21.
- Developed a UNet-based Monocular Depth Estimation model using the NYU Dataset with 94% accuracy.
- Conceptualized a poster on *"Event-based Dynamic Obstacle Avoidance in Outdoor Environments"* for IROS21.

Project Engineer Jul. 2018 – May 2021
CTO Office, Wipro Digital *Banglore, India*

- Led as the AI Project Lead at the Innovation team, orchestrating the quaterly project lineup.
- Developed a 2D CNN-based tool tracking system using a Leap Motion controller, enhancing hardware assembly efficiency.
- Engineered a mobile-centric insurance solution with a Transfer Learning-based car model detector(96% acc.)with *Tflite*.
- Implemented Generative AI and learning-based algorithms for *My Style*, Wipro's top 2 retail solutions for the year 2020.

Publications

[1] "Pose Fusion: Multi-View Pose Integration for Comprehensive Action Recognition". [`preprint`]
[2] "Striking the Balance: Human Pose Estimation based Optimal Fall Recognition". [`preprint`]
[3] "Application of Mobile Collaborative Robot using Deep Learning in Precision Weed Control of Large Farms". Elsevier 2021 [`manuscript`]
[4] "A Univariate Data Analysis Approach for Rainfall Forecasting". ICCIS 2020 [`manuscript`] [`link`]
[5] "Prediction of Rainfall Using Data Mining Techniques". ICICCT 2018 [`link`]
[6] "Wall climbing robot using soft robotics". ICPCSI 2017 [`link`]

Patents

AGGRIP *(In Progress)* [`link`] Oct 2021 – Present

- Developed an innovative gripper for manipulators to perform precision weeding(plucking and spraying) catering to the detected weed type.
- The unique design ensures minimal contact with non-weeds using an adaptive vision-based control mechanism.

Technical Stack

Programming: Python, C/C++, SQL (MySQL), JavaScript, HTML/CSS, Matlab, Labview, Docker, GIT
AI/ML/Data Science Libraries: Tensorflow, Pytorch, OpenCV, Keras, Scikit-Learn Tableau
AI/ML Algorithms: Reinforcement Learning, Imitation Learning, Graph Analysis, Time Series Analysis, NLP, Generative AI
UI/UX/AR/VR/MR/Simulation: Unity, Three.js, A-frame, AR.js, Vuforia, Gazebo, Rviz
Embedded/IOT/Robotics: ROS, ROS2, MQTT, HTTP, Socket, Softrobotics
Robotic Platforms: Turtlebot 2, Turtlebot 3, Delta, OpenManipulator-X, Husky, M500 Drone

Projects

PoseFusion - Multi-view Action Recognition | *Python, Pytorch, OpenCV* [link] Nov 2023 – Dec 2023
- Developed a pipeline for view-based pose aggregation for action recognition in partial/no occlusion scenarios.
- **GCN+Transformer multi-view aggregation model** achieved an accuracy of 96% for multi-class action recognition.
- Implemented a custom data loader to enable batch training that improved training speed by 4 times.

Human Pose Estimation based Fall Recognition | *Python, Tensorflow* [link] Nov 2023 – Dec 2023
- Developed a **Human Pose Estimation** keypoints based dynamic Fall Detection model.
- The custom **Graph CNN + Transformer**-based Fall Detection model achieved 98% accuracy.

Maze Runner | *C++, ROS2, Gazebo, RViz* [link1] [link2] Nov 2023 – Dec 2023
- Implemented autonomous navigation in a maze, based on dynamic cues received from **Aruco** markers in Gazebo world.
- Implemented a **ROS2 Action-Client** server to utilize the **NAV2** to perform visual feed-based waypoint navigation.

Leonardo - Autonomous Retrieval UGV | *Python, Arduino, OpenCV* [video] Feb 2023 – May 2023
- Constructed a Barron robot equipped with an IMU, Encoder, Rpi camera, and servo-based arm.
- Implemented a **Visual Servoing**-based low-level controller for object 'Pick and Place' using the attached arm.
- Developed a custom localization algorithm through **sensor fusion** of IMU, Enocoder, and Range sensor.

Auto Platoon | *Python, OpenCV, Pytorch* [video] [link] Apr 2023 – May 2023
- Deployed a bio-inspired multi-agent leader-follower system for energy-efficient transportation.
- Created a **YoloV7** and **Kalman Filter**-based agent tracking algorithm incorporating dynamic obstacle avoidance.
- Developed a **Socket** communication-based connected-vehicle communication strategy.
- Implemented a **Visual Servoing**-based motion planner and low-level controller for agent tracking and obstacle avoidance.

ACO-RRT* - Bio-Inspired Path Planning | *Python, Numpy* [link] May 2023 – Jun 2023
- Implemented a Bio-Inspired path planning algorithm for quickly exploring random trees by foraging behavior of ants.
- Improvised the sampling strategy of Traditional **RRT*** with the **Ant Colony Optimization technique**.
- Achieved 1.4 times and 3.54 times faster convergence (than RRT*) in finding the 'first path' and 'ideal path' respectively.

Autonomous Weeding Robot | *Python, Matlab, OpenCV, Tensorflow, Pytorch* [video] June 2021 – Present
- Implemented a robotic manipulator-based precision weeding robot for optimizing pesticide usage in indoor farms.
- Created a **YoloR** object detection model trained on augmented synthetic data for weed localization.
- Implemented an Inverse Kinematics solver based on supervised **Behavioral Cloning** for precise manipulation.

my Style | *Python, OpenCV, Tensorflow, Pytorch, Mysql, Flask* [link1] [link2] [video] Jun 2019 – Sep 2019
- An end-to-end AI-powered shopping app.
- Implemented a human body measurement extraction module based on **2D photogrammetry** & **Body Pose Estimation**
- Developed a **RASA** framework-based **chatbot** that can give personalized dress recommendations based on the user's body measurements, shape, color preference and occasion of interest.
- Modelled a **Content-based recommendation engine** for apparel recommendation.
- Developed a **GAN**-based product customization model for dynamic apparel styling.
- Engineered a supervised **Fit Analyzer** model that evaluates the fit of the chosen apparel in terms of a 'Fit %' metric.

Other Robotics Projects: | [A* Planner] | [Dijkstra Planner] | [Irona] | [Robobutler] Aug 2022 – May 2023
Other AI/ML Projects: | [SLIC] | [Image Outpainting] | [Virtual Try-On] | [RL Cricket] July 2018 – Dec 2023

Achievements

RAMI Cascade Campaign - IEEE/RSJ IROS 2021 [link]
- Secured 3rd place for providing an aerial robotic solution for asset Inspection and Management (I&M).

Late Breaking Results - IEEE/RSJ IROS 2021 [link]
- Poster on " Event-based Dynamic Obstacle Avoidance in Outdoor Environments" accepted amongst the top 25 posters for a presentation.

Winter School Projects - IEEE RAS 2021 [link]
- Finished as one of the Top 2 teams to complete 4/4 tasks with a presentation for a challenge on "SLAM in Deformable Environments"