Tharun V Puthanveettil

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— Robotics Engineer with 4+ years of industry and research experience in Machine Learning, Computer Vision, and Robotics.
— Specializes in Anomaly Detection, Action Understanding, Multi-modal networks, and Human-Robot Interaction.
— Holds a portfolio of 5+ publications with over 50 citations, and a pending patent.

Education

University of Maryland - CP, USA | Master of Engineering in Robotics **(GPA:3.88/4.0)** Aug. 2022 – May 2024
Vellore Institute of Technology, India | BTech. in Electronics and Communication **(GPA:8.59/10.0)** Jul. 2014 – Apr 2018

Experience

Robotics Intern | **Multi-Modal Networks, Robotics, Deep Learning, Security, Action Recognition** Feb 2023 – Present
CATT Labs *Maryland, USA*

- Developing **Multi-Modal Anomaly Detectors** to report behaviors that deviate from the robot's normal baseline nature.
- Creating a one-stop log retrieval service using **Large Language Models** for improving accessibility for non-technical users.
- Formulizing **metrics** to measure, compare, and parameterize the safety of robots and cyber-physical systems.

Anomaly detection using Spatio Temporal RObot Data(ASTROD) | *Python, Pytorch* [link]

- Realized **ASTROD**, a one-shot spatiotemporal multi-modal Anomaly Detection framework.
- Generated abnormal samples with **Data Flooding** & **Man In The Middle** attacks of 40%-60% stealth rate, on ROS1 stack.
- Modelled an 86% accurate **GCN+LSTM+Autoencoder**-based anomaly detector for spatiotemporal robot sensor & net data

Fall Detection using Human Pose Estimation | *Python, Pytorch, OpenCV* [link1][link2]

- Crafted a **Human Pose Estimation** keypoints based Fall Detection model. Identified optimal framerate for fall detection
- Quantified the potency of each **pose key point** and the relevance of **camera angle** in improving the detection accuracy.
- Custom **GCN + Transformer**-based Fall Detection model achieved 95%(avg.) accuracy on both UR & NTU dataset.
- Devised a pipeline for multi-view-based pose aggregation for fall recognition in **partial/no occlusion** scenarios.
- **GCN+Transformer multi-view aggregation model** achieved an accuracy of 96% for multi-class action recognition.
- Implemented a bespoke **Data Loader** to facilitate batch training for graph data, improving training speed by 4 times.

Researcher(AI & Robotics) | **Deep Learning, Human-Robot Interaction, Computer Vision, Robotics** June 2021 – Jan 2023
Indian Institute of Science & Perception and Robotics Group, UMD *Bangalore, India & Maryland, USA*

- Implemented an *Imitation Learning-based policy* to instruct robot actions from human demonstration, speech & gestures.
- Constructed a **UNet**-based Monocular Depth Estimation model on the NYU Dataset with 94% accuracy (Top 4 @ IROS21).

Autonomous Weeding Robot | *Python, Matlab, OpenCV, Tensorflow, Pytorch* [link1]

- Engineered a **robotic manipulator** based plucking robot to reduce pesticide usage in indoor farms by up to 80%.
- Created a **YoloR** object detection model trained on augmented synthetic data for weed localization with 98% accuracy.
- Implemented an Inverse Kinematics solver based on supervised **Behavioral Cloning** for precise manipulation.

Project Engineer | **Deep Learning, HCI, Computer Vision, Recommendation Engine, Pattern Recognition** Jul. 2018 – May 2021
CTO Office, Wipro Digital *Bangalore, India*

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

my Style | *Python, OpenCV, Tensorflow, Pytorch, Mysql, Flask* [link1] [link2] [video]

- An end-to-end AI-powered shopping app to reduce trial room drops and improve scope for apparel customization.
- Implemented a human body measurement extraction module based on **2D photogrammetry** & **Human Pose Estimation**.
- Developed a **RASA** framework-based **chatbot** that can give personalized dress recommendations.
- Modelled a **Content-based recommendation engine** for apparels leading to 45% higher customer retention time.
- Created a **GAN**-based product customization model for dynamic apparel styling achieving 82% higher customer traction.
- Engineered a supervised **Fit Analyzer** model that evaluates the fit of the chosen apparel in terms of a 'Fit %' metric.

Technical Stack

Programming: Python, C/C++, SQL (MySQL), JavaScript, HTML/CSS, Matlab, Labview, Docker
AI/ML/CV/Data Science Libraries: Tensorflow, Pytorch, OpenCV, Keras, Scikit-Learn, Tableau, Langchain
AI/ML Algorithms: Reinforcement Learning, Imitation Learning, Self-Supervised Learning, TSA, Generative AI, Federated Learning
Embedded/IOT/Robotics/Simulation: ROS, ROS2, MQTT, HTTP, Socket, Soft robotics, Unity, Flask, Vuforia, Gazebo, Rviz
Robotic Platforms: Turtlebot 2, Turtlebot 3, Delta, OpenManipulator-X, Husky, M500 Drone
S/W Development: Agile Development, Jira, GIT, Gitlab, Bitbucket, Pair Programming, Test-Driven Development, UML, SCM

Publications/Patents/Posters

[1] "ASTROD: Multimodal Anomaly Detection for Autonomous CPS Empowering Real-World Evaluation". IROS 2024. [Manuscript]
[2] "A Data-Driven Approach for Securing Autonomous Cyber-Physical Systems". CDC 2024.[Manuscript]
[3] "Application of Mobile Collaborative Robot using Deep Learning in Precision Weed Control". Elsevier 2021. [Manuscript]
[4] "Event-based Dynamic Obstacle Avoidance in Outdoor Environments". IROS 2021[Poster]
[5] "A Univariate Data Analysis Approach for Rainfall Forecasting". ICCIS 2020. [Manuscript] [Link]
[6] "Prediction of Rainfall Using Data Mining Techniques". ICICCT 2018. [Link]
[7] "Wall climbing robot using soft robotics". ICPCSI 2017. [Link]
[8] "AGGRIP" - Manipulator gripper for precision weeding tailored to identified weed types.(*in process*) [Patent - Link]

Volunteering Experience

Robotics Mentor | **Robotics, Software Development, Computer Vision** Sep. 2023 – Present
The Irrational Engineers *Maryland, USA*

- Mentoring diverse high school students in building competitive robots for **First Robotics** competition, focusing on software development for **Controls** and **Computer Vision** algorithms.

Additional Projects

AI | Computer Vision | Machine Learning

Image Segmentation using SLIC | *Python, OpenCV, Tensorflow, HTML, CSS, Angular.js, Unity* [link] Nov 2023 - Dec 2023

- Utilized **Simple Linear Iterative Clustering algorithm** to generate superpixels for creating a custom segmentation dataset.
- Implemented a CNN-based Deep feature extractor for superpixel-based image segmentation.
- Achieved 20% improved segmentation performance over **KNN**-based image segmentation.

Image Outpainting | *Python, OpenCV, Tensorflow, HTML, CSS, Angular.js, Unity* [link] Nov 2023 - Dec 2023

- Implemented an Image Outpainting algorithm using **Implicit Neural Representation**.
- Achieved 3 points less PSNR using **Positional Encoding** add-on compared to the Feed-Forward network-only model.

AI Cricket Coach | *Python, OpenCV, Tensorflow, HTML, CSS, Angular.js, Unity* [link] Jul 2020 – Present

- AI solution classifying bowl types from video feeds, offering coaching assistance in **WebVR** environment.
- Created a **Body Pose Estimation** plugin for batting pose feedback.
- Utilized a custom **3D CNN** bowl classification model with 92% accuracy trained on synthetic VR data.

Virtual Try-On | *Python, OpenCV, Tensorflow, Pytorch, Flask*[link] Jan 2021 – Mar 2021

- An AI solution to bring down trial room drops and to provide customers with a style quotient evaluator.
- Implemented a **GAN**-based generative model for creating customizable textures rendered onto **3D AR** apparel models.
- Developed an **Aesthetic Quality Assessment Model (AQAM)** and an **Explainable AI** plugin to provide professional recommendations and justify AQAM outputs.

Robotics

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 an algorithm through **sensor fusion** of IMU, Enocoder, & Range sensor for rapid localization in confined zones.

Auto Platoon | *Python, OpenCV, Pytorch* [video] [link] Apr 2023 – May 2023

- Deployed a bio-inspired multi-agent leader-follower system for modular & 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.

GCN - Graph Convolution Network, GAN - Generative Adversarial Network, TSA - Time Series Analysis, SCM - Software Configuration Management
UGV - Unmanned Ground Vehicle