THARUN V PUTHANVEETTIL

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Research Interest : *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 | **Multi-Modal Networks, Robotics, Deep Learning, Security, Representation Learning**   Feb 2023 – Present
CATT Labs   *Maryland, USA*

- Formulating functional and behavioral attacks to model the baseline behavior of the ROS1 autonomy stack.
- Developing Multi-Modal anomaly detectors for robots, enabling the ability to identify injections causing abnormalities.
- Creating a standardized metric to measure and parameterize the safety of robots and cyber-physical systems.
- Designed targetted Data Flooding & Man In The Middle attacks with 40%-60% stealth rate, on ROS1 navigation stack.
- Achieved 91% accuracy with LSTM-based sequential models in detecting anomalies from temporal robot system call data.
- Modelled an 86% accurate GCN+LSTM+Autoencoder-based anomaly detector for spatiotemporal robot sensor data.
- Developed a responsive web interface for live robot tracking and control, facilitating device-agnostic robot operation.
- Built a Flask-powered web app for robot waypoint navigation, enabling twofold acceleration in the data collection pipeline.

Graduate Research Assistant | **Deep Learning, Robotics, Human-Robot Interaction**   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 | **Deep Learning, Human-Robot Interaction, Computer Vision**   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 | **Deep Learning, HCI, Computer Vision, Recommendation Engine, Pattern Recognition**   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 Leap Motion controller, enhancing hardware assembly pipelines.
- 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.
- Designed a Robotics solution for the 'Smart Airport' product improving customer traction by 20%.

PUBLICATIONS

[1] "Pose Fusion: Multi-View Pose Integration for Comprehensive Action Recognition". `[pre-published print]`

[2] "Striking the Balance: Human Pose Estimation based Optimal Fall Recognition". `[pre-published print]`

[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

- Engineered a manipulator gripper for precision weeding (plucking and spraying) tailored to identified weed types.
- 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, TSA, NLP, Gen AI, Federated Learning
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"