Sri Aditya Deevi

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Education

California Institute of Technology *(Sept '22 - Jul '23)*
M.S. Electrical Engineering CGPA: **4.3/4.3**
Master's Research Title: RGB-X Object Detection via Scene-Specific Fusion Modules [Link]

Indian Institute of Space Science and Technology (IIST) *(Aug '18 - Jun '22)*
B.Tech Electronics & Communication Engineering CGPA: **9.60/10**, Batch Rank: **1st**/140
Undergraduate Thesis Title: Autonomous Robotic Grasping [Link]

Publications

Sri Aditya Deevi, Connor Lee, Lu Gan, Sushruth Nagesh, Gaurav Pandey, and Soon-Jo Chung. "*RGB-X Object Detection via Scene-Specific Fusion Modules.*" In Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision (**WACV**), Waikoloa, Hawaii, United States, pp. 7366-7375. 2024. [Link]

- Addressed the challenge of enabling autonomous vehicles to visually understand their surroundings in all weather conditions by developing effective multimodal deep sensor fusion methods for object detection, guided by Dr. Lu Gan and Prof. Soon-Jo Chung of Caltech.
- Developed an efficient RGB-X fusion network that fuses pretrained single-modal models using lightweight, scene-specific convolutional attention-based fusion modules. It outperformed state-of-the-art methods on benchmark RGB-thermal and RGB-gated datasets, achieving mean Average Precision (IoU=0.5) scores >81%.
- The proposed approach yielded comparable results with 75% less coregistered training data, reducing fusion training time and dependence on hard-to-obtain multimodal, co-registered datasets.

Sri Aditya Deevi, and Deepak Mishra. "*Expeditious Object Pose Estimation for Autonomous Robotic Grasping.*" In International Conference on Computer Vision and Image Processing, pp. 15-30. **Springer Nature** Switzerland, 2022. [Link]

- Spearheaded the research for improving object Pose Estimation techniques using Deep Learning for Autonomous Robotic Grasping in cluttered scenes under the guidance of Prof. Deepak Mishra from IIST.
- Designed a series of neural network-based pose estimation models without post-refinement stages, for estimating the 6D pose of an object, using only a single RGB image. The best-performing model achieved high Average Distance (ADD) metric scores >93% for objects tested in the benchmark *LINEMOD* dataset.
- Implemented an end-to-end object Pose Estimation pipeline using Unity and ROS Noetic. The developed pose estimation models were deployed in a simulated pick-and-place task utilizing a *UR3* robotic arm.

Sri Aditya Deevi, Christina Perinbam Kaniraja, Vani Devi Mani, Deepak Mishra, Shaik Ummar, and Cejoy Satheesh. "*HeartNetEC: a deep representation learning approach for ECG beat classification.*" Springer Biomedical Engineering Letters 11 (2021): 69-84. [Link]

- Developed *HeartNetEC*, a deep representation learning approach for ECG beat classification, incorporating a denoising block and a beat classification block to significantly reduce cardiologists' analysis time and effort.
- Designed deep learning architectures for denoising and beat classification stages, achieving an overall F1 Score of 99.53% on PhysioNet's *MIT-BIH Arrhythmia* Database, outperforming other state-of-the-art methods.
- Validated the robustness of *HeartNetEC* through ablation studies & noise analysis, demonstrating reliability across datasets & noise levels, making it a highly reliable solution for ECG heartbeat classification.

Sri Aditya Deevi, and B. S. Manoj. "*Data Summarization in Internet of Things.*" **Springer Nature** Computer Science 3, no. 4 (2022): 304. [Link]

- Conducted a comprehensive review of more than 90 papers, categorizing data summarization approaches in Internet of Things (IoT) into Low & High-level abstraction methods for integration in large IoT networks.
- Highlighted the benefits of these techniques, including reduced processing time, computation, storage, transmission requirements, energy consumption, and user workload, while identifying open challenges.

Sri Aditya Deevi, Asish Kumar Mishra, Deepak Mishra, Ravi Kumar L, Bharat Kumar G V P, and Murali Krishna Bhagavan G. "*Efficient Self-Supervised Neural Architecture Search.*" (Accepted in 19^{th} International Conference on Ubiquitous Information Management and Communication 2025, Bangkok, Thailand) [Link]

- Goal was to develop memory, compute, and time efficient neural architecture search algorithms to address the high resource demands of traditional handcrafted neural architectures.
- Conducted experiments in both fully supervised and self-supervised settings, utilizing a combined loss function of supervised cross-entropy and self-supervision loss to guide the search for optimal architectures.
- Analyzed performance on *CIFAR-10*, demonstrating that the proposed methodology balances time and accuracy, achieving results with less than 3% test error, close to state-of-the-art benchmarks.

Research Internships

Atmospheric Parameter Forecasting for Optical Channel Characterization *(Aug '23 - Nov '23)*
Guide: Dr. Sabino Piazzolla, **Jet Propulsion Laboratory (JPL)**, **Caltech**, **Pasadena**

- Spearheaded research in the *Optical Communication Systems* group to forecast key atmospheric parameters like temperature, pressure, windspeed, humidity & turbulence, critical for optical channel characterisation.
- Proposed effective neural network architectures resulting in significant improvements in sequence forecasting and nowcasting accuracy, achieving up to 25% reduction in prediction errors.
- The developed methods were evaluated using graphical plots, numerical metrics, and Shapley value explanations. The best performing models are deployed for live forecasting at the JPL weather stations located at *Goldstone* and *Table Mountain Facility (TMF).*

Anomaly Detection in Satellite Telemetry Data *(May '20 - Aug '20)*
Guides: Sharvari Gundawar & Nitish Kumar, Scientists, **U.R. Rao Satellite Centre**, **ISRO**, Bengaluru

- Contributed to the *Integrated System Health Management for Power Systems (ISHM)* project, focusing on Phase-II: Fault Detection, by developing advanced anomaly detection techniques.
- Developed a robust Anomaly Detection system, integrating LSTM-based Nominal Behavior Modelling and Non-parametric Dynamic Error Thresholding blocks, to identify potential anomalies in satellite telemetry.
- Tested the designed anomaly detection pipeline on two datasets of Power Systems parameters in Satellite Telemetry Data, demonstrating its effectiveness and showcasing its applicability to space subsystems.

Work Experience

Scientist/Engineer 'SC' @ Mission Simulation Group *(Apr '24 - Present)*
U.R. Rao Satellite Centre, **ISRO**, Bengaluru

- Work involves tackling diverse AI and robotics research challenges in aerospace systems.
- Engaged in notable technology demonstration projects such as pose estimation & tracking of uncooperative spacecraft using monocular data, point-cloud relative pose estimation of space objects with LIDAR, autonomous navigation for rovers, and vision-based autonomous landing for quadcopters.
- Assisted in setting up a camera-based reference system in the *Rendezvous Simulation Laboratory (RSL)* for tracking dynamic object poses with 0.1 mm positional and 0.1 degree orientation precision.

Scholastic Achievements

- Achieved a perfect 4.3 CGPA while earning a Master of Science in Electrical Engineering from Caltech.
- Won the Innovative Student Projects Award 2022 and inducted as a student member by *Indian National Academy of Engineering (INAE)* for my undergraduate thesis titled "*Autonomous Robotic Grasping*".
- Received Institute Gold Medal of Academic Excellence (Undergraduate) from IIST.
- Secured the highly competitive *Dr. Satish Dhawan Fellowship* from the *Department of Space*, Government of India, earning a fully funded opportunity to pursue a Masters program at the prestigious Caltech.
- Received the *Department of Space (DoS)* Semester Fee Financial Assistance and Book Grant for Academic Excellence for all semesters during undergraduate studies.
- Scored the highest marks in my institution in the *Telangana State Board Intermediate Examination.*
- 5 times winner of annual proficiency prize for best academic performance in school, 2011-2016.

Undergraduate Thesis Project

Autonomous Robotic Grasping *(Jan '22 - May '22)*
Guide: Dr. Deepak Mishra, Indian Institute of Space Science and Technolgy, Thiruvananthapuram [Link]

- Devised solutions for two intelligent robotics tasks, "Grasping Various Objects in Diverse Environments" and "Dynamic Grasping of Moving Objects", using *UR5* and *Panda* robotic arms in simulation scenes.
- In Task I, various Deep Reinforcement Learning techniques were developed. Using an advanced DNN architecture *O-AHRNet* designed for feature extraction, the agent was able to achieve more than 87% success rate for grasping novel objects in random scenes.
- For Task II, Deep Learning techniques were developed that integrated an LSTM model into the dynamic grasping pipeline, achieving an average success rate of over 75% for grasping objects in sinusoidal motion.
- Created a real world robotic setup for pick and place using a *Kinova Jaco Gen2* robotic arm.

Other Key Projects

Monocular Pose Estimation of Noncooperative Spacecraft *(May '24 - Present)*
Work Project | U.R. Rao Satellite Centre, ISRO
Supervisor: Dr. L. Ravi Kumar, Group Director, Mission Simulation Group

- Problem statement is to develop a highly accurate method for estimating pose of a known but noncooperative spacecraft during rendezvous operations, using a single grayscale image.
- Created a synthetic data generation pipeline in Blender for a pose estimation dataset with grayscale images and ground truth poses of an ISRO satellite. Crafted a high-fidelity Unreal Engine scene featuring Earth, Sun, and Satellite with reflective materials, enabling generation of more realistic datasets for future research.
- Developed a correspondence-based method using object detection, landmark regression, and iterative pose refinement using Perspective-n-Point (PnP) algorithm. Achieved an average translation error of 1.5 cm and an average orientation error of 0.2 degrees on the test dataset.
- Working on porting the pose estimation pipeline to a Xilinx Versal VCK 190 board for edge inference. The plan involves interfacing the board with a camera to perform a real-time, end-to-end demonstration of satellite pose estimation using a physical satellite model, with inference executed directly on the VCK 190.

Autonomous Rover Navigation *(Aug '24 - Present)*
Work Project | U.R. Rao Satellite Centre, ISRO
Supervisor: Dr. L. Ravi Kumar, Group Director, Mission Simulation Group

- This project is aimed at developing vision-based navigation algorithms for planetary rovers.
- Integrated the OAK-D camera, an RGB-D sensor, onto a four wheel drive mobile robot and used the RTAB-Map ROS package to perform a mapping exercise with RGB, depth images, and IMU data to map the lab environment.
- Focusing on implementing Vision SLAM techniques for autonomous navigation in an indoor, structured lab setting and exploring image-goal-based navigation. This research has promising applications in planetary rover missions, where a drone captures images of a potential science site, enabling the rover to use those images as targets for autonomous navigation, performing tasks like sample collection and in-situ analysis.

Non-Holonomic Mobile Robots: RRT with Dynamic Replanning and Obstacle Mapping
Academic Project | Courses: Robotics II (Planning and Navigation) & Mobile Robots *(Feb '23 - Jun '23)*
Guide: Dr. Gunter Niemeyer, Caltech, Pasadena [Link-1, Link-2]

- A RRT motion planner for non-holonomic wheeled systems was implemented, utilizing CSC (Curve-Straight Line-Curve) notion of distance, and a post-processing function was incorporated to enhance the smoothness of the produced path.
- The planner efficiently and effectively plans through a map and navigates obstacles in various scenarios, including narrow garages, parallel parking, and narrow streets, achieving a 100% success rate in most cases.
- This algorithm was also tested on a real mobile robot (Raspberry Pi based) equipped with ROS.
- Functionalities such as Global Localization using Particle Filter, Path Tracking with PID, and Dynamic Replanning after mapping new obstacles are incorporated so that the robot can drive like a car autonomously while locally localizing itself.

Self Untangling Robotic Snake Arm with Dynamic Obstacle Avoidance *(Nov '22 - Dec '22)*
Academic Project | Course: Robotics I (Robot Kinematics and Dynamics) [Link]
Guide: Dr. Gunter Niemeyer, Caltech, Pasadena

- Implemented effective methods for a robotic snake arm to perform tasks like obstacle avoidance, touching a random target with correct gripper orientation, and untangling itself if entangled in a knot.
- For this problem, we considered a simulated environment in ROS2 with vertically falling obstacles.

Scene Text Recognition *(Mar '21 - May '21)*
Academic Project | Course: Machine Learning for Signal Processing [Link]
Guide: Dr. Deepak Mishra, Indian Institute of Space Science and Technolgy, Thiruvananthapuram

- Problem statement was recognizing text in various scenes, addressing both regular and irregular text recognition challenges using deep learning models.
- Experimented with different end-to-end methods using convolutional encoders and recurrent decoders, exploring various architectures and the impact of a Spatial Transformer Network (STN) in preprocessing.
- Focused on exploring interesting aspects of the models using 7% of the *Synth90k* dataset, aiming to guide future research rather than surpass state-of-the-art benchmarks. Identified the *STN+ResNet+BiLSTM* model as the best performer, with STN improving word accuracy beyond 70% for some word lengths.

Technical Skills

Programming: Python, MATLAB, C++, C, SPICE, Verilog
Software Packages: PyTorch, OpenCV, Kornia, Stable Baselines, Captum
Frameworks: ROS, LaTeX, Git, Blender, Unity3D, Docker, Wireshark

Relevant Coursework

Graduate:- Large Language and Vision Models • Mobile Robots • Statistical Inference • Robotics I (Robot Kinematics and Dynamics) • Robotics II (Planning and Navigation) • Machine Learning and Data Mining • Stochastic and Adaptive Signal Processing

Undergraduate:- Machine Learning for Signal Processing • Navigation Systems and Sensors • Deep Learning for Computational Data Science • Advanced Sensors and Interface Electronics • Satellite and Optical Communication • Information Theory and Coding

Conferences, Workshops and Certifications

- Won the AI/ML challenge organized at U.R. Rao Satellite Centre, competing with over 250 scientists, and participated in a 3-day technical workshop on cutting-edge AI applications (2024).
- Nominated by U.R. Rao Satellite Centre to attend the *National Conference on Computer Vision, Pattern Recognition, Image Processing, and Graphics (NCVPRIPG)* as a delegate (2024).
- Participated in the *AGI Leap Summit* organized by SuperAGI and presented my paper, "RGB-X Object Detection via Scene-Specific Fusion Modules," in the AI Applications and Survey track (2024).
- Received certification on "*Integrated Design of Space Vehicles*" by successfully completing the course offered by Dr. B. N. Suresh, Chancellor, IIST (2022).
- Completed an *XAI (Explainable AI) Bootcamp* hosted by IIT Madras (2021).
- Participated in *International Summit on Data Science and AI* organized by IIT Madras (2020).
- Earned certification in robust Embedded Systems Design at EdGate Technologies Pvt. Ltd, Bengaluru (2020).

Co-Curricular Activities

- Presented interactive demos and explained our research group's work to school students on *National Space Day* at the Mission Simulation Group stall (2024).
- Worked as an undergraduate teaching assistant for the *AVD 624 : Computer Vision* course at IIST (2021).
- Participated in Annual Cultural Fest *Dhanak* and Annual Technical Fest *Conscientia* at IIST (2019).
- Secured first Place in Annual Inter house Sports Meet for Table Tennis at IIST (2019).
- Awarded Gold Medal in the *17th National Science Olympiad (NSO)* organized by the *Science Olympiad Foundation (SOF)* for achieving the best school-level performance (2015).