

Anindya Harchowdhury

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Research Interest

Indoor and Outdoor Autonomous Navigation, Visual Place Recognition, RL in autonomous systems, Graphical Models.

Employment

Novus Hi-Tech

Senior Technical Lead

April 2024 – present

Projects:

- AI stack development for Humanoid and mobile Manipulation: **Software team Lead** (May-26 – to present) .
- Reflector-based Localization and Mapping (RBLAM), **sole inventor** of the algorithm, and team lead for the production-grade development, deployed to at least two customer sites by now. (Oct-25 – April-26).
- Lead the Design and development of the software architecture of the entire robotics stack. A generalist CI/CD enabled software stack, easy to add-on and integrate application-specific features across the product line. (from September 2025– Present)
- **ANS (Team Lead):** Led to the development of the first Off-road Autonomous Navigation System for a Tracked Platform (with **DRDO**) in India. (**completed by August 2025**)
 - Key challenges: Uneven off-road terrains through jungles, rocky terrains, slope climbing, avoiding trenches/negative obstacles. Weather conditions: heavy rain and low visibility due to fog, moderate dust storm in desert setting.
 - Key Technologies: Multi-sensor fusion (LIDAR, EO/IR Camera, IMU), Deep learning based object detection, 2.5D Elevation Mapping, Model predictive motion controller, ROS2-based software framework.

Technical Lead: Mobile Robots

March 2021 – March 2024

- Team Lead for the Project: Development of an Autonomous Navigation System for a tracked platform (with **DRDO**)
- Fail-safe localization for Autonomous Navigation: We address the localization problems faced by our autonomous robots in large indoor facilities such as warehouses, manufacturing sites, hospitals, and shopping malls. I am leading this large project to develop a fault-tolerant robot localization provider for our natural navigation system. It encompasses multi-modal odometry fusion (visual, LIDAR, IMU), Map quality estimation (RGB-D and LIDAR), Localizability Estimation, and optimizing the localization quality by judiciously combining the information obtained from different sensing modalities. Different kinds of scene dynamism and operating surface conditions pose unique challenges to this problem. Apart from preparing the architecture of the whole project, I did the R&D of Localizability Estimation module, which is one of a kind and found to be very effective for a GPS-denied natural navigation system.
- Visual-Inertial Odometry: In large indoor facilities with dynamic environments, proprioceptive sensing (e.g. IMU) has the potential to aid in improving odometry while performing autonomous navigation. My team and I developed a 15 DoF state estimation model to estimate stable VIO by compensating the dominant biases. I am currently researching a DNN-based stable VIO estimation technique to alleviate sudden surges in VIO covariance estimate, which is a critical problem with state-of-the-art classical VIO techniques. The idea is to learn IMU features and fuse them with Visual features with hardware time synchronization to obtain highly precise and stable VIO. This will allow us to switch from feature-based natural navigation to VIO whenever there are insufficient visual features in the environment.
- Before that, I led the mapping team toward developing a Feature-based SLAM product for our robots operating in ultra-large warehouses and manufacturing sites. Solved a critical problem of online map switching for robots with resource-constrained host computers. Our map-switching algorithm helps robots by not asking to load a very large map at once but by dividing it into many small chunks and loading them depending on the navigation requirements.
- Robust loop closure detection in a dynamic environment: This was the first project I worked on in NHRS. An AdaBoost classifier-based loop closure detection model, robust to environmental changes, is developed for a range-based SLAM system. Further, it has been integrated with a feature-based SLAM implementation.

Research Associate

Indian Institute of Technology Bombay

Jan 2021 – March 2021

Internship

Autonomous Robotics and AI Intern (**Otonomy IO**)

June 2020 – Sep 2020

Role: Led a team of cohorts working on Object detection using instance segmentation with LIDAR point cloud and camera images; scene understanding and activity recognition; AWS cloud integration.

Junior Research Assistant

May 2014 – Dec 2014

Passive imaging is a technique being investigated recently in security and surveillance applications. Being a promising solution, millimeter wave radiation of objects is received by radiometer to reconstruct the image of it without using any active illumination on the object. Compressed sensing has been investigated in this application to reduce image acquisition time, making the system highly cost-effective. 2D and 3D-FFT have been used in this application for near-field imaging.

Junior Research Assistant (sponsor: ISRO)

Jan 2014 – Apr 2014

Planar array synthesis is a compute intensive task partly due to the inherently large number of optimization variables and partly for the fact that the fitness function computation is time consuming. A fast computational approach based on the 2D Fast Fourier transform (FFT) is applied on the PSO for the planar array pattern computation. Array factor is calculated using 2D FFT and element excitation are found out using PSO by minimizing a fitness function. The proposed synthesis method provides significant improvements in terms of performance, computational speed, flexibility, and ease of implementation.

Junior Research Assistant (sponsor: ISRO)

Sep 2010 – Mar 2013

Satellite-based AIS relates to monitoring vessels on voyages at sea around the world from a chosen orbit. Although vessels moving in sea use AIS to avoid physical collision by communicating with each other, space-based monitoring is from a national security point of view. I developed a novel simulator for the first time, which produces a composite AIS signal to be received at satellite considering near real-time technical challenges (delay, Doppler, oscillator clock variation etc.). This would serve to determine the capacity of a satellite-based AIS system.

Education

IITB-Monash Research Academy

Jan 2015 – Dec 2020

Thesis: Sparse 3D Sensing and Motion Planning using Nodding LIDAR in Dynamic Environments.

From Nov 2016–May 2018, I worked at the Intelligent Robotics Research Center, Electrical and Computer Systems Engineering department, Monash University as a PhD student.

Thesis brief: The thesis concentrates on the problem of object detection, tracking, and motion planning in a dynamic environment. It ensures robust registration in the presence of dynamic objects by learning from sensor data. In this process, (i) I first designed and developed a novel, cost-effective **3D LIDAR** and then improvised its sensing mechanism to provide a faster scan update rate than usual 2D Lidars, suitable for dynamic object tracking. The FoV of this sensor can be reconfigured programmatically. (ii) Then, a first of its kind two-stage estimation process is proposed; **first stage:** real-time **GMM-based machine learning algorithm** to **track** and estimate **shape** of **dynamic object(s)**(coarsely) and **second stage:** using Kalman Filter based framework (for precise estimate) with arbitrary shape and motion primitives from **sparse 3D data**. (iii) As the last contribution, a fast real-time **motion planning algorithm** (*Adaptive BIT**) in the presence of multiple **dynamic objects** in an initially unknown environment is proposed. A physics-based simulation framework has been developed to test the capacity of motion planning with varying obstacle density in an environment.

MS(research) in E&ECE

Indian Institute of Technology, Kharagpur

2011 – 2014

Thesis brief: Designed a "Test Simulator for Satellite-based Automatic Identification System.". A novel generalized space-based observational model is proposed with the advent of an efficient wireless channel access model (SOTDMA) for AIS-equipped ships. The ships communicate with each other by forming an Ad-hoc network during the voyage. Various capacity enhancement techniques of satellite-based AIS are developed. A constellation of satellites is found to be effective. A novel SDMA-based RF beam steering algorithm is proposed to enhance satellite-based reception performance against the state-of-the-art.

B.Tech in Electronics and Communication Engineering

WestBengal University of Technology

2006 – 2010

Thesis brief: A Data acquisition system for liquid level monitoring. Designed the entire hardware chain, starting from a power supply, analog conditioning circuit for the signal received by the sensor, A/D converter circuit, followed by a data communication to microcontroller 8051. Further, a PC-based front end was developed using MATLAB to facilitate duplex communication between the controller and PC for liquid level monitoring.

Patents

- Anindya Harchowdhury and Vikash Kumar Kumawat, "Simulation System for Testing an Autonomous Vehicle and Method Thereof", Indian Patent (filed).

- Anindya Harchowdhury and Vikash Kumar Kumawat, "System and Method for Creating a Realistic Virtual Environment for Autonomous Vehicle Testing", Indian Patent (filed).
- Anindya Harchowdhury and Vansh Pratap Singh and Manish Shiralkar and Anuj Kapuria, "A Robot Positioning Estimation System and a Method Thereof", Indian Patent (filed).
- Anindya Harchowdhury and Vansh Pratap Singh and Subhanshu Sethi and Tejas Ingale and Manish Shiralkar and Anuj Kapuria, "A Mobile Entity Localization System and a Method Thereof", Indian Patent (filed).

Publications

◆ Journal

- Anindya Harchowdhury, Subhanshu Sethi, Manish Shiralkar, Anuj Kapuria, "*Sparse Landmark only Localization Using Probabilistic Data Association*". (under review- Q1 Journal)
- Anindya Harchowdhury, Lindsay Kleeman, Leena Vachhani, "*Perception Aware Motion Planning in Dynamic Environments: A Data-driven Approach*". (submitted- Q2 journal)
- Anindya Harchowdhury, Leena Vachhani, Lindsay Kleeman, "*Joint Shape and State Estimation of Dynamic Objects using Sparse 3D information*". (under review -Q1 journal)
- Anindya Harchowdhury, Lindsay Kleeman, Leena Vachhani, "*High Density 3D Sensing using a Nodding 2D LIDAR and Reconfigurable Mirrors*", Elsevier Mechatronics, June 2023, DOI: 10.1016/j.mechatronics.2023.102968 [[link](#)])
- Anindya Harchowdhury, Lindsay Kleeman, Leena Vachhani, "*Coordinated Nodding of a 2D Lidar for Dense 3D Range Measurements*", IEEE Robotics and Automation letters, DOI: 10.1109/LRA.2018.2852781 (published in IROS 2018) [[link](#)]

◆ Conference

- Trishant Roy, Anindya Harchowdhury, Leena Vachhani, "*Anytime Motion Planning: A Motion Planner for Dynamic Environment*". (pre-print[[link](#)])
- Anindya Harchowdhury, Kalyan Bandyopadhyay, Binay Kumar Sarkar, "*Beam Scanning for Reception Performance Improvement of Satellite-based AIS*", IEEE International Conference on Aerospace Electronics and Remote Sensing Technology (ICARES), December 2015. [[link](#)]
- Anindya Harchowdhury, Binay Kumar Sarkar, "*Passive Millimeter-wave Imaging for Detection of Objects Under Low Visibility*", APSYM, 2014, Cochin, India.
- Anindya Harchowdhury, Kalyan Bandyopadhyay, Binay Kumar Sarkar, Amitabha Bhattacharya, '*Reception Capacity Enhancement of Satellite based-AIS for Different Classes of Ships*', IEEE Conference on Information and Communication Technologies (ICT-2013). [[link](#)]
- Anindya Harchowdhury, Lindsay Kleeman, Leena Vachhani, Anindya Harchowdhury, Kalyan Bandyopadhyay, Binay Kumar Sarkar, Amitabha Bhattacharya, "*Generalized Mechanism of SOTDMA and Probability of Reception for Satellite-based AIS*", 5th International Conference on Computers and Devices for Communication, CODEC-2012. [[link](#)]

◆ Symposium

- Anindya Harchowdhury, Lindsay Kleeman, Leena Vachhani, "*Simultaneous Obstacle Tracking and Shape Reconstruction of a Dynamic Obstacle using Sparse Depth Data*", 3rd Cyber-Physical Systems Symposium (Cy-PhySS 2019), Indian Institute of Science, Bangalore.

Technical Competencies()

Programming languages: Python, C/C++, C# (fundamentals) MATLAB, Bash

Tools/Libraries PCL, OpenCV, ROS2, Pixi, Distrobbox, Docker, GTSAM, Torch, TensorFlow, Unity, IsaacSim, IsaacLab, Multi-threading, Eigen.

Teaching Assistant /Demonstrator

- ◆ Stochastic and Network Control (Autumn 2019-20 with [Prof. Ankur Kulkarni](#))
- ◆ Optimization (Spring 2018-19 with [Prof. Ankur Kulkarni](#))

- ◆ Mathematical Structures in Systems and Control (Autumn 2018-19 with Prof. S. Srikant)
- ◆ Advanced Engineering Data Analysis (S1 2018 at Monash University with Prof. Zixiang Xiong)
- ◆ Probability Models for Engineering (S2 2017 at Monash University with Prof. Zixiang Xiong)
- ◆ Circuits and Control (S2 2017 at Monash University with Dr. James Saunderson)
- ◆ Computer Organization and Programming (S1 2017 at Monash University with Prof. Tom Drummond)
- ◆ Games and Information (Autumn 2016-17 with Prof. Ankur Kulkarni)
- ◆ Optimization (Spring 2015-16 Prof. Ankur Kulkarni)
- ◆ Games and Information (Autumn 2015-16 Prof. Ankur Kulkarni)

Coursework

Relevant Courses in PhD

Introduction to Probability theory, Optimization, Advanced probability for Engineers, Real Analysis, Systems Theory, Advanced Mobile robotics, Modeling of Dynamical Systems, Control of Nonlinear Dynamical System, and Real-time System Design (Monash University)

Relevant Courses in MS

Linear Algebra and Error Control Coding, Advanced Electromagnetics, Modern Digital Satellite Communication

Relevant Courses in B.Tech

Analog Electronics, Digital Electronics, Digital Signal Processing, Digital Communication, Wireless Communication, Microprocessor 8085 and Microcontroller 8051, Data Communication and Networking

Course Projects (selective)

Real time Hand-Pose Estimation: The goal is to predict the 21 joint locations in human hand from depth images captured with poses. **2D CNN** is not directly suitable for **3D hand pose estimation** due to the lack of 3D spatial information. **3D CNN** model taking a 3D volumetric representation of the hand depth image as input can capture the 3D spatial structure of the input and accurately regress full 3D hand pose in a single pass. Proposed a **D-TSDF** based shallow **3D CNN** architecture, that can train the model in real time.

Real time Pendulum Mimicking: Designed a real time system that mimics a rotating pendulum; used a pendulum attached with a disk and connected by a shaft for free rotation due to a brushless DC motor (+ optical encoder). It outputs to **Altera DE2 FPGA** board. An IR transceiver system attached at the base of the pendulum's mast and a corner cube reflector is facing it. Pendulum's free end looks like a rectangular slot with a divider that make two unequal slots. Slotted region height matches with that of IR transceiver to infer from reflected signals. Unequal size of two slots helps two decide which direction the pendulum was coming from. This received signal (IR) is input to the **FPGA**. The system outputs a control signal to change the speed and direction of the motor. Designed a real time **PID** control to smoothing the mimicking task based on the control signals.

Awards or Achievements

- ◆ IROS SDC travel grant to present paper in IROS 2018, Madrid, Spain.
- ◆ IITB-Monash research fellowship to carry out Doctoral studies (2015-2019) .

Leadership Activities

- ◆ Leader of the ACBIITB team in the **ARTPARK** robotics challenge, 2021. (Moved up to the second stage where 29 out of 130 teams were selected)
- ◆ The five member team was tasked to design an AMR with robotic arms to perform janitorial tasks autonomously.

Invited Talks

- ◆ Topic: **Robot Perception and Navigation in Uncertain Environment** on 20/10/2020, organizer: TCS Research in front of the research heads from all the research labs of TCS.
- ◆ Topic: **Future of Digital Lidar Altimeter for Space Exploration**, on 06/01/2021, organizer: TCS Research in front of the research heads from all the research labs of TCS.

Reviewer

- ◆ Elsevier Mechatronics.

Interests

photography, swimming, soccer, table-tennis, cooking, cycling, traveling, yoga.

Last Updated: *April 15, 2026*