Nandan Banerjee

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SHORT BIO

My areas of interest are in mapping and navigation (SLAM, occupancy grid mapping, etc.), computer vision, robotics manipulation (motion planning, visual servoing, etc.), AI, and general software development. I have worked with robots of all sizes, from iRobot's Roomba, Kinova's Jaco, Rethink's Baxter to the Boston Dynamics' Atlas.

I have substantial experience in various languages which include C++, Python, and C (in order of expertise). I have worked with Java and Delphi (Object Pascal) in the past. I also have substantial experience in working with ROS, Eigen, Boost, Open3D, OpenCV, PCL, OpenRAVE, OpenGL, and other libraries.

EDUCATION

Master of Science, Robotics Engineering
Worcester Polytechnic Institute
2013 - 2015

Bachelor of Technology, Computer Science and Engineering
National Institute of Technology, Durgapur
2008 - 2012

EXPERIENCE

Principal Robotics Software Engineer June, 2015 - Present
iRobot Corporation

- Currently, leading a team of localization experts developing and de-risking algorithms related to visual odometry and non visual localization for next generation robots.
- Mapping and navigation research (algorithms for occupancy grid mapping, landmark management, SLAM graph optimization, map corruption prevention strategies) in heavily constrained computational platforms for next generation Roombas and other consumer robots.
- Productized the research on Lifelong mapping - the ability of a robot to continuously update maps during every mission, thus always staying up to date with any changes in the environment. This enabled a lot of end user benefits on Roomba robots, like the ability to do directed room cleans, better place detected objects, suggest clean zones and keep out zones, etc.
- We published our work on lifelong mapping at ICRA 2018, ECMR 2019, IROS 2019, ECMR 2021, and at the RAS Journal in 2023.
- Created reports and dashboards for tracking various metrics related to SLAM on our robots, re-architected part of our SLAM system, was involved in critical resolution teams when major issues would come up in production software.
- Research and development of algorithms for robotic manipulation related to motion planning using novel trajectory optimization techniques, and kinematic calibration of a low cost dual arm robot. We published some of our work on low cost manipulation at Humanoids 2017.

Graduate student August, 2013 - June, 2015
Worcester Polytechnic Institute

- ARC Lab under Professor Dmitry Berenson - Worked on Visual Servoing techniques to counter the inaccuracies in getting to a desired pose on the Baxter robot. Used simulated annealing to arrive at a better solution for the visibility planning problem in the Baxter robot at the ARC lab.
- ATLAS Lab under Professor Taşkin Padir - Was a part of the WPI-CMU DARPA Robotics Challenge team where I worked on the $ 2 million Boston Dynamics' ATLAS robot in the perception and the manipulation area. I was the team lead for the door task, where I developed algorithms for door detection and motion planning for walking to the door, opening it, and walking through it. We successfully completed the door task both times at the DRC Finals in Pomona, CA.

Teaching Assistant August, 2014 - May, 2015
Worcester Polytechnic Institute

- Teaching and grading freshman Physics laboratory experiments.

Robotics Research Intern June, 2014 - August, 2014
Vecna Robotics (Cambridge Research Lab)

- Porting of a significant part of the Vecna robotics suite to Hydro from Fuerte.
- Implementation of a model based tracking algorithm to track the hand of the Jaco arm.
- Implementation of a Calibration Helper tool to automate partially the process of generating the transform between the camera and the robot base using model based detection techniques.

Software Engineer July, 2012 - July, 2013
Samsung R&D Institute India, Bangalore, India

- Interfaced a part of the Tracfone prepaid engine for a Samsung Feature Phone (S150G) released in May, 2013.
- Implemented carrier specific AT commands for AT&T feature phones.
- Debugged File System, SD card, USB as well as other System Layer RTOS issues related to the ST Ericsson's ARM9 processor in the feature phones.

Undergraduate Student July, 2008 - May, 2012
Computer Science and Engineering Department, NIT Durgapur

- (Chess Robot) Designed and built a 4 DOF manipulator, the control system, and the software to make it capable of playing chess in real time. Used the GNU Chess Engine to determine the computer moves and a webcam to determine the moves made by the opponent using image processing.
- Performed a comparative study of parallel computing techniques using NVIDIA CUDA and OpenMPI on histogram computation at the LHC Grid computing laboratory at the Variable Energy Cyclotron Centre, Kolkata, India.
- (Parking Robot) Added a microcontroller and proximity sensors to a small robot car to enable it to autonomously park itself perpendicularly after finding a desired parking spot.
- (HMedia System) Made a media system capable of being controlled using as many as 100 Android smartphones which also features a customized LED Matrix capable of displaying the frequency spectrum of the media being played.

SKILLS

Programming Languages: C++, Python, C, Java (mostly Android), and Object Pascal (Delphi and Lazarus).

Libraries: OpenCV, Eigne, Boost, ROS, Qt, OpenRAVE, PCL, MoveIt, FCL, OpenGL, Android SDK, and CUDA.

Operating Systems: Windows and Linux.

Software: Matlab, Visual Studio, Qt Creator, Delphi XE2, Source Insight, Lazarus, LaTeX, GDB, Git, Perforce, Lauterbach Trace32.

Embedded Systems: AVR Microcontrollers, Robot design, Various ICs, Designing Embedded Circuits, CircuitLab (Circuit Simulation)

AWARDS

IRNet Young Investigator Award
Presented at the ICCVR - 2012 for my undergraduate thesis and subsequent paper on it.

iRobot Chairman's Team Award
Presented at iRobot's All hands meeting in April, 2019 for my work in the Persistent Maps Team. Candidate teams are peer nominated for this award. Senior management reviews the nominations and selects the top candidates based upon the recognized strengths which best represent corporate goals. This award included a prize money of $10,000.

MEMBERSHIP

IEEE (Senior Member) (Till 2023)

IEEE RAS (Robotics and Automation Society) (Till 2023)

STEM / INVITED TALKS

Invited academic talks

- Was invited to speak at Disney Imagineering (Glendale, CA), Bosch Research Center (Sunnyvale, CA), Northeastern University, and Worcester Polytechnic Institute (WPI) about the vSLAM system on iRobot's Roomba platforms.

Robotics / STEM Talk

- Multiple job shadows - Talked about the various engineering disciplines that come together while building robots, piqued interest in mathematics and science by showing some simulations of the exciting things in robotics that mathematics helps enable, and answered questions about working in the robotics industry to high school juniors/seniors from Massachusetts.
- Seven Hills Charter School, Worcester, MA (Talk about robotics and STEM to primary and middle schoolers).
- Touch Tomorrow 2016, 2017, and 2018 at the Worcester Polytechnic Institute, Worcester, MA (Talk about robotics and STEM to kids of all ages.)
- Boston Children's Museum (Talk about robotics and demonstrating how a Roomba works)
- Yale Hackathon at Yale University (Organized a hackathon based on the iRobot Create 2 platforms)
- MakeMIT Hardware Hackathon 2019 at MIT (Was a mentor and a judge)

JOURNAL/ CONFERENCE/ BOOK CHAPTER PUBS.

Lifelong Mapping in the Wild: Novel Strategies for Ensuring Map Stability and Accuracy over Time Evaluated on Thousands of Robots
Robotics and Autonomous Systems Journal (Elsevier), May 2023

Preventing and Correcting Mistakes in Lifelong Mapping
European Conference on Mobile Robots (ECMR), September 2021
Bonn, Germany

View management for lifelong visual maps
IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), November 2019
Macau, China

Lifelong Mapping using Adaptive Local Maps
European Conference on Mobile Robots (ECMR), September 2019
Prague, Czech Republic

Fast Nonlinear Approximation of Pose Graph Node Marginalization
IEEE International Conference on Robotics and Automation (ICRA), May 2018
Brisbane, Australia

Heuristically initialized motion planning in a low cost consumer robot
IEEE RAS Humanoids Conference (Humanoids), November 2017
Birmingham, UK

Human Supervised Control of the ATLAS Humanoid Robot for Traversing Doors
IEEE RAS Humanoids Conference (Humanoids), November 2015
Seoul, South Korea

NO FALLS, NO RESETS: Reliable Humanoid Behavior in the DARPA Robotics Challenge
IEEE RAS Humanoids Conference (Humanoids), November 2015
Seoul, South Korea

Team WPI-CMU: Achieving Reliable Humanoid Behavior in the DARPA Robotics Challenge
Journal of Field Robotics (DRC Finals Special Issue), January, 2017

A Simple Autonomous Robotic Manipulator for playing Chess against any opponent in Real Time (Best paper award)
International Conference on Computational Vision and Robotics (ICCVR), 2012
Bhubaneswar, India

What Happened at the DARPA Robotics Challenge Finals (book chapter)
Book - "The Darpa Robotics Challenge Finals: Humanoid Robots To The Rescue"
Springer Tracts in Advanced Robotics 121 (April, 2018)

Achieving Reliable Humanoid Robot Operations in the DARPA Robotics Challenge: Team WPI-CMU's Approach (book chapter)
Book - "The Darpa Robotics Challenge Finals: Humanoid Robots To The Rescue"
Springer Tracts in Advanced Robotics 121 (April, 2018)

CITATIONS

Google Scholar Link

- Citations: 424 (January 30, 2024)
- h-index: 8
- i10-index: 7

REVIEWER

Learning OpenCV 3 Computer Vision with Python - Second Edition

Book Reviewer (2015)

Conferences / Journals

- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- IEEE-RAS Humanoids Conference (Humanoids)
- IEEE Robotics and Automation Letters (RA-L)
- European Conference on Mobile Robots (ECMR)
- Journal of Field Robotics
- Journal of Robotics and Autonomous Systems
- Journal of Intelligent Service Robotics

EXTRA-CURRICULAR ACTIVITIES

Robotics and Embedded Systems

- I was a member of the college robotics team. As such I represented my Institution in the India leg of ABU-ROBOCON 2011 and 2012 held in Pune. I led our team in developing the software and control systems for our robots.
- Built Quiz buzzer systems for two companies - QuizWorks and Quizcraft.
- Won 1st prize in the Pacman event organized by the Society of Automotive Engineers collegiate club, NIT Durgapur during their annual auto fest.
- Won 2nd prize in the Dig the Change sensor design competition held by the IEEE students' society of NIT Durgapur during the university's techno management fest AAROHAN.

Quizzing

- Came 1st in the General Quiz at REBOOT 2012 (Bangalore) where I represented Samsung.
- Came 1st in the BizQuiz held at IIT Kharagpur's tech-fest KSHITIJ 2011.
- Came 1st in the TechKnow quiz organized by the Maths and Tech club of NIT Durgapur in 2010.
- Came 1st in the MusicQ quiz organized by QuizInc club of NIT Durgapur 2011.
- Came 1st in the Biz Quiz organized by the Literary Circle of NIT Durgapur in 2011.