SHILADITYA BISWAS

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RESEARCH INTEREST

- Robotics, Machine learning, Control theory, Optimization, Computer vision, Novel view synthesis
- 3D reconstruction, Simultaneous Localization and Mapping (SLAM), loop closure detection
- Uncertainty quantification, Bayesian inference, Perception-aware motion planning.

EDUCATION

Master of Science in Electrical and Computer Engineering 2019-2021
University of California, San Diego, USA CGPA: 3.58/4
Courses: Linear Algebra, Statistical Learning, Linear Systems Theory, Non-linear Systems, Sensing and Estimation in Robotics, Bio-Inspired Robotics, Planning and Learning in Robotics, Convex Optimization, Robot Reinforcement Learning, Principles of Operating Systems.

Bachelor of Engineering in Electronics and Communication Engineering 2014-2018
Birla Institute of Technology, Jharkhand, India. CGPA : 8.10/10
Courses: Control Theory, Network Theory, Intelligent Instrumentation, Digital Signal processing, Sensors and Transducers, Neural networks and Fuzzy systems, Digital electronics.

SOFTWARE SKILLS

Programming Languages	C, C++, CUDA, Python, Shell Scripting
Robotics	Robot Operating System(ROS), Nvidia Jetson Nano
Technologies	Jenkins, CI/CD, Git, TensorRT, CMake, Doxygen, Valgrind, Docker
Operating System	Windows, Ubuntu, Raspbian
Libraries	Numpy, Pytorch, Eigen, Matplotlib, OpenCV, Exiv2, OpenAI-gym

WORK AND RESEARCH EXPERIENCE

Localization System Engineer at Xpeng.Inc Sept 2022-Present

- Research and develop algorithms in C++ for localization, mapping, state estimation, and odometry based on multiple input modalities namely inertial sensors, cameras, and GNSS.
- Design robust Key Performance Indicator (KPI) algorithms in Python to evaluate the performance of mission-critical functional modules such as Localization, Unified Map Fusion, and Perception.

Software Engineer 1 at Material Handling Systems Inc. (Acquired by FORTNA Inc.) Sept 2021-Sept 2022

- Developed high-performance Computer Vision solutions using Neural Network Models (Vision Transformers, Yolov5, Mask-RCNN etc) for the Robotic Singulation Automated Induction task using Pytorch and deployed the trained models to target machines with TensorRT for inferencing.
- Used techniques like hyperparameter tuning and ensemble methods to enhance detection accuracy, carefully considering real-time performance.
- Reduced Package Induction time by 5% by developing a Multiview solution using Point Cloud and RGB images, enhancing visibility to identify packages occluded by the robot.
- Designed and assembled an RGB-D camera rig from scratch, combining separate RGB and ToF cameras, and seamlessly integrated it into the existing software stack.
- Increased image acquisition speed for the RGB-D camera rig by approximately 100% by implementing task-based asynchronous programming in C++.

Graduate Student Researcher at Existential Robotics Lab, UCSD, Jun 20-Mar 21
Advisor: Prof Nikolay Atanasov

- Worked on developing a visual-inertial pipeline for localization and mapping using Schmidt-Extended Kalman Filter and used Consistent Lifting, Embedding, and Alignment Rectification (CLEAR) Algorithm for detecting loop closures.

Undergrad Student Researcher at Autonomous Systems Lab, BIT Mesra Dec 2017-Jul 2019
Advisor: Prof Arun Dayal Udai

- Developed a hardware in a loop simulator for testing and benchmarking Robot controllers.

- Used Decoupled Natural Orthogonal Complement(DeNOC) algorithm for real-time torque/force calculations.

TEACHING EXPERIENCE

CSE176E: Robot Systems Design & Implementation, UCSD Teaching Assistant Winter 2021
CSE276A: Introduction to Robotics, UCSD Teaching Assistant Fall 2020

PROJECTS

1. **Matrix Library (Multiplication and Transpose)** (Video)(Documentation)
   - Developed a Matrix library capable of performing Matrix Multiplication (using Strassen's algorithm) and transpose in **C++11** and used Valgrind for software profiling.
2. **Multi-Agent Reinforcement Learning for Autonomous Driving**
   - Utilized the Multi-Agent Deep Deterministic Policy Gradient (MADDPG) algorithm for multi-agent reinforcement learning in a four-lane traffic intersection scenario.
   - Conducted performance comparison between MADDPG and Proximal Policy Optimization (PPO) algorithms.
   - Enhanced performance stability of MADDPG through prioritized experience replay (PER) and analyzed the impact of batch size, multi-CPU training, and experience collection on agent performance.
3. **Cloud Based End to End Self Driving Car Prototype (UG Final Year Thesis Project)**
   Advisor: Prof Sanjaya Shankar Tripathy
   - Built a wooden, four-wheeled car with a fifth-wheel steering mechanism and derived its mathematical model, incorporating precise physical dimensions.
   - Designed and fabricated a custom direction and speed control circuit on a Veroboard from the ground up.
   - Developed an image acquisition and data relay system for the car using Python on a Raspberry Pi.
   - Implemented and trained a Convolutional Neural Network (CNN) to map RGB images to steering and speed values, enabling the car to traverse a path autonomously.
4. **Bio-Inspired Robotics**
   - Investigated the design and control of a quasi-direct-drive legged robot, gaining practical expertise in experimental robotics, mechanical design, and Python programming.
   - Formulated and implemented kinematic models, deriving forward and inverse kinematics to develop Python code for precise leg position control and executing PID and time-optimal motion strategies.
   - Analyzed the impact of diverse leg designs, studying variations in size, shape, series elasticity, and gearing effects to evaluate their influence on performance and efficiency.
5. **Infinite-Horizon Stochastic Optimal Control**
   - Implemented and compared the performance of value and Policy iteration-based controller in terms of convergence time and state space resolution on an Inverted pendulum balancing controller in Python.
6. **Reinforcement learning on Acrobot robot (OpenAI Gym)**
   - Applied SARSA and Q-Learning algorithms to the Acrobot robot, assessing the impact of function approximation methods (Tile coding, Radial Basis Function Kernels, and Neural Networks) on convergence speed and reward outcomes in Python.
7. **Motion Planning in 3D Space.**
   - Implemented and compared the performance of A* and Rapidly expanding Random Tree (RRT*) Algorithm in terms of planning time and path length on multiple 3D environments with obstacles in Python.
8. **Visual Inertial SLAM**
   - Utilized Extended Kalman Filter (EKF) equations, incorporating a prediction step based on SE(3) kinematics and an update step grounded in the stereo camera observation model for effective localization and mapping.
   - Validated the proposed solution using KITTI Dataset: real-world data from an IMU and a stereo camera mounted on a car.

- Achieved reliable performance, estimating accurate maps and trajectories across various datasets within reasonable computational time.

9. Particle Filter SLAM

- Evaluated the Particle filter using real-world odometry data, indoor 2D laser scans, and RGBD measurements captured by THOR, a humanoid robot equipped with LiDAR and Kinect v2 sensors.
- Demonstrated reliable performance, achieving accurate map estimation and robot trajectory reconstruction across diverse datasets within reasonable computational times

10.Face Recognition using Principle Component Analysis

- Applied Principal Component Analysis (PCA) to a collection of face images to generate a set of basis features.
- Projected face images onto a feature space ("face space") optimized to encode the variation among known face images.
- Defined the face space using 'eigenfaces', which are the eigenvectors derived from the set of faces and represent patterns of variation rather than isolated facial features like eyes, ears, or noses.

PUBLICATIONS

- S. Biswas, A. D. Udai, and G. Kumar **"A Hardware-in-a-Loop Setup for Benchmarking Robot Controllers"** International Conference on Computational Intelligence (ICCI 2018), BIT Mesra, Ranchi, Dec, 2018.

INDEPENDENT COURSEWORK

- CUDA Programming
- Robotics: Mobility by Dr. Daniel Koditschek, Coursera
- Robotics: Aerial Robotics by Dr. Vijay Kumar, Coursera