tshivam2@student.ubc.ca
shivamthukral.github.io

Shivam Thukral

Vancouver, British Columbia
Canada - V3M 5T9

EDUCATION

Master of Science in Computer Science   September 2019 – February 2022
  University of British Columbia (UBC), Vancouver, Canada   **GPA:** 88.8 / 100
  Thesis: Real-time Perception of Potential Docking Locations for Smart Wheelchairs (Slides, Thesis)
Bachelor of Technology in Computer Science and Engineering   August 2013 –August 2017
  Indraprastha Institute of Information Technology (IIIT), Delhi, India   **GPA:** 9.4 / 10.0
  Thesis: Resolving Message Logic Dependencies in Robotic Systems (Poster)

SKILLS

Languages: C/C++, Python, Ansible, AWS, Julia, CUDA, MATLAB, Java, Bash, SQL, R, Haskell.
Technologies: Robotics Operating System (ROS), PyTorch, PCL, OpenCV, AWS, Git, Open3d, Tensorflow, OMPL
Tools: VSCode, Eclipse, PyCharm, CLion, Atom, Qt-Creator, Andriod SDK, Soot, Google Test.
Platform: Linux, Windows, Universal Robots

INDUSTRY EXPERIENCE

Senior Software Engineer - Robotics and Perception, Locus Robotics   April 2024 – Present
Software Engineer - Robotics and Perception, Locus Robotics   April 2022 – April 2024
Locus Learning - Object Detection with Locus bots
  • Transfer learning with YOLOX to detect LocusBots, persons and carts in real-time in indoor warehouse environments.
  • Ported model inference from Python to C++ to reduce inference time by 15% and CPU load by 35%.
  • Single-handedly integrated the object detector into the existing Locus framework.
    • Converted the PyTorch weights into ONNX format for faster Intel iGPU inference.
    • Introduced a light weight inference visualizer for the object detector.
Real-time Multi Object Tracking [In progress]
  • Integrated a Kalman based state-of-the-art Multi-Object Tracker, ByteTracker, with YOLOX detector.
  • The tracker is being used to track and avoid forklifts in warehouses.
AprilTag Detection
  • Upgraded the fiducial marker detector to use AprilTag3 to increase frame processing speed (22%) and recall (28%).
  • Replaced image undistortion with RoI rectification for tag detectors to decrease NUC load by $\sim$ 5%.
  • Integrated Locus's fiducial markers with state-of-the art deep-learning tag detector (DeepTag).
Standard Camera Calibration
  • Substituted per-camera calibration with a standard calibration matrix for all cameras mounted on the robot.
    • Ensured the new calibration errors to be within 1% of the use-case-specific tolerance limits.
  • Reduced the robot deployment time by 6% by alleviating the need to perform per-camera calibration for each robot.

Researcher (Software Engineer), TATA Consultancy Services - Innovation Labs   August 2017 – August 2019
Long Distance Container (LDC) Packing - Palletizer (Video)
  • Designed a new industrial-level system to automatically load heterogeneous-sized parcels in LDCs.
  • Developed pose estimation and motion planning for placing parcels in LDCs using Universal Robots.
  • Increased system throughput by directly publishing poses and joints to the robot, surpassing ROS-MoveIt.
  • Successfully achieved a target filling rate of 12 seconds per LDC.

Amazon Robotic Challenge (Video)
  • Built robot hardware and software that can attempt the task of picking and stowing items on shelves.
  • Replicated this system in a lab environment that was designed in-house by TCS Robotics.
  • Worked on the complete pipeline including object recognition, pose recognition, grasp planning, and motion planning.
Chitrakar: Robot Artist (Video, Paper)
  • Programmed a robotic arm to draw a human face as a recognizable non-self-intersecting loop (Jordan curve).
  • Designed automated image processing pipeline and motion planning module to complete the drawing within 30 minutes.
  • This work demonstrates the use of robotics to augment humans in executing difficult craftwork instead of replacing them.

ACADEMIC EXPERIENCE

Graduate Research Assistant, UBC Vancouver   May 2020 – February 2022
  • Developed vision-based algorithm, ApproachFinder-CV, to find docking locations for a wheelchair in indoor scenes.
    • Each location is accompanied by a desirability weight based on visibility, relative position and heading.

- Proposed a real-time deep network, ApproachFinder-NN, that predicts docking spots using just geometric information.
  - Our end-to-end differentiable Hough voting-based architecture is 15x faster than the computer vision pipeline.
- Evaluated the performance of ApproachFinder-NN on a large state-of-the-art indoor dataset (SUNRGB-D).
- Proposed a way to integrate network output as a 3D temporal desirability cost map for wheelchair navigation.
  - Used a Model Predictive Controller with efficiently designed task-driven cost functions to share human intent.

Graduate Teaching Assistant, UBC Vancouver
- **Advanced Relation Databases** $\times$ 4   Winter 2019, Winter 2020, Winter 2021
- **Introduction to Relation Databases** $\times$ 1   Summer 2020

Undergraduate Research Assistant, IIIT Delhi   Winter 2016
- Developed an optimal path planning algorithm (BugFlood) in an obstacle-rich environment.
- Bugflood delivers lower-cost paths compared to other planners with lower computational time.
  - It is 11x and 18x faster than BFMT* and FMT*, respectively.
  - It generates paths that are only 5% suboptimal compared to the Visibility Graphs (the most optimal path planner).
- Bugflood rapidly indicates if a path does not exist.
  - The planner can detect a no path scenario in 0.4 seconds.

SELECTED PROJECTS

PyTorch Vision Tutorials (Code) (In progress)
- Multiple tutorials covering how to implement vision-focused deep learning architectures in PyTorch with torchvision.
- Focused on state-of-the-art object detection and segmentation (semantic and instance) in the 2D and 3D domains.

Image-based Visual Servoing using Industrial Manipulator (Report, Code)
- Proposed a framework to track moving visual features with occlusion using a 6-DoF robotic arm in 3D.
- Features are tracked using CAMShift, and Kalman filter is used to predict the target's motion in cases of occlusion.
- End-effector velocity is estimated from feature Jacobian and it is used to generate joint velocities from the robot Jacobian.
- Dexterous manipulation capability is demonstrated by using the robot to play ping-pong at a ball speed of 15 cm/s.

Verifying Deep Neural Networks (Report, Code)
- Literature Survey: Summarized 10 research papers on state-of-the-art approaches to verify deep neural networks.
- Used ReLUplex, an SMT solver for verifying deep neural networks, to verify properties of:
  - A prototype DNN for airborne collision avoidance system for unmanned aircraft (ACAS Xu).
  - A simplified network trained on the MNIST Digit Recognition dataset
- Extended ReLUplex to run on piecewise linear maxpooling functions with no significant delay.

Modelling Human Behaviour in Chess (Report, Code)
- Developed a predictive model of human chess moves through supervised learning.
  - Predicting human moves is a multi-class classification problem, but with a different set of classes for each position.
- Trained three models: linear, neural net, and transformer model, on the Lichess dataset.
- The transformer-based model performed best with an accuracy of 76.4% on top-5 accuracy.

3D Pose Estimation from Single RGB Camera (Report, Code)
- Developed a method to estimate the 3D kinematic pose of a human using an RGB camera video stream at 15 Hz.
- Fully connected CNN yields 2D and 3D joint positions simultaneously and eliminates expensive BB computation.
- Real-time model-based kinematic fitting is used against 2D/3D predictions to produce joint positions of the 3D skeleton.

SCHOLARSHIPS AND ACHIEVEMENTS

- UBC Computer Science Financial Aid: Awarded $61,000 in financial assistance during the Master's program.
- International Tuition Award: Received $8,000 to assist with tuition fees for the graduate program.
- St John's College Sir Quo-Wei Lee Fellowship: Awarded $2,000 for the Summer Session 2021.
- Graduate Covid Program Delay Tuition Award: Received $1,900 to support academic and research progress.
- Graduate Teaching Assistant Award: Recognized for outstanding feedback from students in teaching evaluations.
- Chancellor's Gold Medal: Awarded for achieving the best academic record in the entire B.Tech program.
- Dean's Merit List : Acknowledged for excellent academic performance among computer science undergraduates.

PUBLICATIONS, WORKSHOPS AND PATENTS

N. Sharma, S. Thukral, S. Aine, and P.B. Sujit, "A virtual bug planning technique for 2D robot path planning," in *IEEE American Control Conference*, ACC , Milwaukee, June 2018.

A. Singhal, A. Kumar, S. Thukral, D. Raina, S. Kumar,"Chitrakar: Robotic System for Drawing Jordan Curve of Facial Portrait," Workshop on Creativity and Robotics, *International Conference on Social Robotics,* ICSR, November 2020.

A. Singhal, H. Kahdilkar, V. Raju, D. Raina, V.S. Prasad, S. Thukral, R. Sinha, "System and method for autonomous multi-bin parcel loading system", U.S. Patent Application No. 17/167,999.