Jiaheng Liao

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Education

University of Toronto, Robotics   Graduating May 2025

Bachelors in Engineering Science – **Robotics Major, AI and Business Minor**

- Mobile Robotics and Perception, Robot Modelling and Control, Computer Vision, Data Structures and Algorithms, Machine Learning, Computer and Digital Systems, Microprocessors, Linear Control Theory, Natural Language Processing, Probability and Statistics

Professional Experiences

Hardware Verification Engineering Intern   PEY - 16 months

AMD, Toronto

- Verified ASICS RTL designs with **Lint tools** using **Bash** in **Unix/Linux**, reduced lint violations
- Employed **Synthesis** on weekly regression runs, utilized **Synopsis Design Compiler** and **Fusion Compiler**, ensuring that CPUs and GPUs' performance, power, and area targets are met
- Crafted **Python, Tcl, Perl and C shell** scripts to test-flow IP tiles, improve **CDC** flow and parsed Synthesis reports to internal webpage, improved efficiency
- Communicated block design violations through **Jiras** to designers across multiple projects and IP tiles

Software Engineering Intern   Co-op - 4 months

Shlien Lab, The Hospital for Sick Children, Toronto

- Prototyped graphic user interface **(GUI)** in **Python** using **Pandas library** to automate the upload of patient data to REDCap database with **REDCap API**, increasing the data transfer efficiency
- Enhanced **Python** and **Mysql** algorithms used to auto-fill patient tumor reports on **Bash** commands, increasing documentation efficiency significantly

Academic/Research Experience

Robotic Thesis: Virtual Fixture for Da Vinci Surgical Robotics System   2024 - 2025

Centre for image-Guided Innovation and thereapeutic Intervention, SickKids Hospital

- Developed and validated **distance based haptic feedback algorithms** in **Python, ROS and SDFs** (signed distance fields) to aid surgeon during cleft palate repair tasks (line tracing and suturing) using **Da Vinci Surgical Robots**, minimizing tool collisions with surrounding environments
- Simulated dVRK tools with tool and box models built in **Blender** with **AMBF** package

Undergraduate Research Assistant   Co-op - 4 months

Centre for Advanced Coating Technology, University of Toronto

- Developed and validated computer **GUI control system** using micro-controllers **LabJack** and **DAQFactory** in **C++** to provide precise system control on coating abrasion testing mechanism
- Researched and developed hydrogel coating materials for coin size batteries in order to minimize ingestion damage seen commonly among toddlers, **presented poster of preliminary results** at University of Toronto's Undergraduate Research Day 2021

Robotics / Software Experiences

Robotics Capstone: Autonomous Drone Navigation | *Python, ROS, Flight Sensors and Controllers*

- Implemented autonomous stationkeeping for a **quadrotor drone** using **Jetson Nano** in **Python**, achieving a stable hover at a fixed altitude and orientation with Pixhawk 4 and RealSense T265 onboard sensors
- Developed and tested autonomous waypoint navigation, integrating **Pixhawk 4** for flight control and **RealSense T265** for position tracking, enabling the drone to visit predefined waypoints in under 90 seconds

KUKA Robotic Arm Motion Planning and Obstacle Avoidance | *KUKA, MATLAB*

- Engineered and fine-tuned **motion planning algorithms** using potential fields to control KUKA manipulator's movement with obstacle avoidance and inverse kinematics
- Programmed the **KUKA robotic arm** in **MATLAB** to automate object manipulation, integrating repulsive and attractive force functions for real-time path adjustments in dynamic environments

- Optimized motion trajectories through hands-on testing, adjusting force parameters for efficient, collision-free movement, and ensuring successful execution of tasks in simulation and hardware

TurtleBot 3 SLAM and Motion Planning | *ROS, Python, TurtleBot 3*
- Implemented **RRT and RRT***global planners with collision detection, node rewiring, and cost-to-come heuristics for optimal trajectory generation
- Developed a **trajectory rollout local planner** for real-time closed-loop control, verified in **Gazebo Simulation** and real-world environment
- Implemented vehicle calibration, dead reckoning pose estimation, and occupancy grid mapping using ROS, wheel encoders, and LiDAR data.
- Designed and tuned **PID controllers** with **Kalman Filtering, SLAM and Bayesian Estimation** for robust path tracking and localization, achieving top 10% performance in a constrained line-following benchmark
- Engineered **pose-to-pose control** strategies to track straight-line paths, waypoints, and curved trajectories using kinematic constraints and feedback control

Computer Vision Project | *Python, OpenCV, PyTorch*
- Implemented a **stereo correspondence algorithm** for depth estimation and a **Structure from Motion pipeline** to reconstruct 3D scenes from 2D images
- Designed an **Image-Based Visual Servoing controller** using the Moore-Penrose pseudo-inverse and performed depth estimation for robotic visual control
- Trained **CNN** model in **PyTorch** to predict sun azimuth angles from KITTI dataset images, applying batch normalization, dropout, and data preprocessing to improve accuracy

ML Model - Handwritten Mathematical Expressions to Latex | *Pytorch*
- Implemented **AlexNet, CNN encoder, positional encoder and transformers** in a **Pytorch** machine learning model that predicts elementary school level handwritten mathematical expressions with 92%+ accuracy
- Trained machine learning model on 2000+ randomized expressions created by combining individual handwritten images of numbers and operators

ML Predictive Tool - Research Project | *Python, TensorFlow*
- Built **TensorFlow** script to analyse, categorize and grade embryo images according to existing grading scales for IVF (in-vitro fertilization) process with an **accuracy of 92%**
- Trained machine learning models with provided embryo component data and the corresponding results (implantation and component grading) to develop a predictive tool to access embryo's viability

Etch-A-Sketch Robot | *Python, C++, Arduino*
- Design an **Arduino** motor controlled Etch-A-Sketch Robot in **Python and C** that takes user input SVG (Scalable Vector Graphics) files and display it on the Etch-A-Sketch
- Implemented the **travel salesman algorithm** using Bentley-Ottmann sweep-line algorithm, Bezier curves, Euler cycle and postman's tour solver to compute the optimal path for drawing an image

Motion Controlled Drone | *Hardware, Python, C*
- Programmed a **hand-gesture controlled DJI Tello Drone** using accelerometer, gyroscope data and **Raspberry Pi** with material constraints under less than 48 hours

Hardware Experiences

Digital and Computer Systems Lab | *Verilog, ARM Assembly, ModelSim*
- Implemented digital circuits (latches, ALU, FSM) and simulated designs with **Verilog** and **ModelSim**
- Developed interactive systems using **Verilog**, including a seven-segment display with user-controlled inputs
- Programmed **ARM assembly** on the DE1-SoC, handling tasks like summing numbers, detecting bit patterns, sorting arrays, and controlling LEDR lights
- Utilized subroutines and interrupts to optimize code and manage device input/output on the DE1-SoC board

Electronics for Robotics Lab | *Power Amplifiers, Circuit Design, Signal Processing*
- Designed and implemented small-signal common-source and **MOSFET** amplifiers, focusing on Class-A, Class-B, and Class-AB configurations to achieve optimal linearity, efficiency, and distortion control
- Utilized **negative feedback** for improved stability and bandwidth, and measured voltage gain, biasing, and power efficiency using **oscilloscopes** and **multimeters**

VLSI Lab | *Cadence, Sentaurus TCAD*
- Simulated **CMOS** process for NMOS and PMOS transistors in **Sentaurus TCAD**, analyzing IV characteristics and fabrication steps
- Extracted threshold voltage, drain current, and resistance from IDS-VGS and IDS-VDS simulations
- Designed CMOS inverter layout in **Cadence Virtuoso**, ensuring DRC and LVS compliance
- Optimized layout with multi-finger transistors for improved matching and reduced area

Portable Oscillocope PCB Design | *Eagle CAD, LTSPICE*
- Designed and optimized Oscilloscope PCB layout in **Eagle**, integrated input scaling, buffering, and mode selection features
- Optimized a low-pass filter (20 kHz passband, 50 kHz stopband) and protection circuits for input and output, optimizing component selection using **LTSPICE** and incorporated **Arduino Nano** for ADC conversion

Small-Motor PCB Design | *Altium*
- Developed small-motor **PCB** using **Altium**, taught and mentored the design process for a class around 40 students

Leadership & Extra-Curricular Experiences

Robotics Major - Class Rep. | *Member of Engineering Student Council*   Sept 2022 to Present
- Elected by 50 students in the '24 and 25' cohort to serve as a link between Professors, Faculty Staffs and Engineering Society and to ensure students' concerns are met
- Advocated and communicated on important academic matters for 12+ third year level courses

UofT Engineering Ambassador | *Photographer, Mentor and Leader*   Sept 2021 - Present
- Facilitated events and games during Frosh week in welcoming incoming engineering students to UofT and preserving their best moments with a camera. Photos won Frosh's week photo contests and are featured on Orientation week's social media
- Mentored 3 incoming engineering students and provided guidance as an upper-year student, and encouraged brave spaces for all participants

Basketball Intramurals - Captain | *Team Engineering*   Jan 2022 - Present
- Organized lineups prior to games and communicated with 15 team players offensive and defensive plays on and off the basketball court, defending champions and finalist for both seasons
- Lead and organized weekly practices, scrimmages and team building sessions, built a team of fun, tight-knitted and passionate basketball community with players who are supportive of each other

Skills and Tools

Programming Languages: Python, C, C++, Tcl, Perl, Csh, Verilog, Arm Assembly, MATLAB, HTML, CSS, Java
Tools and Libraries: ROS, Ubuntu, Linux, Bash, Vim, Perforce, Tensorflow, Pytorch

Awards and Honours

University of Toronto Undergraduate Research Scholarship
Division of Engineering Science −− Awarded based on research contributions and academic merits

Languages and Interests

Languages: English (Native), Mandarin (Native), French (Novice)
Interest: Basketball, Musical Theatre and Reading

References

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