Marcelo Contreras Cabrera

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EDUCATION

University of Alberta
M.Sc. Mechanical Engineering
Edmonton, Canada
May. 2024 - Present

- Research topic: "Reliable autonomous navigation"
- NODE Lab graduate research assistant, advised by Prof. Ehsan Hashemi

Universidad de Ingenieria y Tecnologia
B.Sc. Mechatronics Engineering (Minor in Robotics)
Lima, Peru
Mar. 2019 - Dec. 2023

- Graduated among the Top 10% of the Program
- Bachelor's Thesis: "Fuzzy-SSVEPformer: Classification of steady-state visual evoked potentials with Neuro-Fuzzy transformer"
- Coursework: Robotics, Computer Vision, Non-linear control

EXPERIENCE

Graduate Research assistant
Networked Optimization, Diagnosis, and Estimation (NODE) Lab
Edmonton, Canada
May. 2024 – present

- Conducting research on autonomous navigation pipeline for outdoor mobile robots and autonomous vehicles with focus on perception and motion planning.
- Collaborated with 6 graduated students and supervised 5 undergraduate students on perception modules for real-time localization and tracking.
- Research outputs contributed to in-house lab projects and published at IEEE T-IV and IEEE ITSC.

Research visitor
Institute of Measurement and Control Systems (MRT)
Karlsruhe, Germany
Jun. – Aug. 2025

- Conducting research on high-level decision making motion planner for reliable and safe autonomous driving.
- Developed a learned-based behavioral planner with Transformer architecture, trained by Reinforcement Learning (RL).
- Implemented a sample-based Frenet trajectory planner with real-time runtime.

Research assistant
Universidad de Ingenieria y Tecnologia, BCI Group
Lima, Peru
Aug. 2022 – present

- Investigated the noise robustness of Neuro-Fuzzy Type 2 block integrated into a Transformer Neural Network for EEG SSVEP classification. Achieved an accuracy improvement of 5∼15% across different datasets.
- Designed an efficient point-process–based sampling strategy that reduced neural network training time by 50% for EEG classification without loss in accuracy.

Research intern
Networked Optimization, Diagnosis, and Estimation (NODE) Lab
Edmonton, Canada
Jan. 2023 – Apr. 2024

- Implemented a Visual Odometry algorithm's front end for feature extraction and dynamic instance filtering, and back end optimization.
- Trained and tested real-time segmentation (YOLACT) and object detection (YOLOv5) to filter dynamic instances with driving data collected at Edmonton.
- Led a team of 6 CS undergraduate students to design a 3D object detector as part of their Deep Learning course.

Control engineer
Vultur Robotics
Lima, Peru
Feb. 2022 – Apr. 2023

- Worked in a multidisciplinary team to developed control algorithms for a 6-DoF robotic arm for search-and-rescue applications.
- Implemented and tested control algorithms into embedded hardware for real-time execution.
- Developed publisher app for command sending and monitoring of control system between a micro-controller and computer terminal.

Projects

Dynamic Visual SLAM
May. 2024 – present

- Implemented a full dynamic Visual SLAM pipeline including feature extraction, stereo matching, local bundle adjustment and object tracking.
- Implemented and derived Jacobians for custom factors into graph optimization by Ceres and Sophus.
- Tested on KITTI and DynaKITTI datasets.
- Achieved RPE drift under 2 cm with 30 ms average runtime.
- **Tools**: C++, Python, Docker, ROS 2, OpenCV, OpenGV, Ceres, Eigen, Sophus

Learned policy for Contingency MPC
Jul. 2024 – present

- Designed an adaptive policy for tuning of parameters of Contingency MPC for multi-modal autonomous driving.
- Trained the policy with Stable-Baselines 3 inside a parallelized CARLA environment for speed-up.
- **Tools**: Python, Stable-Baselines 3, CARLA, CasADI, PyGame

Centralized Collaborative SLAM
Feb. 2025 – Mar. 2025

- Merged in-house visual SLAM module with a open-source centralized optimization (COVINS) for collaborative map merging.
- Deployed in a mobile robot powered by a Jetson Nano Super using Zed Mini.
- Achieved improvement in localization accuracy compared to single-session SLAM.
- **Tools**: C++, ROS 1, OpenCV, Ceres, Eigen

3D High-Definition Map Visualizer
Dec. 2024 – Jun. 2025

- Developed an augmented perception system to generate HD maps for autonomous navigation in urban settings.
- Fused Basler camera and RS-32 LiDAR data stream for long-term map maintenance.
- Aligned HD map with GNSS coordinate system with OpenDriveMap.
- **Tools**: C++, ROS 1, OpenCV, g2o, OpenDriveMap

Unified autonomous navigation pipeline for Turtlebot 3 [code]
Mar. – Jul. 2023

- Integrated perception, localization and planning into a single pipeline to get a unified navigation ROS node for Turtlebot 3 adaptable to changing environments.
- Designed a two-fold map generation that fuses a static map from ORB-SLAM 3 and the projection of RGB-D images with YOLOv5 to detect moving people.
- **Tools**: C++, Python, ROS 1, OpenCV, g2o, Pytorch, Gazebo

Professional service

Reviewer for several conferences

- IEEE Intelligent Transportation Systems Conference (ITSC)

Reviewer for journals

- IEEE Transactions on Vehicular Technology (T-VT)

- IEEE Transactions on Intelligent Vehicles (T-IV)

- IEEE Transactions on Intelligent Transportation Systems (T-ITS)

Workshop organizer in confereces

- European Conference on Computer Vision (ECCV)

Skills & Accomplishments

Languages: English (proficient), Spanish (native)
Technical: Python, C++(17&20), ROS 1&2, Docker, Git, MATLAB, CMake, CUDA, bash
Libraries: PyTorch, Eigen, Ceres, g2o, GTSAM, OpenCV, Stable Baselines 3
Award: UofA Recruitment Scholarship May/Spring 2024 (5000 CAD)
Grant: ELAP Scholarship 2023

PUBLICATIONS

[1] C. Manuel, M. Contreras, and E. Hashemi. "Robust 3D Bounding Box Detection and State Estimation of Dynamic Objects for Autonomous Navigation". In: *2025 IEEE 28th International Conference on Intelligent Transportation Systems (ITSC)*. [Accepted for publication]. 2025.

[2] M. Contreras, N. P. Bhatt, and E. Hashemi. "DynaNav-SVO: Dynamic Stereo Visual Odometry With Semantic-Aware Perception for Autonomous Navigation". In: *IEEE Transactions on Intelligent Vehicles* (2024), pp. 1–12. DOI: 10.1109/TIV.2024.3414653.

[3] M. Contreras, C. Flores, and J. Andreu-Perez. "EEG-TCF2Net: A Novel Deep Interval Type-2 Fuzzy Model for Decoding SSVEP in Brain-Computer Interfaces". In: *2024 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*. 2024, pp. 2906–2911. DOI: 10.1109/SMC54092.2024.10831302.

[4] C. Flores, M. Contreras, I. Macedo, and J. Andreu-Perez. "Transfer Learning with Active Sampling for Rapid Training and Calibration in BCI-P300 Across Health States and Multi-centre Data". In: *IEEE Transactions on Neural Systems and Rehabilitation Engineering* (2024), pp. 1–1. DOI: 10.1109/TNSRE.2024.3420960.

[5] M. Contreras, N. P. Bhatt, and E. Hashemi. "A Stereo Visual Odometry Framework with Augmented Perception for Dynamic Urban Environments". In: *2023 IEEE 26th International Conference on Intelligent Transportation Systems (ITSC)*. 2023, pp. 4094–4099. DOI: 10.1109/ITSC57777.2023.10421981.

[6] M. Contreras, A. Jain, N. P. Bhatt, A. Banerjee, and E. Hashemi. "A survey on 3D object detection in real time for autonomous driving". In: *Frontiers in Robotics and AI* 11 (Mar. 2024). DOI: 10.3389/frobt.2024.1212070. URL: https://doi.org/10.3389/frobt.2024.1212070.