Gabriel Enrique Garcia Chavez

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INTEREST & EXPERIENCE
Control and Robotics researcher with expertise in nonlinear/online optimization, model-reduced robotics and currently researching on Reinforcement Learning.

SKILLS
C++, C, Python, Linux, VSCode, MATLAB/Simulink, Drake, ROS2, LCM, LabVIEW, Unity, LaTeX

EDUCATION

Virginia Polytechnic Institute and State University, VA, USA   Jan 2021 – Dec 2022
- MSc. Graduated in Mechanical Engineering, focused on Control and Robotics.
- Terramechanics, Multibody, and Vehicle Systems Laboratory, advisor: Dr. Corina Sandu

Universidad Nacional de Ingeniería UNI, Lima, Peru   Mar 2015 – Dec 2018
- BSc. Thesis: "Stabilization of the Variable-Height Inverted Pendulum based on Input-State Stability and Sliding Mode Control under Unilateral Contact and Input Saturation"
- Major: Mechatronics Engineering (Finished in 4 years with a normal duration of 5 years). Top Tenth on Class.

RESEARCH EXPERIENCE

CONFERENCES

[1] G. Garcia, R. Griffin, and J. Pratt, "MPC-based Locomotion Control of Bipedal Robots with Line-Feet Contact using Centroidal Dynamics," in *2020 IEEE-RAS 20th International Conference on Humanoid Robots (Humanoids), 2021*, Munich, Germany, Jul 2021.

[2] G. Garcia, R. Griffin, and J. Pratt, "Time-Varying Model Predictive Control for Highly Dynamic Motions of Quadrupedal Robots," in *2021 IEEE International Conference on Robotics and Automation (ICRA), 2021*, Xi'an, China, Jun 2021.

[3] G. Garcia, "A Control Approach for the Variable-Height Inverted Pendulum Based on Sliding Mode Control with Input Saturation," in *Proceedings of the 2019 IEEE-RAS 19th International Conference on Humanoid Robots (Humanoids), 2019*, Toronto, Canada, Oct 2019.

[4] G. Garcia and E. Muñoz, "Global control for the Furuta Pendulum based on Partial Feedback Linearization and stabilization of the Zero Dynamics," in *Proceedings of the 13th IEEE Conference on Automation Science and Engineering (CASE), 2017*, Xi'an, China, Aug 2017.

[5] G. Garcia, J. Gallardo, A. Mauricio, J. López and C. Del Carpio, "Detection of Diabetic Retinopathy Based on a Convolutional Neural Network Using Retinal Fundus Images," in *Part II Proceedings of the 26th International Conference on Artificial Neural Networks 2017*, Alghero, Italy, Sep 2017.

[6] G. Garcia, E. Muñoz, and O. Ramos "Torque Control in Position-Controlled Robots using an Inverse Dynamic Task," in *The 59th Conference on Decision and Control (CDC), 2020*, Jeju, Korea, Dec 2020.

PREPRINTS

[7] G. Garcia, F. Zaldivar, A. Obludzyner and O. Ramos, "Trajectory Optimization for dynamic feasibility of LLM-derived human-like movements in humanoid robots," available at *GitHub Repository Preprint*, Jul 2025

[8] G. Garcia, C. Sandu, "Trajectory morphing for jumps of quadrupedal robots using sensitivities of trajectory optimization", available at *ResearchGate Preprint*, Mar 2021.

[9] G. Garcia, R. Griffin, and J. Pratt, "0-Step Capturability, Motion Decomposition and Global Feedback Control of the 3D Variable Height-Inverted Pendulum," in *arXiv preprint arXiv:1912.06078, 2019*, Dec 2019.

[10] G. Garcia, R. Griffin, and J. Pratt, "Convex Optimization of the Full Centroidal Dynamics for Planning in Multi-Contact Scenarios," available at *ResearchGate Preprint*, Dec 2019.

[11] G. Garcia, R. Griffin, and J. Pratt, "Morphologically Self-Stable 3D Legged Robot using the Single Rigid Body Model for High Speed Running," available at *GitHub Repository Preprint*, Jul 2020

AS REPRESENTATIVE INVITED SPEAKER

[12] G. Garcia, R. Griffin, and J. Pratt, "Time-Varying MPC for Dynamic Jumps with Quadruped Robots", representing Dr. Jerry Pratt's invited talk in Biomimetics MIT Mini-Cheetah Workshop in *International Conference on Intelligent Robots and Systems (IROS), 2020*, Oct 2020.

UTEC Universidad de Ingeniería y Tecnología, Lecturer and thesis co-asesor   Mar 2024- Present
- Lecturer: Modeling and Simulation (3rd year), Process Control (4th year), Intelligent Control (5th year), Nonlinear Control Systems (5th year)
- Thesis Co-asesor: Development and Implementation of a Fan-Cooling System for Motors of Quadrupedal Robot

- Supervising a student's thesis on designing and building a fan-cooling system to address the high temperatures in a quadrupedal robot. The focus is on modeling and adaptive predictive control to optimize the energy consumption of the fan system.
- Thesis Co-asesor: Trajectory Optimization for dynamic feasibility of LLM-derived human-like movements [7]
  - Transforming kinematic trajectories obtained by an LLM-like Generative Masked Modeling (MoMask) into dynamically feasible trajectories, which comply with dynamic restrictions related to friction and contact for legged locomotion.

Universidad Nacional de Ingenieria, Lecturer and researcher — Mar 2024-Dec 2024

- Lecturer: MT230 Nonlinear Control (5th year), MT229 Advanced Control (5th year)
- Research Project: Development of a Soft Robotics Glove for Hand Rehabilitation Therapy
  - Supervising students in designing and constructing a soft robotics glove for hand rehabilitation, with a focus on teaching mathematical modeling techniques using system identification.

Upwork, Software and Research Programmer - (Remote work) — Jul 2023- Present

As a freelance professional specializing in control and programming, I have been actively engaged in diverse projects aimed at addressing complex technical challenges. Some of the key research projects include:

- Project: Improving Energy Efficiency of Electric Axle with MPC
  - Utilized Model Predictive Control (MPC) methods to enhance the energy efficiency of a two-motor electric vehicle, leveraging datasets on electric motor speed, torque, and efficiency maps.
- Project: Design, Modelling, and Locomotion Control of Crawling Robots
  - Design and development of three snake-like robots with a particular emphasis on overcoming the complex challenge of controlling friction during locomotion. Implemented PD control combined with friction compensation techniques, to achieve stable and efficient crawling motion. Simulink, MATLAB.
- Project: Pseudospectral optimal control for orbital transfer
  - Designing a NonLinear Optimization Problem for transfering a satellite from orbits with different heights. Used a collocation method based on the Legendre-Gauss-Lobatto for the selection of timesteps, and fmincon for optimization.
- Project: Mathematical Mesh Deformation for Enhanced Simulation Techniques
  - Developed mathematical transformations for mesh deformation, enhancing computational simulations crucial for computational research. Applied advanced mathematical techniques to ensure accurate representations of morphological changes in simulation models, demonstrating strong programming and mathematical proficiency.

Istituto Italiano di Tecnologia, Research Intern - (Remote work) — Jan 2023- May 2023

- Topic: On-line and On-board Planning for the HyQ robot
  - Reviewed literature of control methods for the quadrupedal robot HyQ in order to upgrade it to current control methods for legged robots (MPC and WBC). Worked on the body action planner, the footstep planner and the whole-body motion generation.

Virginia Tech, Research Assistant, VA, USA - Advisor: Dr. Corina Sandu — Jan 2021 – Jan 2023

- Topic: Analysis of Height Variations for Stabilization — Jan 2021 – Jul 2021
  - Preprint [8]. Highly dynamic motions are usually obtained through a slow offline non-linear optimization over a full-body model. We can obtain online approximations of the solutions of the offline optimization when the parameter of interest changes by using numeric sensitivities to obtain those approximations for a specific task (templates for back-flipping and landing on a table, where the height of the table is the parameter of interest).
- Topic: Sliding contacts for highly dynamic behaviours and stabilization — Sep 2021 – Dec 2022
  - Extension of [12]. When a real cheetah does a U-turn while running, he does not take multiple steps to execute it. Instead, he stops abruptly, slides his feet and drifts around. We are studying the inclusion of sliding contacts not only in the lower-level Whole-Body Controller (like in [12]), but also in the higher-level MPC for the Centroidal Dynamics.

IHMC Robotics - Research Intern, FL, USA - Advisors: Dr. Jerry Pratt/Robert Griffin — Aug 2019 – Dec 2020

- Topic: Analysis of Height Variations for Stabilization — Jun 2019 – Nov 2019
  - Preprint [9]. Worked on control methods and properties of the 3D Variable Height-Inverted Pendulum, extending the results from my BSc. Thesis (Paper [3]). Proved that the necessary and sufficient conditions for 0-step capturability is the existence of a Center of Pressure below the ballistic trajectory. Generalized the Divergent Component of Motion from the 3D LIP and the 2D VHIP to the 3D VHIP. Global feedback controllers applied to the 3D VHIP with Variable CoP.
- Topic: Multi-Contact Locomotion for Planning — Aug 2019 – Dec 2019
  - Analysis of the centroidal dynamics by using Contact Wrench Cones. Provided an iterative QP program that minimizes angular momentum for finding trajectories of the centroidal dynamics under Multiple planar and/or point contacts, including changes on height and angular momentum. Biped Wall-runs and quadruped climbing achieved in a reduced model. Preprint [10].
- Topic: Mini-Cheetah Locomotion Planning — Dec 2019 – Dec 2020
  - Research focused on the application of preprint [5] to multi-contact planning to a Quadruped robot with IHMC Mini-Cheetah's MIT. Analyzing the use of the Rotations and centroidal dynamics for jumping in planes with different orientations using 3D Rotation Groups. Source code taken from MIT Biomimetics Lab - Cheetah Software.

Research Institutes at UNI

- Deep Learning algorithms for detection of Diabetic Retinopathy using retina fundus medical images - My tasks: Image Preprocessing and Deep Network Architecture — Jul 2016 – Jun 2017

- Building of a deep convolutional neural network that classifies digital retina images in order to diagnostic Diabetic Retinopathy. We used a public dataset from Kaggle. The best model used transfer learning and it achieved 83% of accuracy for the test set. Work was done using a Titan X GPU with keras and theano libraries.

- Design and Implementation of the "Paracas Robot" for the execution of tasks in flat agricultural farms, using autonomous navigation technology, a spray module and a sensor module   Jun 2015 – Feb 2016
  - Development of the Paracas Robot for the fumigation process, transport of materials and data acquisition in the agricultural land using control system. We developed path planning algorithms, SCADA system, and we designed the mechanical structure.
  - My tasks: Programming of Autonomous Navigation and Path Planning Algorithms

Personal Research, Additional projects
- "Trajectory Optimization Control and Robustness of an Hybrid 2D Quadcopter with a Ball Attached Through a Chord" - Research on Hybrid Trajectory Optimization using extensively Drake toolbox   Feb 2019 – Mar 2019
- "Stabilization of the Variable-Height Inverted Pendulum based on Input-State Stability and Sliding Mode Control under Unilateral Contact and Input Saturation" - Bachelor Thesis   Jun 2018 – Sep 2018
- "A ZMP approach based on explicit LQR tracking and task space for the walking of a lower-limb rehabilitation exoskeleton" - Solving the ZMP differential equation and removing divergences.   Feb 2018 – May 2018
- Design and implementation of a 2 DOF leg robot using DC motor control   Oct 2017 – Dec 2017
- Implementation of a fall-detector with IMU using Artificial Intelligence in Real-Time - Used an IMU and a PIC16F877 with a 2-layer neural network for fall-detection   Sep 2017 – Nov 2017

AWARDS & HONORS	

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- "Julio Urbina" Outstanding Member Award in Research and Projects IEEE UNI 2017   Mar 2018
  For his scientific contributions in projects along 2017.
- Mention and public recognition by the Congress of the Republic of Peru   Jan 2015
  2nd Place in OMR - River Plate Mathematical Olympiad - South America - Argentina
- Outstanding Student Award in CMSPP (High School) - 2014   Dec 2014
  For winning national and international Math (ONEM, CONAMAT, OMR - South America) and Robotic (FLL, WRO) Contests.

ONLINE COURSES
- Coursera Course Certificate
  Detección de objetos - UAB (Object Detection, Jul 2016), Control of Mobile Robots - Georgia Tech (Aug 2015)
- edX Certificate
  EE210.1x: Signals and Systems, Part 1 (Dec 2015), EE210.2x: Signals and Systems, Part 2 (Dec 2015), Nonlinear Diff. Eq.: Order and Chaos (Tools for Nonlinear Control - Nov 2015) AUTONAVx, Autonomous Navigation for Flying Robots (Jul 2015)
- edX Additional Courses
  6.832x Underactuated Robotics: Advanced tools for Nonlinear Control and Robotics

EXTRA-CURRICULAR ACTIVITIES
- Chief of Research and Projects Area IEEE EMBS UNI 2017: Organizing meetings, seminars, talks and project management in Control, Signal Processing, Machine Learning and Robotics.
- Organizer of AVCAN - Student organization to help dogs, pets of the Mechanical Eng. Department at UNI in their food and healthcare - 2018.
- Swimming, Chess, Play Guitar, Music, Project-Euler coding, Native Spanish-Speaker, Fluent English-Speaker.