

# Guillermo A. Castillo

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Ph.D. candidate in Electrical and Computer Engineering. Experienced Robotics Engineer with six years of specialization in robust locomotion controllers for bipedal robots. Proven track record in applying complex reinforcement learning strategies and model-based controller design in simulation and hardware. Seeking a challenging industry role leveraging analytical skills, hardware testing experience, and proficiency in various programming languages to drive innovative solutions in robotics.

## Education

### The Ohio State University

*Ph.D. in Electrical and Computer Engineering*

Graduate Research Associate at the Cyberbotics Lab, Department of Mechanical Engineering.

**Columbus, OH**

*2019-Current*

### The Ohio State University

*M.Sc. in Electrical and Computer Engineering*

Graduate Research Associate at the Department of Electrical and Computer Engineering.

**Columbus, OH**

*2017-2019*

### National Polytechnic School

*Engineer in Electronics and Control*

**Quito, Ecuador.**

*2009–2015*

## Research Interests

- Modelling and physics-based simulation of 2D and 3D bipedal robots, e.g., Rabbit, Cassie, Digit.
- System identification and model-based controller design for bipedal locomotion.
- Reinforcement learning and data-driven control applied to dynamical systems.
- System integration for implementation of model-free and model-based controllers on hardware.

## Research Experience

*Effective state representation for learning hierarchical robust perceptive locomotion,*

*Jan. 2023 - Current*

Designed a hierarchical framework for bipedal locomotion to merge a data-driven state representation of the system's dynamics and local terrain information with a Reinforcement Learning (RL)-based high-level policy for real-time generation of task space commands and a model-based low-level task space controller for trajectory tracking.

*Design of Learning-based Cascade Controllers for Robust Bipedal Locomotion,*

*Aug. 2019 - Dec 2022*

Worked on the hierarchical combination of model-free and model-based techniques to design controllers that realize light-weighted and sample-efficient policies (95% reduction compared with comparable SOTA methods) for robust dynamic locomotion on bipedal robots. Successful hardware implementation on the robot Digit. More details: <https://sites.google.com/view/rl-cmpd>.

*Design of linear policies for robust bipedal walking and hopping on challenging terrains*

*Nov. 2020 - March 2023*

Worked on the development of a control pipeline to learn simple and interpretable linear policies for bipedal walking and hopping with no loss of performance on challenging terrains like slopes, and stairs. Learned policies are successfully transferred to hardware without the need for additional tuning.

*Off-policy learning for bipedal locomotion*

*Dec. 2020 - Sept 2021*

Designed a RL framework to gradually learn complex bipedal locomotion tasks by i) exploiting offline data collected from previously learned experiences, and ii) using a generalized hybrid zero dynamics framework to formulate a lightweight locomotion control policy. Simulation results implemented on the planar biped Rabbit.

Created URDF models for a quadruped robot and a 2-R robot. Implemented simple control techniques on simulation of the robot models using Gazebo and ROS. Implemented a controller for trajectory tracking on a hardware prototype of one robotic leg.

Designed and built an Automatic Voltage Regulator and an Electronic Load Controller for the voltage and the frequency regulation in an island MHP. Implemented digital PI controllers based on the mathematical model of the plant obtained from experimental data of frequency and voltage.

## **Publications**

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**G. A. Castillo**, B. Weng, S. Yang, W. Zhang, and A. Hereid, "Template model inspired task space learning for robust bipedal locomotion," in *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2023.

R. Sony, **G. A. Castillo**, L. Krishna, A. Hereid, and S. Kolathaya, "Melp: Model embedded linear policies for robust bipedal hopping," in *2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2023.

C. Peng, O. Donca, **G. A. Castillo**, and A. Hereid, "Safe bipedal path planning via control barrier functions for polynomial shape obstacles estimated using logistic regression," in *2023 IEEE International Conference on Robotics and Automation (ICRA)*, pp. 3649–3655, 2023.

B. Weng, **G. A. Castillo**, W. Zhang, and A. Hereid, "On the comparability and optimal aggressiveness of the adversarial scenario-based safety testing of robots," *IEEE Transactions on Robotics*, vol. 39, no. 4, pp. 3299–3318, 2023.

B. Weng, **G. A. Castillo**, W. Zhang, and A. Hereid, "On safety testing, validation, and characterization with scenario-sampling: A case study of legged robots," in *2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 5179–5186, 2022.

**G. A. Castillo**, B. Weng, W. Zhang, and A. Hereid, "Reinforcement learning-based cascade motion policy design for robust 3d bipedal locomotion," *IEEE Access*, vol. 10, p. 20135, 2022.

L. Krishna\*, **G. A. Castillo\***, U. A. Mishra, A. Hereid, and S. Kolathaya, "Linear policies are sufficient to realize robust bipedal walking on challenging terrains," *IEEE Robotics and Automation Letters*, vol. 7, no. 2, pp. 2047–2054, 2022.

L. Krishna, U. A. Mishra, **G. A. Castillo**, A. Hereid, and S. Kolathaya, "Learning Linear Policies for Robust Bipedal Locomotion on Terrains with Varying Slopes," *2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, vol. 00, pp. 5159–5164, 2021.

**G. A. Castillo**, B. Weng, W. Zhang, and A. Hereid, "Robust feedback motion policy design using reinforcement learning on a 3D digit bipedal robot," in *2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2021.

**G. A. Castillo**, B. Weng, T. C. Stewart, W. Zhang, and A. Hereid, "Velocity Regulation of 3D Bipedal Walking Robots with Uncertain Dynamics Through Adaptive Neural Network Controller," *2020 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, vol. 00, pp. 7703–7709, 2021.

**G. A. Castillo**, B. Weng, W. Zhang, and A. Hereid, "Hybrid zero dynamics inspired feedback control policy design for 3d bipedal locomotion using reinforcement learning," in *2020 IEEE International Conference on Robotics and Automation (ICRA)*, 2020.

**G. A. Castillo**, B. Weng, A. Hereid, and W. Zhang, "Reinforcement learning meets hybrid zero dynamics: A case study for RABBIT," in *2019 IEEE International Conference on Robotics and Automation (ICRA)*, 2019.

G. A. Castillo, L. Ortega, M. Pozo, and X. Dominguez, "Control of an island micro-hydropower plant with self-excited avr and combined ballast load frequency regulator," in *ETCM*, pp. 1–6, IEEE, 2016.

## Submitted for Publication

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G. A. Castillo, B. Weng, W. Zhang, and A. Hereid, "Data-Driven Latent Space Representation for Robust Bipedal Locomotion Learning," *IEEE International Conference on Robotics and Automation (ICRA)*, In review.

## Teaching and Work Experience

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### The Ohio State University

Guest lecturer - ECE5463 Introduction to Robotics

ROS tutorials 1, 2, 3. DC motor fundamentals and control.

Columbus, OH

Mar. 2018

### National Polytechnic School

Full time lecturer and lab instructor

Classes taught: Geometry Fundamentals, Chemistry Fundamentals, Electricity Fundamentals, Electrical Technology lab, Electrical Circuits lab.

Quito, Ecuador

Sep. 2015 - Aug. 2017

### National Polytechnic School

Laboratory assistant

Prepared laboratory equipment for practices. Planned regular maintenance of computers and laboratory equipment. Supported students who use the lab to develop projects and thesis

Quito, Ecuador

Sep. 2014 - Aug. 2015

## Honors & Awards

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### International Conference on Robotics and Automation 2023

Best Paper Award

Workshop on Effective Representations, Abstractions, and Priors for Robot Learning

Paper: Effective State Representation for Learning Hierarchical Robust Bipedal Locomotion

London, UK

May 2023

### The Ohio State University

Presidential Fellowship

Fellowship to support graduate students to continue their research and complete their dissertations

Ohio, USA

Jan. 2023

### Fulbright Commission

Fulbright Faculty Development Scholarship

Scholarship provided to pursue graduate education in the USA.

Quito, Ecuador

Aug. 2017

### TU Delft

Travel award

Scholarship to attend a coursework in Photovoltaic Solar Energy in TU Delft.

Delft, Holland

May. 2014

### Municipality of Quito

Academic Excellence Grant

Grant to fund undergraduate research thesis.

Quito, Ecuador

2014

### National Polytechnic School

Academic Excellence Fellowship

Awarded to the top 3% students of each major.

Quito, Ecuador

2010 - 2014

## Invited Talks

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### Universidad San Francisco de Quito

"Control and machine learning algorithms applied to humanoid robots and exoskeletons".

Online

Jun. 2023

**Laboratory for Intelligent Decision and Autonomous Robots, Georgia Tech**

*"Reinforcement Learning-Based Policy Design for Robust 3D Bipedal Locomotion".*

**Online**

Apr. 2022

**Wandercraft-Exoskeleton Company**

*"Robust 3D Bipedal Locomotion using Reinforcement Learning and Control".*

**Online**

Feb. 2022

## **Presentations and Posters**

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**IEEE International Conference on Intelligent Robots and Systems**

*Attendee and presenter.*

**Online**

Oct. 2023

**IEEE International Conference on Robotics and Automation**

*Attendee and presenter.*

**Online**

May. 2023

**IEEE International Conference on Intelligent Robots and Systems**

*Attendee and presenter.*

**Online**

Oct. 2021

**IEEE International Conference on Robotics and Automation**

*Attendee and poster presenter at the Workshop Recent advances in MPC and RL for legged robots.*

**Online**

May 2021

**IEEE International Conference on Machine Learning**

*Attendee and poster presenter at the LatinX in AI Research Workshop.*

**Online**

Jul. 2020

**IEEE International Conference on Robotics and Automation**

*Attendee and presenter.*

**Online**

May 2020

**CCTS Annual Scientific Meeting, The Ohio State University**

*Attendee and poster presenter.*

**Columbus, OH**

Dec. 2019

**Telluride 2019 Neuromorphic Cognition Engineering Workshop**

*Selected to participate in the three-week workshop. Theme: Embodied Learning and Intelligence.*

**Telluride, CO**

Jul. 2019

**IEEE Ecuador Technical Chapter Meeting**

*Attendee and presenter.*

**Guayaquil, Ecuador**

Oct. 2016

## **Professional Activities**

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### **Society Memberships**

*Institute for Electrical and Electronics Engineers (IEEE)*

2019-Present

Graduate student member: Robotics and Automation Society

### **Fulbright Scholar Program**

*From Lab to Market: Tech Transfer*

**Salt Lake City, UT**

May. 2018

Fulbright Enrichment Seminar for current Fulbright fellows.

### **Technical Papers Review**

*Journals:* IEEE Robotics and Automation Letters, Nonlinear Dynamics.

*Conferences:* IEEE International Conference on Robotics and Automation, IEEE International Conference on Intelligent Robots and Systems.

## **Mentoring**

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**The Ohio State University**

*Undergraduate mentor*

**Columbus, OH**

Mentored undergraduate students at the Cyberbotics Lab with projects and honor's thesis.

**The Ohio State University**

*Graduate mentor*

**Columbus, OH**

Mentored new incoming graduate students at the Cyberbotics Lab.

# Skills

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- **Software:** Matlab, ROS, Gazebo, MuJoCo, Isaac Gym.
- **Programming languages:** Matlab, Python, C++.
- **Technical writing:** Published articles in top-tier robotics conferences and journals.
- Strong collaboration skills for successful team project completion.
- Experienced in mentoring, strong leadership, and communication skills.