Ulices Santa Cruz Leal

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PERSONAL STATEMENT

I hold a Ph.D. in Electrical Engineering and Computer Science from UC Irvine, specializing in AI-driven aircraft auto-landing and self-driving vehicles, with a focus on artificial intelligence, control theory, and sensor perception for safety and reliability. With a Master's in Aerospace Engineering and a Bachelor's in Mechatronics Engineering, I bring over five years of hands-on experience in design, testing, and R&D within the aerospace industry. Currently, as a Solutions Engineer at Applied Dynamics International, I leverage my expertise in aerospace technology and real-time systems to drive the integration and deployment of System Integration Laboratories (SIL) for novel aircraft, ensuring comprehensive testing and validation of advanced aerospace systems.

EDUCATION

PhD in Electrical Engineering & Computer Science, University of California, Irvine.   (Aug 2019 – Jun 2024)
   Thesis: Formal Verification of Vision-Based Artificial Intelligence-Controlled Aircraft Landing.

MSc in Astronautics and Space Engineering, Cranfield University.   (Aug 2017 – Aug 2018)
   Thesis: Predictive Networked Attitude Control of Fractionated Satellites.

BSc in Mechatronics Engineering, Universidad Autónoma de Baja California.   (Aug 2009 – Nov 2014)
   Project: Motor control system based on stepper motors and EtherCAT PLC.
   Exchange Study Abroad: Technical University Munich (Electrical and Computer Science).

HONORS & ACHIEVEMENTS

- Finalist Award on Best Student Research Competition (Graduate Category) at ACM SIGBED (2023).
- USA-Mexico government full fellowship (CONACYT) for PhD at University of California, Irvine (2019-2024).
- UK-Mexico government full fellowship (CONACYT) for a MSc at Cranfield University (2017-2018).
- Mexico government award (CENEVAL) for outstanding Bachelor Exit Examination results (2015).
- German government scholarship (DAAD) for final year of BSc at Technical University Munich (2013-2014).

PUBLICATIONS

- **Santa Cruz, U.** and Shoukry Y. "*Certified Vision-based State Estimation for Auto Landing Systems using Monotone Reachability Analysis*". In: 62nd IEEE Conference on Decision and Control, 2023.

- **Santa Cruz, U**. and Shoukry Y. "*NNLander-VeriF: A Neural Network Formal Verification Framework for Vision-Based Autonomous Aircraft Landing*". In: 14th NASA Formal Methods Symposium, 2022.

- **Santa Cruz, U**., Ferlez, J. and Shoukry Y. "*Safe-by-Repair: A Convex Optimization Approach for Repairing Unsafe TLL Neural Network Controllers*". In: 61st IEEE Conference on Decision and Control, 2022.

- Sun, X., Fatnassi, W., **Santa Cruz, U**., and Shoukry, Y. *"Provably Safe Model-Based Meta Reinforcement Learning: An Abstraction-Based Approach"* 60th IEEE Conference on Decision and Control, 2021.

- Morales, J., Khalife, J., **Santa Cruz, U.**, and Kassas, Z. "*Orbit modeling for simultaneous tracking and navigation using LEO satellite signals. In: ION Global Navigation Satellite Systems Conference*", 2019.

- Kempf, F., Scharnagl, J., **Santa Cruz, U.** and Schilling, K. *"Networked and Distributed Cooperative Attitude Control of Fractionated Small Satellites"*. In: 69th International Astronautical Congress, 2018.

PROFESSIONAL EXPERIENCE

Solutions Engineer | Applied Dynamics International, Long Beach, CA. (Jun 2024 – Present)
- Provide on-site consulting and technical support for JetZero's Blended Wing Body (BWB) aircraft at the Long Beach Facility, ensuring compliance with aerospace standards and critical project milestones.
- Serve as the primary point of contact between Applied Dynamics International (ADI) and JetZero, facilitating cross-functional collaboration across simulation, software, electrical, and aerospace engineering teams.
- Design and implement 6-DoF Aircraft high fidelity simulation framework using ADEPT, MATLAB/Simulink and Python, integrating avionics, flight controls, landing gear, and other systems with X-Plane 12.
- Develop automated test languages in Python and MATLAB to optimize safety, performance, and cost efficiency in subsystem verification.
- Conduct Site Acceptance Testing (SAT) and integrate real-time hardware, including NI PXI, ARINC/CAN, FPGAs, LVDT/RVDTs, Digital/Analog Boards with Flight Controls such as Pilot Sidesticks, Pedals, Throttle, Wing Surface Actuators, etc. To ensure functionality and reliability for Flight Demonstrator.

Applied Scientist Intern | Amazon (AWS) Artificial Intelligence Labs, Pasadena, CA. (Jun 2023 – Sep 2023)
- Deployment of a cutting-edge vision-based Liveness Security framework utilizing a variable focus camera for precise Depth estimation.
- Creation of a Data Set and Neural Network training for accurate liveness image classification complemented by a physics-informed neural network for enhanced security measures.
- Engineered advanced Depth Map Estimation algorithms leveraging Focus/Defocus techniques, demonstrating an understanding of classical non-conventional computer vision principles.
- Integration of various sensors, including the ArduCAM 16MP, Depth Camera Intel RealSense 435, UWB Radar on Raspberry Pi Platform, achieving robust and comprehensive security solutions.
- Utilized: Python, MATLAB/Simulink, Git, Linux/Ubuntu/Raspbian OS, and Microsoft Office.

Graduate Research Assistant | Resilient CPS Lab, UC Irvine, Irvine, CA. (Feb 2020 – Jun 2024)
- Developed software framework for formal verification of closed-loop aircraft landing using a neural network (NN) for perception and control while offering theoretical safe guarantees.
- Designed NN Generative Models to emulate Event-Based Camera Images. NN Imitation Learning for multi-input to multi-output vehicle control.
- Integration and testing of Custom COEX Clover Drone using Raspberry Pi and PX4 Flight Controller. Kalman filtering/State Estimation and ROS for Guidance/Navigation.
- Developed and tested a small-scale autonomous car using Raspberry Pi, integration with a vision camera system (VICON), Kalman filtering, and a nonlinear controller for path following.
- Taught a group of 20 graduate students as a teaching assistant (TA) for the Autonomous Systems Course (EECS295). Developed comprehensive class materials and conducted coding sessions.
- Utilized: Python, Tensorflow/Keras, Pytorch, MATLAB/Simulink, ROS, X-Plane 11, Z3 Theorem Prover, SAT4J, Git, Linux/Ubuntu/Raspbian OS, and Microsoft Office.

Graduate Research Assistant | ASPIN Navigation Lab, UC Irvine, Irvine, CA. (Sep 2019 – Feb 2020)
- Developed software framework for orbit modeling of Low-Earth Orbit Satellites in order to improve simultaneous tracking and navigation of terrestrial Drones under denied GPS Environments.
- Utilized: MATLAB, LabVIEW, Orekit, Git, and Office Tools.

Quality Engineer | Safran Electronics & Defense, Mexicali, Mexico (Feb 2019 – Jul 2019)
- Defined electromechanical systems (EMS) quality requirements for private, commercial, and military flight deck controls. Responsible for the repair and overhaul facility with +15 technicians under my supervision.
- Trained technicians on new quality standards requirements and improved inspection techniques.

Visiting Research Student | Zentrum für Telematik, Würzburg, Germany (Apr 2018 – Sep 2018)
- Designed software plant dynamics for nanosatellite: A nonlinear system that comprises actuators (reaction wheels and magnetorquers) and sensors (sun sensor and inertial units) and environmental perturbations.
- Developed several orientation control algorithms (feedback linearization / Lyapunov control) and simulated Lyapunov model predictive controller (LMPC) for a cluster of nanosatellites.
- Integrated LMPC controller and Orekit attitude propagator (Plant of a satellite orbiting the earth subject to low earth orbit astrodynamic perturbations) under precarious scenarios such as packet-loss or data delay on an actual hardware (in the loop testing). Obtained robust stability guarantees on practical scenario.
- Utilized: MATLAB/Simulink, GRAMPC (Model Predictive Control), STK, Orekit, Git and Office tools.

Test Engineer | Honeywell Aerospace, Mexicali, Mexico (Aug 2015 – Sep 2017)
- Designed test solutions for qualification of aircraft systems (Airbus and Boeing). Responsible for software infrastructure development, integration and testing (AIV) in all phases of aerospace procedure (PDR,CDR,TRR,V&V). Weekly team meetings with +20 test engineers, +5 technicians and 2 managers.
- Developed LabVIEW & C Code applications for actuation and monitoring of test facilities: starter-motor control room (Boeing 777X) and air pressure facility simulator (Airbus A350).
- Designed gain-scheduled PID Control for largest Latin-American Wind Tunnel and Ram Air Turbine Test.
- Developed state machine for electromechanical systems used to simulate aircraft conditions while testing units, instrumentation setup (NI PXI / RTOS) and sensors setup (pressure, temperature, flow, power) to meet data processing requirements during testing campaigns.
- Reduced defects and test time in multiple manufacturing areas by implementation of automated processes using high potential testers.
- Led drafting team composed of 4 Test engineers in charge of electrical drawings for complete Test Facility. Generation of project documentation, business presentations, work instructions, test procedures, and quality standards in English and Spanish (office word, excel, power point, visio, outlook).
- Utilized: LabVIEW, C/C++, MATLAB/Simulink, AutoCAD, ClearCase/Git, RTOS/Arduino and Office tools.

Test Engineer Intern | Max Planck Institute for Physics: Munich, Germany (Mar 2014 – Aug 2014)
- Executed transition from the development phase to the testing stage of an electro-mechanical control system designed to operate an adaptive optics instrument used on a Telescope (VLT), enabling its reliable functionality across a wide range of environmental conditions, from ambient to cryo-vacuum conditions.
- Developed LabVIEW acquisition architecture in order to validate experimental data (measured position, velocity, temperature and torque) for different communications protocols (e.g. RS232, GPIB, DAQ).
- Performed activities such as prototype development of feedback system, characterization of cryo-stepper motors, PID control tunning, setup of instrumentation\sensors, and programming of EtherCAT PLC.
- Minimized failures in qualification phase by generation of test procedures in English (office word & excel).
- Utilized: LabVIEW, DAQs, TwinCAT and Microsoft Office.

SKILLS

- **Languages**: Fluent English (TOEFL iBT 99), basic German (Goethe B1), and native Spanish.
- **Software Skills:** Linux/Windows/MAC OS's, MATLAB/Simulink, LabVIEW/PXI, C/Python, TensorFlow/Keras, Pytorch, OpenCV, ROS, AutoCAD Electrical, Satellite Tool Kit (STK), Solidworks Mechanical design, Git, EC2 Amazon, Office (Word, Excel, PowerPoint, Outlook, Visio).
- **Hardware Skills**: Event-Based/Depth Perception Camera, Multimeter, Oscilloscope, Soldering, Machining/CNC, Bread-board Circuit Prototyping, Raspberry Pi/Arduino, Microcontrollers, PLC/PAC.

CERTIFICATES

- Green Belt Design for Six Sigma (DFSS).
- Solidworks Associate in Mechanical Design (CSWA).
- NI LabVIEW: Core I&II, Teststand.
- Project Management Diploma (PMI) – Tecnologico de Monterrey (Mexico)