

## Experience

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05/2001 - present      **Jet Propulsion Laboratory**      Senior Robotics Engineer  
Pasadena, CA

### **Planck Spacecraft**

*Electronics and Software Engineer, Sorption Cryocooler*

- Designed custom electronics to control/operate the first-of-its kind hydrotren sorption cryocooler, which cools to 16K with no moving parts
- Developed (and implemented in software) the algorithms used to operate/control the cooler

### **Aquarius Project**

*Control System Designer, Active Thermal Controller*

- JPL's first implementation of PID thermal control on a flight mission (believe it or not)
- Implemented a novel hardware design, whereby the primary pass element (transistor) was co-located with the heating element
- Performed thermal and control system analysis to achieve precise temperature regulation while ensuring adequate stability margin

### **Space Interferometry Mission (SIM)**

*Electrical and Opto-Mechanical Engineer*

- Designed custom optics shipping containers, incorporating vibration isolators, flexure-based kinematic mount points, and custom acceleration data loggers
- Designed optics bonding fixtures incorporating precision opto-mechanical techniques
- Designed custom load cell measurement electronics for optics bonding fixtures
- piezo-electric actuator control electronics design

### **Mars Science Laboratory (Curiosity Rover)**

*Hardware/Algorithm Engineer, MSL Distributed Motor Controller*

- Developed space-qualified BLDC/stepper motor control electronics
- Extremely broad temperature range: -180C to +90C
- Required extremely low-level design of analog and digital circuitry, due to lack of available integrated circuits capable of operating in the required thermal and radiation environment
- Detailed design and thermal characterization of a high-voltage, high-current winding driver output stage
- Developed high-fidelity simulation software modeling BLDC motor operation, and the effects of differing control electronics schemes/designs
- Created low-cost, non-flight motor controller (BB5) used for all MSL motor/mechanism testing

*Software Lead, Actuator Electrical Ground Support Equipment (AEGSE)*

- Led a team of developers in writing the embedded and front-end software components for a scalable, modular motor/mechanism controller system, based on the BB5 motor controller
- Provided users (MSL mechanisms engineers) with a simple, flight-like command interface for actuator operation, ranging from low-level, single-motor moves to high-level, synchronized operations
- Trained end users (mechanism and sub-system engineers) on motor/actuator fundamentals and operation
- Provided ongoing support for the large (>20 engineer) user-community during mechanism development and testing

*Technical Lead, Integrated Motion Control System*

- Responsible for end-to-end functionality of all 40 brushless motor-driven actuators on the rover
- Primary investigator/troubleshooter of all motor-control related issues encountered during system integration and V&V phases
- Developed flight software algorithms, parameter-tuning strategies, and operating schemes for rover mechanisms such as the robotic arm, remote sensing mast, high-gain antenna, percussive drill, and the mobility system
- Trained/mentored the mechanism system engineers in the topics of motor theory, operation and control
- Developed the ground software tools used by mechanism system engineers to visualize flight system data products and diagnose problems during V&V and eventually surface operations on Mars

*Mechanisms Downlink Lead, Surface Mission Operations*

- Responsible for health assessment, parameter tuning, and first-motion tests following landing
- Developed ground software tools to automate assessment of mechanism health and operation from downlinked telemetry
- Instituted guidelines and procedures used by subsystem downlink engineers throughout the life of the mission

## **DARPA Robotics Challenge - Robosimian**

### *Lead Electrical Engineer*

- Devised top-level electrical system architecture
- Designed joint controller motherboard, used on all 30 actuators of Robosimian
- Designed hand controller board
- Wrote embedded firmware running on joint controller and hand controller processors
- Wrote low-level software and drivers for interfacing with actuators and sensors

## **Robotic Mobility and Manipulation R&D**

### *Software Developer*

- Implemented cutting edge full-body inverse kinematics algorithm for 21-DOF manipulator
- Generalized Compliant Motion (GCM) controller
- Developed mobility path-following controller for a track-based robot

### *Hardware Developer*

- Designed and built a novel articulated sensor head complete with custom pan/tilt mechanism, stereo cameras, perception computer, scanning Lidar, IMU, and custom timing synchronization electronics

## **Skills**

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### **Electrical Engineering**

- Analog design (amplifiers, filters, controllers)
- Microcontrollers and DSP's
- Digital logic and communication circuits
- Detailed design of BLDC motor drive electronics
- IMU design
- Schematic design and PCB layout

### **Mechanical Engineering**

- Structural, dynamics and vibration analysis, simulation and design (analytical and numerical methods)
- Flexure analysis and design
- Actuator design, sizing, modeling and operation
- High-precision opto-mechanical alignment fixture design
- Thermal system design and analysis (heat exchangers/spreaders, nitrogen vaporizers)

### **Programming**

- Languages: C, C++, Java, Python, Perl, Tcl, LabVIEW, Javascript, MATLAB
- Operating Systems: Unix/Linux, OS X, Windows
- Modular, object-oriented programming in C
- GUI development: GTK+, Qt, OpenGL, WebGL, HTML 5 canvas
- Embedded programming and hardware device drivers

### **Control Systems**

- Classical (frequency-based) and modern (state-space) controller analysis and design
- Analog and digital controller implementations
- System identification and stability analysis
- Dynamic system modeling and simulation
- Non-linear system analysis, simulation and controller design

## **Education**

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1997 - 2001	Bachelor of Science, Mechanical Engineering	University of Southern California Los Angeles, CA
2003 - 2006	Master of Science, Mechanical Engineering Dynamics and Controls	University of Southern California Los Angeles, CA

## **Licenses**

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Licensed Professional Engineer, Mechanical Branch	California License #32891
Licensed Professional Engineer, Electrical Branch	California License #17769

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