Willy Bernal

Curriculum Vitae

Education

University of Pennsylvania, Philadelphia, PA.

2010 – 2014 **Masters of Electrical Engineering**, *GPA: 3.81*.
Area of Study: Cyber-Physical Systems

2008 – 2010 **Masters of Mechanical Engineering**, *GPA: 3.94*.
Area of Study: Robotics

2005 – 2010 **Bachelor of Mechanical Engineering**, *GPA: 3.85*.
Area of Study: Embedded Systems

2005 – 2010 **Bachelor of Electrical Engineering**, *GPA: 3.80*.
Area of Study: Mechatronics and Robotics

Professional Experience

2015–Present **Engineer III**, National Renewable Energy Laboratory (NREL), Golden, CO.
Develop guidelines and technologies to facilitate renewable energy integration in commercial buildings.
Duties:
- Measure, simulate, and evaluate energy use in bulidings using the building energy analysis sofware tools, EnergyPlus and OpenStudio.
- Develop a framework and guidelines to implement demand response strategies for commercial buildings.
- Develop advanced control algorithms for energy-efficient buildings.
- Collect field data and perform data analysis.
- Develop and design experiments for data acquisition.

2014–2015 **Lead Mechatronics and Controls Engineer**, Litmotors, San Francisco, CA.
Build a framework for system identification and develop controls for driving an Auto-balancing 2-wheel Electric Vehicle (*AEV*).
Detailed achievements:
- Sofware and hardware development to interface sensors and actuators with the vehicle's CAN bus.
- Design static balancing and driving controls for the C-1 (*AEV*).
- Develop dynamic models using Lagrange and Kane's method.
- Perform structure identification using first-princicples and greybox modeling.
- Perform Frequency Response (I/O) analysis to develop controls using frequency compensation.
- Simulate and visualize 3-D dynamics of the vehicle.

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Summer 2013 **Research Participant Program**, National Renewable Energy Laboratory (NREL), Golden, CO.

Develop an integrated framework for campus-wide building energy modeling and Hardware-in-the-Loop simulation in the Matlab/Simulink environment.
Detailed achievements:

- Expand the capabilities of *MLE+* to interconnect multiple buildings through a heating/cooling piping system.
- Automate the dispatch of multiple Computing Units from the Amazon Web Services to distribute computation of multiple building simulations.
- Create a database with weather-feed to pull information on demand for the simulations.
- Program Real-Time target machine (OPAL RT-Lab) to perform hardware-in-the-loop simulation.

2010–2014 **Graduate Research Assistant**, mLAB - University of Pennsylvania, Philadelphia, PA.

Research and develop advanced controls for dynamic systems.
Detailed achievements:

- Research and synthesize controls for energy-efficient buildigs.
- Develop and provide support for *MLE+*, a co-simulation program for controls of energy-efficient buildings (*MLE+*).
- Develop and deploy a fleet of wireless sensors for data gathering.
- Lead a team to design and fabricate a wearable Electrocardiogram Patch for long term monitoring (1 month).

2006–2010 **Research Assistant**, MODLAB - University of Pennsylvania, Philadelphia, PA.

Develop and research the robotic platform for modular robotics CKbot (*CKbot*).
Detailed achievements:

- Contributed to the design, control and testing of a *novel scalable biologically-inspired legged style of locomotion*.
- Built a dynamic model capable of simulating the dynamics of the robotic centipede in two and three-dimensions utilizing the Spring Loaded Inverted Pendulum (SLIP) template for the dynamical model.
- Responsible of design, software development and manufacturing of custom mechanical and electrical research platforms: *CKbot*.
- Gait Generation and hardware design for the *Self-Assembly after Explosion (SAE)*. TechFest presentations in Chicago (2008) and Bombay (2009).

Selected Projects

MLE+: Cloud-Based Optimization

- The cloud module in MLE+ leverages the computation power of Amazon Elastic Compute Cloud Units (EC2) provided by Amazon Web Services (AWS) for highly-intensive simulations.
- The module computes the optimal campus control strategy when faced with a DR event using MLE+.
- The system automatically balances and dispatches the computation of the EnergyPlus and Matlab/Simulink models into the Amazon Elastic Compute Cloud (EC2) service.

Low-Cost Portable Wireless Sensor System for Inverse Building Modeling

- The project aimed at developing and deploying a wireless sensor network for identifying and training a model that can support Model Predictive Control. This work examined sensitivity of model training results to the location, density of sensors and richness of training data via simulation and through real deployment. To gather environment data (solar radiation, ambient temperature, etc) I designed, built and deployed a fleet of low-cost wireless sensor nodes.
- This project was part of the Energy-Efficient Buildings Hub (*EEB Hub*) supported by the Department of Energy. This initiative focused on advancing promising areas of energy science and engineering from the earliest stages of research to the point of commercialization.

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iBod: Wearable Electrocardiogram Patch

- The project focused on heart monitoring and detection of arrhythmia for long term monitoring (1-2 month). A low power Real-Time Operating System (Nano-RK) was used to schedule the multiple tasks like sensing, RF transmission, feature extraction and arrhythmia detection. A mobile application recollected and displayed vital signs and the full ecg signal.
- This project required a strong understanding of analog and digital circuitry. The board implemented stringent analog filtering to capture the ECG pulse in a low SNR environment.

Modular Robotics: Robotic Centipede

- This project researched a scalable biologically-inspired legged style of locomotion using the modular robotic platform *CKbot*. Each module consist of a hobby servo that drives a rotary degree of freedom.
- The dynamic locomotion is achieved with a *modular robot* with pure body articulation and passive compliant legs. The Communication to each module is through a global bus based on the RoboticsBus protocol built on the CANbus standard.

Publications

Bernal, W.; Behl, M.; Nghiem, T.; and Mangharam, R. **Campus-wide integrated building energy simulation** *In ASHRAE/IBPSA-USA Building Simulation Conference, Atlanta, 2014.*

Willy Bernal, Madhur Behl, Truong X. Nghiem, and Rahul Mangharam **MLE+: A Tool for Integrated Design and Deployment of Energy Efficient Building Controls**, *4th ACM Workshop On Embedded Sensing Systems For Energy-Efficiency In Buildings*. (BuildSys '12), Toronto, Canada. 2012.

Sastra, J., **Bernal Heredia, W.**, Yim, M. and Clark J. **A Biologically-Inspired Dynamic Legged Locomotion with a Modular Reconfigurable Robot**, *Dynamic System Control Conference*. 2008.

Technical skills

Engineering Expertise	Control: Linear Systems Theory, Feedback, Non-Linear Control and Optimal Control Theory. Optimization: Linear Optimization, Convex Optimization. Robotics: Machine Perception, Motion Planning. Statistics: Support Vector Machines, Regression Analysis, Estimation.
Embedded Systems	Entensive Hardware and software experience in embedded systems, Real Time operating systems, wireless cards (Chipcon CC2420), and analog and digital electronics. Firefly, CKbot. ARM microprocessors (mbed), Motorola MCU's, Texas Instruments MCU's, Atmel ATmega MCU's, Microchip PIC MCU's, and others).
RTOS	Real-Time Operating Systems: Nano-RK,ChibiOS/RT
Programming	C/C++, Java, Matlab, HTML, Python, CSS.
Matlab	Experience with the following packages: Linear Algebra, Fourier transforms, Nonlinear Numerical Methods, Support Vector Machines, GUI utilities, Optimization, Communication tools, Visualization, Simulink, MPC toolbox.

References

mLAB	Academic Advisor: **Dr. Rahul Mangharam**. rahulm@seas.upenn.edu
NREL	Supervisor: **Dr. Brian Ball**. Brian.Ball@nrel.gov
Lit Motors	Co-Worker: **M.Eng. Harsh Jain**. reach.harsh10@gmail.com

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