

Craig Beal

Curriculum Vitae

87 Hulme Ct. Apt. 419
Stanford, CA 94305
607.427.2443
cbeal@stanford.edu
<http://stanford.edu/~cbeal>

Education

- Stanford University** - Stanford, CA *Spring 2011*
Ph.D. in Mechanical Engineering
Thesis: Applications of Model Predictive Control to Vehicle Dynamics for Active Safety and Stability
My dissertation describes a framework for using model predictive control to assist drivers in maintaining control of a vehicle in highly dynamic situations. Key to the controller development are models that represent essential tire nonlinearities. Experimental results demonstrate the efficacy of my envelope controller in maintaining control of the vehicle and proofs of controller behavior describe the nominal and worst-case dynamics in the case of sudden friction changes.
Research Group: Dynamic Design Laboratory
Advisor: J. Christian Gerdes
GPA: 3.74/4.0
- Stanford University** - Stanford, CA *April 2006*
M.S. in Mechanical Engineering
GPA: 3.72/4.0
- Bucknell University** - Lewisburg, PA *May 2005*
B.S. with Honors in Mechanical Engineering
GPA: 4.0/4.0 (Summa Cum Laude)

Teaching Experience

- Vehicle Dynamics and Control** - Stanford Graduate Teaching Affiliate *Spring 2010*
Taught *Vehicle Dynamics and Control* with peer lab member. Lectured weekly, held office hours, revised homework and labs, and graded assignments. Rewrote lectures and collaboratively developed midterm. Coached and evaluated final research project teams. Competitive with Stanford ME faculty teaching evaluations with highest marks in “interactions with students.”
- Mentor for Visiting European Diploma Thesis Students** - Stanford *2008-2010*
Advised German and Swiss students in thesis work. Helped students align research to resources available at Stanford. Met frequently to monitor progress and brainstorm solutions to research problems.
- Vehicle Dynamics and Control** - Stanford Course Assistant *Spring 2009*
Hosted office hours, graded assignments, conducted midterm review. Wrote and presented lecture on theory and implementation of electronic stability control. Coached final research project teams.
- Manufacturing Processes** - Bucknell Teaching Assistant *Winter 2005*
Provided guidance to students learning CAD/CAM software for design and CNC machining. Supervised bench-top CNC machining lab, graded student homework assignments.
- Classical and Modern Physics** - Bucknell Lab Assistant *2002-2003*
Instructed students on proper use of physics lab equipment. Monitored progress in lab exercises, explained underlying concepts, conducted verbal “check-out” quizzes with lab teams.
- Science and Engineering Course Design** *Winter 2010*
Enhanced skills in structuring the content and delivery of courses in science and engineering through Stanford Center for Teaching and Learning. Developed syllabus and materials for a hypothetical introductory lab class in control systems.

Research Experience

Stanford University - Graduate Research Assistant

2005 – present

My research is focused on the design and development of active automotive safety systems that have the capability to reduce the risk of loss-of-control accidents to vehicle occupants.

Model Predictive Envelope Control

Designed a state envelope guaranteeing vehicle stability that included the determination of boundaries that are intuitive for human drivers. Implemented a model predictive controller to keep vehicle inside boundaries of the envelope and adjusted the underlying vehicle model to include essential tire nonlinearities. Collected data from dynamic driving maneuvers to examine controller performance and developed proofs of controller action with worst-case performance guarantees.

Development of a Modular Electric Vehicle Research Testbed

As part of the initial design team, analyzed vehicle chassis design for safety, modularity, and aesthetics. Designed and assembled high-voltage electric charging and drive systems and coordinated installation of FlexRay communication bus for distributed sensing and control. Once operational, installed networked sensing and data collection systems on the vehicle.

Roll Dynamics Control with Model Prediction

Developed model predictive controller to indirectly control body roll dynamics by altering the planar behavior of the vehicle with coordinated differential drive and four-wheel steering.

Control of Vehicle Body Roll with Active Suspension

Modeled hazardous suspension dynamics leading to rollover situations. Designed an active suspension to reduce suspension loading and rollover in highly dynamic situations.

Bucknell University - Undergraduate Student Researcher

2001 – 2005

Development and Validation of Controllers using Pulse Width Control Technique

Developed and validated two pulse width control schemes to improve precision positioning of a two degree-of-freedom flexible robotic arm in the presence of stick-slip friction.

Design of a Control System for an Animatronic Figure

Designed and implemented control hardware and software to improve life-like motion of a large scale animatronic figure using a novel actuator technology being explored by Universal Studios.

Industry Experience

Lockheed Martin Systems Integration, Owego, NY - Intern

Summer 2005

Performed stress analysis for an equipment rack to be installed on the MH-60 series of naval helicopters. Co-authored a safety-of-flight stress analysis report detailing the results.

Lockheed Martin Systems Integration, Owego, NY - Intern

Summer 2004

Designed a dummy radar antenna mechanism for checking clearances before final radar installation on the MH-60 series of naval helicopters. Created a database used for tracking the weight of equipment installed on the aircraft.

Institute for Leadership in Technology and Management, Bucknell University

Summer 2003

Attended seminars and discussion sessions focused on leadership at the intersection of the fields of engineering and management. With a multi-disciplinary final project team, consulted for a business software company to focus the company's portfolio of services and improve the company's market share in the regional market.

Metal Fab, LLC., Binghamton, NY - Intern

Summer 2001

Learned basic metal fabrication skills including shearing, bending, rolling, and punching of sheet metal and plate. Also performed MIG welding on sheet metal and heavy plate.

Professional Service

Reviewer - International Federation of Automatic Control (IFAC) World Congress	2011
Reviewer - IFAC International Symposium on Advances in Automotive Control	2010
Reviewer - ASME Dynamic Systems and Control Conference	2010
Representative - Student Panel for Stanford Mechanical Engineering Broad Faculty Search	2010

Honors and Awards

Best Presentation in Session - 2010 American Control Conference	June 2010
Stanford Graduate Fellow - 3 year fellowship for graduate research	2005 – 2008
Tau Beta Pi National Scholarship	2004 – 2005
Eagle Scout	January 2000

Memberships

American Society for Engineering Education	2010 – present
Tau Beta Pi National Engineering Honor Society	2004 – present
American Society of Mechanical Engineers	2003 – present

Publications and Talks

Journal Papers

- C. E. Beal and J. C. Gerdes, “Model Predictive Control for Vehicle Stabilization at the Limits of Handling,” *IEEE Transactions on Control Systems Technology*, 2011. (In Preparation).
- C. E. Beal and J. C. Gerdes, “Boundary Selection for Vehicle Envelope Control,” *Vehicle System Dynamics*, 2011. (In Preparation).

Conference Papers Presented

- C. E. Beal and J. C. Gerdes, “Rollover Event Prevention Through Predictive Control of Coordinated Actuators,” in *Proceedings of the 21st International Symposium on Dynamics of Vehicles on Roads and Tracks, Stockholm, Sweden*, International Association for Vehicle System Dynamics, August 2009.
- C. E. Beal and J. C. Gerdes, “Enhancing Vehicle Stability Through Model Predictive Control,” in *Proceedings of the 2009 ASME Dynamic Systems and Control Conference, Hollywood, USA*, ASME DSCD, October 2009.
- C. E. Beal and J. C. Gerdes, “Predictive Control of Vehicle Roll Dynamics with Rear Wheel Steering,” in *Proceedings of the 2010 American Control Conference, IFAC AACC, June-July 2010*. (Best Presentation in Session Award).
- C. E. Beal and J. C. Gerdes, “Experimental Validation of a Linear Model Predictive Envelope Controller in the Presence of Vehicle Nonlinearities,” in *2010 IFAC Symposium on Advances in Automotive Control, IFAC Technical Committee on Automotive Control, July 2010*.
- C. E. Beal and J. C. Gerdes, “A Method for Incorporating Nonlinear Tire Behavior into Linear Model Predictive Control for Vehicle Stability,” in *Proceedings of the 2010 ASME Dynamic Systems and Control Conference, Boston, Massachusetts, USA, ASME DCSD, October 2010*.

Conference Papers

- K. W. Buffinton, A. D. Perkins, C. E. Beal, and M. C. Berg, “Evaluation of Pulse-Width Controllers for Multi-Link, Revolute-Jointed Robotic Arms,” in *Proceedings of the IASTED International Conference on Robotics and Applications, Oct.-Nov. 2005*.

Theses

- C. E. Beal, *Applications of Model Predictive Control to Vehicle Dynamics for Active Safety and Stability*. PhD thesis, Stanford University, Spring 2011. (In Preparation).
- C. Beal, *Pulse-Width Control Criteria and Evaluation for Serially Connected Flexible Robotic Arms*. Undergraduate honors thesis, Bucknell University, May 2005.

Invited Talks

Driven: Steering yourself to a degree

ME201: Dim Sum of Mechanical Engineering Seminar
December 2010 - Stanford University

Staying in control at the limits of handling: A model predictive envelope controller to keep you and your car out of danger.

Mechanical Engineering Seminar Series
September 2010 - Villanova University

Vehicle Dynamics Principles for Formula SAE

July 2008 - York College of Pennsylvania

References

J. Christian Gerdes - Associate Professor of Mechanical Engineering

Director, Center for Automotive Research at Stanford (CARS)

Co-Director, Center for Design Research

Stanford University
Building 550, Room 102
416 Escondido Mall
Stanford, CA 94305-4021
650.823.1174

Sheri Sheppard - Professor of Mechanical Engineering

Associate Vice Provost for Graduate Education

Co-Director, Center for Design Research

Stanford University
Building 550, Room 119
416 Escondido Mall
Stanford, CA 94305-4021
650.723.4287

Stephen Boyd - Professor of Electrical Engineering

Samsung Professor in the School of Engineering

Stanford University
Packard Building, Room 264
Stanford, CA 94305-4021
650.723.0002

Markus Maurer - Professor of Automotive Electronic Systems

Professor of the Institute of Control Engineering

Technical University of Braunschweig
Hans-Sommer-Str. 66, Room 620
D-38106 Braunschweig, Germany
+49.0531.391.3838