Blane A. Rhoads, Ph.D.

10399 SW Eastridge St
Portland, OR 97225
918 232 0440
blane.rhoads@gmail.com
http://blanerhoads.com

EDUCATION

Ph.D., Mechanical Engineering **2007 – 2013**
Dissertation: Efficient guidance of underpowered vehicles in time-varying flow fields (Abstract below)
Doctoral Committee: I Mezić (chair), A Teel, F Gibou, J Moehlis
Emphases:

- Computational Science & Engineering
- Dynamical Systems, Control, & Robotics

Relevant Coursework:

- Stochastic Processes, Real Analysis, Parallel Computing, Optimal Control, Linear and Nonlinear Systems, Numerical Methods for ODEs and PDEs, Level Set Methods.

University of California, Santa Barbara
Santa Barbara, CA 93106

B.S., Applied Mathematics **2003 – 2007**
B.S., Mechanical Engineering
Minor, Spanish
University of Tulsa
800 S Tucker Dr
Tulsa, OK 74104

RESEARCH EXPERIENCE

Senior Imaging Scientist – Computational Lithography **January 2014 – present**
Intel Corporation Hillsboro, OR

- Debugged, refactored, wrote, tested, and parallelized cutting-edge C++ software in the million+ line code-base that houses Intel's Optical Proximity Correction (OPC) tool suite, helping CLT win its record-setting 4th Intel Achievement Award.
- Developed innovative image processing algorithms to better utilize state-of-the-art lithography models in CLT's production-critical defect identification tool.
- Overhauled core image processing algorithms on short notice to enable on-time release of CLT's most advanced model calibration tool.

Research Assistant **2008 – 2013**
University of California, Santa Barbara Santa Barbara, CA

- Developed Lagrangian and semi-Lagrangian algorithms for front tracking and globally optimal trajectories of underpowered vehicles in time-varying ocean flow fields.
- Characterized relationship between optimal trajectories in flow fields and Lagrangian quantities such as finite time Lyapunov exponents (FTLEs).
- Implemented object-oriented quadtree/octree/"n-d tree" & triangle/tetrahedron adaptive mesh refinement (AMR) algorithms for solution of PDEs and visualization of state space structures in complex dynamical systems such as ocean flow fields and neuron models.

Research Assistant – Controls Group, Systems Department **Fall 2012**
United Technologies Research Center East Hartford, CT

- Developed from scratch a variant of the Fast Marching algorithm for feedback control of a point mass autonomous vehicle in an obstacle-rich environment.
- Improved existing implementation of integral-constrained multi-objective path planning algorithm, in the context of Probablistic Road Map (PRM) graph generation algorithms.

Research Assistant – Combustion Research Facility **Summer 2009**
Sandia National Lab Livermore, CA

- Evaluated accuracy and efficiency of a new method of model reduction for stiff chemical systems known as Computational Singular Perturbation (CSP) with Tabulation.
- Improved the k-d tree tabulation efficiency by generalizing the Euclidean distance metric to properly account for the anisotropy of the state space – e.g. for the 10-dimensional case of pre-mixed hydrogen and air.

TEACHING EXPERIENCE

Teaching Assistant – Mechanical Engineering Department **2007 – 2012**
University of California, Santa Barbara Santa Barbara, CA

- Statics (Fall 2007)
- Vibrations (Winter 2008)
- Dynamics (Spring 2009)
- Control Systems (Spring 2012)
- Robot Design (Fall 2012)

Private Tutor **2004 – 2011**

- Linear algebra, calculus, geometry, physics, Spanish.

OTHER RELEVANT EXPERIENCE

Engineering Intern – Assembly Capital Equipment Development **Summer 2007**
Intel Corporation Chandler, AZ

- Recommended design changes for next generation (i.e. 450mm wafer) process tools, based on research of various production delays; delivered an Excel macro to automatically convert raw "station controller" data into useful visualizations of long-term process tool activity.
- Created and proved a standard set of CPU substrates with 2D Data Matrix ID laser marks of varying quality, for benchmarking various ID reading camera systems.

SKILLS & INTERESTS

Proficient in:

- C++, Matlab, STL, Unix/Linux, CVS, SVN, SlickEdit, Visual Studio, Excel/VBA, LaTex, PowerPoint.
- Algorithms, object-oriented programming (OOP), computational geometry, quadtrees/octrees, robotics, optimal control, global optimization, parallel computing, image processing, big data.

Familiar with / interested in:

- Java, Hadoop, SQL, Python, Perl, Bash, GIT, OPC, EDA.
- k-d trees, graph theory, distributed systems, high performance computing, machine learning.

PEER-REVIEWED JOURNAL ARTICLES

A Mauroy, B Rhoads, J Moehlis, I Mezić. Global isochrons and phase sensitivity of bursting neurons. SIAM Journal on Applied Dynamical Systems 13 (1), 306-338. 2014.

B Rhoads, I Mezić, AC Poje. Minimum time heading control of underpowered vehicles in time-varying ocean currents. Ocean Engineering 66, Elsevier, 12-31. 2013.

BJ Debusschere, YM Marzouk, HN Najm, B Rhoads, DA Goussis, M Valorani. Computational singular perturbation with non-parametric tabulation of slow manifolds for time integration of stiff chemical kinetics. Combustion Theory and Modelling 16 (1), 173-198. 2012.

PEER-REVIEWED CONFERENCE PAPERS

B Rhoads, I Mezić, A Poje. Efficient Guidance in finite time flow fields. 52nd IEEE Conference on Decision and Control (CDC), 6182-6189. 2013.

B Rhoads, I Mezić, A Poje. Minimum time feedback control of autonomous underwater vehicles. 49th IEEE Conference on Decision and Control (CDC), 5828-5834. 2010.

S Radloff, M Abravanel, B Rhoads, D Steeg, P Van der Meulen, M Petraitis. First wafer delay and setup: How to measure, define and improve first wafer delays and setup times in semiconductor fabs. Advanced Semiconductor Manufacturing Conference (ASMC). IEEE/SEMI, 86-90. 2009.

CONFERENCE PRESENTATIONS

2013 SIAM Conference on Applications of Dynamical Systems – Minisymposium presentation**.**
2011 SIAM Conference on Applications of Dynamical Systems – Poster presentation.
2009 SIAM Conference on Applications of Dynamical Systems – Contributed presentation.

HONORS

2012/13 Best Teaching Assistant **2013**
Department of Mechanical Engineering, University of California, Santa Barbara

Summa Cum Laude **2007**
University of Tulsa

Faculty Honors Medal **2007**
University of Tulsa

Phi Beta Kappa National Honor Society **2007**
University of Tulsa

Tau Beta Pi Engineering Honor Society **2006**
University of Tulsa

ASSOCIATIONS

Society for Industrial and Applied Mathematics (SIAM) **2008-2013**

American Society of Mechanical Engineers (ASME) **2003-2007**

DISSERTATION ABSTRACT

In this thesis we study high-level trajectory planning for underpowered vehicles in spatially complex, 2D, time-varying flow fields. In particular, we consider a minimum time problem and a minimum energy problem. These problems are difficult because locally optimal trajectories abound and currents stronger than the vehicle can push it far off course. Nevertheless, globally optimal trajectories can be obtained by numerical solution of a dynamic Hamilton Jacobi Bellman (HJB) partial differential equation (PDE) for the time-varying optimal cost-to-go function---the gradient of which yields an optimal feedback control law. Locally optimal trajectories are associated with shocks---discontinuities in the gradient of the cost-to-go. Strong currents are associated with discontinuities in the cost-to-go itself. Existing work is primarily concerned with the proper capturing of shocks, and is mostly limited to weak, time-invariant flows. But strong, time-varying flows play a large role in the real-life problem. Thus the characterization of solutions for realistic flows has involved significant experimentation with novel solution approaches. A key theme has been the complementary nature of Eulerian or semi-Lagrangian finite difference methods and Lagrangian particle methods. The former methods are associated with implicit front tracking methods such as Level Set Methods and Fast Marching, and rely on shock-capturing (e.g. Godunov) schemes. The latter methods are associated with explicit front tracking methods but compute particle trajectories in a higher-dimensional state-``costate'' space using the well-known Euler Lagrange ordinary differential equations; these are variants of the so-called ``extremal field'' method. Other themes include the use of adaptive grids and the dichotomy between backward-in-time methods for closed-loop optimal trajectories and forward-in-time methods for open-loop optimal trajectories. In all cases, the resulting trajectories are globally optimal. First, we present a forward-in-time Lagrangian method that exploits a special property of minimum time control to obtain open-loop optimal trajectories, without actually solving the dynamic HJB equation. The algorithm proved highly dependent on adaptive remeshing of the Lagrangian marker particles along the tracked front and a rather complicated trimming procedure for local optima. Examples include a numerically defined strong, time-varying flow field from a model of the Adriatic Sea. Second, we present a backward-in-time semi-Lagrangian method on an adaptive triangle grid for the fixed final time minimum energy problem. The algorithm effectively transforms the optimal control problem into a point wise optimization problem, which we choose to solve exactly by keeping the discretizations first order in space and time. In the end, there turn out to be fundamental limitations on the performance of this algorithm, due to the computational complexity of the point wise optimization problem. Third, we briefly present an idea for a coordinate transformation based on the Jacobian of the so-called flow map---the state at the fixed final time if one were to turn the control off. This suggests a greedy heuristic control scheme, which we compare to the minimum energy control. Finally, we conclude with a 1D proof of concept for a hybrid Lagrangian-Eulerian minimum energy algorithm that combines the best of the Lagrangian minimum time algorithm and the semi-Lagrangian minimum energy algorithms.