

Dave I. Ferguson

CONTACT INFORMATION

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RESEARCH INTERESTS

I'm interested in solving hard, real world problems. My current research focuses on developing intelligent autonomous systems, from driverless cars to robotic butlers, and the challenges associated with creating such systems. In particular, I'm developing techniques to enable sophisticated reasoning given imperfect information and complex, high-dimensional problem spaces. I'm also interested in the application of these techniques to a wide range of domains.

EDUCATION

Carnegie Mellon University, Pittsburgh, PA

Ph.D., Robotics, September, 2006
M.S., Robotics, May, 2004

- Advised by Anthony Stentz and Sebastian Thrun
- Dissertation area: Reasoning for single agents and multi-agent teams operating in unknown and dynamic environments

University of Otago, Dunedin, New Zealand

B.S. Honors, Computer Science and Mathematics, November, 2001

- General and departmental academic honors.
- Highest ranked computer science student for three years.
- Awards for top student in mathematics, physics, and legal studies.

RESEARCH AND WORK EXPERIENCE

Research Scientist, Intel Research

2006 - present

Adjunct Faculty, Carnegie Mellon University

2006 - present

Principal Investigator, Personal Robotics. Currently co-lead Personal Robotics at Intel Research, where we are creating an autonomous mobile manipulator for performing useful tasks in unstructured indoor environments. Have developed novel algorithms for reasoning under uncertainty and applied them to generating smooth trajectories for an 11 degree-of-freedom robotic arm and autonomous navigation of a robotic Segway in cluttered, dynamic spaces.

Planning Lead, Urban Grand Challenge. Planning lead for Carnegie Mellon's winning entry into the DARPA Urban Grand Challenge, an autonomous robotic race through an urban environment. Coordinated the talents of a team of world-class researchers to advance the state of the art in motion planning and driverless vehicles. In November 2007 our team won the Urban Challenge and received the \$2 million award for first place.

Ph.D. Student, Carnegie Mellon University

2002 - 2006

Planning Research. Research focused on navigation, planning, coordination, and mapping for robotic systems operating in the real world. Developed several algorithms to plan for single agents and multi-agent teams operating in partially-known and dynamic environments. These algorithms have been implemented on a wide range of fielded robotic systems, including off-the-shelf products, custom-built outdoor vehicles, and passenger cars.

Mars Exploration Rovers. Developed an algorithm for long range navigation that was selected by NASA for inclusion in the autonomy framework of the Mars Exploration Rovers. Worked with NASA to integrate it into their system and it is currently being used for autonomous traverses on Mars.

Software Lead, Mine Mapping Project. Led a software team to develop an autonomous mine mapping robot in response to the Quecreek mining accident in 2002. In one year the team created a robotic system and successfully deployed it into an unknown, abandoned mine. Subsequently, a robotics company has been created to bring this technology to the market.

FELLOWSHIPS,
SCHOLARSHIPS,
AND AWARDS

NASA Space Act Award	2007
National Science Foundation Graduate Research Fellowship	2004 - 2006
Carnegie Mellon Graduate Student Scholarship	2002 - 2004
University of Otago Senior Scholarship in Science Awarded to 3 exceptional science honors students in their final year.	2001
Black Albatross Award Awarded to the top computer science student in the university.	1999 - 2001
Beverly Bursary in Mathematics, Statistics, and Physics Awarded to outstanding students in mathematics, statistics, and physics.	1998 - 2001
The Stuart Prize¹, the Brooker's Prize², the Bell Prize³, the Sawyer Prize⁴ Awarded to the top student in: (1) first-year physics, (2) first-year legal studies, (3) second-year mathematics, (4) third-year mathematics.	1998 - 2001

PATENTS

W. Whittaker, W. Whittaker, S. Thayer, Z. Omohundro, C. Reverte, D. Ferguson, A. Morris, and C. Baker. *Robotic Modeling of Voids*. U.S. Patent 7069214.

JOURNAL AND
MAGAZINE
ARTICLES

C. Baker, D. Ferguson, and J. Dolan. A Robust Reasoning Framework for Autonomous Urban Driving. Submitted to *Journal of Intelligent Transportation Systems*, 2008.

T. Howard, C. Green, D. Ferguson, and A. Kelly. State-space Sampling of Feasible Motions for High Performance Mobile Robot Navigation in Complex Environments. Accepted to *Journal of Field Robotics*, 2007.

C. Urmson et al. Autonomous Driving in Urban Environments: Boss and the Urban Challenge. Accepted to *Journal of Field Robotics*, 2008.

N. Kalra, D. Ferguson, and A. Stentz. Incremental Reconstruction of Generalized Voronoi Diagrams. *Journal of Robotics and Autonomous Systems*, 2007. In press.

M. Likhachev, D. Ferguson, et al. Anytime Planning in Large, Dynamic Graphs. *Artificial Intelligence*, 2007. To appear.

N. Kalra, D. Ferguson, and A. Stentz. Hoplitest: A Market-based Framework for Planned Tight Coordination in Multirobot Teams. *Journal of Autonomous Robots*, 2007. To appear.

D. Ferguson and A. Stentz. Using Interpolation to Improve Path Planning: The Field D* Algorithm. *Journal of Field Robotics*, 23(2): 79–101, 2006.

D. Silver, D. Ferguson, A. Morris, and S. Thayer. Topological Exploration of Subterranean Environments. *Journal of Field Robotics*, 2006.

A. Morris, D. Ferguson, et al. Recent Developments in Subterranean Robotics. *Journal of Field*

Robotics, 23(1): 35–57, 2006.

S. Thrun, S. Thayer, W. Whittaker, C. Baker, W. Burgard, D. Ferguson, D. Hähnel, M. Montemerlo, A. Morris, Z. Omohundro, C. Reverte, and W. Whittaker. Autonomous Exploration and Mapping of Abandoned Mines. *IEEE Robotics and Automation Magazine*, 11(4): 79–91, 2004.

CONFERENCE
PAPERS

D. Ferguson, T. Howard, and M. Likhachev. Motion Planning in Urban Environments: Part I. *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2008.

D. Ferguson, T. Howard, and M. Likhachev. Motion Planning in Urban Environments: Part II. *IEEE/RSJ International Conference on Intelligent Robots and Systems*, 2008.

M. Likhachev and D. Ferguson. Planning Long Dynamically-Feasible Maneuvers for Autonomous Vehicles. *Robotics: Science and Systems*, 2008. Also appeared in *First International Symposium on Search Techniques in Artificial Intelligence and Robotics*, 2008.

R. Diankov, N. Ratliff, D. Ferguson, S. Srinivasa, and J. Kuffner. BiSpace Planning: Concurrent Multi-Space Exploration. *Robotics: Science and Systems*, 2008.

C. Baker, D. Ferguson, and J. Dolan. Robust Mission Execution for Autonomous Urban Driving. *International Conference on Intelligent Autonomous Systems*, 2008.

S. Srinivasa, D. Ferguson, M. Vande Weghe, R. Diankov, D. Berenson, C. Helfrich, and H. Strasdat. The Robotic Busboy: Steps Towards Developing a Mobile Robotic Home Assistant. *International Conference on Intelligent Autonomous Systems*, 2008.

D. Ferguson, C. Baker, M. Likhachev, and J. Dolan. A Reasoning Framework for Autonomous Urban Driving. *IEEE Intelligent Vehicles Conference*, 2008.

D. Ferguson, M. Darms, C. Urmson, and S. Kolski. Detection, Prediction, and Avoidance of Dynamic Obstacles in Urban Environments. *IEEE Intelligent Vehicles Conference*, 2008.

D. Ferguson and M. Likhachev. Efficiently using Cost Maps for Planning Complex Maneuvers. *Workshop on Planning with Cost Maps, IEEE International Conference on Robotics and Automation*, 2008.

M. Vande Weghe, D. Ferguson, and S. Srinivasa. Randomized Path Planning for Redundant Manipulators Without Inverse Kinematics. *IEEE International Conference on Humanoid Robots*, 2007.

D. Ferguson. Autonomous Automobiles: Developing Cars That Drive Themselves. *ACM/IEEE Design Automation Conference*, 2007.

D. Ferguson and A. Stentz. Anytime, Dynamic Planning in High-dimensional Search Spaces. *IEEE International Conference on Robotics and Automation*, 2007.

N. Kalra, D. Ferguson, and A. Stentz. A Generalized Framework for Solving Tightly-coupled Multi-robot Planning Problems. *IEEE International Conference on Robotics and Automation*, 2007.

J. Carsten, A. Rankin, D. Ferguson, and A. Stentz. Global Path Planning on-board the Mars Exploration Rovers. *IEEE Aerospace Conference*, 2007.

S. Kolski, D. Ferguson, C. Stachniss, and R. Siegwart. Autonomous Driving in Dynamic Environments. Workshop on Safe Navigation in Open and Dynamic Environments, *IEEE International Conference on Intelligent Robots and Systems*, 2006.

- D. Ferguson and A. Stentz. Anytime RRTs. *IEEE International Conference on Intelligent Robots and Systems*, 2006.
- J. Carsten, D. Ferguson, and A. Stentz. 3D Field D*: Improved Path Planning and Replanning in Three Dimensions. *IEEE International Conference on Intelligent Robots and Systems*, 2006.
- S. Srinivasa and D. Ferguson. Meet Point Planning for Multirobot Coordination. *IEEE International Symposium on Robotics and Automation*, 2006.
- D. Ferguson, N. Kalra, and A. Stentz. Replanning with RRTs. *IEEE International Conference on Robotics and Automation*, 2006.
- J. van den Berg, D. Ferguson, and J. Kuffner. Anytime Path Planning and Replanning in Dynamic Environments. *IEEE International Conference on Robotics and Automation*, 2006.
- N. Kalra, D. Ferguson, and A. Stentz. Constrained Exploration for Studies in Multirobot Coordination. *IEEE International Conference on Robotics and Automation*, 2006. **Winner of Best Short Paper Award.**
- S. Kolski, D. Ferguson, M. Bellino, and R. Siegwart. Autonomous Driving in Structured and Unstructured Environments. *IEEE Intelligent Vehicles Symposium*, 2006.
- D. Ferguson and A. Stentz. Randomized Planning for Multi-agent Teams. *AUVSI Unmanned Systems North America*, 2006.
- D. Ferguson and A. Stentz. Multi-resolution Field D*. *International Conference on Intelligent Autonomous Systems*, 2006.
- N. Kalra, D. Ferguson, and A. Stentz. Incremental Reconstruction of Generalized Voronoi Diagrams on Grids. *International Conference on Intelligent Autonomous Systems*, 2006.
- D. Ferguson and A. Stentz. Field D*: An Interpolation-based Path Planner and Replanner. *International Symposium on Robotics Research*, 2005.
- D. Ferguson, M. Likhachev, and A. Stentz. A Guide to Heuristic-based Path Planning. *International Workshop on Planning under Uncertainty for Autonomous Systems, International Conference on Automated Planning and Scheduling*, 2005.
- M. Likhachev, D. Ferguson, et al. Anytime Dynamic A*: An Anytime, Replanning Algorithm. *International Conference on Automated Planning and Scheduling*, 2005.
- D. Ferguson and A. Stentz. The Delayed D* Algorithm for Efficient Path Replanning. *IEEE International Conference on Robotics and Automation*, 2005.
- N. Kalra, D. Ferguson, and A. Stentz. Hoplitess: A Market-Based Framework for Planned Tight Coordination in Multirobot Teams. *IEEE International Conference on Robotics and Automation*, 2005.
- A. Morris, D. Silver, D. Ferguson, and S. Thayer. Towards Topological Exploration of Abandoned Mines. *IEEE International Conference on Robotics and Automation*, 2005.
- D. Ferguson and A. Stentz. Focussed Processing of MDPs for Path Planning. *IEEE International Conference on Tools with Artificial Intelligence*, 2004.
- D. Ferguson and A. Stentz. Robust Path Planning with Imperfect Maps. *Army Science Conference*,

2004.

D. Ferguson and A. Stentz. Planning with Imperfect Information. *IEEE International Conference on Intelligent Robots and Systems*, 2004.

D. Silver, D. Ferguson, A. Morris, and S. Thayer. Feature Extraction for Topological Mine Maps. *IEEE International Conference on Intelligent Robots and Systems*, 2004.

D. Ferguson, A. Stentz, and S. Thrun. PAO* for Planning with Hidden State. *IEEE International Conference on Robotics and Automation*, 2004.

C. Baker, A. Morris, D. Ferguson, et al. A Campaign in Autonomous Mine Mapping. *IEEE International Conference on Robotics and Automation*, 2004.

D. Ferguson, A. Morris, D. Hähnel, et al. An Autonomous Robotic System for Mapping Abandoned Mines. *Neural Information Processing Systems*, 2003.

S. Thrun, D. Hähnel, D. Ferguson, et al. A system for volumetric mapping of underground mines. *IEEE International Conference on Robotics and Automation*, 2003.

D. Ferguson and W. Labuschagne. Information-theoretic semantics for epistemic logic. *International Conference on Logic and the Foundations of Game Theory*, 2002.

M. Jefferies, W. Yeap, L. Smith and D. Ferguson. Building a map for robot navigation using a theory of cognitive maps. *IASTED International Conference on Artificial Intelligence and Applications*, 2001.

M. Jefferies, W. Yeap, L. Smith and D. Ferguson. Computing individual local spaces for a mobile robot: An initial algorithm. *International Conference on Cognitive Science*, 2001.

REFERENCES

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