

Christopher Urmson

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Research Interests

Autonomous vehicles
Algorithms for perception and navigation
Software architectures for autonomous systems

Education

Ph.D. Robotics: Navigation Regimes for Off-Road Autonomy (2005)

Carnegie Mellon University, Pittsburgh, PA.
Advisors: Prof. William “Red” Whittaker and Prof. Reid Simmons

B.Sc. Computer Engineering *with Distinction* (1998)

University of Manitoba, Winnipeg, Canada.
CGPA: 4.25/4.5

Professional Experience

Director of Technology for the Urban Challenge (June 2006 – Present)

Robotics Institute, Carnegie Mellon University

Robotics Research Scientist (November 2004 – June 2006)

Advanced Concepts Business Unit,
Science Applications International Corporation

Adjunct Faculty (March 2005 – June 2006)

Robotics Institute, Carnegie Mellon University

Red Team Technical Leader (August 2003 – May 2004)

Robotics Institute, Carnegie Mellon University

Research Assistant (1998 – 2005)

Robotics Institute, Carnegie Mellon University

Research Experience

Research Program for Caterpillar Inc. (co-PI)

The research topic and details for this work are protected by a non-disclosure agreement.

Autonomous Urban Driving (Director of Technology)

Tartan Racing, DARPA Urban Challenge

This project developed a complete autonomous vehicle capable of safely and reliably navigating in urban traffic. Our research encompassed perception, behavioral reasoning, motion planning, and mechatronic design. We demonstrated these capabilities in the context of the DARPA Urban Challenge, winning the competition in 2007.

Pedestrian Detection & Tracking from a Moving Vehicle (PI)

SAIC IR&D

This project developed techniques to detect and track pedestrians from a moving vehicle. Our approach used simple image transforms to detect potential pedestrians in a scene.

Pose Estimation & Modeling from a Walking Robot

DARPA RATPACK program

This project developed algorithms to perform six degree-of-freedom pose estimation and height map building for environments without GPS. Our algorithm builds locally consistent maps and position estimates by combining pedometry, gravity vector sensing and motion estimates from successive depth images from a flash LIDAR. Dynamic programming was used to selectively smooth height maps and estimate heights in occluded regions, generating a map suitable for locomotion planning. A further thrust of this work was the detailed characterization of the CSEM SR-3000 Flash LIDAR.

High-Speed, Off-Road Navigation

Red Team, DARPA Grand Challenge

This project developed new approaches to navigating trails and off-road terrain at high speeds. We demonstrated this capability using a pair of autonomous vehicles which drove at up to 50 mph, on trails and in benign off-road environments. Both vehicles completed the DARPA Grand Challenge (a 132 mile race through the Mojave desert), finishing 2nd and 3rd in 2005.

Reusable Software Architectures for Planetary Rovers

CLARAty

The goal of the CLARAty project is to provide a software framework through which autonomy systems can be rapidly developed and tested. We developed the navigation framework that decomposes the navigation task into sets of reusable and interchangeable software components. This software is now in day-to-day use at two NASA centers.

Social Robotics

Grace, AAI Challenge Robot

This project researched ways to improve human robot interaction. My focus was approaches for standing-in-line using stereo vision and laser line scanners.

Stereo-Vision Based Navigation for Planetary Rovers

Sun Synchronous Navigation, Life in the Atacama

This project developed and demonstrated a planning system capable of accounting for resource constraints. I developed the on-line navigation system and designed the sensing and perception system. As part of this team, I also participated in field testing in Arctic Canada and the Atacama Desert of Chile. During this project I also developed the Linux Firewire Camera interface (now released under the GPL).

Autonomous Mobile Robots for Space Assembly

Skyworker

This project developed a robot for the assembly, inspection and maintenance of large scale space facilities. I led the software and electrical development of the robot.

Advising

PhD. Students

Matthew McNaughton (current)

Young-Woo Seo (current)

Masters Students

Nikhil Naikal (2007)

Thesis Committees

Jarrod Snider (current)

Josh Struble (2006)

Daniel Bartz (2006)

Teaching

Guest Lecturer

Introduction to Robotics
Engineering of Software Intensive Systems
Mechatronic Design

Teaching Assistant

Mobile Robot Design (1999, 2000)

Service

Workshop Organizer (2007)

“The Urban Challenge – Perspectives on Autonomous Driving” at NIPS 2007

Workshop Organizer (2006)

“The DARPA Grand Challenge” at RSS 2006

President Robotics Students Society (2002)

Robotics Institute, Carnegie Mellon University

Vice-President Robotics Students Society (2001)

Robotics Institute, Carnegie Mellon University

Reviewer

Journal of Field Robotics
IEEE Transactions on Systems, Man and Cybernetics
Various academic conferences (ICRA, IROS, ITS, etc.)

Honors and Awards

1st place at the DARPA Urban Challenge (2007)

Science Applications International Corporation RDT&E Technology Award (2005)

2nd and 3rd place at the DARPA Urban Challenge (2005)

Robotics Institute Graduate Fellowship (1998-2005)

Siebel Scholar (class of 2005)

Boeing Red Phantom Award (2004)

Best video, International Conference on Robotics and Automation (2001)

National Science and Engineering Research Council Post Graduate Scholarship, *Declined* (1998)

Dean’s Honor List, Engineering, University of Manitoba (1994-1998)

Canada Scholar (1994-1998)

SHL System House President’s Award (1997)

University of Manitoba Student Union Scholarship (1997)

E.P. Fetherstonhaugh Memorial Scholarship (1997)

University of Manitoba Entrance Scholarship (1994)

Bessie F. Lawrence Scholarship to the Wiezman Institute Summer Program (1994)

Silver Medalist, Canada Wide Science Fair (1992, 1994)

Invited Talks

Innovative Applications of Artificial Intelligence (July 2008)

Chicago, Illinois

Berkeley Robotics and Control Seminar (April 2008)

University of California Berkeley

Qatar Science and Technology Park TECHtalk (March 2008)

Doha, Qatar

Keynote of Spar Point Research Conference 2008 (March 2008)

Houston, Texas

Keynote of Magma Users Summit on Integrated Circuits (February 2008)

Santa Clara, California

American Society of Highway Engineers (February 2008)

Pittsburgh, Pennsylvania

Robotics Institute Seminar (December 2007)

Carnegie Mellon University

Future of Artificial Intelligence in Robotics (November 2007)

NSF & USAF, Gotemba, Japan

Robotics Center Seminar Series (December 2006)

Massachusetts Institute of Technology

Society of American Military Engineers Seminar (September 2006)

Oklahoma University

Computer Science Seminar (May 2006)

Georgia Institute of Technology

Institute for Security Technology Studies Speaker Series (May 2006)

Dartmouth College

National Robotics Engineering Center Seminar (February 2006)

Carnegie Mellon University

Journal Publications

1. Obstacle Detection and Tracking for the Urban Challenge

M. Darms, P Rybski, C. Baker, C. Urmson

Under review for the IEEE Transactions on Intelligent Transportation Systems.

2. Autonomous Driving in Urban Environments: Boss and the Urban Challenge

C. Urmson, J. Anhalt, D. Bagnell, C. Baker, R. Bittner, M. Clark, J. Dolan, D. Duggins, D. Ferguson, T. Galatali, C. Geyer, M. Gittleman, S. Harbaugh, M. Hebert, T. Howard, A. Kelly, N. Miller, M. McNaughton, K. Peterson, M. Likhachev, R. Rajkumar, P. Rybski, B. Salesky, Y. Seo, S. Singh, J. Snider, A. Stentz, W. Whittaker, Z. Wolkowicki, J. Zigar, H. Bae, T. Brown, D. Demitrish, B. Litkouhi, J. Nickolaou, V. Sadekar, W. Zhang, J. Struble, M. Taylor, M. Darms

Under review for the Journal of Field Robotics.

3. A Robust Approach to High-Speed Navigation for Unrehearsed Desert Terrain

C. Urmson, J. Anhalt, D. Bartz, M. Clark, T. Galatali, A. Gutierrez, S. Harbaugh, J. Johnston, H. Kato, P. Koon, W. Messner, N. Miller, A. Mosher, K. Peterson, C. Ragusa, D. Ray, B. Smith, J. Snider, S. Spiker, J. Struble, J. Zigar, W. Whittaker

Journal of Field Robotics, Vol. 23, No. 8, August, 2006, pp. 467-508.

4. Sun-Synchronous Robot Exploration: Technical Description and Field Experimentation

D. Wettergreen, P. Tompkins, C. Urmson, M. Wagner, W. Whittaker
The International Journal of Robotics Research, Vol. 24, No. 1, January, 2005, pp. 3-30.

5. Robotic Assembly of Space Solar-Power Facilities

W. Whittaker, P. Staritz, R. Ambrose, B. Kennedy, S. Fredrickson, J. Parrish, C. Urmson
The Journal of Aerospace Engineering, Volume 14, Issue 2, April 2001, pp. 59-64.

Conference Papers

1. Boss: A Robust Urban Driving Autonomous Vehicle

C. Urmson, C. Baker, M. Darms, J. Dolan, D. Ferguson, P. Rybski, B. Salesky, W. Whittaker
Under review for the International Symposium on Experimental Robotics, 2008.

2. A Multi-sensor Multi-object Tracking System for an Autonomous Vehicle Driving in an Urban Environment

M. Darms, P. Rybski, C. Urmson
Under review for the International Symposium on Advanced Vehicle Control, 2008.

3. A Perception Mechanism for Supporting Autonomous Intersection Handling in Urban Driving

Y. Seo, C. Urmson
Under review for the IEEE/RSJ IROS, 2008.

4. Validating the Performance of an Autonomous Car

M. Clark, R. Bittner, B. Salesky, C. Urmson
To appear, AUVSI Unmanned Systems North America, June 2008.

5. Measuring Software Complexity to Target Risky Modules in Autonomous Vehicle Systems

M. Clark, D. Brennan, B. Salesky, C. Urmson
To appear, AUVSI Unmanned Systems North America, June 2008.

6. Detection, Prediction, and Avoidance of Dynamic Obstacles in Urban Environments

D. Ferguson, M. Darms, C. Urmson, S. Kolski
To appear, IEEE Intelligent Vehicle Symposium, 2008.

7. Classification and Tracking of Dynamic Objects with Multiple Sensors for Autonomous Driving in Urban Environments

M. Darms, P. Rybski, C. Urmson
To appear, IEEE Intelligent Vehicles Symposium, 2008 .

8. Vehicle Detection and Tracking for the Urban Challenge

M. Darms, P. Rybski, C. Urmson
AAET 2008, Braunschweig, Germany, February, 2008.

9. A Complete System for High-Speed Navigation of Prescribed Routes

C. Urmson, A. Gutierrez, N. Miller, K. Peterson, S. Spiker, J. Struble, W. Whittaker
IEEE/RSJ IROS 2006, Beijing, China, October, 2006.

10. Driving Beyond Stopping Distance Constraints

C. Urmson
IEEE/RSJ IROS 2006, Beijing, China, October, 2006.

11. First Experiments in the Robotic Investigation of Life in the Atacama Desert of Chile

D. Wettergreen, N. Cabrol, J. Teza, P. Tompkins, C. Urmson, V. Verma, M.D. Wagner, and W.L. Whittaker
IEEE International Conference on Robotics and Automation, Barcelona, Spain, April, 2005.

12. Low Cost Fault Detection Isolation and Recovery Implemented On an Autonomous Unmanned Vehicle

P. Koon, M. Robertson, C. Urmson, J. Gowdy and K. Peterson
International Conference on Intelligent and Adaptive Systems and Software Engineering, Nice, France, July, 2004.

13. Approaches for Heuristically Biasing RRT Growth

C. Urmson and R. Simmons
IEEE/RSJ IROS 2003, Las Vegas, Nevada, USA, October, 2003.

14. A Generic Framework for Robotic Navigation

C. Urmson, R. Simmons, and I. Nesnas
IEEE Aerospace Conference 2003, Big Sky, USA, March, 2003.

15. Stereo Vision Based Navigation for Sun-Synchronous Exploration

C. Urmson, M.B. Dias, and R. Simmons
IEEE/RSJ IROS 2002, Lausanne, Switzerland, September, 2002.

16. First Experiment in Sun-Synchronous Exploration

D. Wettergreen, M.B. Dias, B. Shamah, J. Teza, P. Tompkins, C. Urmson, M.D. Wagner, and W. Whittaker
IEEE International Conference on Robotics and Automation, Washington, USA, May, 2002.

17. A Sensor Arm for Robotic Antarctic Meteorite Search

C. Urmson, B. Shamah, J. Teza, M.D. Wagner, D. Apostolopoulos, and W. Whittaker
Proceedings of the 3rd International Conference on Field and Service Robotics, Helsinki, Finland, July, 2001.

18. Skyworker: a robot for assembly, inspection and maintenance of large scale orbital facilities

P. Staritz, S. Skaff, C. Urmson, and W. Whittaker
IEEE International Conference on Robotics and Automation, Seoul, Korea, May, 2001.

19. Robotics for Assembly, Inspection, and Maintenance of Space Macrofacilities

W. Whittaker, C. Urmson, P. Staritz, B. Kennedy, and R. Ambrose
AIAA Space 2000 Conference and Exposition, Reston, USA, September, 2000.

20. Video Compression Through Fractal Block Coding

C. Urmson, K. Ferens
IEEE Canadian Conference on Electrical and Computer Engineering, May, 1998.

Invited Papers

1. Self-Driving Cars and the Urban Challenge

C. Urmson and W. Whittaker
IEEE Intelligent Systems, March 2008, Volume 23, Number 2, pp 66-68.

2. Grace and George: Autonomous Robots for the AAAI Robot Challenge

R. Simmons, A. Bruce, D. Goldberg, A. Goode, M. Montemerlo, N. Roy, B. Sellner, C. Urmson, A. Schultz, W. Adams, M. Bugajska, M. MacMahon, J. Mink, D. Perzanowski, S. Rosenthal, S. Thomas, I. Horswill, R. Zubeck, D. Kortenkamp, B. Wolfe, T. Milam, and B. Maxwell
Workshop paper for AAAI 2003.

3. GRACE: An Autonomous Robot for the AAAI Robot Challenge.

R. Simmons, D. Goldberg, A. Goode, M. Montemerlo, N. Roy, B. Sellner, C. Urmson, A. Schultz, M. Abramson, W. Adams, A. Atrash, M. Bugajska, M. Coblenz, M. MacMahon, D. Perzanowski, I. Horswill, R. Zubeck, D. Kortenkamp, B. Wolfe, T. Milam, B. Maxwell.
AAAI Magazine, 24:2, pp. 51-72, Summer 2003.

Technical Reports

1. Preplanning for High Performance Autonomous Traverse of Desert Terrain Exploiting a priori Knowledge to Optimize Speeds and to Detail Paths

A. Gutierrez, T. Galatali, J.P. Gonzalez, C. Urmson, and W.L. Whittaker
Tech. report CMU-RI-TR-05-54, Robotics Institute, Carnegie Mellon University, December, 2005.

2. Navigation Regimes for Off-Road Autonomy

C. Urmson
Doctoral dissertation, tech. report CMU-RI-TR-05-23, Robotics Institute, Carnegie Mellon University, May, 2005.

3. High Speed Navigation of Unrehearsed Terrain: Red Team Technology for Grand Challenge 2004

C. Urmson, J. Anhalt, M. Clark, T. Galatali, J.P. Gonzalez, J. Gowdy, A. Gutierrez, S. Harbaugh, M. Johnson-Roberson, H. Kato, P.L. Koon, K. Peterson, B.K. Smith, S. Spiker, E. Tryzelaar, and W.L. Whittaker

Tech. report TR-04-37, Robotics Institute, Carnegie Mellon University, June, 2004.

4. Locally Randomized Kino-dynamic Motion Planning for Robots in Extreme Terrain.

C. Urmson

Ph.D. Thesis Proposal, The Robotics Institute Carnegie Mellon University, May, 2002.

5. Principles of Computer System Design for Stereo Perception

M.D. Wagner, D. O'Hallaron, D. Apostolopoulos, and C. Urmson

Tech. report CMU-RI-TR-02-01, Robotics Institute, Carnegie Mellon University, January, 2002.