

NIKOLAS TRAWNY

Department of Computer Science & Engineering
University of Minnesota
4-192 EE/CS Building, 200 Union St. SE
Minneapolis, MN 55455

(612) 242-4266
trawny@cs.umn.edu
www.cs.umn.edu/~trawny

EDUCATION

- Ph.D. in Computer Science, University of Minnesota, USA** *Aug. 2010*
- Advisor: Prof. Stergios I. Roumeliotis
 - Thesis title: “Cooperative localization: On motion-induced initialization and joint state estimation under communication constraints”
- M.Sc. in Computer Science, University of Minnesota, USA** *Dec. 2008*
- Diplom-Ingenieur in Aerospace Engineering, University of Stuttgart, Germany** *Aug. 2004*
- Majors: Space systems and utilization, automatic control systems
 - Thesis: “Mission Scenarios for a Controlled Lunar Impact of a Small Satellite”
 - Ranked 8th of 135
- DEA in Automatic Control Systems, ISAE/SUPAERO, Toulouse, France** *Sep. 2003*
- Mention Très Bien

PROFESSIONAL EXPERIENCE

- Navigation Engineer, Guidance, Navigation & Control Sect., Optical Navigation Group** *Sep. 2010 – Present*
NASA Jet Propulsion Laboratory, Pasadena, CA
- Member of MAVEN navigation team
- University of Minnesota, Department of Computer Science & Engineering** *Aug. 2004 – Jul. 2010*
Research Assistant
- Formulated novel mathematical framework for batch estimation using quantized measurements in distributed mobile sensor networks
 - Developed current state-of-the-art vision-aided inertial navigation algorithms for precision NASA spacecraft entry, descent and landing, achieving an estimation accuracy of 0.16 m/sec for velocity, 6.4 m for position, and sub-degree for attitude in a 120 km apogee sounding rocket experiment
 - Designed and implemented current state-of-the-art autonomous stair climbing algorithms for tracked vehicles that fuses inertial and camera measurements in an extended Kalman filter, with important applications in search and rescue robotics
- Navigation Intern, Advanced Technology & Strategic Applications Group** *Jun. – Aug. 2009*
Northrop Grumman Navigation Systems Division, Woodland Hills, CA
- Implemented, tested, and characterized two EKF-based 3D vision-aided inertial navigation algorithms
 - Helped shape department strategy for future visual navigation R&D
- NASA Jet Propulsion Laboratory, Pasadena, CA** *Aug. 2006 & Jul. 2007*
Robotic software systems group
Visiting Independent Advisor
- Developed and implemented real-time, EKF-based 3D inertial navigation module within the CLARAty software architecture, integrating inertial measurements, rocker-bogie kinematics, and zero-velocity updates
 - Field-tested these algorithms on Mars rover prototypes in Mars-like outdoor test environment
- University of Toronto, Inst. of Aerospace Studies, Canada** *Apr. – Sep. 2003*
Visiting Scholar
- Thesis (co-supervised by University of Stuttgart (IFR) and SUPAERO):
"Optimized Motion Strategies for Cooperative Localization of Mobile Robots"

MT Aerospace, European Space Port, Kourou, French Guyana*Nov. 2000 – Apr. 2001***Intern**

- Participated in operation and maintenance of Ariane 4 & 5 launch facilities during two complete launch campaigns, including launch vehicle assembly and transfer, payload integration, and count-down sequence activities
- Performed incident analysis, damage assessment, and fault-resistant redesign for rocket part handling devices

Carlo Gavazzi Space, Milano, Italy*Aug. 2001***Euroavia International Design Workshop**

- Preliminary design of a mini-satellite for the monitoring of interplanetary dust

TEACHING EXPERIENCE

University of Minnesota, Department of Computer Science & Engineering

- Teaching Assistant for CSci 5551 (Introduction to Intelligent Robotic Systems), Spring 2008
- Teaching Assistant for CSci 5552 (Sensing and Estimation in Robotics), Fall 2005 and 2007
- Designed and graded homework problems and midterm exams for more than 30 students

University of Stuttgart, Germany

- Undergraduate Teaching Assistant in Statics and Dynamics, Summer 2000

RESEARCH FOCUS

- Design, tuning, implementation, and evaluation of **estimators** (e.g., EKF, UKF, particle filters, MAP, MLE, WLS)
- **2D/3D Simultaneous Localization and Mapping (SLAM)** for single- and multirobot systems with odometry, IMU, laser scanner, monocular camera, etc. Displacement- and zero-velocity updates, visual odometry, sliding window filtering
- Vision-aided **inertial navigation**, IMU noise characterization, 3D georeferenced navigation (familiar with SRTM DEMs, USGS satellite imagery, WGS-84, NAD-83, EGM96, Geoid03 models), precision spacecraft navigation for entry, descent and landing
- **Computer vision** and image processing, multiple view geometry, structure from motion, vocabulary tree (bag-of-words) for image/place recognition
- **Algebraic geometry** for polynomial system solving (Groebner bases, homotopy continuation, multiplication matrix decomposition, etc.). Application: kinematics, extrinsic calibration, estimator initialization, robust estimation
- Estimation in **sensor networks**, quantization, compressed/sparse sensing and classification (Lasso, SVM)
- Sparse, nonlinear **optimization** (SOCS, GESOP/ASTOS) and convex optimization (SeDuMi), convex relaxation, trajectory optimization

RELEVANT COURSEWORK

- Sensing/Estimation in Robotics
- Navigation and Guidance Systems
- Real-Time and Embedded Systems
- Computer Vision
- Pattern Recognition
- Optimization Theory

PROFESSIONAL SKILLS

Programming Languages & Software:

Matlab[®], Maple[™], C/C++, Python, SQL, svn
AutoCad
MS Office, L^AT_EX
Windows, Linux, Mac OS X, VxWorks

Languages:

English: Business fluent (Cambridge certificate of proficiency in English)
French: Fluent (Diplôme d'études en langue française 2nd degré)
Spanish: Basic working knowledge

HONORS AND AWARDS

Co-recipient of the King-Sun Fu Best Paper Award of the IEEE Transactions on Robotics (Paper [J3])	2009
Fellow, NSF Grassroots US-Japanese Student Exchange Program	2009
“Excellent Reviewer”, AIAA Journal of Guidance, Control, and Dynamics	2008
Guidant Award, Dept. of Computer Science, University of Minnesota	2006
Fellow, Studienstiftung des Dt. Volkes (German Natl. Academic Foundation)	2001 – 2004
Fellow, e-fellows.net	2001 – 2004
Dr.-Juergen-Ulderup Scholarship	2003
Hermann-Reissner Scholarship	2002
Leonardo da Vinci Scholarship	2000

SERVICE

Program Committee Member for Robotics: Science and Systems Conference	2009
Reviewer for Journals:	
• International Journal of Computer Vision 2006	
• Autonomous Robots 2005, 2007	
• Journal of Field Robotics 2006, 2007, 2010	
• IEEE Transactions on Robotics 2007 – 2010	
• IEEE Transactions on Aerospace and Electronic Systems 2008 – 2010	
• IEEE Transactions on Automatic Control 2009	
• AIAA Journal of Guidance, Control, and Dynamics 2008	
Conferences:	
• Robotics: Science and Systems Conference 2005 – 2010	
• IEEE International Conference on Robotics and Automation (ICRA) 2006 – 2010	
• IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS) 2007, 2010	
Director of Graduate Studies Advisory Council member, Univ. of Minnesota	2007 – 2008
Ph.D. Student Evaluation Process Committee member, University of Minnesota	2007

PROFESSIONAL AFFILIATIONS

- Student member of IEEE, IEEE Robotics and Automation Society, American Institute of Aeronautics and Astronautics (AIAA)
- Member of the German Society for Aeronautics and Astronautics (DGLR)

PUBLICATIONS

Dissertations:

- T3: Nikolas Trawny. “*Cooperative localization: On motion-induced initialization and joint state estimation under communication constraints*”, Ph.D. Thesis, University of Minnesota, Department of Computer Science & Engineering, Aug. 2010.
- T2: Nikolas Trawny. “*Mission scenarios for a controlled lunar impact of a small satellite*” (in German), Diploma Thesis IRS-04-S-18, University of Stuttgart, Institute of Space Systems, 2004.
- T1: Nikolas Trawny. “*Optimized Motion Strategies for Cooperative Localization of Mobile Robots*,” Studienarbeit / Thèse de DEA, University of Stuttgart, Institute for Flight Mechanics and Control, 2003.

Journal articles:

- J5: Guoquan P. Huang, Nikolas Trawny, Anastasios I. Mourikis, and Stergios I. Roumeliotis. “Observability-based Consistent EKF Estimators for Multi-robot Cooperative Localization,” Invited paper to appear in *Autonomous Robots*.
- J4: Nikolas Trawny, Xun S. Zhou, Ke X. Zhou, and Stergios I. Roumeliotis. “Inter-robot Transformations in 3D,” *IEEE Transactions on Robotics*, vol. 26, no.2, pp. 226–243, April 2010.
- J3: Anastasios Mourikis, Nikolas Trawny, Stergios Roumeliotis, Andrew Johnson, Adnan Ansar, and Larry Matthies. “Vision-Aided Inertial Navigation for Spacecraft Entry, Descent, and Landing,” *IEEE Transactions on Robotics*, vol. 25, no. 2, pp. 264–280, April 2009.
- J2: Anastasios I. Mourikis, Nikolas Trawny, Stergios I. Roumeliotis, Daniel M. Helmick, and Larry Matthies. “Autonomous Stair Climbing for Tracked Vehicles,” *International Journal of Computer Vision & International Journal of Robotics Research - Joint Special Issue on Vision and Robotics*, vol. 26, no. 7, pp. 737 – 758, July 2007.
- J1: Nikolas Trawny, Anastasios I. Mourikis, Stergios I. Roumeliotis, Andrew E. Johnson, and James F. Montgomery. “Vision-aided Inertial Navigation for Pin-Point Landing using Observations of Mapped Landmarks,” *Journal of Field Robotics - Special Issue on Space Robotics*, vol. 24, no. 5, pp. 357 – 378, April 2007.

Conference Papers:

- C11: Guoquan P. Huang, Ke Zhou, Nikolas Trawny, and Stergios I. Roumeliotis. “A Bank of Maximum A Posteriori Estimator for Single-Sensor Range-only Target Tracking,” in *Proceedings of the American Control Conference (ACC)*, pp. 6974 – 6980, Baltimore, MD, Jun. 30 – Jul. 2, 2010.
- C10: Nikolas Trawny and Stergios I. Roumeliotis. “On the Global Optimum of Planar, Range-based Robot-to-Robot Relative Pose Estimation,” in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 3200 – 3206, Anchorage, AK, May 3 – 8, 2010.
- C9: Nikolas Trawny, Xun S. Zhou, and Stergios I. Roumeliotis. “3D Relative Pose Estimation from Six Distances,” *Robotics: Science and Systems*, Seattle, WA, June 28 – July 1, 2009.
- C8: Guoquan P. Huang, Nikolas Trawny, Anastasios I. Mourikis, and Stergios I. Roumeliotis. “On the Consistency of Multi-robot Cooperative Localization,” *Robotics: Science and Systems*, Seattle, WA, June 28 – July 1, 2009.
- C7: Nikolas Trawny, Stergios I. Roumeliotis, and Georgios B. Giannakis. “Cooperative Multi-Robot Localization under Communication Constraints,” in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 4394 – 4400, Kobe, Japan, May 12 – 18, 2009.
- C6: Nikolas Trawny, Xun S. Zhou, Ke X. Zhou, and Stergios I. Roumeliotis. “3D Relative Pose Estimation from Distance-Only Measurements,” in *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pp. 1071 – 1078, San Diego, CA, Oct. 29 – Nov. 2, 2007.
- C5: Anastasios I. Mourikis, Nikolas Trawny, Stergios I. Roumeliotis, Andrew E. Johnson, and Larry Matthies. “Vision-Aided Inertial Navigation for Precise Planetary Landing: Analysis and Experiments,” in *Proceedings of Robotics: Science and Systems*, Atlanta, GA, June 26 – 30, 2007.
- C4: Nikolas Trawny, Anastasios I. Mourikis, Stergios I. Roumeliotis, Andrew E. Johnson, Jim Montgomery, Adnan Ansar, and Larry Matthies. “Coupled Vision and Inertial Navigation for Pin-Point Landing,” in *Proc. NASA Science Technology Conference (NSTC’07)*, College Park, MD, June 19 – 21, 2007.
- C3: Andrew E. Johnson, Adnan Ansar, Larry H. Matthies, Nikolas Trawny, Anastasios I. Mourikis, Stergios I. Roumeliotis. “A General Approach to Terrain-Relative Navigation for Planetary Landing,” *AIAA Infotech@Aerospace Conference*, Rohnert Park, CA, May 7 – 10, 2007.

C2: Nikolas Trawny and Stergios I. Roumeliotis. "A Unified Framework for Nearby and Distant Landmarks in Bearing-Only SLAM," in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, pp. 1923–1929, Orlando, FL, May 15 – 19, 2006.

C1: Nikolas Trawny and Tim Barfoot. "Optimized Motion Strategies for cooperative localization of mobile robots," in *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, Vol. 1, pp. 1027–1032, New Orleans, LA, April 2004.

Poster Presentations:

P1: Nikolas Trawny, Michael Graesslin, Rene Laufer and Hans-Peter Roeser. "Mission scenarios for a controlled lunar impact of a small satellite," in *Proceedings of the International Astronautical Congress (IAC)*, Vancouver, Canada, Oct. 4 – 8, 2004.

Technical Reports:

R4: Nikolas Trawny, Xun S. Zhou, and Stergios I. Roumeliotis. "Solving systems of Polynomials using the Action Matrix," October 2008.

R3: Nikolas Trawny and Stergios I. Roumeliotis. "Cooperative Multi-Robot Localization under Communication Constraints," May 2008.

R2: Nikolas Trawny and Stergios I. Roumeliotis. "Bearing-Only SLAM Without Explicit Landmark Position Initialization," August 2005.

R1: Nikolas Trawny and Stergios I. Roumeliotis. "Indirect Kalman Filter for 3D Attitude Estimation," March 2005.