College of Computing
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Michael Kaess

Research Interests

Mobile Robotics (simultaneous localization and mapping)
Computer Vision (SFM, calibration, multi-camera rigs, large-scale 3D reconstruction)
Probabilistic Methods (Bayesian inference)
Optimization (sparse non-linear systems)

Education

Ph.D. Computer Science expected Aug 2008
Georgia Institute of Technology, Atlanta, GA

M.S. Computer Science Dec 2002
Georgia Institute of Technology, Atlanta, GA

B.S. Computer Science (Vordiplom Informatik) Sep 1998
University of Karlsruhe, Germany

Relevant courses: Multiview Geometry, Computer Vision, Computational Perception, Partial Differential Equations, Machine Learning, Pattern Recognition, Autonomous Robotics, 3D Modeling and Graphics, Iterative Methods for Systems of Equations

Research Experience

Incremental Smoothing and Mapping
Advisor: Dr. Frank Dellaert
Thesis research: Devised and implemented a fast incremental SLAM algorithm, that performs full optimization and provides efficient access to the exact covariances needed for data association. The algorithm has been used with both cameras and laser-range sensors on multiple platforms. See [2], [3], [7], [8], [9].

Visual Odometry
Advisor: Dr. Frank Dellaert
Developed a real-time system and demonstrated it live to the DARPA LAGR program manager in San Antonio, Texas. Devised an algorithm that robustly handles degenerate data. See [4], [6].

Multi-planar Stereo
Advisor: Dr. Drew Steedly
Implemented a graph-cut based multi-planar stereo reconstruction to synthesize oblique urban views from multiple images and laser-range data.

Probabilistic Data Association for SLAM
Advisor: Dr. Frank Dellaert
Deployed the probabilistic framework of Dr. Dellaert's thesis work to the incremental correspondence problem of SLAM for both laser-range sensors and a multi-camera rig. See [1], [10].

Multi-view Subdivision Curve Fitting
Advisor: Dr. Frank Dellaert
Developed a Markov chain Monte Carlo approach to fit a 3D subdivision curve to multiple images of an object with both jagged and round edges. See [11], [12].

3D Mapping and Compression
Advisor: Dr. Ronald C. Arkin, Dr. Jarek Rossignac
Implemented 3D laser-based mapping of a building with a focus on data compression for efficient wireless transmission. See [13].

Publications

Journal Publications

[1] M. Kaess and F. Dellaert, "Probabilistic structure matching for visual SLAM with a multi-camera rig," *Submitted to Computer Vision and Image Understanding, CVIU*, 2008.

[2] M. Kaess, A. Ranganathan, and F. Dellaert, "iSAM: Incremental smoothing and mapping," *Accepted by IEEE Trans. on Robotics*, 2008.

[3] F. Dellaert and M. Kaess, "Square Root SAM: Simultaneous localization and mapping via square root information smoothing," *Intl. J. of Robotics Research*, vol. 25, pp. 1181–1204, Dec 2006.

Peer-reviewed Conference Publications

[4] M. Kaess, K. Ni, and F. Dellaert, "Flow separation for fast and robust stereo odometry," in *Submitted to the Eur. Conf. on Computer Vision (ECCV)*, 2008.

[5] R. Mottaghi, M. Kaess, A. Ranganathan, R. Roberts, and F. Dellaert, "Place recognition-based fixed-lag smoothing for environments with unreliable GPS," in *IEEE Intl. Conf. on Robotics and Automation, ICRA*, (Pasadena, CA), May 2008. In press.

[6] A. Ranganathan, M. Kaess, and F. Dellaert, "Fast 3D pose estimation with out-of-sequence measurements," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems, IROS*, (San Diego, CA), pp. 2486–2493, Oct 2007.

[7] M. Kaess, A. Ranganathan, and F. Dellaert, "iSAM: Fast incremental smoothing and mapping with efficient data association," in *IEEE Intl. Conf. on Robotics and Automation, ICRA*, (Rome, Italy), pp. 1670–1677, April 2007.

[8] M. Kaess, A. Ranganathan, and F. Dellaert, "Fast incremental square root information smoothing," in *Intl. Joint Conf. on Artificial Intelligence, IJCAI*, (Hyderabad, India), pp. 2129–2134, Jan 2007. Oral presentation acceptance ratio 15.7% (212 of 1353).

[9] A. Ranganathan, M. Kaess, and F. Dellaert, "Loopy SAM," in *Intl. Joint Conf. on Artificial Intelligence, IJCAI*, (Hyderabad, India), pp. 2191–2196, Jan 2007. Oral presentation acceptance ratio 15.7% (212 of 1353).

[10] M. Kaess and F. Dellaert, "A Markov chain Monte Carlo approach to closing the loop in SLAM," in *IEEE Intl. Conf. on Robotics and Automation, ICRA*, (Barcelona, Spain), pp. 645–650, Apr 2005.

[11] M. Kaess, R. Zboinski, and F. Dellaert, "MCMC-based multiview reconstruction of piecewise smooth subdivision curves with a variable number of control points," in *Eur. Conf. on Computer Vision, ECCV*, vol. 3023 of *Lecture Notes in Computer Science*, (Prague, Czech Republic), pp. 329–341, Springer, May 2004. Acceptance ratio 34.2% (190 of 555).

[12] M. Kaess and F. Dellaert, "Reconstruction of objects with jagged edges through Rao-Blackwellized fitting of piecewise smooth subdivision curves," in *Proceedings of the IEEE 1st International Workshop on Higher-Level Knowledge in 3D Modeling and Motion Analysis*, (Nice, France), pp. 39–47, IEEE Computer Society, Oct 2003.

[13] M. Kaess, R. Arkin, and J. Rossignac, "Compact encoding of robot-generated 3D maps for efficient wireless transmission," in *IEEE Intl. Conf. on Advanced Robotics, ICAR*, (Coimbra, Portugal), pp. 324–331, Jun 2003.

[14] M. Likhachev, M. Kaess, and R. Arkin, "Learning behavioral parameterization using spatio-temporal case-based reasoning," in *IEEE Intl. Conf. on Robotics and Automation, ICRA*, vol. 2, (Washington, DC), pp. 1282–1289, IEEE, May 2002.

Other Publications

[15] F. Dellaert, T. Balch, M. Kaess, R. Ravichandran, F. Alegre, M. Berhault, R. McGuire, E. Merrill, L. Moshkina, and D. Walker, "The Georgia Tech Yellow Jackets: A marsupial team for urban search and rescue," in *AAAI Mobile Robot Competition*, (Edmonton, Alberta, Canada), pp. 44–49, AAAI Press, 2002.

[16] M. Kaess and F. Dellaert, "Visual SLAM with a multi-camera rig," Tech. Rep. GIT-GVU-06-06, Georgia Institute of Technology, Feb 2006.

Invited Talk

iSAM: Incremental Smoothing and Mapping, University of Bremen and University of Freiburg, Germany, 2007

Employment

Research Assistant May 2003–today
Georgia Institute of Technology, BORG Lab
DARPA LAGR Program and NSF Career Award, Dr. Frank Dellaert

Research Intern Sep 2005–Dec 2005
Microsoft Research, Interactive Visual Media Group
Virtual Earth, Dr. Richard Szeliski and Dr. Drew Steedly

Research Assistant (Wissenschaftlicher Angestellter) Sep 2004–Dec 2004
University of Freiburg, Autonomous Intelligent Systems, Germany
Closing the Loop, Dr. Wolfram Burgard

Teaching Assistant Jan 2003–May 2003
Georgia Institute of Technology, College of Computing
Machine Learning, Dr. Frank Dellaert

Research Assistant May 2001–Dec 2002
Georgia Institute of Technology, Mobile Robot Lab
DARPA MARS Program, Dr. Ronald C. Arkin

Undergraduate Research Assistant Aug 1998–Jul 2000
Research Center for Information Technologies (FZI), Karlsruhe, Germany
Electronic Systems and Microsystems, Dr. Stefan Schmerler

Skills

Languages: German, English
Programming: OCaml, C, C++, Matlab, Java, 8086 Assembly
Tools and Libraries: Intel Image Processing Libraries, Matlab, OpenCV, OpenGL
Environments: Linux/UNIX, Windows

Awards

Marshall D. Williamson Fellowship 2001
College of Computing, Georgia Institute of Technology

Exchange Student Scholarship 2000
Federation of German-American Clubs

Robert Mayer Jugendpreis 1995
City of Heilbronn, Germany

Service

Program Committee, Workshop: Inside Data Association, RSS 2008

Reviewer for:
TRO (IEEE Trans. on Robotics) 2004, 2007, 2008
PAMI (IEEE Trans. on Pattern Analysis and Machine Intelligence) 2008
JFR (Journal of Field Robotics) 2006
ICCV (International Conference on Computer Vision) 2005, 2007
ECCV (European Conference on Computer Vision) 2004, 2006
CVPR (Computer Vision and Pattern Recognition) 2004-2008
RSS (Robotics Science and Systems) 2005, 2006
ICRA (International Conference on Robotics and Automation) 2005, 2007, 2008
IROS (International Conference on Intelligent Robots and Systems) 2007
NIPS (Neural Information Processing Systems) 2003, 2004
IJCAI (International Joint Conference on Artificial Intelligence) 2003
ICML (International Conference on Machine Learning) 2004

Citizenship

German, holder of F1 visa.

References

References are available upon request.