

# Michael Kaess

Field Robotics Center, The Robotics Institute  
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## Education

<b>Ph.D. Computer Science</b> <i>Georgia Institute of Technology, Atlanta, GA</i>	Dec 2008
<b>M.S. Computer Science</b> <i>Georgia Institute of Technology, Atlanta, GA</i>	Dec 2002
<b>B.S. Computer Science (Vordiplom Informatik)</b> <i>University of Karlsruhe, Germany</i>	Sep 1998

## Employment

<b>Assistant Research Professor</b> Carnegie Mellon University, Robotics Institute	Nov 2013–today
<b>Research Scientist</b> Massachusetts Institute of Technology, MechE/CSAIL Marine Robotics and Persistent Mapping, Dr. John Leonard	Jul 2010–Oct 2013
<b>Postdoctoral Associate</b> Massachusetts Institute of Technology, MechE/CSAIL Marine Robotics and Persistent Mapping, Dr. John Leonard	Nov 2008–Jun 2010
<b>Research Assistant</b> Georgia Institute of Technology, College of Computing DARPA LAGR Program and NSF Career Award, Dr. Frank Dellaert	May 2003–Oct 2008
<b>Research Intern</b> Microsoft Research, Interactive Visual Media Group Virtual Earth, Dr. Richard Szeliski and Dr. Drew Steedly	Sep 2005–Dec 2005
<b>Research Assistant (Wissenschaftlicher Angestellter)</b> University of Freiburg, Autonomous Intelligent Systems, Germany Closing the Loop, Dr. Wolfram Burgard	Sep 2004–Dec 2004
<b>Teaching Assistant</b> Georgia Institute of Technology, College of Computing Machine Learning, Dr. Frank Dellaert	Jan 2003–May 2003

**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

## Teaching Experience

**CMU Course 16-833, Spring 2017: Robot Localization and Mapping**  
 new course

**CMU Course 16-831, Fall 2016: Statistical Techniques in Robotics**  
 co-taught with Dr. Kris Kitani

**CMU Course 16-831, Fall 2015: Statistical Techniques in Robotics**  
 co-taught with Dr. Kris Kitani

**MIT Course 2.017, Spring 2013: Design of Electro-Mechanical Robotic Systems**  
 co-taught with Dr. John Leonard

## Awards

**ICRA: Best vision paper finalist (one of five)** 2016  
 Title: Articulated robot motion for simultaneous localization and mapping (ARM-SLAM)

**Google Faculty Research Award** 2014  
 Tightly coupled visual-inertial localization and mapping

**ICRA: Best student paper finalist (one of five)** 2013  
 Title: Temporally scalable visual SLAM using a reduced pose graph

**Runner-up (top 3) for Dick Volz Best 2008 US PhD Thesis in Robotics and Automation** 2012  
 Delayed award that also considers impact of dissertation

**ICRA: Best automation paper finalist (one of five)** 2011  
 Title: Efficient AUV navigation fusing acoustic ranging and side-scan sonar

**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

## Publications

### Journal Publications

1. F. Dellaert and M. Kaess, "Factor graphs for robot perception," *Foundations and Trends in Robotics*, vol. 6, no. 1-2, pp. 1–139, 2017.
2. H. Alismail, M. Kaess, B. Browning, and S. Lucey, "Direct visual odometry in low light using binary descriptors," *IEEE Robotics and Automation Letters (RA-L)*, vol. 2, pp. 444–451, Apr. 2017, part of ICRA/RA-L: Presented at ICRA 2017 and published in RA-L.
3. J. Zhang, M. Kaess, and S. Singh, "A real-time method for depth enhanced monocular odometry," *Autonomous Robots (AURO)*, vol. 41, no. 1, pp. 31–43, Jan. 2017.
4. M. Klingensmith, S. Srinivasa, and M. Kaess, "Articulated robot motion for simultaneous localization and mapping (ARM-SLAM)," *IEEE Robotics and Automation Letters (RA-L)*, vol. 1, no. 2, pp. 1156–1163, Jul. 2016, part of ICRA/RA-L: presented at ICRA 2016 and published in RA-L. **Best vision paper finalist (one of five).**
5. T. Whelan, M. Kaess, H. Johannsson, M. Fallon, J. Leonard, and J. McDonald, "Real-time large scale dense RGB-D SLAM with volumetric fusion," *Intl. J. of Robotics Research (IJRR)*, vol. 34, no. 4-5, pp. 598–626, Apr. 2015.
6. G. Huang, M. Kaess, and J. Leonard, "Consistent unscented incremental smoothing for multi-robot cooperative target tracking," *Journal of Robotics and Autonomous Systems (RAS)*, vol. 69, pp. 52–67, Jul. 2015.
7. N. Carlevaris-Bianco, M. Kaess, and R. Eustice, "Generic factor-based node removal: Enabling long-term SLAM," *IEEE Trans. on Robotics (TRO)*, vol. 30, no. 6, pp. 1371–1385, Dec. 2014.
8. D. Rosen, M. Kaess, and J. Leonard, "RISE: An incremental trust-region method for robust online sparse least-squares estimation," *IEEE Trans. on Robotics (TRO)*, vol. 30, no. 5, pp. 1091–1108, Oct. 2014.
9. S. Williams, V. Indelman, M. Kaess, R. Roberts, J. Leonard, and F. Dellaert, "Concurrent filtering and smoothing: A parallel architecture for real-time navigation and full smoothing," *Intl. J. of Robotics Research (IJRR)*, vol. 33, no. 12, pp. 1544–1568, Oct. 2014.
10. M. Fallon, H. Johannsson, M. Kaess, and J. Leonard, "The MIT Stata Center dataset," *Intl. J. of Robotics Research (IJRR)*, vol. 32, no. 14, pp. 1695–1699, Dec. 2013.
11. V. Indelman, S. Williams, M. Kaess, and F. Dellaert, "Information fusion in navigation systems via factor graph based incremental smoothing," *Journal of Robotics and Autonomous Systems (RAS)*, vol. 61, no. 8, pp. 721–738, Aug. 2013.
12. J. McDonald, M. Kaess, C. Cadena, J. Neira, and J. Leonard, "Real-time 6-DOF multi-session visual SLAM over large scale environments," *Journal of Robotics and Autonomous Systems (RAS)*, vol. 61, no. 10, pp. 1144–1158, Oct. 2013.
13. A. Wu, E. Johnson, M. Kaess, F. Dellaert, and G. Chowdhary, "Autonomous flight in GPS-denied environments using monocular vision and inertial sensors," *AIAA J. of Aerospace Information Systems (JAIS)*, vol. 10, no. 4, pp. 172–186, Apr. 2013.

14. F. Hover, R. Eustice, A. Kim, B. Englot, H. Johannsson, M. Kaess, and J. Leonard, "Advanced perception, navigation and planning for autonomous in-water ship hull inspection," *Intl. J. of Robotics Research (IJRR)*, vol. 31, no. 12, pp. 1445–1464, Oct. 2012.
15. M. Kaess, H. Johannsson, R. Roberts, V. Ila, J. Leonard, and F. Dellaert, "iSAM2: Incremental smoothing and mapping using the Bayes tree," *Intl. J. of Robotics Research (IJRR)*, vol. 31, no. 2, pp. 217–236, Feb. 2012.
16. M. Kaess and F. Dellaert, "Probabilistic structure matching for visual SLAM with a multi-camera rig," *Computer Vision and Image Understanding (CVIU)*, vol. 114, no. 2, pp. 286–296, Feb. 2010.
17. M. Kaess and F. Dellaert, "Covariance recovery from a square root information matrix for data association," *Journal of Robotics and Autonomous Systems (RAS)*, vol. 57, no. 12, pp. 1198–1210, Dec. 2009.
18. M. Kaess, A. Ranganathan, and F. Dellaert, "iSAM: Incremental smoothing and mapping," *IEEE Trans. on Robotics (TRO)*, vol. 24, no. 6, pp. 1365–1378, Dec. 2008.
19. F. Dellaert and M. Kaess, "Square Root SAM: Simultaneous localization and mapping via square root information smoothing," *Intl. J. of Robotics Research (IJRR)*, vol. 25, no. 12, pp. 1181–1204, Dec. 2006.

#### **Book Chapter**

20. M. Fallon, H. Johannsson, M. Kaess, J. Folkesson, H. McClelland, B. Englot, F. Hover, and J. J. Leonard, "Simultaneous localization and mapping in marine environments," in *Marine Robot Autonomy*, M. L. Seto, Ed. Springer, 2013, pp. 329–372.

#### **Peer-reviewed Publications**

21. P. Puri, D. Jia, and M. Kaess, "GravityFusion: Real-time dense mapping without pose graph using deformation and orientation," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Vancouver, Canada, Sep. 2017, to appear.
22. S. Zhang, W. Xie, G. Zhang, H. Bao, and M. Kaess, "Robust stereo matching with surface normal prediction," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Singapore, May 2017.
23. M. C. Koval, M. Klingensmith, S. S. Srinivasa, N. S. Pollard, and M. Kaess, "The manifold particle filter for state estimation on high-dimensional implicit manifolds," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Singapore, May 2017.
24. M. Hsiao, E. Westman, G. Zhang, and M. Kaess, "Keyframe-based dense planar SLAM," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Singapore, May 2017.
25. S. Yang, Y. Song, M. Kaess, and S. Scherer, "Pop-up SLAM: Semantic monocular plane SLAM for low-texture environments," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, Oct. 2016, pp. 1222–1229.
26. P. Teixeira, M. Kaess, F. Hover, and J. Leonard, "Underwater inspection using sonar-based volumetric submaps," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, Oct. 2016, pp. 4288–4295.

27. D. Fourie, J. Leonard, and M. Kaess, "A nonparametric belief solution to the Bayes tree," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, Oct. 2016, pp. 2189–2196.
28. G. Hemann, S. Singh, and M. Kaess, "Long-range GPS-denied aerial inertial navigation with LIDAR localization," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, Oct. 2016, pp. 1659–1666.
29. T. Huang and M. Kaess, "Incremental data association for acoustic structure from motion," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Daejeon, Korea, Oct. 2016, pp. 1334–1341.
30. J. Zhang, M. Kaess, and S. Singh, "On degeneracy of optimization-based state estimation problems," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Stockholm, Sweden, May 2016, pp. 809–816.
31. T. Huang and M. Kaess, "Towards acoustic structure from motion for imaging sonar," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Hamburg, Germany, Sep. 2015, pp. 758–765.
32. H.-C. Wang, C. Finn, L. Paull, M. Kaess, R. Rosenholtz, S. Teller, and J. Leonard, "Bridging text spotting and SLAM with junction features," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Hamburg, Germany, Sep. 2015, pp. 3701–3708.
33. M. Kaess, "Simultaneous localization and mapping with infinite planes," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Seattle, WA, May 2015, pp. 4605–4611.
34. P. Ozog, G. Troni, M. Kaess, R. Eustice, and M. Johnson-Roberson, "Building 3D mosaics from an autonomous underwater vehicle and 2D imaging sonar," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Seattle, WA, May 2015, pp. 1137–1143.
35. J. Zhang, M. Kaess, and S. Singh, "Real-time depth enhanced monocular odometry," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Chicago, IL, Sep. 2014, pp. 4973–4980.
36. T. Whelan, M. Kaess, R. Finman, M. Fallon, H. Johannsson, J. Leonard, and J. McDonald, "3D mapping, localisation and object retrieval using low cost robotic platforms: A robotic search engine for the real-world," in *RSS Workshop on RGB-D: Advanced Reasoning with Depth Cameras*, Berkeley, CA, Jul. 2014.
37. R. Finman, T. Whelan, M. Kaess, and J. Leonard, "Efficient incremental map segmentation in dense RGB-D maps," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Hong Kong, Jun. 2014, pp. 5488–5494.
38. G. Huang, M. Kaess, and J. Leonard, "Towards consistent visual-inertial navigation," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Hong Kong, Jun. 2014, pp. 4926–4933.
39. M. VanMiddlesworth, M. Kaess, F. Hover, and J. Leonard, "Mapping 3D underwater environments with smoothed submaps," in *Conf. on Field and Service Robotics (FSR)*, Brisbane, Australia, Dec. 2013, pp. 17–30.
40. T. Whelan, M. Kaess, J. Leonard, and J. McDonald, "Deformation-based loop closure for large scale dense RGB-D SLAM," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Tokyo, Japan, Nov. 2013, pp. 548–555.

41. G. Huang, R. Truax, M. Kaess, and J. Leonard, "Unscented iSAM: A consistent incremental solution to cooperative localization and target tracking," in *European Conference on Mobile Robots (ECMR)*, Barcelona, Spain, Sep. 2013, pp. 248–254.
42. G. Huang, M. Kaess, and J. Leonard, "Consistent sparsification for graph optimization," in *European Conference on Mobile Robots (ECMR)*, Barcelona, Spain, Sep. 2013, pp. 150–157.
43. R. Finman, T. Whelan, M. Kaess, and J. Leonard, "Toward lifelong object segmentation from change detection in dense RGB-D maps," in *European Conference on Mobile Robots (ECMR)*, Barcelona, Spain, Sep. 2013, pp. 178–185.
44. G. Huang, M. Kaess, J. Leonard, and S. Roumeliotis, "Analytically-selected multi-hypothesis incremental MAP estimation," in *Intl. Conf. on Acoustics, Speech, and Signal Proc. (ICASSP)*, Vancouver, Canada, May 2013.
45. T. Whelan, H. Johannsson, M. Kaess, J. Leonard, and J. McDonald, "Robust real-time visual odometry for dense RGB-D mapping," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Karlsruhe, Germany, May 2013, pp. 5724–5731.
46. D. Rosen, M. Kaess, and J. Leonard, "Robust incremental online inference over sparse factor graphs: Beyond the Gaussian case," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Karlsruhe, Germany, May 2013, pp. 1025–1032.
47. H. Johannsson, M. Kaess, M. Fallon, and J. Leonard, "Temporally scalable visual SLAM using a reduced pose graph," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Karlsruhe, Germany, May 2013, pp. 54–61, **Best student paper finalist (one of five)**.
48. A. Walcott-Bryant, M. Kaess, H. Johannsson, and J. Leonard, "Dynamic pose graph SLAM: Long-term mapping in low dynamic environments," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Vilamoura, Portugal, Oct. 2012, pp. 1871–1878.
49. T. Whelan, J. McDonald, M. Kaess, M. Fallon, H. Johannsson, and J. Leonard, "Kintinuous: Spatially extended KinectFusion," in *RSS Workshop on RGB-D: Advanced Reasoning with Depth Cameras*, Sydney, Australia, Jul. 2012.
50. H. Johannsson, M. Kaess, M. Fallon, and J. Leonard, "Temporally scalable visual SLAM using a reduced pose graph," in *RSS Workshop on Long-term Operation of Autonomous Robotic Systems in Changing Environments*, Sydney, Australia, Jul. 2012, pp. 54–61.
51. M. Kaess, S. Williams, V. Indelman, R. Roberts, J. Leonard, and F. Dellaert, "Concurrent filtering and smoothing," in *Intl. Conf. on Information Fusion (FUSION)*, Singapore, Jul. 2012, pp. 1300–1307.
52. V. Indelman, S. Williams, M. Kaess, and F. Dellaert, "Factor graph based incremental smoothing in inertial navigation systems," in *Intl. Conf. on Information Fusion (FUSION)*, Singapore, Jul. 2012, pp. 2154–2161.
53. D. Rosen, M. Kaess, and J. Leonard, "An incremental trust-region method for robust online sparse least-squares estimation," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, St. Paul, MN, May 2012, pp. 1262–1269.
54. J. McDonald, M. Kaess, C. Cadena, J. Neira, and J. Leonard, "6-DOF multi-session visual SLAM using anchor nodes," in *European Conference on Mobile Robots (ECMR)*, Orebro, Sweden, Sep. 2011, pp. 69–76.

55. M. Kaess, H. Johannsson, R. Roberts, V. Ila, J. Leonard, and F. Dellaert, "iSAM2: Incremental smoothing and mapping with fluid relinearization and incremental variable reordering," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Shanghai, China, May 2011, pp. 3281–3288.
56. M. Fallon, M. Kaess, H. Johannsson, and J. Leonard, "Efficient AUV navigation fusing acoustic ranging and side-scan sonar," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Shanghai, China, May 2011, pp. 2398–2405, **Best automation paper finalist (one of five)**.
57. M. Kaess, V. Ila, R. Roberts, and F. Dellaert, "The Bayes tree: An algorithmic foundation for probabilistic robot mapping," in *Intl. Workshop on the Algorithmic Foundations of Robotics (WAFR)*, Singapore, Dec. 2010, pp. 157–173.
58. H. Johannsson, M. Kaess, B. Englot, F. Hover, and J. Leonard, "Imaging sonar-aided navigation for autonomous underwater harbor surveillance," in *IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Taipei, Taiwan, Oct. 2010, pp. 4396–4403.
59. B. Kim, M. Kaess, L. Fletcher, J. Leonard, A. Bachrach, N. Roy, and S. Teller, "Multiple relative pose graphs for robust cooperative mapping," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Anchorage, Alaska, May 2010, pp. 3185–3192.
60. M. Kaess, K. Ni, and F. Dellaert, "Flow separation for fast and robust stereo odometry," in *IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Kobe, Japan, May 2009, pp. 3539–3544.
61. 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, pp. 1862–1867.
62. 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, Oct. 2007, pp. 2486–2493.
63. 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, Apr. 2007, pp. 1670–1677.
64. M. Kaess, A. Ranganathan, and F. Dellaert, "Fast incremental square root information smoothing," in *Intl. Joint Conf. on Artificial Intelligence (IJCAI)*, Hyderabad, India, Jan. 2007, pp. 2129–2134, **Oral presentation acceptance ratio 15.7% (212 of 1353)**.
65. A. Ranganathan, M. Kaess, and F. Dellaert, "Loopy SAM," in *Intl. Joint Conf. on Artificial Intelligence (IJCAI)*, Hyderabad, India, Jan. 2007, pp. 2191–2196, **Oral presentation acceptance ratio 15.7% (212 of 1353)**.
66. 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, Apr. 2005, pp. 645–650.
67. 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)*, ser. Lecture Notes in Computer Science, vol. 3023. Prague, Czech Republic: Springer, May 2004, pp. 329–341, acceptance ratio 34.2% (190 of 555).
68. 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: IEEE Computer Society, Oct. 2003, pp. 39–47.

69. 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, Jun. 2003, pp. 324–331.
70. 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, May 2002, pp. 1282–1289.

### Other Publications

71. M. Klingensmith, M. Koval, S. Srinivasa, N. Pollard, and M. Kaess, “The manifold particle filter for state estimation on high-dimensional implicit manifolds,” arXiv, Tech. Rep. arXiv:1604.07224, Apr. 2016.
72. S. Singh, H. Cover, A. Stambler, B. Grocholsky, J. Mishler, B. Hamner, K. Strabala, G. Sherwin, M. Kaess, G. Hemann, M. Bergerman, and S. Spiker, “Perception for safe autonomous helicopter flight and landing,” in *72nd Annual Forum and Technology Display, American Helicopter Society (AHS)*, May 2016.
73. T. Whelan, H. Johannsson, M. Kaess, J. Leonard, and J. McDonald, “Robust tracking for real-time dense RGB-D mapping with Kintinuous,” Computer Science and Artificial Intelligence Laboratory, MIT, Tech. Rep. MIT-CSAIL-TR-2012-031, Sep. 2012.
74. M. Fallon, H. Johannsson, M. Kaess, D. Rosen, E. Muggler, and J. Leonard, “Mapping the MIT Stata Center: Large-scale integrated visual and RGB-D SLAM,” in *RSS Workshop on RGB-D: Advanced Reasoning with Depth Cameras*, Jul. 2012.
75. M. Kaess, H. Johannsson, B. Englot, F. Hover, and J. Leonard, “Towards autonomous ship hull inspection using the Bluefin HAUV,” in *Ninth International Symposium on Technology and the Mine Problem*, Naval Postgraduate School, Monterey, CA, May 2010.
76. M. Kaess, V. Ila, R. Roberts, and F. Dellaert, “The Bayes tree: Enabling incremental reordering and fluid relinearization for online mapping,” Computer Science and Artificial Intelligence Laboratory, MIT, Tech. Rep. MIT-CSAIL-TR-2010-021, Jan. 2010.
77. E. Olson and M. Kaess, “Evaluating the performance of robot mapping systems,” in *Workshop on Good Experimental Methodology in Robotics*, 2009.
78. M. Kaess, “Incremental smoothing and mapping,” Ph.D. dissertation, Georgia Institute of Technology, Dec. 2008.
79. M. Kaess and F. Dellaert, “Visual SLAM with a multi-camera rig,” Georgia Institute of Technology, Tech. Rep. GIT-GVU-06-06, Feb. 2006.
80. 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: AAAI Press, 2002, pp. 44–49, **Award for best mapping**.



## Invited Talks and Seminars

- Efficient Incremental Smoothing, ICRA SLAM Tutorial, Stockholm, Sweden, 2016
- Localization and Mapping in Confined Areas with a Hovering AUV, ICRA Workshop on Marine Robot Localization, Stockholm, Sweden, 2016
- Robust and Efficient Real-time Mapping for Autonomous Robots, University of Michigan, Ann Arbor, MI and Duke University, Durham, NC, 2015
- Real-Time Dense 3D Mapping, Reality Computing Pittsburgh, Pittsburgh, PA, 2014
- Robust and Efficient Real-time Mapping for Autonomous Robots, George Washington University, Washington, DC, 2013
- Towards Persistent Mapping for Long-Term Autonomy, ICRA Workshop on Long-Term Autonomy, Karlsruhe, Germany, 2013
- Incremental Inference and Applications, ICRA Workshop on Robust and Incremental Inference in Factor Graphs, Karlsruhe, Germany, 2013
- Robust and Efficient Real-time Mapping for Autonomous Robots, Univ. of Texas, Austin, TX and Carnegie Mellon Univ., Pittsburgh, PA and Univ. of Southern California, CA, 2013
- Incremental Smoothing and Mapping, Brown University, Providence, RI, 2012
- Temporally Scalable Visual SLAM using the Reduced Pose Graph, University of Technology, Sydney, Australia, 2012
- Incremental Smoothing and Mapping, Sarnoff/SRI International, Princeton, NJ, 2012
- Towards Life-long Mapping and Navigation, ICRA Workshop on Long-term Autonomy, Shanghai, China, 2011
- Incremental Smoothing and Mapping and Applications to Ship Hull Inspection, SMART Center, National University of Singapore, Singapore, 2010
- iSAM and the Bayes Tree, IROS Workshop on Probabilistic Graphical Models in Robotics (GraphBot), Taipei, Taiwan, 2010
- iSAM: Incremental Smoothing and Mapping, German Research Center for Artificial Intelligence (DFKI), Bremen, Germany, 2007

## Service

### Associate Editor

TRO (IEEE Transactions on Robotics) 2015–2018

ICRA (International Conference on Robotics and Automation) 2013–2015, 2017

IROS (International Conference on Intelligent Robots and Systems) 2010, 2012–2015

### Senior Program Committee Member

IJCAI (International Joint Conference on Artificial Intelligence) 2017

**Tutorial Organizer**

Visual Simultaneous Localization and Mapping Tutorial at CVPR (Computer Vision and Pattern Recognition) 2014

**Workshop Organizer**

International Workshop on Lines, Planes and Manhattan Models for 3-D Mapping, IROS 2017  
Automated SLAM Evaluation Workshop, RSS (Robotics: Science and Systems) 2011

**Program Committee Member**

RSS (Robotics: Science and Systems) 2011–2016  
AAAI Robotics Track 2012  
RSS Workshop: Long-term Operation of Autonomous Robotic Systems 2012  
DARS (International Symposium on Distributed Autonomous Robotic Systems) 2010  
RSS Workshop: Inside Data Association 2008

**Journal reviewer**

TRO (IEEE Transactions on Robotics) 2004, 2007–2009, 2011–2017  
IJRR (International Journal of Robotics Research) 2010, 2012–2014  
RAS (Journal of Robotics and Autonomous Systems) 2009, 2012, 2016  
IJCV (International Journal of Computer Vision) 2015  
MVAP (Machine Vision and Applications) 2015  
PAMI (IEEE Transactions on Pattern Analysis and Machine Intelligence) 2008, 2014  
TAES (IEEE Transactions on Aerospace and Electronic Systems) 2014  
AURO (Autonomous Robots) 2009, 2011, 2013  
FTR (Foundations and Trends in Robotics) 2011  
JFR (Journal of Field Robotics) 2006, 2009, 2010  
IVC (Image and Vision Computing) 2010  
IEEE Pervasive Computing 2010

**Conference reviewer**

RSS (Robotics Science and Systems) 2005, 2006, 2010–2016  
ICRA (International Conference on Robotics and Automation) 2005, 2007–2016  
IROS (International Conference on Intelligent Robots and Systems) 2007, 2009–2016  
SIGGRAPH Asia 2016  
AAAI (AAAI Conference on Artificial Intelligence) 2012  
ICCV (International Conference on Computer Vision) 2005, 2007  
ECCV (European Conference on Computer Vision) 2004, 2006  
CVPR (Computer Vision and Pattern Recognition) 2004–2008

**Professional Memberships**

IEEE  
IEEE Computer Society  
IEEE Robotics and Automation Society