CHAO GUO

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EDUCATION

Ph. D. candidate in Computer Science, University of Minnesota (UMN), MN   Aug. 2010 - present

GPA: 3.9/4

Advisor: Prof. Stergios I. Roumeliotis

M. Sc. in Information Science and Electronic Engineering, Zhejiang University, China   Apr. 2010

B. Sc. in Information Science and Electronic Engineering, Zhejiang University, China   Jul. 2007

RESEARCH INTERESTS

- 3D navigation and mapping on mobile devices and autonomous vehicles in GPS-denied areas
- High-quality, large-scale 3D mapping using visual-inertial data
- Intrinsic and extrinsic calibrations of/between IMU, camera, RGBD camera, LIDAR, and wheel odometer
- Observability analysis of nonlinear navigation and calibration systems

PROFESSIONAL EXPERIENCE

- Member of UMN MARS Lab's Partnership w/ Project Tango, Google   May 2013 - present
- Research/Teaching Assistant, Dept. of Computer Science, UMN   Aug. 2010 - Aug. 2015
- Doctoral Dissertation Fellow, UMN   Aug. 2015 - present

RESEARCH PROJECTS

All the accomplished projects are the effort of the whole MARS group. I lead or co-lead the projects listed below.

R1.   Visual-inertial Mapping

- ➤ Developed and implemented a *robust* batch-least-squares-based *online* mapping system for mobile devices
- ➤ Developed and implemented a *resource-aware* cooperative mapping system that *efficiently* creates a high-quality, large-scale map from multiple datasets on a laptop
- ➤ Improved the mapping accuracy by employing wheel odometer data and 2D local motion constraints
- ▪ Publications: J1, C1, W2
- ▪ Demos: D1, D2
- ▪ Patents: P1

R2.   Visual-inertial Navigation

- ➤ Developed and implemented a *robust*, sliding-window filter-based *online* navigation system on a cell phone
- ➤ Designed an algorithm for estimating and compensating the IMU-camera time sync. and rolling-shutter images *online*
- ➤ Developed and implemented a *robust* navigation initialization algorithm (Applied in Google, Project Tango)
- ➤ Developed an IMU-RGBD camera navigation system
- ▪ Publications: J2, C2, C3, C4, C6, W1, W3
- ▪ Demos: D3, D4
- ▪ Patents: P2, P3

R3. Sensor calibrations

- ➢ Calibrate the IMU intrinsic parameters (e.g., skewness and scaling) using derived IMU propagation model
- ➢ Developed algorithms for extrinsically calibrating between camera, IMU, LIDAR, wheel odometer, and VICON
- ➢ Studied the observability properties of designed calibration systems
- ▪ Publications: C5, C7

DEMOS

All below have been demonstrated to various industrial and academic research peers

D1. Online visual-inertial navigation and mapping on a tablet. Video available at: https://youtu.be/uPryQE4251U

D2. High-quality, large-scale cooperative visual-inertial mapping. Created feature maps of conference sites and buildings available at: http://onionmaps.info

D3. Online navigation and localization for a wheeled Vehicle. Video available at: https://youtu.be/-A9GII1abhc

D4. Online visual-inertial navigation on a cell phone (Samsung S4). Video available at: https://youtu.be/ZGuUhm6DdDQ

PATENTS

P1. S. I. Roumeliotis, E. D. Nerurkar, J. A. Hesch, **C. X. Guo**, R. C. DuToit, K. Sartipi, and G. A. Georgiou, "Resource-Aware Large-Scale Cooperative 3D Mapping using Multiple Mobile Devices", US Patent, Application number: 62/341,237.

P2. S. I. Roumeliotis and **C. X. Guo**, "Efficient Visual-Inertial Navigation using a Rolling-Shutter Camera with Inaccurate Timestamps", US Patent 20,150,369,609.

P3. S. I. Roumeliotis, D. G. Kottas, **C. X. Guo**, and J. A. Hesch, "Observability-constrained Vision-aided Inertial Navigation", US Patent 20,140,316,698.

JOURNAL ARTICLES

J1. **C. X. Guo**, K. Sartipi, R. C. DuToit, G. A. Georgiou, R. Li, J. O'Leary, E. D. Nerurkar, J. A. Hesch, and S. I. Roumeliotis, "Resource-Aware Large-Scale Cooperative 3D Mapping using Multiple Mobile Devices", (in preparation), 2016.

J2. **C. X. Guo**, R. C. DuToit, A. Ahmed, and S. I. Roumeliotis, "Rolling-Shutter Camera-aided Inertial Navigation on a Cell Phone: Algorithm and Observability Analysis", (in preparation), 2016.

CONFERENCE PAPERS

C1. **C. X. Guo**, K. Sartipi, R. C. DuToit, G. A. Georgiou, R. Li, J. O'Leary, E. D. Nerurkar, J. A. Hesch, and S. I. Roumeliotis, "Large-Scale Cooperative 3D Visual-Inertial Mapping in a Manhattan World", International Conference on Robotics and Automation (ICRA), 2016.

C2. **C. X. Guo**, D. G. Kottas, R. C. DuToit, A. Ahmed, R. Li, and S. I. Roumeliotis, "Efficient Visual-Inertial Navigation using a Rolling-Shutter Camera with Inaccurate Timestamps", Robotics: Science and Systems Conference (RSS), 2014.

C3. **C. X. Guo** and S. I. Roumeliotis, "IMU-RGBD Camera Navigation using Point and Plane Features", International Conference on Intelligent Robots and Systems (IROS), 2013.

C4. G. Panahandeh, **C. X. Guo**, M. Jansson, and S. I. Roumeliotis, "Observability Analysis of a Vision-Aided Inertial Navigation System using Planar Features on the Ground", International Conference on Intelligent Robots and Systems (IROS), 2013.

C5. **C. X. Guo** and S. I. Roumeliotis, "An Analytical Least-Squares Solution to the Line Scan LIDAR-Camera Extrinsic Calibration Problem", International Conference on Robotics and Automation (ICRA), 2013.

C6. **C. X. Guo** and S. I. Roumeliotis, "IMU-RGBD Camera 3D Pose Estimation and Extrinsic Calibration:

Observability Analysis and Consistency Improvement", International Conference on Robotics and Automation (ICRA), 2013.

C7. **C. X. Guo**, F. M. Mirzaei, and S. I. Roumeliotis, "An Analytical Least-Squares Solution to the Odometer-Camera Extrinsic Calibration Problem", International Conference on Robotics and Automation (ICRA), 2012.

WORKSHOP PAPERS

W1. R. C. DuToit, G. A. Georgiou, K. Wu, and **C. X. Guo**, "Vision-aided Inertial Navigation for Virtual Reality Applications", Demo Session, CVPR, 2016.

W2. **C. X. Guo**, R. C. DuToit, K. Sartipi, G. A. Georgiou, R. Li, J. O'Leary, E. D. Nerurkar, J. A. Hesch, and S. I. Roumeliotis, "Resource-Aware Large-Scale Cooperative 3D Mapping from Multiple Cell Phones", Late Breaking Results, ICRA, 2015.

W3. D. G. Kottas, R. C. DuToit, A. Ahmed, **C. X. Guo**, G. A. Georgiou, R. Li, and S. I. Roumeliotis, "A Resource-aware Vision-aided Inertial Navigation System for Wearable and Portable Computers", Workshop on "Long-Term Autonomy: Navigation and Mapping for Real-World Applications", ICRA, 2014.

TECHNICAL REPORTS

T1. **C. X. Guo**, K. Sartipi, and S. I. Roumeliotis, "A Taxonomy of Consistent BA Approximations", 2016.

T2. **C. X. Guo**, K. Sartipi, R. C. DuToit, G. A. Georgiou, R. Li, J. O'Leary, E. D. Nerurkar, J. A. Hesch, and S. I. Roumeliotis, "Large-Scale Cooperative 3D Visual-Inertial Mapping in a Manhattan World", 2015.

T3. **C. X. Guo**, D. G. Kottas, R. C. DuToit, A. Ahmed, R. Li, and S. I. Roumeliotis, "Efficient Visual-Inertial Navigation using a Rolling-Shutter Camera with Inaccurate Timestamps", 2014.

T4. **C. X. Guo** and S. I. Roumeliotis, "Observability-constrained EKF Implementation of the IMU-RGBD Camera Navigation using Point and Plane Features", 2013.

T5. **C. X. Guo** and S. I. Roumeliotis, "IMU-RGBD Camera Extrinsic Calibration: Observability Analysis and Consistency Improvement", 2012.

STUDENTS MENTORED

• K. Sartipi, R. C. DuToit, G. A. Georgiou, and J. O'Leary [D1, D2, J1, C1, W2]