

Chen Feng



Department of Civil and Urban Engineering
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RESEARCH INTERESTS

Computer Vision, Robotics, Machine Learning, Photogrammetry, Augmented Reality, Remote Sensing and their applications in Civil and Mechanical Engineering.

EDUCATION

University of Michigan, Ann Arbor, Michigan, USA

- 2015/08 **Ph.D. in Civil Engineering**
- 2013/12 **M.S.E. in Electrical Engineering: Systems**
 - Major: Signal Processing; Minor: Robotics and Computer Vision
- 2012/04 **M.S.E. in Construction Engineering and Management**
- Wuhan University**, Wuhan, Hubei, China
- 2010/06 **B.Eng. in Geodesy and Geomatics**
 - Major: Photogrammetry and Remote Sensing

RESEARCH EXPERIENCE

New York University, Brooklyn, NY, USA

Assistant Professor

- 2018/08—present **Robotic Vision, Learning, and Applications in Civil and Mechanical Engineering**
 - Joint tenure-track appointment in the Department of Civil and Urban Engineering, and the Department of Mechanical and Aerospace Engineering.

Mitsubishi Electric Research Laboratories (MERL), Cambridge, MA, USA

Research Scientist

- 2015/07—2018/07 **Visual Simultaneous Localization and Mapping (SLAM) and Deep Learning**
 - Unsupervised/supervised deep learning on point clouds (**two CVPR'18 papers**).
 - A multi-label semantic edge detection via convolutional neural networks (CVPR'17).
 - Civil infrastructure defect detection and classification using deep active learning.
 - A fast T-spline fitting algorithm for 3D modeling from point clouds.
 - A multi-camera-localization method for autonomous driving and parking w/o GPS.

Research Intern

- 2012/05—2012/08 **Kinect SLAM**
- 2013/05—2013/08
 - SLAM and Bundle Adjustment using Kinect (resulted in a **patent**).
- 2014/07—2014/08
 - Fast plane extraction from point cloud (**fastest method to date**, resulted in a **patent**).

Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI, USA

Research Assistant

- 2013/05—2015/06 **Marker-based Articulated Machine Pose Estimation**
 - Designed, analyzed and improved its robustness and accuracy (see the ENR report).
- 2013/01—2015/06 **Autonomous Construction Robotic Onsite Assembly**
 - Designed vision-guided robotic assembly in unstructured environment. Explored digital fabrication for construction with Prof. Wes McGee from Taubman College of Architecture, University of Michigan.
 - This work won a **Best Paper Award** at the 2014 ISARC.

- 2011/12—2012/12 **Mobile Augmented Reality for Indoor Navigation**
- Designed novel indoor navigation for AECFM (e.g. way-finding) on mobile devices.
- 2010/09—2012/02 **Natural Marker Based Augmented Reality Registration**
- Designed a novel tracking algorithm for robust real-time Augmented Reality which outperforms several registration methods (e.g., KLT/ESM/FERs).
- Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI, USA
- Project Member*
- 2011/02—2011/05 **Learn to Sketch Up from Google Maps**
- Developed a graphical model to jointly identify 2D building regions and reconstruct 3D structures given multiple street-view images.
- Michigan Autonomous Aerial Vehicles Team, University of Michigan, Ann Arbor, MI, USA
- Research Fellow*
- 2010/11—2011/05 **Real-time Doorplate Recognition**
- Investigated algorithms to recognize doorplate containing Arabic characters in real-time (15 Hz), as a subtask for the International Aerial Robotics Competition.
- School of Geodesy and Geomatics, Wuhan University, Wuhan, Hubei, China
- Research Assistant*
- 2009/05—2010/08 **Single View Image-based Modeling**
- Integrated methods of photogrammetry, computer vision and graphics, to reconstruct a 3D model from a single image and prior knowledge of geometric constraints.
- Research Assistant*
- 2008/09—2010/06 **Estimation of Orthometric Height based on GPS signals**
- Computer simulation and field experiment of using gravity frequency shift in GPS signals based on Relativity Effects to estimate the orthometric height. Developed patented software based on the proposed method.
- Wuhan Planning & Design Institute, Wuhan, Hubei, China
- Software Engineer*
- 2008/05—2008/11 **Digital Wuhan 3D GIS Platform**
- Designed the data storage framework and developed pre-process software to generate paged level-of-details (LOD) 3D models from raw 3D data, enabling the smooth walk-through of a Digital City with massive geometry and texture data.

GRANT EXPERIENCE

National Science Foundation (NSF)

- 2014—2017 Scalable and Autonomous Post-Event Subsurface Characterization from UAV-based Quantitative Surface Measurements: \$389,845 Co-PI: Prof. Vineet R. Kamat
- Contributed several technical sections to the grant proposal.
- 2013—2015 PFI: AIR Technology Translation - Development and Evaluation of Field Prototype for Determining Excavator Proximity to Buried Utilities: \$150,000 PI: Prof. Vineet R. Kamat
- Contributed several technical sections to the grant proposal.
- 2015 submitted Vision-Based Metrology Network for Large-Scale Robotic Manipulation in Civil Infrastructure Environments PI: Prof. Vineet R. Kamat
- Initiated and led the grant proposal and most of its writing.
- Rackham Graduate Student Research Grant, University of Michigan
- 2013—2015 UAV-based Civil Infrastructure Data Collection and Inspection: \$3,000
- Developed and led the grant proposal and its writing.

TEACHING EXPERIENCE

Department of Civil and Environmental Engineering, University of Michigan, Ann Arbor, MI, USA

Co-instructor

Instructor: Prof. Vineet R. Kamat

2014 Winter

CEE 501: Automation and Robotics in Construction

- Co-developed the course; taught applications of vision and robotics in construction.

2013 Fall

CEE 531: Construction Cost Engineering

2013 Winter

- Taught topics such as learning curves and unit price proposal.

2012 Fall

CEE 539: Construction Management Information Systems

2011 Fall

- Taught construction simulation in EZSTROBE, STROBOSCOPE, and VITASCOPE.

INVITED TALKS

2018/07

Can Neural Networks Learn Paper Folding?

- Wayfair, Boston, MA

2018/05

Deep Learning on Point Clouds

- CSAIL, MIT

2016/07

Marker-based Real-time Pose Estimation

- ISARC Technical Tutorial Workshop, Auburn University

2016/04

Camera Marker Networks for Pose Estimation and Scene Understanding in Construction Automation and Robotics

- Texas A&M University, Department of Civil Engineering

2014/07

Fast Plane Extraction and Template Registration: Algorithm and Applications in Civil and Architectural Engineering

- Wuhan University, School of Geodesy and Geomatics

JOURNAL PUBLICATIONS

2018

Feng, C., Kamat, V.R., and Cai, H. (2018). "Camera Marker Networks for Articulated Machine Pose Estimation." *Automation in Construction*, 96, 148-160.

2017

Feng, C., and Taguchi, Y. (2017). "FasTFit: A Fast T-spline Fitting Algorithm." *Computer-Aided Design*, 92, 11-21.

2017

Chen, S., Tian, D., **Feng, C.**, Vetro, A., and Kovacevi, J. (2017). "Fast Resampling of 3D Point Clouds via Graphs." *IEEE Transactions on Signal Processing*, 66(3), 666-681.

2016

Xiao, Y., **Feng, C.**, Taguchi, Y., and Kamat, V.R. (2016). "User-Guided Dimensional Analysis of Indoor Building Environments from Single Frames of RGB-D Sensors." *Journal of Computing in Civil Engineering*, 31(4).

2015

Feng, C., Xiao, Y., Willette, A., McGee, W., and Kamat, V. R. (2015). "Vision Guided Autonomous Robotic Assembly and As-Built Scanning on Unstructured Construction Sites." *Automation in Construction*, 59, 128-138 (**Invited Paper**).

2015

Rezazadeh, A. E., **Feng, C.**, and Kamat V. R. (2015). "Feasibility of In-Plane Articulation Monitoring of Excavator Arm Using Planar Marker Tracking." *Journal of Information Technology in Construction*, 20, 213-229.

2014

Feng, C., Deng, F., and Kamat, V. R. (2014). "Rapid geometric modeling for visual simulation using semi-automated reconstruction from single image." *Engineering with Computers*, 30(1), 31-39. (First published online in 2012)

2014

Menassa, C., Kamat, V., Lee, S., Azar, E., **Feng, C.**, and Anderson, K. (2014). "Conceptual Framework to Optimize Building Energy Consumption by Coupling Distributed Energy Simulation and Occupancy Models." *Journal of Computing in Civil Engineering*, 28(1), 50-62.

- 2013 **Feng, C.**, and Kamat, V. R. (2013). "Plane Registration Leveraged by Global Constraints for Context-Aware AEC Applications." *Computer-Aided Civil and Infrastructure Engineering*, 28(5), 325-343. (First published online in 2012)
- 2013 Dong, S., **Feng, C.**, and Kamat, V. R. (2013). "Real-Time Occlusion Handling for Dynamic Augmented Reality Using Geometric Sensing and Graphical Shading." *Journal of Computing in Civil Engineering*, 27(6), 607-621.
- 2013 Dong, S., **Feng, C.**, and Kamat, V. R. (2013). "Sensitivity analysis of augmented reality-assisted building damage reconnaissance using virtual prototyping." *Automation in Construction*, 33(0), 24-36.
- 2013 Dong, S., Behzadan, A. H., **Feng, C.**, and Kamat, V. R. (2013). "Collaborative visualization of engineering processes using tabletop augmented reality." *Advances in Engineering Software*, 55(0), 45 - 55.
- 2009 Wan, J., Shen, W., Yang, Q., and **Feng, C.** (2009). "Experimental Investigations of the GeoPotential Difference between Two Stations Based on the GPS Signals." *Surveying and Mapping Science, Special Issue (in Chinese)*, 34, 23-25.
- 2008 Zou, J., and **Feng, C.** (2008). "Search Algorithms for Least Independent Close Loops." *Geospatial Information (in Chinese)*, 34, 6.

REFEREED CONFERENCE PUBLICATIONS

- 2018 Yu, Z., Liu, W., Zou, Y., **Feng, C.**, Ramalingam, S., Kumar, V., and Kautz, J. (2018) "Simultaneous Edge Alignment and Learning." *European Conference on Computer Vision (ECCV)*.
- 2018 Yu, X., Chaturvedi, S., **Feng, C.**, Taguchi, Y., Lee, T., Fernandes, C., and Ramalingam, S. (2018). "VLASE: Vehicle Localization by Aggregating Semantic Edges." *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Madrid, Spain.
- 2018 Yang, Y., **Feng, C.**, Shen, Y., and Dong, T. (2018) "FoldingNet: Point Cloud Auto-encoder via Deep Grid Deformation." *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* (spotlight paper, acceptance rate<9%).
- 2018 Shen, Y.*, **Feng, C.***, Yang, Y., and Dong, T. (2018) "Mining Point Cloud Local Structures by Kernel Correlation and Graph Pooling." *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* (* denotes equal contribution).
- 2017 Yu, Z.*, **Feng, C.***, Liu, M., Ramalingam, S., and Lee, T. (2017) "CASENet: Deep Category-Aware Semantic Edge Detection." *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)* (* denotes equal contribution).
- 2017 Jaramillo, C., Taguchi, Y., and **Feng, C.** (2017) "Direct Multichannel Tracking", *International Conference on 3D Vision (3DV)*.
- 2017 Tian, D., Ochimizu, H., **Feng, C.**, Cohen, R.A., and Vetro, A. (2017) "Geometric Distortion Metrics for Point Cloud Compression", *IEEE International Conference on Image Processing (ICIP)*.
- 2017 **Feng, C.**, Liu, M., Kao, C., and Lee, T. (2017). "Deep Active Learning for Civil Infrastructure Defect Detection and Classification." *International Workshop on Computing in Civil Engineering*.
- 2016 Chen, S., Tian, D., **Feng, C.**, Vetro, A., and Kovacevi, J. (2017). "Contour-enhanced Resampling of 3D Point Clouds via Graphs." *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*.
- 2016 **Feng, C.**, Kamat, V.R., and Menassa, C.C. (2016). "Marker Assisted Structure from Motion for 3D Environment Modeling and Object Pose Estimation." *Construction Research Congress*, San Juan, Puerto Rico.

- 2015 **Feng, C.**, Dong, S., Lundeen, K. M., Xiao, Y., and Kamat, V. R. (2015). "Vision-Based Articulated Machine Pose Estimation for Excavation Monitoring and Guidance." *Proceedings of the 32nd International Symposium on Automation and Robotics in Construction and Mining*, Oulu, Finland.
- 2015 Xiao, Y., **Feng, C.**, Taguchi, Y., and Kamat, V. R. (2015). "User-Guided Dimensional Analysis of Indoor Scenes Using Depth Sensors." *Proceedings of the 32nd International Symposium on Automation and Robotics in Construction and Mining*, Oulu, Finland.
- 2015 Mantha, B., **Feng, C.**, Menassa, C., and Kamat, V.R. (2015). "Real-time Building Energy and Comfort Parameter Data Collection Using Mobile Indoor Robots." *Proceedings of the 32nd International Symposium on Automation and Robotics in Construction and Mining*, Oulu, Finland. 639-647.
- 2014 **Feng, C.**, Xiao, Y., Willette, A., McGee, W., and Kamat, V. R. (2014). "Towards Autonomous Robotic In-Situ Assembly on Unstructured Construction Sites Using Monocular Vision." *Proceedings of the 31th International Symposium on Automation and Robotics in Construction and Mining*, Sydney, Australia, 163-170. (**Best Paper Award**)
- 2014 **Feng, C.**, Taguchi, Y., and Kamat, V. R. (2014). "Fast Plane Extraction in Organized Point Clouds Using Agglomerative Hierarchical Clustering." *Proceedings of the IEEE International Conference on Robotics and Automation (ICRA)*, Hong Kong, China, 6218-6225. (**48% acceptance rate of 2085 submissions**)
- 2013 Taguchi, Y., Jian, Y.-D., Ramalingam, S., and **Feng, C.** (2013). "Point-Plane SLAM for Hand-Held 3D Sensors." *Proceedings of IEEE International Conference on Robotics and Automation (ICRA)*, Karlsruhe, Germany, 5182-5189. (**40% acceptance rate**)
- 2013 **Feng, C.**, Fredricks, N., and Kamat, V. R. (2013). "Human-Robot Integration for Pose Estimation and Semi-Autonomous Navigation on Unstructured Construction Sites." *Proceedings of the 30th International Symposium on Automation and Robotics in Construction and Mining*, Montréal, Canada, 1317-1325.
- 2013 Kang, W., **Feng, C.**, and Chen, Y. (2013). "Mask strategy and layout decomposition for self-aligned quadruple patterning." *Proc. SPIE 8684, Design for Manufacturability through Design-Process Integration VII*, 86840E.
- 2012 Taguchi, Y., Jian, Y.-D., Ramalingam, S., and **Feng, C.** (2012). "SLAM Using both Points and Planes for Hand-Held 3d Sensors." *Proceedings of IEEE International Symposium on Mixed and Augmented Reality (ISMAR)*, Georgia, USA, 321-322.
- 2012 **Feng, C.**, and Kamat, V. R. (2012). "A plane tracker for AEC-automation applications." *Proceedings of 2012 International Symposium on Robotics and Automation in Construction*, Eindhoven, NL, 83.
- 2012 **Feng, C.**, and Kamat, V. R. (2012). "Augmented Reality Markers as Spatial Indices for Indoor Mobile AECFM Applications." *Proceedings of the 2012 Conference on Construction Applications of Virtual Reality*, Taipei, Taiwan, 235-242.
- 2011 Dong, S., **Feng, C.**, Kamat, V. R. (2011). "Occlusion handling method for ubiquitous augmented reality using reality capture technology and GLSL." *Proceedings of the 2011 ASCE International Workshop on Computing in Civil Engineering*, Reston, VA, 494-503.
- 2010 **Feng, C.**, Deng, F., and Kamat, V. R. (2010). "Semi-Automatic 3d Reconstruction of Piecewise Planar Building Models from Single Image." *Proceedings of the 10th International Conference on Construction Applications of Virtual Reality*, Sendai, Japan, 309-317.

AWARDS AND HONORS

- 2018 **Outstanding Reviewer for CVPR**
- The Conference on Computer Vision and Pattern Recognition (CVPR)

- 2016 **Recognition of Contributions to Mitsubishi Electric of Work on 3D Reconstruction for Elevator Replacement Business**
- Mitsubishi Electric Research Laboratories (MERL), Cambridge, Massachusetts
- 2016 **Nominee of ProQuest Distinguished Dissertation Awards** (54 out of 800 grad students)
- Rackham Graduate School, University of Michigan
- 2015 **Rackham Pre-doctoral Fellowship** (72 out of 240 candidates)
- Rackham Graduate School, University of Michigan
- 2014 **Best Paper Award**
- International Symposium on Automation and Robotics in Construction and Mining
- 2014 **Tishman Pre-doctoral Fellowship**
- Department of Civil and Environmental Engineering, University of Michigan
- 2014 **Student Travel Grant for IEEE ICRA, Hong Kong**
- National Science Foundation (NSF)
- 2014 **Rackham International Travel Grant for IEEE ICRA, Hong Kong**
- Rackham Graduate School, University of Michigan
- 2013 **Rackham International Student Fellowship**
- Rackham Graduate School, University of Michigan
- 2012 **PARTNERBOT Award for General Contribution to Robotics** (awarded to 10 out of nominated 150 robotics research groups from over the world)
- CLEARPATH Robotics
- 2012 **Rackham International Travel Grant for ISARC, Eindhoven**
- Rackham Graduate School, University of Michigan
- 2011 **Best Ph.D. Student Scholarship (3 out of 120)**
- International Computer Vision Summer School 2011: Registration, Recognition and Reconstruction in Images and Video
- 2010 **C.E. Bottum and R. Harris Fellowship**
- Department of Civil and Environmental Engineering, University of Michigan
- 2009 **National Academician Xia Jianbai Award for Innovative Student** (awarded to 10 out of several thousand eligible Geomatics students in China)
- School of Geodesy and Geomatics, Wuhan University
- 2008 **“Baidu Cup” Central/North China Collegiate Programming Contest, 1st class award**
- Wuhan University
- 2008 **Chinese Undergraduate Math Contest of Modeling, 1st class award in Hubei**
- Wuhan University
- 2007–2009 **Outstanding Student Scholarship**
- Wuhan University

PATENTS

- 2012/06 U.S. Serial No. 13/539,060, “*Method for Registering Points and Planes of 3D Data in Multiple Coordinate Systems*”, Patent 9,183,631 held by MERL, issued Nov 10, 2015.
- 2013/12 U.S. Serial No. 14/096,378, “*Method for Extracting Planes from 3D Point Cloud Sensor Data*,” Patent 9,412,040 held by MERL, issued Aug 09, 2016.
- 2015/04 U.S. Serial No. 14/698,200, “*Method for Determining Dimensions in an Indoor Scene from a Single Depth Image*,” Patent 9,761,015 held by MERL, issued Sep 12, 2017.

OPEN SOURCE SOFTWARE

CASENet <http://www.merl.com/research/license#CASENet>

- A Caffe implementation of the corresponding CVPR'17 paper for multi-label semantic edge detection.

PEAC <http://www.merl.com/research/license#PEAC>

- A C++ library with Matlab interface for extracting planar regions from organized point cloud in real-time
- The library received many download requests across the world from various academic/business domains

masfm <https://github.com/simbaforrest/masfm>

- A C++ library for marker-based pose estimation using structure from motion assisted with markers

cv2cg <https://github.com/simbaforrest/cv2cg>

- A lightweight library with applications for computer vision, computer graphics and augmented reality interactions, including KEG tracker and AprilTag for robotics applications.
- The library was used and cited by the best paper of 2014 IEEE ICRA.

vpdetection <https://github.com/simbaforrest/vpdetection>

- A library to automatically detect vanishing points using jlinkage+lsd, by grouping line segments by their corresponding vanishing point.

TECHNICAL SKILLS

Programming: C, C++, Matlab, Python, Java, C#, VBA, JavaScript, VCS (Hg, Git, SVN)
 Library: OpenCV, Caffe, Pytorch, ROS, PCL, Ceres, LCM, OpenSceneGraph, OpenGL
 Text Editing: TeX (LaTeX, BibTeX), MS Office
 OS: MS Windows family, Linux, Android

MENTORED GRADUATE STUDENTS

Master Students Civil Engineering: Yuhang Xu, Da Li, Yingqi Liu, Chao-Chung Yang
 Robotics: Zhiyuan Zuo
 PhD Students Yaoqing Yang, Yiru Shen, Carlos Jaramillo (research intern at MERL), Lichao Xu

PROFESSIONAL SERVICES

2018 Reviewer
 • IEEE Conference on Computer Vision and Pattern Recognition (CVPR)
 • The European Conference on Computer Vision (ECCV)
 • IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

2017 Technical Committee Member
 • International Workshop on Computing in Civil Engineering (IWCCE)
 Reviewer
 • IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
 • IEEE Transactions on Circuits and Systems for Video Technology (TCSVT)

2016 Computer Vision Workshop Organizer and Speaker
 • International Symposium on Automation and Robotics in Construction
 Reviewer
 • Journal of Image and Vision Computing (IMAVIS)
 • Journal of Automation in Construction (AUTCON)
 • Journal of Computing in Civil Engineering
 • Journal of Sensing and Imaging (SSTA)
 • Journal of Electronic Imaging (JEI)
 • IEEE Transactions on Human-Machine Systems (THMS)

- IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)
- International Conference on Computing in Civil and Building Engineering (ICCCBE)
- Journal of Computer Assisted Surgery

2015

Technical Committee Member

- International Conference on Construction Applications of Virtual Reality (CONVR)

Reviewer

- Journal of Robotics and Computer Integrated Manufacturing
- Journal of Computing in Civil Engineering
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
- IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)

2014

Reviewer

- Advanced Engineering Informatics
- Visualization in Engineering
- IEEE International Conference on Robotics and Automation (ICRA)

2013

Reviewer

- IEEE International Conference on Automation Science and Engineering (CASE)
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)

2011

Technical Session Chair of Civil and Environmental Engineering

- the 6th Engineering Graduate Symposium, University of Michigan