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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/FERNs).

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 Urban Engineering, NYU Tandon, Brooklyn, NY, USA

2019 Spring **CE-GY 7963 A: Emerging Information and Automation Technologies**
- Developed the course; taught introduction to photogrammetry/Lidar/Machine-Learning/AR/Robotics for civil engineering graduate students.

Department of Mechanical and Aerospace Engineering, NYU Tandon, Brooklyn, NY, USA

2018 Fall **ME-GY 7863 C: Robot Perception**
- Developed the course; taught graduate-level computer vision for robotics.

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
- Google Brain, New York, NY
- NYU CUSP, Brooklyn, NY

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

2019 Ding, L., and **Feng, C.** (2019) "DeepMapping: Unsupervised Map Estimation From Multiple Point Clouds." *IEEE Conference on Computer Vision and Pattern Recognition (**CVPR**) (oral paper, acceptance rate<5.6%)*.

2019 Wang, R., Xiang, S., **Feng, C.**, Wang, P., Ergan, S., and Fang, Y. (2019) "Through-Wall Object Recognition and Pose Estimation." *Proceedings of the 36nd International Symposium on Automation and Robotics in Construction and Mining*, Banff, AB, Canada.

2019 Xiang, S., Wang, R., and **Feng, C.** (2019) "Towards Mobile Projective AR for Construction Co-Robots." *Proceedings of the 36nd International Symposium on Automation and Robotics in Construction and Mining*, Banff, AB, Canada.

2019 Li, D., and **Feng, C.** (2019) "Primitive Fitting Using Deep Geometric Segmentation." *Proceedings of the 36nd International Symposium on Automation and Robotics in Construction and Mining*, Banff, AB, Canada.

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

New York University, Brooklyn, NY, USA

PhD Students	Civil Engineering: Ruoyu Wang, Siyuan Xiang

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

PhD Students	Ding Li (University of Rochester), Yaoqing Yang (CMU), Yiru Shen (Clemson), Carlos Jaramillo (CUNY)
Master Students	Zhen Liu (Georgia Institute of Technology)

University of Michigan, Ann Arbor, MI, USA

PhD Students	Lichao Xu
Master Students	Civil Engineering: Yuhang Xu, Da Li, Yingqi Liu, Chao-Chung Yang
	Robotics: Zhiyuan Zuo

PROFESSIONAL SERVICES

Reviewer

2017-present	IEEE Conference on Computer Vision and Pattern Recognition (CVPR)
2018-present	The European Conference on Computer Vision (ECCV)
2013-present	IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)
2014-present	IEEE International Conference on Robotics and Automation (ICRA)
2016-present	Journal of Automation in Construction (AUTCON)
2015-present	Journal of Computing in Civil Engineering (JCCE)
2018-present	International Symposium on Automation and Robotics in Construction (ISARC)
2017	IEEE Transactions on Circuits and Systems for Video Technology (TCSVT)
2017	International Workshop on Computing in Civil Engineering (IWCCE)
2015	International Conference on Construction Applications of Virtual Reality (CONVR)
2015-2016	IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)
2016	Journal of Image and Vision Computing (IMAVIS)
2016	Journal of Sensing and Imaging (SSTA)
2016	Journal of Electronic Imaging (JEI)
2016	IEEE Transactions on Human-Machine Systems (THMS)
2016	Journal of Computer Assisted Surgery
2015	Journal of Robotics and Computer Integrated Manufacturing
2014	Advanced Engineering Informatics
2014	Visualization in Engineering
2013	IEEE International Conference on Automation Science and Engineering (CASE)

Computer Vision Workshop Organizer and Speaker

2016	International Symposium on Automation and Robotics in Construction (ISARC)