

Justin G. Chen, Ph.D

Contact Information

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Research Interests

My research focuses on novel sensor systems and applying them to solving problems in infrastructure with structural health monitoring and non-destructive testing. My work is inherently interdisciplinary and draws from many different fields including vibration analysis, computer vision, optics, and signal processing.

I am interested in the following research topics: smart and resilient infrastructure, computer vision, sensor systems, structural dynamics, machine learning, signal processing, vibration analysis, non-destructive testing, structural health monitoring.

Education

Ph.D, Massachusetts Institute of Technology, Cambridge, MA

Ph.D in Structures and Materials, Civil and Environmental Engineering **September 2010 – June 2016**

Thesis Title: Video Camera-based Vibration Measurement of Infrastructure

Thesis Advisor: Oral Buyukozturk

Committee Members: William T. Freeman, Jerome J. Connor, M. Nafi Toksoz, Robert W. Haupt

S.M., Massachusetts Institute of Technology, Cambridge, MA

Master of Science, Civil and Environmental Engineering **September 2010 – February 2013**

Thesis Title: Detection of Defects in FRP-Reinforced Concrete with the Acoustic-Laser Vibrometry Method

Thesis Advisors: Oral Buyukozturk and Robert W. Haupt

B.S., California Institute of Technology, Pasadena, CA

Bachelor of Science, Physics **September 2005 – December 2008**

Professional and Research Experience

Massachusetts Institute of Technology, Cambridge, MA

Post-doctoral Associate, Laboratory for Infrastructure Science and Sustainability **June 2016 – Present**

Working on camera-based methods of non-contact measurement, structural health monitoring, and developing a laser vibrometer system as a seismic sensor. Collaborating with MIT CSAIL on camera-based methods and MIT Lincoln Laboratory on laser vibrometry.

Massachusetts Institute of Technology, Cambridge, MA

Research Assistant, Laboratory for Infrastructure Science and Sustainability **September 2010 – June 2016**

Worked on novel non-contact methodologies for structural health monitoring and non-destructive testing. Adapted and developed computer vision algorithms (Motion Magnification) to visualize mode shapes and displacements of structures, in collaboration with computer vision and graphics groups at CSAIL. Developed a laboratory model for structural health monitoring experimentation and testing of damage detection algorithms. Worked with an acoustic-laser vibrometry system to remotely detect defects in FRP-reinforced concrete. Assisted with grant and proposal writing for submission to the NSF and Shell.

MIT Lincoln Laboratory, Lexington, MA
Assistant Staff, Active Optical Systems, Group 106

May 2009 – August 2010

Assisted in the development of a laser vibrometry system on a moving ground platform.

Neutron EDM Group, California Institute of Technology, Pasadena, CA
Research Assistant and Summer Undergraduate Researcher

January 2008 - April 2009

Advisor: Professor Bradley W. Filippone

Mapped the magnetic field of a one-half scale modified 30-turn Cos θ coil for field uniformity and made modifications of the coil and ferromagnetic shield assembly in support of the SNS nEDM experiment.

Econophysics, University of Maryland, College Park, MD
Undergraduate Research Assistant

June - August 2007

Advisor: Professor Victor Yakovenko

Gathered and reviewed IRS tax data for changes in the distribution of taxable income, particularly in the Pareto tail, and created an animation in MATLAB to show the result of an agent based simulation.

Astrophysics, California Institute of Technology, Pasadena, CA
Research Assistant

June - August 2006

Advisor: Dr. Andrew Benson, Senior Research Fellow

Investigated the effects of stochastic supernovae events on early galaxy formation by modeling the process using Mathematica.

Paints and Processes Branch, Naval Surface Warfare Center, Carderock, West Bethesda, MD
GWU Science and Engineering Apprenticeship

June - August 2004

Advisor: Elizabeth Haslbeck

Conducted experiments on antifouling paints.

Refereed Publications

1. **J. G. Chen**, A. Davis, N. Wadhwa, F. Durand, W. T. Freeman, and O. Buyukozturk, "Video camera-based vibration measurement for civil infrastructure applications," *ASCE Journal of Infrastructure Systems*, 2016. Accepted
2. A. Davis, K. L. Bouman, **J. G. Chen**, O. Buyukozturk, M. Rubinstein, F. Durand, and W. T. Freeman, "Visual vibrometry: Estimating material properties from small motions in video," in *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 2016. DOI: 10.1109/TPAMI.2016.2622271
3. Y.-J. Cha, **J. G. Chen**, and O. Buyukozturk, "Output only computer vision based damage detection using phase-based optical flow and unscented kalman filters," *Engineering Structures*, 2016. Accepted
4. N. Wadhwa, H.-Y. Wu, A. Davis, M. Rubinstein, E. Shih, G. Mysore, **J. G. Chen**, O. Buyukozturk, J. Guttag, W. T. Freeman, and F. Durand, "Eulerian video magnification and applications," *Communications of the ACM*, 2016. Accepted
5. **J. G. Chen**, N. Wadhwa, Y.-J. Cha, F. Durand, W. T. Freeman, and O. Buyukozturk, "Modal identification of simple structures with high-speed video using motion magnification," *Journal of Sound and Vibration*, vol. 71, pp. 43–53, 2015
6. A. Davis, **J. G. Chen**, and F. Durand, "Image-space modal bases for plausible manipulation of objects in video," *ACM Transactions on Graphics (TOG)*, vol. 34, no. 6, p. 239, 2015
7. A. Davis, K. L. Bouman, **J. G. Chen**, M. Rubinstein, F. Durand, and W. T. Freeman, "Visual vibrometry: Estimating material properties from small motions in video," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pp. 5335–5343, 2015

8. **J. G. Chen**, R. W. Haupt, and O. Buyukozturk, "Operational and defect parameters concerning the acoustic-laser vibrometry method for FRP-reinforced concrete," *NDT & E International*, vol. 345, pp. 58–71, 2015
9. **J. G. Chen**, R. W. Haupt, and O. Buyukozturk, "Acoustic-laser vibrometry technique for the noncontact detection of discontinuities in fiber reinforced polymer-retrofitted concrete," *Materials evaluation*, vol. 72, no. 10, pp. 1305–1313, 2014
10. L. A. Jiang, M. A. Albota, R. W. Haupt, **J. G. Chen**, and R. M. Marino, "Laser vibrometry from a moving ground vehicle," *Applied optics*, vol. 50, no. 15, pp. 2263–2273, 2011

Publications Under Review

1. **J. G. Chen** and O. Buyukozturk, "A symmetry measure for damage detection with mode shapes," *Journal of Sound and Vibration*, 2016. Submitted for initial review
2. R. Mohammadi Ghazi, **J. G. Chen**, and O. Buyukozturk, "Ising graphical models for structural health monitoring with dense sensor networks," *Mechanical Systems and Signal Processing*, 2016. Under review

Conference Proceedings

1. O. Buyukozturk, **J. G. Chen**, N. Wadhwa, A. Davis, F. Durand, and W. T. Freeman, "Smaller than the eye can see: Vibration analysis with video cameras," in *19th World Conference on Non-Destructive Testing, WCNDT*, 2016. Munich, Germany, June 13-17, 2016, Presenter
2. **J. G. Chen**, A. Davis, N. Wadhwa, F. Durand, W. T. Freeman, and O. Buyukozturk, "Video camera-based vibration measurement for condition assessment of civil infrastructure," in *International Symposium Non-Destructive Testing in Civil Engineering (NDT-CE)*, 2015. Berlin, Germany, Sept. 15-17, 2015, Presenter
3. **J. G. Chen**, N. Wadhwa, A. Davis, F. Durand, W. T. Freeman, and O. Buyukozturk, "Long distance video camera measurements of structures," in *IWSHM-10th International Workshop on Structural Health Monitoring*, 2015. Stanford, CA, Sept. 1-3, 2015
4. Y.-J. Cha, **J. G. Chen**, and O. Buyukozturk, "Motion magnification based damage detection using high speed video," in *IWSHM-10th International Workshop on Structural Health Monitoring*, 2015. Stanford, CA, Sept. 1-3, 2015
5. **J. G. Chen**, N. Wadhwa, F. Durand, W. T. Freeman, and O. Buyukozturk, "Developments with motion magnification for structural modal identification through camera video," in *Dynamics of Civil Structures, Volume 2*, pp. 49–57, Springer, 2015. IMAC XXXIII, Orlando, Florida, USA, February 2-5, 2015, Presenter
6. Z. Dzunic, **J. G. Chen**, H. Mobahi, O. Buyukozturk, and J. W. Fisher III, "A Bayesian state-space approach for damage detection and classification," in *Dynamics of Civil Structures, Volume 2*, pp. 171–183, Springer, 2015. IMAC XXXIII, Orlando, Florida, USA, February 2-5, 2015
7. O. Buyukozturk, **J. G. Chen**, T. J. Emge, and R. W. Haupt, "Acoustic-laser vibrometry for standoff detection of defects in materials," in *11th European Conference on Non-Destructive Testing (ECNDT)*, 2014. Prague, Czech Republic, October 6-10, 2014, Presenter
8. O. Buyukozturk, J. Long, R. M. Ghazi, Y.-J. Cha, **J. Chen**, and D. Smit, "Structural health monitoring: A quest towards the use of combined approaches," in *EWSHM-7th European Workshop on Structural Health Monitoring*, 2014. Nantes, France, July 8-11, 2014

9. **J. G. Chen**, N. Wadhwa, Y.-J. Cha, F. Durand, W. T. Freeman, and O. Buyukozturk, “Structural modal identification through high speed camera video: Motion magnification,” in *Topics in Modal Analysis I, Volume 7*, pp. 191–197, Springer, 2014. IMAC XXXII, Orlando, Florida, USA, February 3-5, 2014, Presenter
10. B. Klingensmith, S. R. Burgess, T. A. Campbell, P. G. Sherman, M. Y. Feng, **J. G. Chen**, and O. Buyukozturk, “Modular system for high-speed 24-bit data acquisition of triaxial MEMS accelerometers for structural health monitoring research,” in *Special Topics in Structural Dynamics, Volume 6*, pp. 313–320, Springer, 2014. IMAC XXXII, Orlando, Florida, USA, February 3-5, 2014
11. **J. G. Chen**, R. W. Haupt, and O. Buyukozturk, “Remote characterization of defects in FRP strengthened concrete using the acoustic-laser vibrometry method,” in *Proceedings of the ASNT Fall Conference 2013*, 2013. Las Vegas, Nevada, USA Nov 4-7, 2013, Presenter
12. **J. G. Chen**, R. W. Haupt, and O. Buyukozturk, “A novel method for the remote detection of debonding in FRP-strengthened concrete: Acoustic-laser vibrometry,” in *Proceedings of the ASNT Fall Conference 2012*, 2012. Orlando, Florida, USA, Oct. 29 - Nov. 1, 2012, Presenter
13. O. Buyukozturk, R. Haupt, C. Tuakta, and **J. Chen**, “Remote detection of debonding in FRP-strengthened concrete structures using acoustic-laser technique,” in *Nondestructive Testing of Materials and Structures*, pp. 19–24, Springer, 2013. NDTMS, Istanbul, Turkey, May 15-18, 2011
14. A. Perez Galvan, B. Filippone, **J. Chen**, and B. Plaster, “Measurement of the uniformity of a 1/2 scale prototype magnet for the SNS neutron electric dipole moment experiment,” in *APS Meeting Abstracts*, vol. 1, 2009

Poster Presentations

1. N. Wadhwa, **J. G. Chen**, A. Davis, F. Durand, and W. T. Freeman, “Video magnification.” MIT Deshpande Center, IdeaStream Symposium, April 15, 2016, Cambridge, MA
2. **J. G. Chen**, A. Davis, and N. Wadhwa, “Kinetic vision: Monitoring infrastructure with video cameras - a beevision project.” Infrastructure Innovation in a Changing Environment, MIT ILP Conference, November 20, 2015, Cambridge, MA
3. O. Buyukozturk, R. Haupt, and **J. G. Chen**, “A robust methodology for the standoff condition assessment of FRP-retrofitted concrete systems.” NSF CMMI Engineering Research and Innovation Conference, July 9 - 12 2012, Boston, MA

Invited and Workshop Presentations

1. **Justin Chen** and Neal Wadhwa, “Smaller Than the Eye Can See: Big Engineering from Tiny Motions in Video”, Big Data Conference, Harvard Center of Mathematical Sciences and Applications, Cambridge, MA, August 23, 2016.
2. **Justin Chen**, “Motion magnification for health monitoring of structures”, Multiscale Assessment and Monitoring of Ancient Structures, Pompeii, Italy, June 23, 2016.
3. **Justin Chen**, “Camera-based Sensing for Modal Identification”, ITU - MIT Workshop on New Sensors for SHM & Energy Based Design, Istanbul Technical University, Istanbul, Turkey, May 26, 2015.

Patent Applications

1. O. Buyukozturk, W. T. Freeman, F. Durand, M. A. Davis, N. Wadhwa, and **J. G. Chen**, “Video-based identification of operational mode shapes.” US Patent Application 15/012,835

2. M. A. Davis, F. Durand, and **J. G. Chen**, “Methods and apparatus for modeling deformations of an object,” Sept. 15 2016. US Patent Application 15/068,357
3. O. Buyukozturk, W. T. Freeman, F. Durand, M. A. Davis, N. Wadhwa, and **J. G. Chen**, “Methods and devices for measuring object motion using camera images.” US Patent Application 62/382,709

Teaching Experience

- **Mechanics and Design of Concrete Structures 1.054/1.541**, MIT, Grader Fall 2014 (Overall rating 7/7), Grader Fall 2013, Grader Fall 2012. Responsibilities included grading homework assignments and designing exams.
- **Structural and Geotechnical Engineering Design, 1.036**, MIT, Grader Spring 2014, TA Spring 2012 (Overall rating 7/7). Responsibilities included giving a 1 hour recitation lecture and office hours every week
- **Experimental Physics Laboratory, Ph 7**, Caltech, TA Spring 2008. Responsibilities included assisting students with use of experimental apparatus and teaching experimental procedure.
- **Experimental Physics Laboratory, Ph 6**, Caltech, TA Winter 2008. Responsibilities included assisting students with use of experimental apparatus and teaching experimental procedure.

Undergraduate Mentoring

- Faisal Al-Refae, Summer 2014, Kuwait-MIT Center for Natural Resources Summer Research Internship
- Alan Samboy, Summer 2014, MIT Undergraduate Research Opportunities Program
- Kelley Determan, Summer 2011, MIT Undergraduate Research Opportunities Program

Awards and Leadership

- Shell - MIT Energy Fellow, 2016 - 2017, 2012 - 2013
- 3rd Annual MIT CEE Video Competition, People’s Choice Award, 2016, Big Engineering from Small Motions: <https://youtu.be/OGiVsiBSWmw>
- MIT \$100k Launch Competition Semi-Finalist, 2016, (50 out of 180)
- MIT \$100k Pitch Competition Finalist, 2015, (21 out of 110)
- Founding Member of MIT Civil and Environmental Engineering Graduate Committee, 2013 - 2015
- American Society for Nondestructive Testing Fellowship Award, 2011
- Harvey Schoettler Fellowship, 2010 - 2011