Nathan Jacobs

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h-index: 18, i10-index: 32 (Nov 14, 2019)

Areas of Expertise

Computer Vision, Deep Learning, Big Data, Geospatial Data, Social Media, Medical Imaging

Education

2005–2010 Ph.D. in Computer Science — Washington University in St. Louis
Adviser: Robert Pless
Thesis: Calibrating and Using the Global Network of Outdoor Webcams

1995–1999 B.S. in Computer Science (Minor in Mathematics) — University of Missouri
Summa Cum Laude with Honors

Appointments and Affiliations

Associate Professor — Dept. of Computer Science, University of Kentucky
2016–present — *Lexington, KY*

(interim) Associate Department Chair — Dept. of Computer Science, University of Kentucky
2019–present — *Lexington, KY*

Owner — Multidomain Vision Research, LLC
2019–present — *Lexington, KY*

Member — Institute for Biomedical Informatics, University of Kentucky
2017–present — *Lexington, KY*

Affiliated Faculty — Unmanned Systems Research Consortium, University of Kentucky
2013–present — *Lexington, KY*

Affiliated Faculty — Center for Visualization and Virtual Environments, University of Kentucky
2010–2019 — *Lexington, KY*

Visiting Research Scientist (one-year sabbatical) — Orbital Insight, Inc.
2017–2018 — *Mountain View, CA*

Assistant Professor of Computer Science — University of Kentucky
2010–2016 — *Lexington, KY*

Graduate Research Assistant — Washington University
2005–2010 — *St. Louis, MO*

Awards

- Outstanding Reviewer Recognition (ICCV 2019).

- University of Kentucky, College of Engineering Dean's Award for Excellence in Research (2018).
- Google Faculty Research Award (2018).
- Outstanding Reviewer Recognition (CVPR 2017).
- National Science Foundation CAREER Award (2016).
- Google Faculty Research Award (2016).
- Best Student Paper Award at Applied Imagery Pattern Recognition (2009).
- Ph.D. Forum Prize at the ACM/IEEE International Conference on Distributed Smart Cameras (2009).
- Best Talk Award for the Doctoral Student Seminar in the Washington University Department of Computer Science (Fall 2006).

Publications

Refereed Journal Publications

[1] Xiaoqin Wang, Gongbo Liang, Yu Zhang, Hunter Blanton, Zachary Bessinger, and Nathan Jacobs. Inconsistent performance of deep learning models on mammogram classification. *Journal of the American College of Radiology*, 2020. Impact factor: 3.785.

[2] Raian V. Maretto, Leila M. G. Fonseca, Nathan B. Jacobs, Thales S. Körting, Hugo N. Bendini, and Leandro L. Parente. Spatio-temporal deep learning approach to map deforestation in amazon rainforest. *IEEE Geoscience and Remote Sensing Letters*, 2020. Impact factor: 3.534.

[3] Hamid Hamraz, Nathan B. Jacobs, Marco A. Contreras, and Chase H. Clark. Deep Learning for Conifer/Deciduous Classification of Airborne LiDAR 3D Point Clouds Representing Individual Trees. *ISPRS Journal of Photogrammetry and Remote Sensing*, 158:219–230, 2019. Impact factor: 6.946.

[4] Radu Paul Mihail, Gongbo Liang, and Nathan Jacobs. Automatic hand skeletal shape estimation from radiographs. *IEEE Transactions on NanoBioscience*, 2019. Impact factor: 1.927.

[5] Hasan Sajid, Nathan Jacobs, and Sen-ching S. Cheung. Motion and appearance based background subtraction for freely moving cameras. *Signal Processing: Image Communication*, 2019. Impact factor: 2.814.

[6] Xiaofei Zhang, Yi Zhang, Erik Han, Nathan Jacobs, Qiong Han, Xiaoqin Wang, and Jinze Liu. Classification of whole mammogram and tomosynthesis images using deep convolutional neural networks. *IEEE Transactions on NanoBioscience*, 2018. Impact factor: 1.927.

[7] Hasan Sajid, Sen-ching S. Cheung, and Nathan Jacobs. Appearance based background subtraction for PTZ cameras. *Signal Processing: Image Communication*, 2016. Impact factor: 1.602.

[8] Nathan Jacobs, Scott Workman, and Richard Souvenir. Cloudmaps from static ground-view video. *Image and Vision Computing (IVC)*, 52:154–166, August 2016. Impact factor: 1.766.

[9] Mohammad T. Islam, Connor Greenwell, Richard Souvenir, and Nathan Jacobs. Large-Scale Geo-Facial Image Analysis. *EURASIP Journal on Image and Video Processing (JIVP)*, 2015(1):1–14, June 2015. Impact factor: 1.060.

[10] Scott Workman, Richard Souvenir, and Nathan Jacobs. Scene Shape Estimation from Multiple Partly Cloudy Days. *Computer Vision and Image Understanding (CVIU)*, pages 116–129, April 2015. Impact factor: 1.54.

[11] Nathan Jacobs, Austin Abrams, and Robert Pless. Two Cloud-Based Cues for Estimating Scene Structure and Camera Calibration. *IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI)*, 35(10):2526–2538, 2013. Impact factor: 4.795.

[12] Nathan Jacobs and Robert Pless. Time Scales in Video Surveillance. *IEEE Transactions on Circuits and Systems for Video Technology (CSVT)*, 18(8):1106–1113, 2008. Impact factor: 2.615.

Book Chapters

[13] Radu Paul Mihail, Nathan Jacobs, Judy Goldsmith, and Kristine Lohr. Using visual analytics to inform rheumatoid arthritis patient choices. In Christian Sebastian Loh, Yanyan Sheng, and Dirk Ifenthaler, editors, *Serious Games Analytics*, Advances in Game-Based Learning, pages 211–231. Springer International Publishing, 2015.

Refereed Conference Publications

[14] Armin Hadzic, Gordon Christie, Jeffrey Freeman, Amber Dismer, Stevan Bullard, Ashley Greiner, Nathan Jacobs, and Ryan Mukherjee. Estimating displaced populations from overhead. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2020.

[15] Scott Workman, M. Usman Rafique, Hunter Blanton, Connor Greenwell, and Nathan Jacobs. Single image cloud detection via multi-image fusion. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2020.

[16] Hunter Blanton, Sean Grate, and Nathan Jacobs. Surface Modeling for Airborne LiDAR. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2020.

[17] Gongbo Liang, Xiaoqin Wang, and Yu Zhang Nathan Jacobs. Weakly-supervised self-training for breast cancer localization. In *International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)*, 2020.

[18] Tawfiq Salem, Scott Workman, and Nathan Jacobs. Learning a Dynamic Map of Visual Appearance. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2020.

[19] Scott Workman and Nathan Jacobs. Dynamic traffic modeling from overhead imagery. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2020. (oral).

[20] Yu Zhang, Xiaoqin Wang, Hunter Blanton, Gongbo Liang, Xin Xing, and Nathan Jacobs. 2D Convolutional Neural Networks for 3D Digital Breast Tomosynthesis Classification. In *IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, 2019.

[21] Gongbo Liang, Xiaoqin Wang, Yu Zhang, Xin Xing, Hunter Blanton, Tawfiq Salem, and Nathan Jacobs. Joint 2d-3d breast cancer classification. In *IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, 2019.

[22] Tawfiq Salem, Connor Greenwell, Hunter Blanton, and Nathan Jacobs. Learning to map nearly anything. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2019.

[23] Weilian Song, Tawfiq Salem, Hunter Blanton, and Nathan Jacobs. Remote estimation of free-flow speeds. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2019.

[24] M. Usman Rafique and Nathan Jacobs. Weakly supervised building segmentation. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2019.

[25] Gongbo Liang, Sajjad Fouladvand, Jie Zhang, Michael A Brooks, Nathan Jacobs, and Jin Chen. Ganai: Standardizing ct images using generative adversarial network with alternative improvement. In *IEEE International Conference on Healthcare Informatics (ICHI)*, 2019.

[26] Zachary Bessinger and Nathan Jacobs. A generative model of worldwide facial appearance. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, 2019.

[27] Radu Paul Mihail and Nathan Jacobs. Automatic hand skeletal shape estimation from radiographs. In *IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, 2018. Acceptance rate: 19.6%.

[28] Nathan Jacobs, Adam Kraft, M. Usman Rafique, and Ranti Dev Sharma. A weakly supervised approach for estimating spatial density functions from high-resolution satellite imagery. In *ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL)*, 2018.

[29] Samuel Schulter, Menghua Zhai, Nathan Jacobs, and Manmohan Chandraker. Learning to look around objects for top-view representations of outdoor scenes. In *European Conference on Computer Vision (ECCV)*, 2018.

[30] Menghua Zhai, Tawfiq Salem, Connor Greenwell, Scott Workman, Robert Pless, and Nathan Jacobs. Learning geo-temporal image features. In *British Machine Vision Conference (BMVC)*, 2018.

[31] Weilian Song, Scott Workman, Armin Hadzic, Reginald Souleyrette, Eric Green, Mei Chen, Xu Zhang, and Nathan Jacobs. Farsa: Fully automated roadway safety assessment. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, 2018.

[32] Connor Greenwell, Scott Workman, and Nathan Jacobs. What goes where: Predicting object distributions from above. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2018.

[33] Tawfiq Salem, Menghua Zhai, Scott Workman, and Nathan Jacobs. A multimodal approach to mapping soundscapes. In *IEEE International Geoscience and Remote Sensing Symposium (IGARSS)*, 2018.

[34] Derek Jones, Jeevith Bopaiah, Fatemah Alghamedy, Nathan Jacobs, Heidi Weiss, Wibe A De Jong, and Sally Ellingson. Polypharmacology within the full kinome: a machine learning approach. In *AMIA Informatics Summit*, 2018.

[35] Xiaofei Zhang, Yi Zhang, Erik Han, Nathan Jacobs, Qiong Han, Xiaoqin Wang, and Jinze Liu. Whole Mammogram Image Classification With Convolutional Neural Networks. In *IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, 2017. Acceptance rate: 19%.

[36] Scott Workman, Menghua Zhai, David Crandall, and Nathan Jacobs. A unified model for near/remote sensing. In *IEEE International Conference on Computer Vision (ICCV)*, 2017.

[37] Scott Workman, Richard Souvenir, and Nathan Jacobs. Understanding and mapping natural beauty. In *IEEE International Conference on Computer Vision (ICCV)*, 2017.

[38] Nam Vo, Nathan Jacobs, and James Hays. Revisiting im2gps in the deep learning era. In *IEEE International Conference on Computer Vision (ICCV)*, 2017.

[39] Menghua Zhai, Zach Bessinger, Scott Workman, and Nathan Jacobs. Predicting ground-level scene layout from aerial imagery. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2017.

[40] Zachary Bessinger, Chris Stauffer, and Nathan Jacobs. Who goes there? approaches to mapping facial appearance diversity. In *ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL)*, 2016.

[41] Scott Workman, Menghua Zhai, and Nathan Jacobs. Horizon lines in the wild. In *British Machine Vision Conference (BMVC)*, 2016.

[42] Menghua Zhai, Scott Workman, and Nathan Jacobs. Camera Geo-Calibration using an MCMC Approach. In *IEEE International Conference on Image Processing (ICIP)*, 2016.

[43] Zachary Bessinger and Nathan Jacobs. Quantifying curb appeal. In *IEEE International Conference on Image Processing (ICIP)*, 2016.

[44] Menghua Zhai, Scott Workman, and Nathan Jacobs. Detecting vanishing points using global image context in a non-manhattan world. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2016.

[45] Tawfiq Salem, Scott Workman, Menghua Zhai, and Nathan Jacobs. Analyzing human appearance as a cue for dating images. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, pages 1–8, 2016.

[46] Ryan Baltenberger, Menghua Zhai, Connor Greenwell, Scott Workman, and Nathan Jacobs. A fast method for estimating transient scene properties. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, pages 1–8, 2016.

[47] Radu Paul Mihail, Scott Workman, Zach Bessinger, and Nathan Jacobs. Sky segmentation in the wild: An empirical study. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, pages 1–6, 2016.

[48] Scott Workman, Richard Souvenir, and Nathan Jacobs. Wide-area image geolocalization with aerial reference imagery. In *IEEE International Conference on Computer Vision (ICCV)*, pages 1–9, 2015.

[49] Calvin Murdock, Nathan Jacobs, and Robert Pless. Building dynamic cloud maps from the ground up. In *IEEE International Conference on Computer Vision (ICCV)*, pages 1–9, 2015.

[50] Scott Workman, Connor Greenwell, Menghua Zhai, Ryan Baltenberger, and Nathan Jacobs. Deepfocal: A method for direct focal length estimation. In *IEEE International Conference on Image Processing (ICIP)*, 2015. Acceptance rate: 45% (overall).

[51] Mohammad T. Islam, Scott Workman, and Nathan Jacobs. Face2GPS: Estimating Geographic Location from Facial Features. In *IEEE International Conference on Image Processing (ICIP)*, 2015. Acceptance rate: 45% (overall).

[52] Scott Workman, Radu Paul Mihail, and Nathan Jacobs. A Pot of Gold: Rainbows as a Calibration Cue. In *European Conference on Computer Vision (ECCV)*, pages 820–835, 2014. Acceptance rate: 25%.

[53] Feiyu Shi, Menghua Zhai, Drew Duncan, and Nathan Jacobs. MPCA: EM-Based PCA For Mixed-Size Image Datasets. In *IEEE International Conference on Image Processing (ICIP)*, pages 1807–1811, 2014. Acceptance rate: 40%.

[54] Ann Whitney, John Fessler, Johne Parker, and Nathan Jacobs. Received Signal Strength Indication Signature for Passive UHF Tags. In *IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*, pages 1183–1187, 2014.

[55] Menghua Zhai, Feiyu Shi, Drew Duncan, and Nathan Jacobs. Covariance-Based PCA for Multi-Size Data. In *International Conference on Pattern Recognition (ICPR)*, pages 1603–1608, 2014. Acceptance rate: 56.2%.

[56] Mohammad T. Islam, Scott Workman, Hui Wu, Richard Souvenir, and Nathan Jacobs. Exploring the Geo-Dependence of Human Face Appearance. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, pages 1042–1049, 2014. Acceptance rate: 40%.

[57] Nathan Jacobs, Joshua King, Daniel Bowers, and Richard Souvenir. Estimating Cloud Maps from Outdoor Image Sequences. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, pages 961–968, 2014. Acceptance rate: 40%.

[58] Radu Paul Mihail, Gustav Blomquist, and Nathan Jacobs. A CRF Approach to Fitting a Generalized Hand Skeleton Model. In *IEEE Winter Conference on Applications of Computer Vision (WACV)*, pages 409–416, 2014. Acceptance rate: 40%.

[59] Nathan Jacobs, Scott Workman, and Richard Souvenir. Scene Geometry from Several Partly Cloudy Days. In *ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC)*, pages 1–6, 2013.

[60] Radu Paul Mihail, Judy Goldsmith, Nathan Jacobs, and Jerzy Jaromczyk. Teaching Graphics for Games using Microsoft XNA. In *International Conference on Computer Games (CGAMES)*, pages 36–40, 2013. Best Student Paper Award (runner-up).

[61] Nathan Jacobs, Mohammad T. Islam, and Scott Workman. Cloud Motion as a Calibration Cue. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 1344–1351, 2013. Acceptance rate: 26.2%.

[62] Michael Dixon, Austin Abrams, Nathan Jacobs, and Robert Pless. On Analyzing Video with Very Small Interesting Motions. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 1–8, 2011. Acceptance rate: 26.4%.

[63] Austin Abrams, Nick Fridrich, Nathan Jacobs, and Robert Pless. Participatory Integration of Live Webcams into GIS. In *International Conference on Computing for Geospatial Research and Applications (COM.GEO)*, pages 1–8, 2010.

[64] Nathan Jacobs, Brian Bies, and Robert Pless. Using Cloud Shadows to Infer Scene Structure and Camera Calibration. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 1102–1109, June 2010. Acceptance rate: 4.5% (oral).

[65] Nathan Jacobs, Stephen Schuh, and Robert Pless. Compressive Sensing and Differential Image Motion Estimation. In *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*, pages 718–721, March 2010. Acceptance rate (oral) = 10%, (overall) = 48%.

[66] Nathan Jacobs, Walker Burgin, Nick Fridrich, Austin Abrams, Kylia Miskell, Bobby H. Braswell, Andrew D. Richardson, and Robert Pless. The Global Network of Outdoor Webcams: Properties and Applications. In *ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems (ACM SIGSPATIAL)*, pages 111–120, November 2009. Acceptance rate: 20.9%.

[67] Michael Dixon, Nathan Jacobs, and Robert Pless. An Efficient System for Vehicle Tracking in Multi-Camera Networks. In *ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC)*, pages 1–8, September 2009.

[68] Nathan Jacobs, Scott Satkin, Nathaniel Roman, Richard Speyer, and Robert Pless. Geolocating Static Cameras. In *IEEE International Conference on Computer Vision (ICCV)*, pages 1–6, October 2007. Acceptance rate: 23%.

[69] Nathan Jacobs, Nathaniel Roman, and Robert Pless. Consistent Temporal Variations in Many Outdoor Scenes. In *IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pages 1–6, June 2007. Acceptance rate: 23.4%.

[70] Terry Anderson, Ali Hussam, Bill Plummer, and Nathan Jacobs. Pie charts for visualizing query term frequency in search results. In *International Conference on Asian Digital Libraries (ICADL)*, 2002.

[71] Ali Hussam, Terry Anderson, Nathan Jacobs, Damon Eckhoff, Ali Merayyan, and Yunhai Yang. Semantic Highlighting: Enhancing Search Engine Display and Web Document Interactivity. In *IFIP Conference on Human-Computer Interaction (INTERACT)*, September 1999.

Refereed Workshop Publications

[72] Armin Hadzic, Hunter Blanton, Weilian Song, Mei Chen, Scott Workman, and Nathan Jacobs. RasterNet: Modeling Free-Flow Speed using LiDAR and Overhead Imagery. In *EARTHVISION: Large Scale Computer Vision for Remote Sensing Imagery 2020*, 2020.

[73] Yu Zhang, Gongbo Liang, Tawfiq Salem, and Nathan Jacobs. Defense-PointNet: Protecting PointNet Against Adversarial Attacks. In *The Next Frontier of Big Data From LiDAR Workshop (co-located with IEEE Big Data)*, 2019.

[74] M. Usman Rafique, Hunter Blanton, and Nathan Jacobs. Weakly supervised fusion of multiple overhead images. In *IEEE/ISPRS Workshop: Large Scale Computer Vision for Remote Sensing (EARTHVISION)*, 2019. Acceptance rate: 23.5%.

[75] Scott Workman and Nathan Jacobs. On the location dependence of convolutional neural network features. In *IEEE/ISPRS Workshop: Looking from above: When Earth observation meets vision (EARTHVISION)*, pages 1–9, 2015. Acceptance rate: 30%.

[76] Connor Greenwell, Scott Spurlock, Richard Souvenir, and Nathan Jacobs. GeoFaceExplorer: Exploring the Geo-Dependence of Facial Attributes. In *ACM SIGSPATIAL International Workshop on Crowdsourced and Volunteered Geographic Information (GEOCROWD)*, pages 32–37, 2014.

[77] Mohammad T. Islam, Nathan Jacobs, Hui Wu, and Richard Souvenir. Images+Weather: Collection, Validation, and Refinement. In *IEEE CVPR Workshop on Ground Truth*, pages 1–7, 2013. Acceptance rate: 67%.

[78] Calvin Murdock, Nathan Jacobs, and Robert Pless. Webcam2Satellite: Estimating Cloud Maps from Webcam Imagery. In *IEEE Workshop on Applications of Computer Vision (WACV)*, pages 214–221, 2013. Acceptance rate: 40%.

[79] Radu Paul Mihail, Nathan Jacobs, and Judy Goldsmith. Real Time Gesture Recognition With 2 Kinect Sensors. In *International Conference on Image Processing, Computer Vision, and Pattern Recognition (IPCV)*, pages 1–7, 2012.

[80] Austin Abrams, Jim Tucek, Nathan Jacobs, and Robert Pless. LOST: Longterm Observation of Scenes (with Tracks). In *IEEE Workshop on Applications of Computer Vision (WACV)*, pages 297–304, 2012. Acceptance rate: 44%.

[81] Nathan Jacobs, Kylia Miskell, and Robert Pless. Webcam Geo-localization using Aggregate Light Levels. In *IEEE Workshop on Applications of Computer Vision (WACV)*, pages 132–138, 2011.

[82] Nathan Jacobs, Richard Souvenir, and Robert Pless. Passive vision: The Global Webcam Imaging Network. In *IEEE Applied Imagery and Pattern Recognition (AIPR)*, pages 1–8, 2009. Best Student Paper.

[83] Robert Pless, Nathan Jacobs, Michael Dixon, Ralph Hartley, Patrick Baker, Derek Brock, Nick Cassimatis, and Dennis Perzanowski. Persistence and Tracking: Putting Vehicles and Trajectories in Context. In *IEEE Applied Imagery and Pattern Recognition (AIPR)*, 2009.

[84] Nathan Jacobs, Michael Dixon, Scott Satkin, and Robert Pless. Efficient Tracking of Many Objects in Structured Environments. In *IEEE ICCV Workshop on Visual Surveillance*, pages 1161–1168, October 2009.

[85] Nathan Jacobs and Robert Pless. Calibrating and Using the Global Network of Outdoor Webcams. In *ACM/IEEE International Conference on Distributed Smart Cameras (ICDSC)*, pages 1–2, September 2009. Winner PhD Forum Prize.

[86] Nathan Jacobs, Walker Burgin, Richard Speyer, David Ross, and Robert Pless. Adventures in Archiving and Using Three Years of Webcam Images. In *IEEE CVPR Workshop on Internet Vision*, pages 39–46, June 2009.

[87] Nathan Jacobs, Michael Dixon, and Robert Pless. Location-specific Transition Distributions for Tracking. In *IEEE Workshop on Motion and Video Computing (WMVC)*, January 2008. Acceptance rate: 33.3%.

[88] Nathan Jacobs, Nathaniel Roman, and Robert Pless. Toward Fully Automatic Geo-Location and Geo-Orientation of Static Outdoor Cameras. In *IEEE Workshop on Applications of Computer Vision (WACV)*, pages 1–6, January 2008. Acceptance rate: 33.3%.

[89] Nathan Jacobs and Robert Pless. Shape Background Modeling: The Shape of Things That Came. In *IEEE Workshop on Motion and Video Computing (WMVC)*, pages 1–6, February 2007.

[90] Nathan Jacobs and Robert Pless. Real-time Constant Memory Visual Summaries for Surveillance. In *ACM International Workshop on Visual Surveillance and Sensor Networks (VSSN)*, October 2006.

[91] Michael Dixon, Nathan Jacobs, and Robert Pless. Finding Minimal Parameterizations of Cylindrical Image Manifolds. In *IEEE CVPR Workshop on Perceptual Organization in Computer Vision (POCV)*, pages 1–8, June 2006.

Abstracts

[92] Connor Greenwell, Scott Workman, and Nathan Jacobs. Implicit land use mapping using social media imagery. In *IEEE Applied Imagery and Pattern Recognition (AIPR)*, 2019.

[93] Tyler Hammond, Xin Xing, Nathan Jacobs, and Ai-Ling Lin. Phase-dependent importance of amyloid-beta, phosphorylated-tau, and hypometabolism in determining mild cognitive impairment and alzheimer's disease: A machine learning study. In *Alzheimer's Disease Therapeutics: Alternatives to Amyloid*, 2019.

[94] Yu Zhang, Gongbo Liang, Nathan Jacobs, and Xiaoqin Wang. Unsupervised Domain Adaptation for Mammogram Image Classification: A Promising Tool for Model Generalization. In *Conference on Machine Intelligence in Medical Imaging (CMIMI)*, 2019.

[95] Gongbo Liang, Nathan Jacobs, and Xiaoqin Wang. Training deep learning models as radiologists: Breast cancer classification using combined whole 2d mammography and full volume digital breast tomosynthesis. In *Radiological Society of North America (RSNA)*, 2019.

[96] Junfeng Zhu, Adam M Nolte, Nathan Jacobs, and Ming Ye. Incorporating Machine Learning with LiDAR for Delineating Sinkholes. In *Kentucky Water Resources Annual Symposium*, 2019.

[97] Gongbo Liang, Nathan Jacobs, Jinze Liu, Kyle Luo, Wendi Owen, and Xiaoqin Wang. Translational relevance of performance of deep learning models on mammograms. In *SBI/ACR Breast Imaging Symposium*, 2019.

[98] Gongbo Liang, Xiaoqin Wang, and Nathan Jacobs. Evaluating the publicly available mammography datasets for deep learning model training. In *SBI/ACR Breast Imaging Symposium*, 2018.

[99] Derek Jones, Nathan Jacobs, and Sally Ellingson. Learning deep feature representations for kinase polypharmacology. In *ACM Richard Tapia Celebration of Diversity in Computing Conference*, 2018.

[100] Weilian Song, Tawfiq Salem, Nathan Jacobs, and Michael Johnson. Detecting the presence of bird vocalizations in audio segments using a convolutional neural network architecture. In *International Symposium on Acoustic Communication by Animals*, 2017.

[101] Nathan Jacobs, Scott Workman, and Menghua Zhai. Crossview convolutional networks. In *IEEE Applied Imagery and Pattern Recognition (AIPR)*, 2016.

[102] J. David Smith, Ryan Baltenberger, Scott Workman, and Nathan Jacobs. User-in-the-Loop Calibration and Mensuration. In *National Conference on Undergraduate Research (NCUR)*, 2014.

[103] Xuzi Zhou, Scott Workman, Mohammad T. Islam, Nathan Jacobs, and James Griffioen. Cyber Infrastructure for the VOEIS Project. In *Symposium in the Mathematical, Statistical and Computer Sciences*, 2013. Best Student Presentation.

[104] Scott Workman, James Knochelmann, Nathan Jacobs, David S. White, and Richard Hauer. Registration and Visualization of Scientific Aerial Imagery at Kentucky Lake. In *Kentucky EPSCoR Conference*, 2012.

[105] Ethan Welty, Tad Pfeffer, Shad O'Neel, and Nathan Jacobs. Calving Dynamics of the Columbia Glacier, AK (2000-2011 Update). In *Workshop on the Dynamics and Mass Budget of Arctic Glaciers*, 2012.

[106] Peishing Wang, Siddhartha Bhattacharyya, David White, and Nathan Jacobs. Visualization of Kentucky Lake. In *Kentucky EPSCoR Conference*, 2011.

[107] Tom Milliman, Koen Hufkins, Isaac Lavine, Nathan Jacobs, Robert Pless, Andrew Richardson, and Steve Frolking. The PhenoCam Website: Adventures in "Crowd-Sourcing" Data Collection, Distribution and Analysis. In *American Geophysical Union Annual Meeting*, 2011.

Datasets

[108] Scott Workman, Menghua Zhai, and Nathan Jacobs. Horizon Lines in the Wild: A large database of images with known horizon-line location. http://hlw.csr.uky.edu.

[109] Mohammad T. Islam, Connor Greenwell, and Nathan Jacobs. GeoFaces: A large database of geolocated face patches. http://geofaces.csr.uky.edu.

[110] Nathan Jacobs, Robert Pless, Austin Abrams, and many others (see website for details). AMOS: The Archive of Many Outdoor Scenes. http://amos.cse.wustl.edu.

[111] Austin Abrams, Jim Tucek, Joshua Little, Nathan Jacobs, and Robert Pless. LOST: Longterm Observation of Scenes (with Tracks). http://lost.cse.wustl.edu.

Other Publications

[112] Nathan Jacobs, Stephen Schuh, and Robert Pless. On Unusual Pixel Shapes and Image Motion. Technical Report WUCSE-2009-16, Computer Science and Engineering, Washington University in St. Louis, MO, USA, June 2009.

[113] Austin Abrams, Chris Hawley, Kylia Miskell, Adina Stoica, Nathan Jacobs, and Robert Pless. Shadow estimation method for "the episolar constraint: Monocular shape from shadow correspondence", 2013.

Funding

Grants (awarded/active)

1. *CAREER: Learning and Using Models of Geo-Temporal Appearance*
   PI: Nathan Jacobs
   Sponsor: National Science Foundation (NSF)
   Amount Funded: $499,426
   Duration: 2016–2021

2. *Crossview ConvNets for Near/Remote Sensing*
   PI: Nathan Jacobs
   Sponsor: Google
   Amount Funded: $46,209
   Duration: 2016–2017

3. *GeoLookbook: Modeling Worldwide Human Visual Appearance*
   PI: Nathan Jacobs
   Sponsor: National Geospatial Intelligence Agency (NGA, New Investigator Program)
   Amount Funded: $299,204
   Duration: 2014–2018

4. *Monomeric G-proteins and Cardioprotection from Heart Failure (R01)*
   PI: John Satin
   Co-PI(s): Douglas Andres, Ahmed Abdel-Latif, Nathan Jacobs, Peter Kekenes-Huskey
   Sponsor: National Institute of Health (NIH)
   Amount Funded: $1,575,279
   Duration: 2016–2020

5. *Mechanism of a Novel Stable Compensatory Cardiac Hypertrophy Model*
   PI: Jonathan Satin
   Co-PI(s): Douglas Andres, Nathan Jacobs, Moriel Vandsburger
   Sponsor: American Heart Association
   Amount Funded: $154,000
   Duration: 2016–2018

6. *Listening to Markets: A Temporal Convolutional Net (TCN) Analysis of Conservatism in Company Reporting*
   PI: Dan Stone (Business)
   Co-PI(s): Nathan Jacobs (Computer Science), Mark Lauersdorf (Linguistics), Hong Xie (Accountancy)
   Sponsor: University of Kentucky: Igniting Research Collaborations
   Amount Funded: $33,315
   Duration: 2018–2019

7. *Calibrated Pose Regression Networks*
   PI: Nathan Jacobs
   Sponsor: The Design Knowledge Company/Air Force Research Lab (Wright-Patterson AFB)
   Amount Funded: $155,700
   Duration: 2018–2019

8. *ASER Multi Center Review of Blunt Splenic Trauma: Optimal CT Diagnosis, Characterization*
   PI: James Lee (Radiology)
   Co-PI(s): David Nickels, Nathan Jacobs, Emily Slade
   Sponsor: American Society of Emergency Radiology
   Amount Funded: $5,000
   Duration: 2018–2019

Grants (completed)

1. *WALDO: Wide Area Localization of Depicted Objects*
   PI: Nathan Jacobs
   Sponsor: Intelligence Advanced Research Projects Activity (subcontract through Object Video Inc.)
   Amount Funded: $373,395
   Duration: 2012–2016

2. *ContextualEyes: A Context-Aware Surveillance System*
   PI: Nathan Jacobs
   Sponsor: Defense Advanced Research Projects Agency (DARPA)
   Amount Funded: $743,131
   Duration: 2011–2015

3. *Image-Net: Discriminatory Imaging and Network Advancement for Missiles, Aviation, and Space*
   PI: Brent Seales
   Co-PI(s): Ken Calvert, James Griffioen, Jane Hayes, Nathan Jacobs, Victor Marek, Thomas Seigler, Suzanne Smith, Miroslaw Truszczynski, Ruigang Yang

Sponsor: United States Army Space and Missile Defense Command/United States Army Forces Strategic Command
Amount Funded: $2,092,905
Duration: 2011–2012

Donations

1. *Google Cloud Compute Research Credits*
   PI: Nathan Jacobs
   Sponsor: Google
   Amount Funded: $5,000
   Date: August 2018
2. *NVIDIA Titan X (Maxwell) GPU*
   PI: Nathan Jacobs
   Sponsor: NVIDIA Corporation
   Amount Funded: $778
   Date: October 2016
3. *AWS Research Education Grant*
   PI: Nathan Jacobs
   Sponsor: Amazon, Inc.
   Amount Funded: $5,000
   Date: July 2015
4. *NVIDIA Tesla K40 GPU*
   PI: Nathan Jacobs
   Sponsor: NVIDIA Corporation
   Amount Funded: $3,900
   Date: December 2014
5. *OKAO Vision Software*
   PI: Nathan Jacobs
   Sponsor: OMRON Corporation
   Amount Funded: -
   Date: May 2013

Talks

- "Deep Convolutional Neural Networks: Foundations to Frontiers (a 2-day short course)", Mar 2020, Brazilian Space Agency (INPE), Sao Jose dos Campus, Brazil
- "What, Where, and When: Mapping the World Using Webcams, Cell Phones, and Satellites", Mar 2020, Brazilian Space Agency (INPE), Sao Jose dos Campus, Brazil
- "Learning to Map Visual Appearance", Jan 2020, Wageningen University, Netherlands
- "What, Where, and When: Mapping the World Using Webcams, Cell Phones, and Satellites", Nov 2019, University of Kentucky (Forestry), Lexington, KY
- "Learning to Map the Visual World", Jul 2019, Wright State University, Dayton, OH
- "Keynote: Understanding Places Using Ground-Level and Overhead Views", May 2019, Kentucky Geological Society (Annual Symposium), Lexington, KY
- "Understanding Places Using Ground-Level and Overhead Views", Feb. 2019, Notre Dame University, South Bend, IN
- "A Generative Model of Worldwide Facial Appearance", Jan. 2019, Workshop on Demographic Variations in Performance of Biometric Algorithms, Waikoloa Village, HI
- "A Generative Model of Worldwide Facial Appearance", Jan. 2019, IEEE WACV, Waikoloa Village, HI
- "A Weakly Supervised Approach for Estimating Spatial Density Functions from High-Resolution Satellite Imagery", Nov. 2018, ACM SIGSPATIAL, Seattle, WA
- "Understanding Places Using Ground-Level and Overhead Views", Oct. 2018, Commonwealth Computational Summit, Lexington, KY

- "GeoLookbook: Modeling Worldwide Human Visual Appearance (Year 4)", Sep. 2018, National Academy of Sciences (IC Academic Research Symposium), Washington, DC
- "Understanding Places Using Ground-Level and Overhead Views", Aug. 2018, Oak Ridge National Lab, Oak Ridge, TN
- "WhatGoesWhere: Predicting Object Distributions from Above", July 2018, IGARSS, Valencia, Spain
- "Building World Models for Situated Training and Planning", May 2018, Air Force Science and Technology 2030 Workshop, Bloomington, IN
- "Recent Advances in Image Understanding", May 2018, DASC, Lexington, KY
- "(Tutorial) Recent Advances in Deep Learning: Fusing Overhead and Ground-Level Views for Remote Sensing", April 2018, USGIF Annual Symposium, Tampa, FL
- "Understanding Places Using Ground-Level and Overhead Views", Feb 2018, CVPR Area Chair Meeting, Toronto, Canada
- "GeoLookbook: Modeling Worldwide Human Visual Appearance (Year 3)", Sep. 2017, National Academy of Sciences (IC Academic Research Symposium), Washington, DC
- "GPU Accelerated Computer Vision, Remote Sensing, and Machine Learning", Aug. 2017, Kentucky Geological Service, Lexington, KY
- "Fusing Overhead and Ground-Level Imagery to Improve Scene Understanding", July 2017, Planet, San Francisco, CA
- "Learning about When and Where from Imagery", June 2017, Orbital Insight, Mountain View, CA
- "(Tutorial) Recent Advances in Deep Learning: Fusing Overhead and Ground-Level Views for Remote Sensing", June 2017, USGIF Annual Symposium, San Antonio, TX
- "How Computers See People (extended)", May 2017, CCTS Biomedical Informatics Seminar Series, Lexington, KY
- "Understanding Places Using Ground-Level and Overhead Views", May 2017, Midwest Vision Meeting, Chicago, IL
- "How Computers See People", Feb. 2017, Suds'n'Science Speaker Series, West Sixth Brewing, Lexington, KY
- "Learning about When and Where from Imagery", Feb. 2017, University of Missouri, Department of Computer Science
- "Localization, Mapping, and Image Understanding", Feb. 2017, USGIF Machine Learning Symposium
- "Deep Convolutional Neural Networks: Concepts and Examples (in Computer Vision", Nov. 2016, University of Kentucky, Society of Industrial and Applied Mathematics
- "Crossview Convolutional Networks", Oct. 2016, Applied Imagery and Pattern Recognition, Washington, D.C.
- "GeoLookbook: Modeling Worldwide Human Visual Appearance (Year 2)", Sep. 2016, National Academy of Sciences (IC Academic Research Symposium), Washington, DC
- "Deep Convolutional Neural Networks: Concepts and Examples", Jul. 2016, University of Kentucky: Systems Biology and Omics Integration Seminar
- "Crossview Methods for Localization and Mapping", Jun. 2016, IEEE CVPR Workshop on "Vision from Satellite to Street" (invited talk)

- "A Fast Method for Estimating Transient Scene Properties", Mar. 2016, Winter Conference on Applications of Computer Vision, Lake Placid, NY
- "Novel Cues for Geocalibration", Feb. 2016, Indiana University, Bloomington, IN
- "Novel Cues for Camera Geocalibration", Jan. 2016, Uber Advanced Technology Center, Pittsburgh, PA
- "Novel Cues for Geocalibration: Cloudy Days, Rainbows, and More", Oct. 2015, Carnegie Mellon University, Pittsburgh, PA
- "Using Geotagged Internet Imagery to Understand the World", Sep. 2015, Université Laval, Quebec City, Canada
- "face2gps: Estimating Geographic Location from Facial Features", Sep. 2015, International Conference on Image Processing, Quebec City, Canada
- "GeoLookbook: Modeling Worldwide Human Visual Appearance", Sep. 2015, National Academy of Sciences (IC Academic Research Symposium), Washington, DC
- "Exploring the Geo-Dependence of Human Face Appearance", Mar. 2014, Winter Conference on Applications of Computer Vision, Steamboat Springs, CO
- "Estimating Cloudmaps from Outdoor Image Sequences", Mar. 2014, Winter Conference on Applications of Computer Vision, Steamboat Springs, CO
- "Scene Geometry from Several Partly Cloudy Days", Oct. 2013, International Conference on Distributed Smart Cameras, Palm Springs, CA
- "Unlocking the Potential of the Global Network of Outdoor Webcams", Apr. 2013, Rochester Institute of Technology
- "Geo-temporal Computer Vision: Applications to the NGA", Nov. 2011, National Geospatial-Intelligence Agency
- "Geo-temporal Computer Vision: Applications to the Army", Oct. 2011, Army Research Lab
- "Localizing, Calibrating, and Using Thousands of Outdoor Webcams", Feb. 2011, University of North Carolina–Charlotte
- "Using Clouds Shadows to Infer Scene Structure and Camera Calibration", Jun. 2010, CVPR, San Francisco, CA
- "Passive Vision and The Power of Collective Imaging", Apr. 2010, Object Video Inc., Reston, VA
- "Localizing, Calibrating, and Using Thousands of Outdoor Webcams", Apr. 2010, University of Kentucky
- "Time-Lapse Vision: Localizing, Calibrating, and Using Thousands Outdoor Webcams", Apr. 2010, Google, Mountain View, CA
- "Passive Vision and The Power of Collective Imaging", Jan. 2010, Google, Mountain View, CA
- "Incorporating Domain Constraints in Urban Vehicle Tracking", Nov. 2010, University of Missouri, Columbia, MO
- "Compressive Sensing and Differential Image-Motion Estimation", Mar. 2010, ICASSP, Dallas, TX
- "The Global Network of Outdoor Webcams: Properties and Applications ", Nov. 2009, ACM GIS, Seattle, WA
- "Passive Vision: The Global Webcam Imaging Network", Oct. 2009, AIPR, Washington, DC

- "Calibrating and Using the Global Network of Outdoor Webcams", Aug. 2009, ICDSC, Italy
- "Adventures in Archiving and Using Three Years of Webcam Images", Jun. 2009, CVPR Workshop on Internet Vision, Miami, FL
- "Recent Work: Webcams and Grooves", Aug. 2009, Object Video, Reston, VA
- "Location-Specific Models for Tracking", Jan. 2008, WMVC, Copper Mountain, CO
- "Using natural cues to geo-locate and geo-orient distributed cameras", Jan. 2008, VISN, Copper Mountain, CO
- "Foreground Modeling: The Shape of Things That Came", Feb. 2007, WMVC, Austin, Texas

Service

University Service

- 2019–: Computer Science Department: Executive Committee
- 2013–2017, 2018–2020: Computer Science Department: Faculty Search Committee
- 2018–2019: University Senate (Academic Facilities Committee, Technology Committee)
- 2017: Member (Information Technology Task Force for Research Enablement and Outreach)
- 2015–2016: Computer Science Department: ABET Committee
- 2010–2012, 2015–2016: Computer Science Department: Media and Outreach
- 2013: Center for Visualization and Virtual Environment: Director Search Committee
- 2013: Computer Science Department: Chair Search Committee
- 2012–2013: Computer Science Department: Curriculum Development Committee
- 2012–2013, 2015: University of Kentucky Engineering Day (EDay) participant, giving an oral presentation and/or software demonstrations

Professional Service

- Doctoral Consortium Co-Chair: IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2019)
- PhD Forum Chair: IEEE Winter Conference on Applications of Computer Vision (WACV 2018)
- Doctoral Consortium Co-Chair: IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2017)
- Video Proceedings Chair: IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2015)
- Area Chair for:
  - IEEE Computer Vision and Pattern Recognition (CVPR 2018, 2019, 2021)
  - IEEE Winter Application and Computer Vision Conference (WACV 2014)
- Co-Organizer: IEEE/ISPRS Workshop. Large Scale Computer Vision for Remote Sensing Imagery (EARTH-VISION 2019, 2020)
- Co-Organizer: IEEE Workshop on Motion and Video Computing (WMVC 2011)

- Session Chair for:
  - IEEE/ISPRS EARTHVISION (2019, Held at CVPR)
  - IEEE Computer Vision and Pattern Recognition (CVPR 2018)
  - IEEE Winter Conference on Computer Vision (WACV 2016, 2019)
  - IEEE/ACM International Conference on Distributed Smart Cameras (ICDSC 2013)
- Guest Editor, Computer Vision and Image Understanding (CVIU), Special Issue "Computer Vision for Remote Sensing"
- Reviewing for Journals:
  - ISPRS Journal of Photogrammetry and Remote Sensing (2019)
  - IEEE Transactions on Geoscience and Remote Sensing (2017)
  - IEEE Transactions on Computational Imaging (2016)
  - IEEE Journal on Selected Topics in Remote Sensing (2015)
  - Computer Vision and Image Understanding (2010, 2013, 2016×2)
  - Machine Vision and Applications (MVAP) (2014)
  - Elsevier Image and Vision Computing (IVC) (2013)
  - IEEE Sensors (2014)
  - IEEE Transactions on Pattern Analysis and Machine Intelligence (PAMI) (2011, 2011, 2012, 2018, 2019)
  - IEEE Transactions on Multimedia (2011,2016)
  - IEEE Transactions on Circuits and Systems for Video Technology (CSVT) (2007, 2008, 2009, 2010, 2011)
  - IEEE Computer Graphics and Applications (2010)
  - IEEE Transactions on Aerospace and Electronic Systems (2010)
  - Computers and Electronics in Agriculture (2010)
  - Cartography and Geographic Information Science (2010)
- Program Committee / Reviewer for:
  - Conferences
    - IEEE Conference on Computer Vision and Pattern Recognition (CVPR) (2006–, Outstanding Reviewer 2017, 2020)
    - European Conference on Computer Vision (ECCV) (2010, 2014, 2020)
    - IEEE International Conference on Computer Vision (ICCV) (2007, 2009, 2019 [outstanding reviewer])
    - Neural Information Processing Systems (NeurIPS) (2010–2012, 2020)
    - AAAI Conference on Artificial Intelligence (AAAI) (2020)
    - IEEE International Conference on Robotics and Automation (ICRA) (2016)
    - International Conference on Machine Learning (ICML) (2012)
    - Asian Conference on Computer Vision (ACCV) (2010,2016)
    - IEEE International Conference on Advanced Video and Signal-Based Surveillance (AVSS) (2010)
  - Workshops
    - IEEE/ISPRS EARTHVISION (2019, Held at CVPR)
    - Photogrammetric Computer Vision (2019, Held at CVPR)

    - DeepGlobe Satellite Challenge (2018, Held at CVPR)
    - IEEE/ISPRS EARTHVISION (2017, Held at CVPR)
    - The Second ACM International Workshop on Geotagging and Its Applications (2013)
    - ICCV Workshop on Computer Vision for Converging Perspectives (CVCP) (2013)
    - ECCV Workshop on Visual Analysis and Geo-Localization of Large-Scale Imagery (2012)
    - IEEE Workshop on Motion and Video Computation (WMVC) (2009–2011)
    - IEEE Workshop on Applications of Computer Vision (WACV) 2012–2013
    - ACM Workshop on Geotagging and Its Applications in Multimedia (2012)
    - ACM Workshop on Video Surveillance and Sensor Networks (VSSN)

- Reviewing for Funding Agencies:
  - Panelist for NSF Information and Intelligent Systems Division (2019)
  - Panelist for NSF Information and Intelligent Systems Division (2018)
  - Panelist for NSF Information and Intelligent Systems Division (2017)
  - Panelist for NSF Division of Industrial Innovation and Partnerships (2016)
  - Panelist for NSF Information and Intelligent Systems Division (2016)
  - Panelist for NSF Information and Intelligent Systems Division (2015)
  - External reviewer for NSF Information and Intelligent Systems Division (2015)
  - External reviewer for Fonds de recherche du Quebec (2014)

Memberships

- Senior Member: Institute of Electrical and Electronics Engineers (IEEE)
- Full Member: British Machine Vision Association and Society for Pattern Recognition
- Affiliate Member: International Association of Pattern Recognition

Teaching

Courses Taught

- *Computer Vision*, CS 636, (S2011, S2013, S2017), University of Kentucky
- *Introduction to Machine Learning*, CS 460g, (Fall 2012–2016 and 2018), University of Kentucky
- *Learning-Based Methods for Computer Vision*, CS 585/685, (S2015), University of Kentucky
- *Advanced Topics in Computer Science: Machine Learning*, CS 685, (S2012), University of Kentucky
- *Independent Work in Computer Science*, CS 395/612, University of Kentucky:
  - S2016, "Applied Deep Learning: Understanding Urban Areas"
  - S2015, "Understanding Real-Estate Imagery"
  - F2014, "Recent Techniques in Machine Learning" ($\times 4$)
  - F2014, "Learning-Based Methods for Background Subtraction"
  - F2014, "A Novel Approach for Category-Level Object Detection from Partial Pose Estimation of Symmetric Objects"

  - S2013, “Extracting Geo-Temporal Image Appearance Patterns from Flickr Imagery”
  - S2013, “Automatic Camera Calibration Methods”
  - S2013, “Deep-Learning Architectures for Computer Vision”
  - F2012, “Automatic Image Geolocalization”
  - S2012, “Image Calibration using Natural Scene Variations”
  - F2011, “Practical Methods in Crowd Sourcing”
- *Intermediate Topics in Computer Science: Computational Photography*, CS 585, (F2010,F2011), University of Kentucky
- *Theory of Computation*, CECS 341, (F2002), University of Missouri