## References

- [1] Sami Abu-El-Haija, Nisarg Kothari, Joonseok Lee, Paul Natsev, George Toderici, Balakrishnan Varadarajan, and Sudheendra Vijayanarasimhan. Youtube-8m: A large-scale video classification benchmark. *CoRR*, abs/1609.08675, 2016. 1, 5
- [2] Sameer Agarwal, Noah Snavely, Ian Simon, Steven M. Seitz, and Richard Szeliski. Building Rome in a day. ICCV, 2009.
- [3] Jimmy Lei Ba, Jamie Ryan Kiros, and Geoffrey E Hinton. Layer normalization. arXiv preprint arXiv:1607.06450, 2016. 4
- [4] Oleksandr Bogdan, Viktor Eckstein, Francois Rameau, and Jean-Charles Bazin. Deepcalib: A deep learning approach for automatic intrinsic calibration of wide field-of-view cameras. In *Proceedings of the 15th ACM SIGGRAPH European Conference on Visual Media Production*, CVMP '18, pages 6:1–6:10, New York, NY, USA, 2018, ACM. 2, 7
- [5] Michael Burri, Janosch Nikolic, Pascal Gohl, Thomas Schneider, Joern Rehder, Sammy Omari, Markus W Achtelik, and Roland Siegwart. The euroc micro aerial vehicle datasets. *The International Journal of Robotics Research*, 2016. 1, 5, 7
- [6] Vincent Casser, Soeren Pirk, Reza Mahjourian, and Anelia Angelova. Unsupervised learning of depth and ego-motion: A structured approach. In AAAI-19, 2019. 2, 3, 4, 5, 6, 8, 14, 16
- [7] Marius Cordts, Mohamed Omran, Sebastian Ramos, Timo Rehfeld, Markus Enzweiler, Rodrigo Benenson, Uwe Franke, Stefan Roth, and Bernt Schiele. The cityscapes dataset for semantic urban scene understanding. In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2016.
- [8] David Eigen and Rob Fergus. Predicting depth, surface normals and semantic labels with a common multi-scale convolutional architecture. *ICCV*, 2015. 2
- [9] David Eigen, Christian Puhrsch, and Rob Fergus. Depth map prediction from a single image using a multi-scale deep network. NIPS, 2014. 2
- [10] Ravi Garg, Gustavo Carneiro, and Ian Reid. Unsupervised cnn for single view depth estimation: Geometry to the rescue. ECCV, 2016. 2
- [11] Andreas Geiger, Philip Lenz, Christoph Stiller, and Raquel Urtasun. Vision meets robotics: The kitti dataset. *The International Journal of Robotics Research*, 32(11):1231–1237, 2013. 1
- [12] Clément Godard, Oisin Mac Aodha, and Gabriel J. Brostow. Unsupervised monocular depth estimation with left-right consistency. CVPR, 2017. 2
- [13] Clément Godard, Oisin Mac Aodha, Michael Firman, and Gabriel Brostow. Digging into self-supervised monocular depth estimation. arxiv.org/pdf/1806.01260, 2018. 6, 8, 14, 16
- [14] Priya Goyal, Piotr Dollár, Ross Girshick, Pieter Noordhuis, Lukasz Wesolowski, Aapo Kyrola, Andrew Tulloch, Yangqing Jia, and Kaiming He. Accurate, large mini-

- batch sgd: Training imagenet in 1 hour. arXiv preprint arXiv:1706.02677, 2017. 4
- [15] Joel Janai, Fatma Guney, Anurag Ranjan, Michael Black, and Andreas Geiger. Unsupervised learning of multi-frame optical flow with occlusions. ECCV, 2018. 2
- [16] Hiroharu Kato, Yoshitaka Ushiku, and Tatsuya Harada. Neural 3d mesh renderer. In *The IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2018.
- [17] Alex Kendall, Hayk Martirosyan, Saumitro Dasgupta, Peter Henry, Ryan Kennedy, Abraham Bachrach, and Adam Bry. End-to-end learning of geometry and context for deep stereo regression. In *The IEEE International Conference on Computer Vision (ICCV)*, Oct 2017.
- [18] Sameh Khamis, Sean Fanello, Christoph Rhemann, Adarsh Kowdle, Julien Valentin, and Shahram Izadi. Stereonet: Guided hierarchical refinement for real-time edge-aware depth prediction. In *The European Conference on Computer Vision (ECCV)*, September 2018.
- [19] Iro Laina, Christian Rupprecht, Vasileios Belagiannis, Federico Tombari, and Nassir Navab. Deeper depth prediction with fully convolutional residual networks. arXiv:1606.00373, 2016.
- [20] Zhengqi Li and Noah Snavely. Megadepth: Learning singleview depth prediction from internet photos. CVPR, 2018.
- [21] Fayao Liu, Chunhua Shen, and Guosheng Lin. Deep convolutional neural fields for depth estimation from a single image. CVPR, 2015. 2
- [22] F. Liu, C. Shen, G. Lin, and I. Reid. Learning depth from single monocular images using deep convolutional neural fields. *PAMI*, 2015. 2
- [23] David G. Lowe. Distinctive image features from scaleinvariant keypoints. *Int. J. Comput. Vision*, 60(2):91–110, Nov. 2004. 1
- [24] Reza Mahjourian, Martin Wicke, and Anelia Angelova. Unsupervised learning of depth and ego-motion from monocular video using 3d geometric constraints. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 5667–5675, 2018. 2, 6, 8, 14, 16
- [25] Michal Neoral, Jan Sochman, and Jir Matas. Continual occlusions and optical flow estimation. ECCV, 2018. 2
- [26] Thu H Nguyen-Phuoc, Chuan Li, Stephen Balaban, and Yongliang Yang. Rendernet: A deep convolutional network for differentiable rendering from 3d shapes. In Advances in Neural Information Processing Systems, pages 7902–7912, 2018. 2
- [27] Andrea Pilzer, Dan Xu, Mihai Marian Puscas, Elisa Ricci, and Nicu Sebe. Unsupervised adversarial depth estimation using cycled generative networks. *3DV*, 2018. 5, 6, 14
- [28] Olaf Ronneberger, Philipp Fischer, and Thomas Brox. U-net: Convolutional networks for biomedical image segmentation. In Nassir Navab, Joachim Hornegger, William M. Wells, and Alejandro F. Frangi, editors, *Medical Image Computing and Computer-Assisted Intervention MICCAI 2015*, pages 234–241, Cham, 2015. Springer International Publishing. 3
- [29] Ashutosh Saxena, Jamie Schulte, and Andrew Y. Ng. Depth estimation using monocular and stereo cues. In *Proceedings*

- of the 20th International Joint Conference on Artifical Intelligence, IJCAI'07, pages 2197–2203, San Francisco, CA, USA, 2007. Morgan Kaufmann Publishers Inc. 2
- [30] Johannes L. Schonberger and Jan-Michael Frahm. Structurefrom-motion revisited. CVPR, 2016. 2
- [31] Jared Shamwell, Sarah Leung, and William Nothwang. Vision-aided absolute trajectory estimation using an unsupervised deep network with online error correction. 10 2018.
  8, 16
- [32] Shubham Tulsiani, Tinghui Zhou, Alexei A. Efros, and Jitendra Malik. Multi-view supervision for single-view reconstruction via differentiable ray consistency. CVPR, 2017. 2
- [33] Benjamin Ummenhofer, Huizhong Zhou, Jonas Uhrig, Nikolaus Mayer, Eddy Ilg, Alexey Dosovitskiy, and Thomas Brox. Demon: Depth and motion network for learning monocular stereo. CVPR, 2017. 2
- [34] Sudheendra Vijayanarasimhan, Susanna Ricco, Cordelia Schmid, Rahul Sukthankar, and Katerina Fragkiadaki. Sfm-net: Learning of structure and motion from video. arXiv:1704.07804, 2017. 2
- [35] Chaoyang Wang, Jose Miguel Buenaposada, Rui Zhu, and Simon Lucey. Learning depth from monocular videos using direct methods. CVPR, 2018. 2, 6, 14
- [36] Yang Wang, Yi Yang, Zhenheng Yang, Liang Zhao, Peng Wang, and Wei Xu. Occlusion aware unsupervised learning of optical flow. CVPR, 2018. 2
- [37] Scott Workman, Connor Greenwell, Menghua Zhai, Ryan Baltenberger, and Nathan Jacobs. DeepFocal: A Method for Direct Focal Length Estimation. In *International Conference* on *Image Processing*, 2015. 2, 7
- [38] Abhinav Gupta Xiaolong Wang, David F. Fouhey. Designing deep networks for surface normal estimation. CVPR, 2015.
- [39] Han Yan, Yu Zhang, Shunli Zhang, Sicong Zhao, and Li Zhang. Focal length estimation guided with object distribution on focalens dataset. *Journal of Electronic Imaging*, 26(3):1 14 14, 2017. 2, 7
- [40] Zhenheng Yang, Peng Wang, Yang Wang, Wei Xu, and Ram Nevatia. Every pixel counts: Unsupervised geometry learning with holistic 3d motion understanding. arxiv.org/pdf/1806.10556, 2018. 2, 6, 14
- [41] Zhenheng Yang, Peng Wang, Yang Wang, Wei Xu, and Ram Nevatia. Lego: Learning edge with geometry all at once by watching videos. CVPR, 2018. 2, 6, 14
- [42] Zhenheng Yang, Peng Wang, Wei Xu, Liang Zhao, and Ramakant Nevatia. Unsupervised learning of geometry with edge-aware depth-normal consistency. arXiv:1711.03665, 2017. 2, 6, 14
- [43] Yao Yao, Zixin Luo, Shiwei Li, and Tian Fangand Long Quan. Mvsnet: Depth inference for unstructured multi-view stereo. ECCV, 2018. 2
- [44] Zhichao Yin and Jianping Shi. Geonet: Unsupervised learning of dense depth, optical flow and camera pose. CVPR, 2018. 2, 6, 8, 14, 16
- [45] Zifeng Wu Yuanzhouhan Cao and Chunhua Shen. Estimating depth from monocular images as classification using deep fully convolutional residual networks. CoRR:1605.02305, 2016. 2

- [46] Huangying Zhan, Ravi Garg, Chamara Saroj Weerasekera, Kejie Li, Harsh Agarwal, and Ian Reid. Unsupervised learning of monocular depth estimation and visual odometry with deep feature reconstruction. CVPR, 2018. 2, 8, 16
- [47] Tinghui Zhou, Matthew Brown, Noah Snavely, and David G. Lowe. Unsupervised learning of depth and ego-motion from video. CVPR, 2017. 2, 5, 6, 8, 14, 16