Investigation of Lightness Illusions in Artificial Neural Networks

Leslie Wöhler, Marcus Magnor

Institut für Computergraphik, TU Braunschweig

Overview

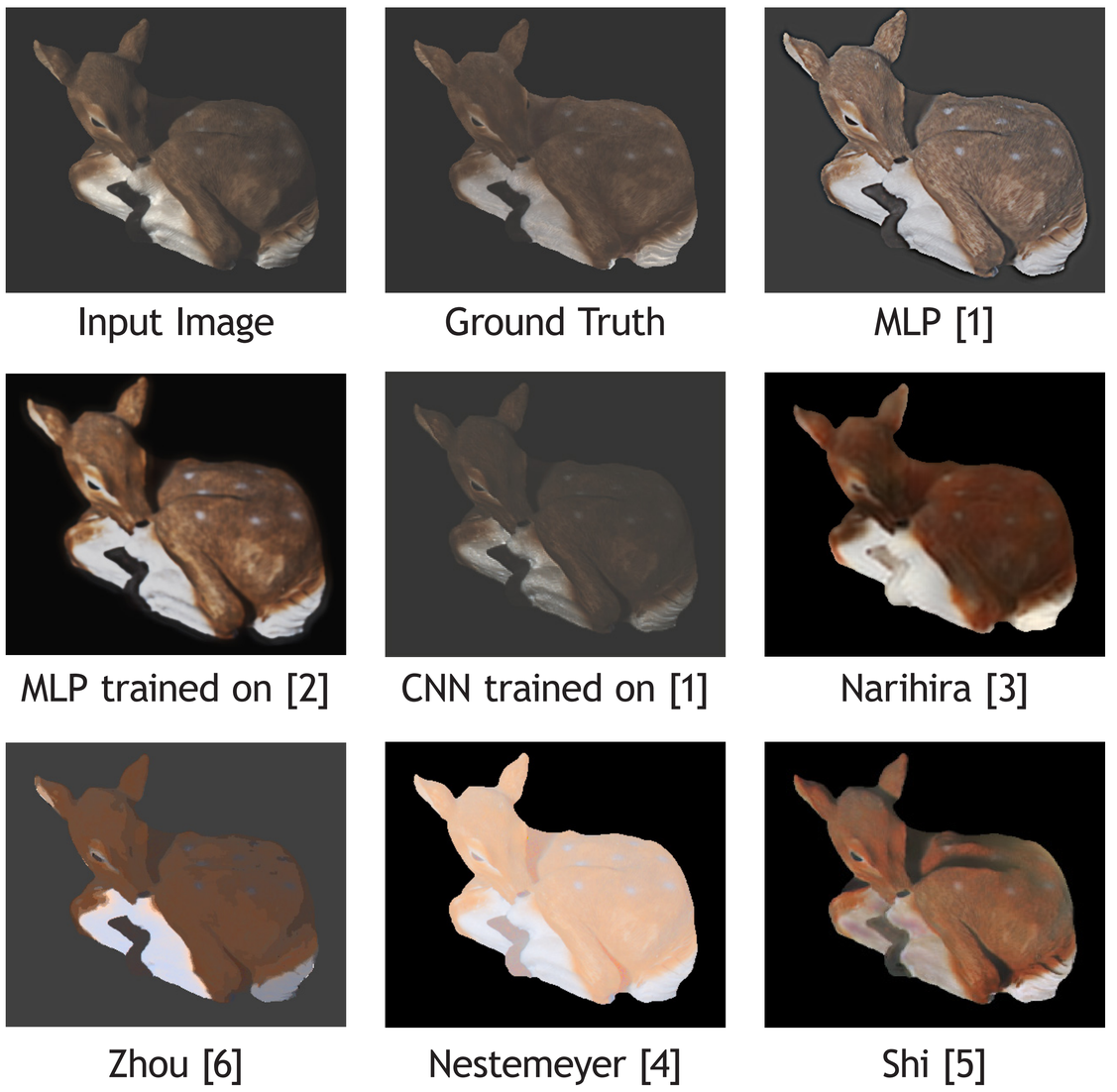
- Comparison of Artificial Neural Networks (ANNs) that decompose images to albedo and illumination components
- Investigation of ANN behavior towards lightness illusions
- Implementation of a simple CNN for further investigation

Approach

We investigate how different ANNs trained to decompose images into albedo and illumination information perceive well-known lightness illusions. In 2007, Corney et. al. [1] constructed a Multi Layer Perceptron (MLP) to solve this decomposition task. They found that its perception of lightness illusions was very similar to that of humans.

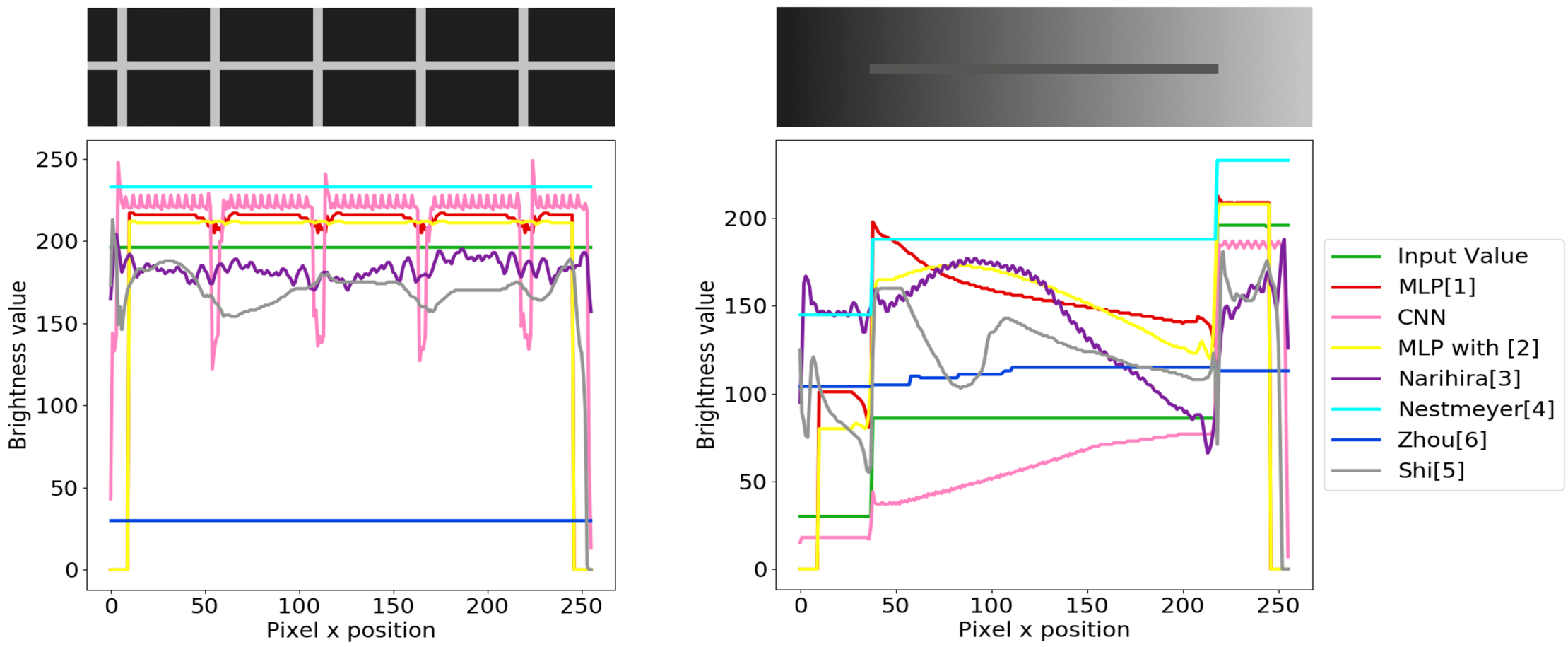
To investigate this effect, we create and train a Convolutional Neural Network (CNN) with the same dataset and compare the results. Moreover, we retrain the original MLP on a different dataset and include comparisons to four pre-trained, published CNNs, which were designed for the same task but utilize different architectures and training data.

Differences of Estimated Albedo Values



Note that these results do not include any post-processing steps as we only focus on the output of the ANN.

Experiments



We find vast differences between the different ANNs. Only the original MLP by Corney [1] perceives all tested illusions similar to humans. Our CNN using the same training data behaves significantly different and perceives less illusions. Using a different dataset with the architecture from [1] also changes the network‘s behavior and prevents it from perceiving some of the illusions. Moreover, two of the pre-trained, published CNNs, when trained on the same dataset, display similar behavior towards illusions.
We conclude that the architecture as well as the training data influence the perception of lightness illusions of ANNs. In our experiments CNNs were more robust to illusions than the MLPs.

[1] Corney, David, and R. Beau Lotto. „What are lightness illusions and why do we see them?.“ PLoS computational biology 3.9 (2007): e180.
[2] Grosse, Roger, et al. „Ground truth dataset and baseline evaluations for intrinsic image algorithms.“ Computer Vision, 2009 IEEE 12th International Conference on. IEEE, 2009.
[3] Narihira, Takuya, Michael Maire, and Stella X. Yu. „Direct intrinsics: Learning albedo-shading decomposition by convolutional regression.“ Proc. IEEE International Conf. on Computer Vision. 2015.
[4] Nestmeyer, Thomas, and Peter V. Gehler. „Reflectance Adaptive Filtering Improves Intrinsic Image Estimation.“ arXiv preprint arXiv:1612.05062 (2016).
[5] Shi, Jian, et al. „Learning non-lambertian object intrinsics across shapenet categories.“ 2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR). IEEE, 2017.
[6] Zhou, Tinghui, Philipp Krahenbuhl, and Alexei A. Efros. „Learning data-driven reflectance priors for intrinsic image decomposition.“ Proc. of the IEEE International Conf. on Computer Vision. 2015.