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Thesis Prospectus

# LDR Data Augmentation for Convolutional Neural Network Construction

Convolutional Neural Network based Computer Vision combined with Deep Learning have permeated all aspects of our society. From medical imaging and self-driving cars to your favorite Instagram filter, these technologies are changing how we interact with the world. We are no longer limited by our narrow human visual understanding - as these tools advance our knowledge will expand to unforeseen places.

Convolutional Neural Networks function similarly and are influenced by the design of the human visual system. Each neuron layer in our visual system filters certain features within its receptive field. The receptive field being the range of stimuli that provoke a sensory response. [1]

Convolution Neural Networks (CNN) use a similar construction. A filter called a kernel is moved across the input image data, emphasizing and deemphasizing selected features.[2]. Stacks of these kernels are layered providing a map of the image features.

Camera captured RGB feature maps are bounded by the input device. The dynamic range of a camera's sensor along with the exposure settings at capture are the primary limiting factors.

High dynamic range images and cameras (HDR) are the obvious solution to this problem. Expanding the range of light a camera sensor can capture increases the feature information in the image data. While setting camera exposure, is most important feature in the shadows, mid-tones, or the highlights? The increased information in HDR allows the CNN to learn more about a scene and reduces the need for the perfect exposure settings at capture. Without a HDR camera and the correct exposure the information in the under and over exposed feature regions will be lost. HDR images provide great benefits but currently come at a high cost and unavailable in most applications.

Low Dynamic Range images and cameras (LDR) make up most cameras in use. Techniques have been developed to convert LDR images to HDR. One common approach is to capture multiple exposures of a scene and then combine them. Others include the use of GAN networks, Deep neutral networks, and virtual environment rendering techniques. The multi-shot approach assumes a static scene without fast motion and all these approaches are computationally expensive. [3].

Is there a naïve approach for creating a HDR image from a single-shot LDR image at a low computational cost?

I will explore approaches for increasing the feature information in LDR images. My study will begin by examining the use of image blending modes along with other digital image processing

techniques in the Data Augmentation layer of a CNN. The vast majority of publicly available image datasets are LDR, giving these approaches a large test set to track accuracy variations.

The aim of the study is to create a general approach to increase the dynamic range of a LDR image at a low computational cost. This approach is intended to be applied to all LDR datasets no matter the image content, with the goal of increased classification accuracy from the CNN network.

[1] Wikimedia Foundation. (2021, September 17). Convolutional neural network. Wikipedia. Retrieved September 22, 2021, from https://en.wikipedia.org/wiki/Convolutional_neural_network#History.

[2] Kaggle. (n.d.). Learn computer Vision Tutorials. Kaggle. Retrieved September 22, 2021, from https://www.kaggle.com/learn/computer-vision.

[3] Metzler, Christopher A., et al. "Deep Optics for Single-Shot High-Dynamic-Range Imaging." *2020 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*, 2020, https://doi.org/10.1109/cvpr42600.2020.00145.