EE367 Final Project Proposal

HDR image reconstruction from a single short-exposure image

ZhuoYi Cai

Motivation

Cameras on mobile devices, such as cell phones, have small sensor pixels which limit the number of photos capture, leading to limited dynamic range images. Conventionally, in order to create high dynamic range (HDR) images, a set of images with different exposures is captured and then combined in post-processing. This approach faces a challenge in image fusion where different parts of the fused image represent the scene at different times. To solve this problem, one modern approach in Google's HDR+ [1] is to capture a burst of images with constant exposure and combining them with dynamic range compression. Another challenge faced by mobile devices is power-constraint. Capturing a burst of images results in cleaner and less noisy images but it consumes power, time and memory space. Other approach to reconstruct HDR images from a single exposure using deep convolutional neural network has also been proposed [2][3]. These approaches attempt to hallucinate the overblown regions of the images. However, they may introduce patterns that do not exist in the scene or not always able to reconstruct all the details. They may also reconstruct an incorrect color in those saturated areas.

In this project, an approach inspired by the methods mentioned above is proposed. We attempt to reconstruct a HDR image from a single low exposure image using a deep neural network. We are using a low exposure image to avoid blowing out highlights as in HDR+ method. This may solve the issues faced in highlight hallucination. At the same time, since only one low exposure image is needed, we can save time, power and memory in the capturing process.

Proposed Method

The proposed method for this project is to use U-Net based architecture network to reconstruct a HDR image from a single short exposure raw image. The flat raw image is first split into Red, Green, and Blue channels. The missing pixel values for each channel are initialized to 0. Batches of small size patches (250x250) from this "split" image will be used to train the network. The final goal is to let the network hallucinate the missing information for each channel and reconstruct the image with higher dynamic range.

As dataset, HDR+ Burst Photography Dataset from google research is used. Specifically, for this project, only a subset of the dataset (153 raw images) will be used. Each image is about 12-13 Mpixels. More data may be added if necessary. Only the reference frame of the burst is used. The ground truth is the final result generated from google HDR+ algorithm.

The result will be evaluated using SSIM against the corresponding ground truth images. Also, the reconstructed images will be compared qualitatively against the ground truth and the images processed using conventional ISP.

Tool and Framework

We will be using colab as the compute environment and tensorflow as the framework.

Milestones

FEB 21ST
- Dataset
- Network structure

FEB 28TH
- Hyperparameter tuning
- Network structure experiment

MAR 7TH
- Data Collection

MAR 11TH
- Final report
- Video presentation

References

[1] **Burst photography for high dynamic range and low-light imaging on mobile cameras**
Samuel W. Hasinoff, Dillon Sharlet, Ryan Geiss, Andrew Adams, Jonathan T. Barron, Florian Kainz, Jiawen Chen, and Marc Levoy
ACM Transactions on Graphics (Proc. SIGGRAPH Asia 2016), 35(6), 12 pp.

[2] **HDR image reconstruction from a single exposure using deep CNNs**
GABRIEL EILERTSEN, JOEL KRONANDER, GYORGY DENES, RAFAŁ K. MANTIUK, JONAS UNGER
ACM Transactions on Graphics, Vol. 36, No. 6, Article 178. Publication date: November 2017.

[3] **Single Image HDR Reconstruction Using a CNN with Masked Features and Perceptual Loss**
MARCEL SANTANA SANTOS, TSANG ING REN, NIMA KHADEMI KALANTARI
ACM Trans. Graph., Vol. 39, No. 4, Article 80. Publication date: July 2020.