Image Restoration for Under-Display Camera

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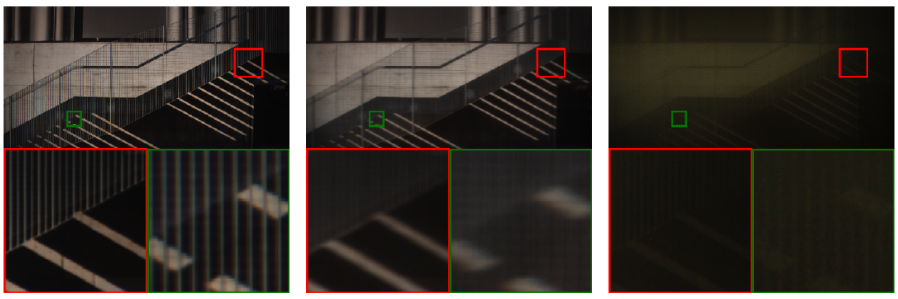
Motivation

In today's world, the push for under display cameras has increased as numerous applications exist. These applications include full frame phone screens without camera notches and cameras at the center of displays to allow for a more natural gaze during video meetings. Datasets have been developed with images from Under-Display Cameras (UDCs) alongside normal cameras to obtain training and evaluation data allowing for competitions for the best image output from UDC's. As a result, we would like to apply methods such as ADMM, HQS, and Neural Networks to see how methods from this class stack up.



(a) Display-free (b) TOLED (c) POLED

Related Work

Several smartphones with under-display cameras already exist, particularly ZTE's Axon 20 and the Galaxy Z Fold 3, with various degrees of success [1]. The first research driven collaboration towards solving this problem was undertaken at CVPR 2021 under the "Image Restoration for Under-Display Camera" challenge [2]. Several teams from different university and industry research settings competed, most of whom used a combination of classical signal processing techniques (wavelets, ADMM, filtering) and deep learning (Unets, residual networks) [3] .

Project Overview

Our goal is to use techniques from this class to attempt this problem on T-OLED and P-OLED (two different display types) images. This is effectively a blind deconvolution problem, since the kernel is unknown (and likely non-linear).

We will also test out HQS and ADMM methods with TV regularization and denoising with DnCNN. If time permits, we will also investigate the combination of Wiener deconvolution (even though we do not know the kernel, it might be worthwhile seeing if we can estimate it) and Unets. Our metric for success will be the PSNR of the deconvolved images. We're also curious if we will be able to achieve equivalent performance between T-OLED and P-OLED displays even though deconvolving through P-OLED is empirically known to be a more challenging task.

Milestones and Timeline

- ☐ Week 7: Define Project
- ☐ Week 8: Download Dataset/Evaluate HQS + ADMM methods on dataset
- ☐ Week 9: Train a Neural Network and evaluate performance on Dataset
- ☐ Week 10: Paper + Poster

References

[1] **Under-display cameras are slowly getting better.**
https://www.theverge.com/22776271/under-display-selfie-cameras-zte-microsoft-xiaomi

[2] Zhou Y, Ren D, Emerton N, Lim S, Large T. ***Image restoration for under-display camera.*** In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition 2021 (pp. 9179-9188).

[3] Zhou Y, Kwan M, Tolentino K, Emerton N, Lim S, Large T, Fu L, Pan Z, Li B, Yang Q, Liu Y. ***UDC 2020 challenge on image restoration of under-display camera: Methods and results.*** In European Conference on Computer Vision 2020 Aug 23 (pp. 337-351). Springer, Cham.