EE367 Term Project Proposal

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1 Motivation

High dynamic scenarios are one of the most challenging situation encountered by photographers. Originally developed in Taiwan, black card technique is one of the solutions to exposure reduction in bright areas of the scene. By shaking a black card in front of the lens, photographers can reduce the local exposure of the photo. For example, by blocking the upper part of the scene for a certain time frame, one can reduce the exposure for certain area and take a high dynamic range (HDR) photo in one shot. Inspired by such technique, we propose to design and implement a programmable liquid crystal (LC) based filter. Through real-time modulation in front of lenses we can achieve HDR as well as polarization filtering effect in one shot.

2 Related work

2.1 LCD

Combined with polarizers, liquid crystal glasses have been widely used to modulate light intensity. Previous techniques such as using programmable binary liquid crystal array (LCA) as the camera aperture [1]. For this project, we will utilize not only the programmablility of thin-film-transistor LCD (TFT-LCD) arrays but use its color and brightness gradient to enhance our device's flexibility in dealing with multiple issues at the same time.

2.2 HDR

Popular HDR techniques such as [2] and [3] use post-processing algorithms to merge photos with different exposure together. Latest HDR functions in mobile device cameras also take multishots which requires static imaging condition. To achieve real-time HDR, Zhao et al. uses a different sensor structure to achieve HDR effects, providing a hardware solution. But such implementation can be costly and might not be applicable to existing cameras [4].

3 Project overview

We want to design and implement a device that can help cameras capture single shot HDR photo without further post-processing. Mounted in front of the lens, the proposed device can locally modulate incident light intensity and color saturation thus enhance the photo dynamically in real-time.

4 Outlook

4.1 Milestone

4.1.1 LC control

Program development of an Arduino Uno embedded TFT-LCD. First by figuring out the gray scale value control of the panel, we are able to achieve local gray scale modulation. Colors are added on the other hand to enhance our device's capability in saturation enhancement.

4.1.2 LC modulation calibration

Measure and calibrate the effective light attenuation factor of our LC array and achieve a correlation function between LC gray scale value and exposure.

4.1.3 Real-time image acquisition

Implement real-time live-view acquisition from digital camera, and realize HDR image computation.

4.1.4 Final product

The device is mounted onto a DSLR camera. If the first generation concept is proven effective, our goal will be building a compact system that can be mounted onto any commercially available camera with ease.

4.2 Time line

week	progress
Feb 1	First draft of proposal
Feb 8	LC control
Feb 15	LC modulation calibration
Feb 22	Real-time image acquisition
Feb 29	Final product
Mar 7	Poster & report

4.3 Goal

Our goal for this project is to achieve real time light modulation using the LCD array we developed. The basic function of such device is capturing one-shot HDR photos by controlling local exposure of a scene. In addition to what we have presented, further development will be made in color saturation control to achieve local multi-color polarization filtering.

References

[1] Chia-Kai Liang, Tai-Hsu Lin, Bing-Yi Wong, Chi Liu, and Homer H. Chen, "Programmable Aperture Photography: Multiplexed Light Field Acquisition," Proceeding ACM Siggraph 2008, 27, no. 55 (2008).

[2] Paul E. Debevec and Jitendra Malik, "Recovering High Dynamic Range Radiance Maps from Photographs," Proceeding ACM Siggraph 1997.

[3] Fredo Durand and Julie Dorsey, ”Fast Bilateral Filtering for the Display of High-Dynamic-Range Images,” Proceeding ACM Siggraph 2002.

[4] Hang Zhao, Boxin Shi, Christy Fernandez-Cull, Sai-Kit Yeung, and Ramesh Raskar, ”Unbounded High Dynamic Range Photography using a Modulo Camera,” ICCP 2015, Houston, TX.