Project 2 Questions

Template Instructions

This document is a template with specific answer regions and a fixed number of pages. Given limited TA time, the template helps the course staff to grade efficiently and still focus on the content of your submissions. Please help us in this task:

- Make this document anonymous.
- Compile the document without any answers and see the page layout.
- Add your answers.
- Maintain the page layout—your answers should not break a new page and change which question lands on which page.
- If you need extra pages, e.g., for images, please put them at the back of the document.

Gradescope Submission

- Compile this document to a PDF and submit it to Gradescope.
- Pages will be automatically assigned to the right questions on Gradescope to ease TA workload.

Instructions

- Complete the four questions.
- Include code, images, or equations where appropriate.

Questions

Q1: When capturing a set of images (a *bracket*) for high-dynamic range radiance map recovery, the camera's control and various photography accessories present us with different options for varying the exposure in a measured way. Describe:

1. What options the camera and various photography accessories presents to us to vary exposure,
2. What benefits or drawbacks each of those options presents,
3. How easy each of those drawbacks might be to overcome computationally, and a brief description of what that would entail to your understanding.

There are at least three options. Are there more than three?

A1: Your answer here.

Q2: Once we've recovered a high dynamic range radiance map that represents very large exposure variations in a single image, we must store it efficiently. This requires us to use a new storage method for our images as the intensity variations no longer fit within an unsigned 8-bit integer per pixel per channel (1 Mpixel image = 3 MB). One candidate option is to store a double floating point number per pixel per channel (1 Mpixel image = 24 MB).

Can you do better? Design a pixel encoding scheme for HDR images, and explain why you think this is a good solution among possible designs.

Points to consider: numerical precision, storage requirements, CPU/GPU register size, computational efficiency.

Points that you are not required *to consider:* compression.

Hint: The lecture material has a few slides on this topic, and you are free to research common existing formats (like the RAW images we captured in lab 2). Use your broader CS knowledge, but there's no need to go too deep.

A2: Your answer here.

Q3a: The stretch goal task 3 in Lab 3 looks at the *cross bilateral filter* (sometimes called a joint bilateral filter); the lab explains how it can be used for flash/no-flash photography to reduce noise in low light.

Using your implementation of the bilateral filter, complete task 3 and attempt to combine a high-noise low-light image with a low-noise high-light (flash) image. You might have to tweak your implementation, and find appropriate σ_r and σ_s values.

Note: wherever the flash image is smooth, it's OK to blur. So, shadows from flash might be a problem as they *introduce* edges where none existed in the low-light image. Clever scene selection can avoid this.

This will be your 'interesting image' for this project.

Please upload your before + after photos to this Google Drive: https://tinyurl.com/csci1290fall2023. We will share the images with the class.

A3a: Your answer here.

Q3b: In general, the idea of using statistics from across multiple aligned images is powerful. What other application of the cross bilateral filter can you think of? How might it be applied, and what are its effects?

Consider the many sources of information in images: low/high dynamic range images, IR (+thermal) images, UV images, terahertz or xray images, low/high resolution images, sparsely-sampled images (LIDAR), adding other kinds of light sources to a scene (e.g., projected light), depth images, multiple cameras, video.

For inspiration, please feel free to research for techniques, and include example images here (with citation) if you use this method.

A3b: Your answer here.