Problem 1.

1. (40%) The tradeoff between spatial resolution and the imaging field of view has been a longstanding issue for optical microscopy (or any other optical imaging systems). Please name two methods that can help to address this issue and briefly describe how they work.

Ans:

Problem 2.

2. (20%) Name three techniques that can be used in designing wearable display.

Ans:

Under the taxonomy list of wearable displays: glasses-bound stereoscopic, head -mounted see thru is a technique where a synthetic image is overlayed onto reality. The glasses by google are a commercial attempt at a wearable display. Here a prism projects a layer over light from reality. The idea of wearable displays is an old one, especially for military operations. U.S. Air Force fighter pilots have been wearing displays for at least 35 years. Albeit, military displays are bulky, they have the same principle of trying to overlay a synthetic image over reality.

Problem 3.

3. (20%) Besides the existing topics, what do you think we can add to the future computational imaging courses? (Identify one emerging area in computational imaging research)

Ans:

In the lectures from week 10 on the topic of “Time of Flight”, under transient images you mentioned some applications: diffusers, lensless imaging and scattering. Also in the lecture from week 13, the first part of class you covered scattering thru media. I am not sure, but I would guess that in your biomedical optics class you probably cover the topic of tissue scattering. In my brief literature research into the diffuser cam problem I found that the topic of Wigner distributions has a direct tie into light fields and Fourier Optics. I also saw in a lot of the papers from L. Waller into the topic of diffuserCams that for their forward model, they opted to use ray optics as part of their system model. I saw the same thing to a degree in the PSF prediction paper by Jin. I would add a little to either slide lectures 10 or 13 something about Wigner distributions or expand what you have. (I went back to your earlier lectures and could find no mention, but I may have missed)

Wigner distributions, although developed for Quantum mechanics, where it predicts the behavior of wave functions as well as any other theory that supports quantum mechanics, also has a tie into many rich areas of mathematics. The paper by S. Twareque, et al., “The Wigner Function for General Lie Groups and the Wavelet Transform,” bear out its ties into wavelet theory, Lie Algebra and Lie Groups (Manifold theory) and kernel-based methods, with operators in Hilbert space. The math is quite advanced (for me also!), but it would be worth a few slides to mention given its ties to so many disciplines.

Problem 4.

4. (20%) What are the challenges that you have had for your research project? What kind of resources (the instructor and the school can provide) do you think would help to improve your research?

Ans:

The challenges that I faced in my research project were trying to recreate the tutorial for Antipa research paper on DiffuserCams. The first problem was that the sensor described in the tutorial had to be modified for experiments. However, when I made the prescribed changes, it slightly damaged the sensor affecting my measurements going forward. A second problem was performing calibration needed for a good reconstruction, here the problem was one of stability for the sensor. To perform calibration you want a point source of light to vary across a z-axis but control the distance to the sensor with a distance that measure in the millimeters. Trying to control distance of the above sizes is very difficult without a stable housing. A third challenge I faced was that my picture was saturated because I could not vary my point source. This meant that I took many measurements and only used an experiment that had some variation of pixel values. A fourth and final impediment was just trying to get a dark enough area to perform the experiments but control the Raspberry Pi camera. This last problem was more logistical in nature, but no less a challenge to overcome.

I think that the instructor and UND for optical types of experiments can pair up a student on campus with one off campus, so that the equipment remains on site (UND). In this way, the university can spend a little extra money investing in something with a longer shelf life and can give better results, especially for optical types of research.