Conclusion

Through this project we have shown several important results.

First of all, we have shown that with a model of a lens that incorporates wavelength-dependent distortions, it is possible for colour aberrations to be manifested in the image. This aberration was shown to be relatively small with the model used, but present nevertheless.

We then showed that these aberrations could be corrected in the realm of colour balancing. The difficultly that presented itself, however, was that the distortions could be spatially-dependent. As such, a unique colour balancing matrix could not be uniformly applied to the entire image.

It was also shown that the distortions could be properly modelled, and subsequently the correct balancing matrix could be determined for each pixel in the image. If this were to be done at the factory, then the correct colour balancing matrices required could be stored in the camera and applied to the data.

A second distortion model that was both wavelength and spatially-dependent was also developed. This model would have variable photon loss, resulting in variable colour effects across this image. Given this distortion model, we proceeded to find techniques to combat these effects.

While chromatic aberrations are visually unappealing, we do not want to introduce additional artifacts in the process of removing them.

We showed with Global Gray World that a single colour balancing matrix is insufficient for compensating for spatially-dependent chromatic aberrations. To effectively compensate for these distortions, multiple kernels are necessary.

Working with Localized Gray World, we know that working with large zones and having jumps in kernels can create border artifacts, and we want to minimize the perceptual effect of those artifacts.

Several strategies presented are effective at compensating for non-uniform chromatic aberrations, specifically those that are spatially-dependent. Localized Gray World with smoothing is a possibility for non-uniform colour balancing without artifacts, although it comes with the expense of increased memory requirements, having to hold multiple kernels. Localized Gray World with Linear Piece-Wise Interpolation is a strong performers in terms of resultant image quality, and is a candidate for hardware implementation given its reduced computational complexity compared to the polynomial fit variant of Localized Gray World, while maintaining a continuous transition between kernels to keep from introducing border artifacts.

As previously stated, non-uniform chromatic balancing is a problem that can be solved with colour balancing. It may be possible, at the manufacturing stage, to calibrate and store several compensation kernels into a camera's internal storage for online compensation. In this case, it is possible to use some of the strategies presented here: Reduced Zone Sizes, or Linear Piece-Wise Interpolation to create smooth transitions between zone kernels, resulting in cleanly compensated images devoid of chromatic aberration.