Conclusions and Future Work

Throughout this text we have grasped Fourier Theory in order to model and study imaging systems, applied those concepts to the anatomical description of the human eye, and created a numerical model capable of simulating the corneal receptor mosaic. The Rayleigh Criterion was discussed, and we showed there is a new limit of resolution beyond what we expected. We even applied the scanning method to the system and were able to mimic the images that will be seen in the experimental setup. We wanted to know if it was possible to improve the minimum distance for optical resolvability in cone counting methods, by using a phase vortex in a coronagraph setup. The results showed in the previous chapter prove that from a theoretical and numerical standpoint this goal can be achieved.

We collaborated with researchers from the Visual Optics goup in the Universidad Autónoma de Nuevo León (UANL) to test the viability of the method. For this purpose we sent them 6 video simulations of two moving cones very close together. Several siulations where sent, the first pair of them was at 20% the Rayleigh distance and the other at 40%, each pair with a vortex of $m = 1, 2$, or 3. Their job was to measure the distance between the center of the two cones. At the time we were not sure which topological charge was best to use, but a m=2 was later agreed because of the properties described before. As a control method we also sent them three simulations of a single cone with a vortex of topological charge $m = 1, 2$ or 3, to see if a false positive was triggered, and two cones were detected.

As shown in Fig.4.17, their results were as expected and confirmed the usefulness of the cone detecting method resolving cones beyond the Rayleigh minimum distance of optical resolvability. They could accurately detect if they were seeing one or two cones, and even measure the distance between them. Fig.4.17 is an example of their results identifying the two cones, at 40% the Rayleigh distance.

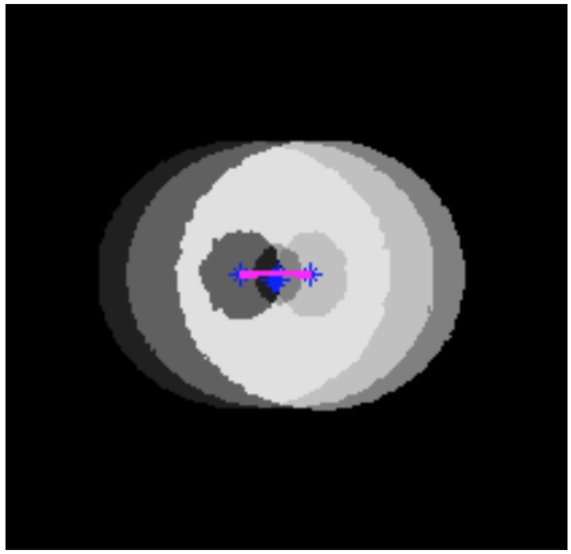

Figure 4.17: Succesful result from UANL, identifying the two cones at 40% the Rayleigh distance.

The next step for this topic of research is to make an experimental setup to back up the numerical simulations. Queensland University of Technology, abbreviated as QUT, is a public research university located in the urban coastal city of Brisbane, Queensland, Australia. As of the writing of this text their research group in the Contact Lens and Visual Optics Laboratory (CLVOL) has accepted our proposal to attempt an experimental setup of the method.

At this point, we are sure the detecting method works in paper and has a solid mathematical background. However, there is another optical configuration that we would like to test. We can see it in Fig.4.18

The evaluation of a vortex cone detector has to be tested even further. Next in order is the task to get more realistic simulations by adding geometrical aberrations to our model, and see how well the system responds. In regards to aberrations present in the experimental measuring, the most common of them (myopia, astigmatism, hyperopia, etc,) can be almost fully reduced by common corrective lenses. The remaining aberrations should be small enough to be a problem, but a more extensive research has to be done on the subject.

We are aware there are systems capable of obtaining high quality images

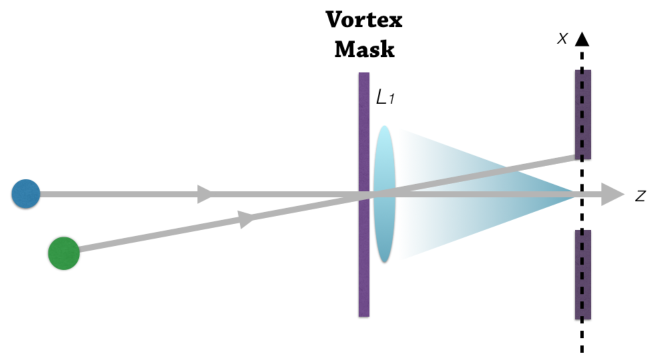

Figure 4.18: An alternative configuration proposed by Swartzlander (Swartzlander).

of the retina (Rha et al. Gao et al., "Measuring directionality of the retinal reflection with a Shack-Hartmann wavefront sensor."), but the system we are proposing is faster, more accurate, and automatic.