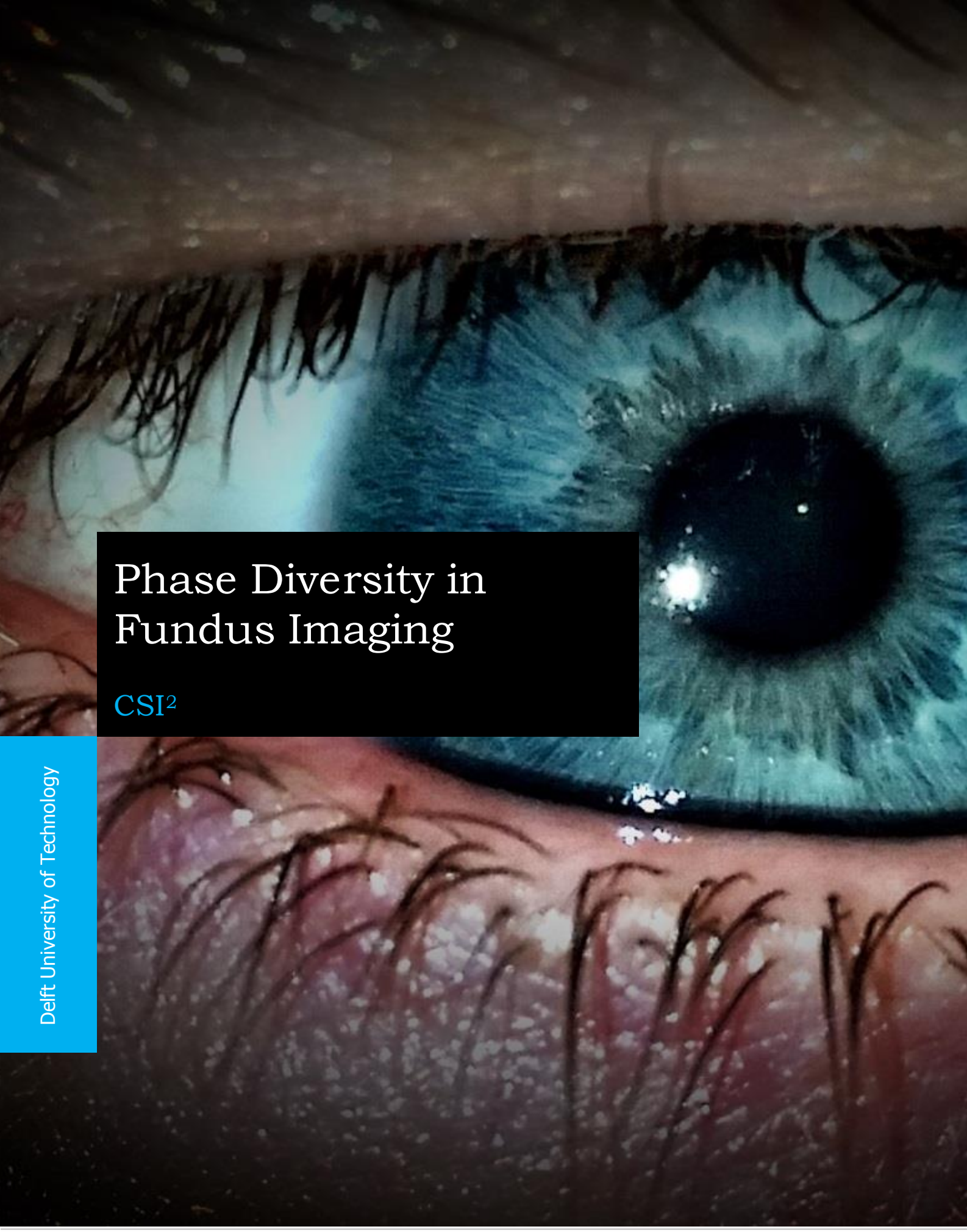

Phase Diversity in Fundus Imaging

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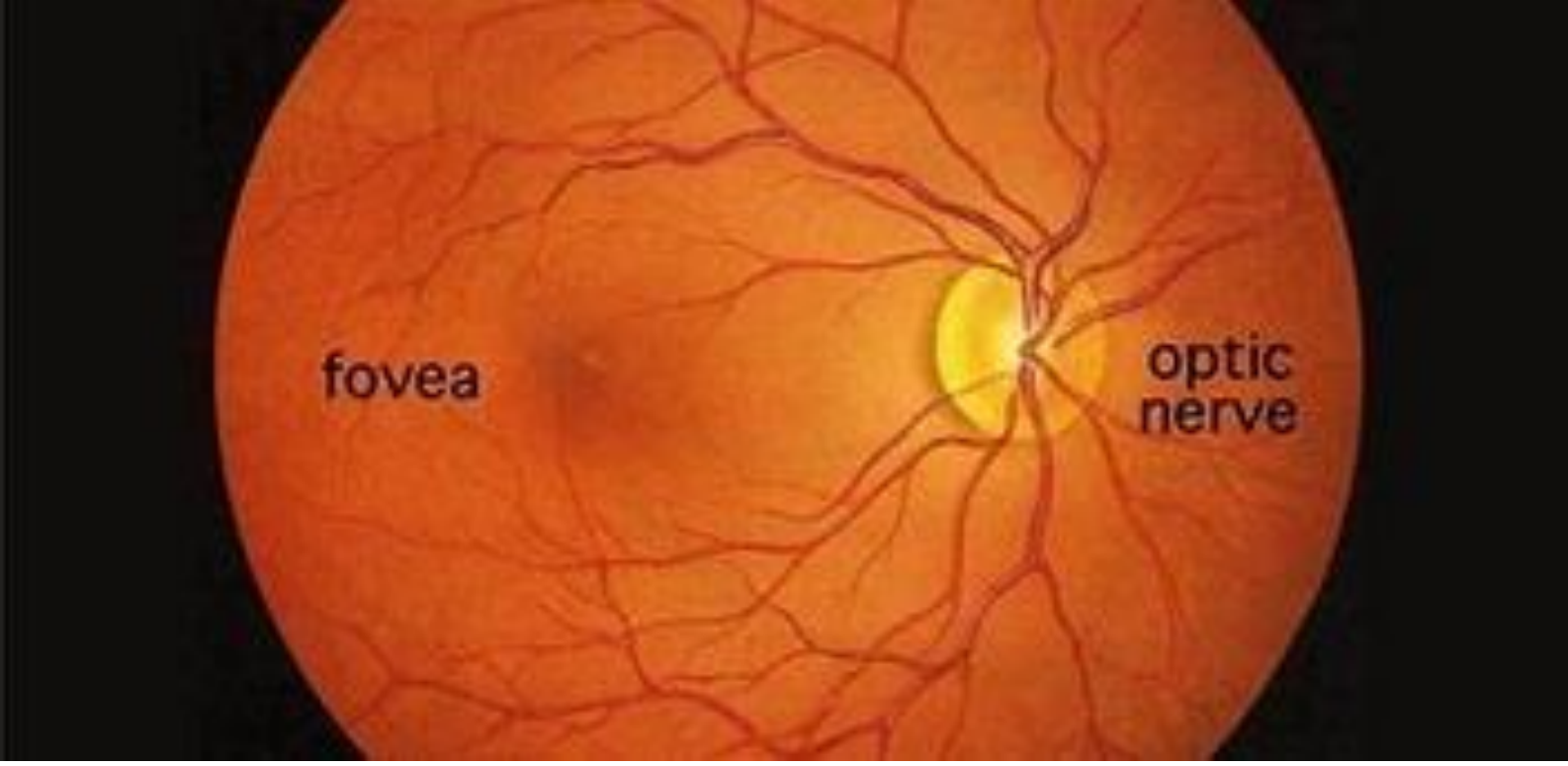

Phase Diversity in Fundus Imaging

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Level	Master's

Introduction

In medical imaging, fundus cameras have a vital role in the diagnosis of retinal diseases and artefacts. Fundus photography is the creation of a photograph of the interior surface of the eye, including the retina, optic disc, macula, and posterior pole (i.e. the fundus). Fundus photography is used by optometrists, ophthalmologists, and trained medical professionals for monitoring progression of a disease, diagnosis of a disease or in screening programs and epidemiology. Fundus photography has the advantage of storing the image to be examined by a specialist at another location/time for future reference. Modern fundus photographs generally capture considerably larger areas of the fundus than what can be seen at any one time with handheld ophthalmoscopes.

However, the quality of the image of the fundus is undermined by the aberrations introduced by the eye lens. Because most people have to wear glasses or contact lenses, aberrations such as the defocus and astigmatism (or cylindrical aberration) often deteriorate the image quality. The quality of the images can be improved using smart algorithms such as phase diversity that can estimate the aberrations. This allows a proper diagnosis to be made and also adds to the functionality of the device. The

doctor will also obtain specifications of aberrations in the eye lens sizes which can be used to provide correct spectacles or contact lenses.

Background
Phase diversity is a powerful technique to reconstruct an unknown phase aberration in an optical path. It uses one or more diversity images with a different phase aberration to numerically reconstruct the original phase aberration together with the object (as shown in Figure 2.

Either the reconstructed image of the object is used or an active element in the optical path corrects for the reconstructed phase aberration to obtain a new, sharper image.

Research Question
The goal of the thesis is to contribute to the applicability of the algorithm in a medical imaging environment and in a further step apply it on real fundus images. The goal is to see what aberrations can be found in what time frame to check if it is a viable solution for a real medical diagnosing instrument. (This research is in cooperation with industrial developers of fundus cameras: focal bv.)

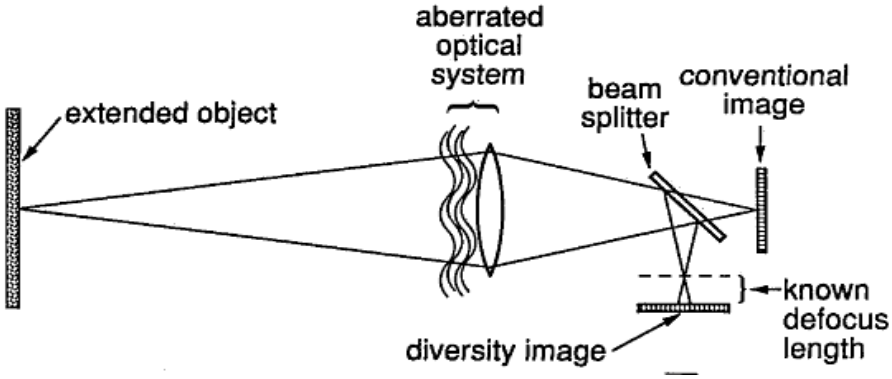

Figure 2: [1] Optical layout of a phase-diversity system. The conventional image is degraded by aberrations in the optical system. The diversity image is degraded by the combination of the same aberrations and a known amount of defocus.

Literature
[1] Paxman, Richard G., Timothy J. Schulz, and James R. Fienup. "Joint estimation of object and aberrations by using phase diversity." JOSA A 9.7 (1992): 1072-1085.