ISBN 978-1-9996465-0-9

BioMedEng18

3D reconstruction of the fundus of a phantom eye through stereo matching of slit lamp images

I. Coghill[1], K.C. Jordan [1], R.A. Black [1], I.A.T. Livingstone [2], M.E. Giardini [1]

[1] Biomedical Engineering, University of Strathclyde, Glasgow, G1 1XQ. [2]Ophthalmology, NHS Forth Valley, Falkirk Community Hospital, FK1 5QE, Falkirk.

Introduction

In the detection of glaucoma, the second leading cause of blindness worldwide[1], the alteration of the optic disc's morphology is a key clinical indicator. The current gold standard test, stereo funduscopy using stereo fundus cameras, is subjective[2]. Quantitative devices exist but are prohibitively expensive. Work carried out elsewhere has demonstrated quantitative results from stereo matching fundus camera images[3]. Building on this idea, the slit lamp microscope (a mainstay of eye diagnostics, present in practically all ophthalmology and optometry practices) has the potential to be used as a quantitative device. This study explored the feasibility of uncalibrated 3D reconstructions of retinal structures of a phantom eye's fundus using a slit lamp.

Methods

A Zeiss 30 SL-M slit lamp was mounted with 720p cameras to its eyepieces and a fundoscopy lens in front of its objective. A scaled up eye phantom comprising a 14D lens and interchangeable 3D printed retinal targets with cylindrical step/depression structures was built and imaged using the device. A 3D map was reconstructed from the stereo images through matching via fundamental matrix estimation using RANSAC, rectification and Semi-Global Block Matching.

Results

The stereo matching algorithm yielded a 3D reconstruction of the targets. As an example, Figure 1 shows one of the retinal targets and its corresponding 3D reconstruction.

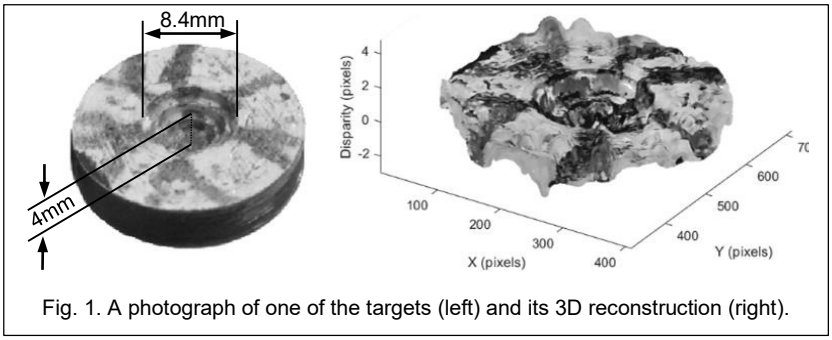

Fig. 1. A photograph of one of the targets (left) and its 3D reconstruction (right).

Discussion & Conclusion

The fundus structures were detected and an overall 3D structure was recovered for all targets. The reconstructions are consistent with the targets. However, at this stage of the research, they are uncalibrated and performance in vivo is also yet to be assessed. The findings warrant further work to assess the potential of the slit lamp being used for quantitative measurements in vivo.

References

1. Kingman S. *Bull World Health Organ.* 2004; 82(11): 887-888.
2. Stone et al. *Invest Ophthalmol Vis Sci.* 2010; 51(11): 5667-5674.
3. Bansal et al. *Conf Proc IEEE Eng Med Biol Soc.* 2013; 2013: 5877-5882.

Acknowledgments

The authors wish to acknowledge the support of the UK EPSRC Centre for Doctoral Training in Medical Devices and Health Technologies, University of Strathclyde, for the studentship awarded to IC (Grant Ref. EP/L015595/1).

BioMedEng18