Fraunhofer
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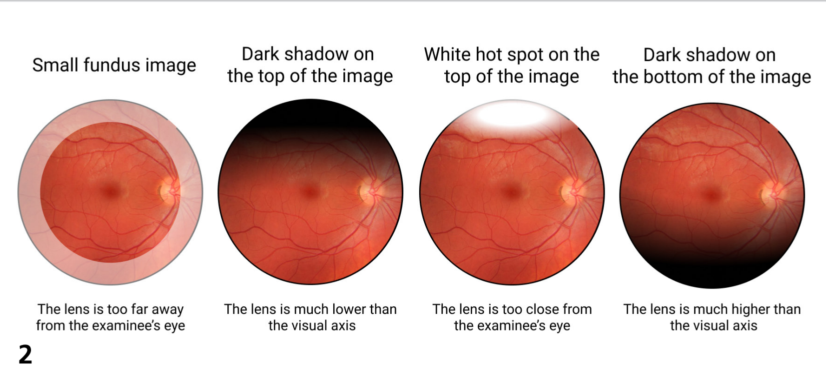
RESEARCH CENTER FOR ASSISTIVE INFORMATION AND COMMUNICATION SOLUTIONS



1 *Fraunhofer's EyeFundusScope prototype.*

2 *Possible Failures from EFS acquisition.*

HANDHELDIMAHCI – HANDHELD IMAGE ACQUISITION WITH REAL-TIME VISION FOR HUMAN COMPUTER INTERACTION ON MOBILE APPLICATIONS

Motivation

The robustness of computer vision algorithms is strongly related with the quality of the images acquired. The consistency of handheld capture deeply depends on proper human interaction, which is frequently neglected.

In order to tackle these problems, real-time computer vision combined with inertial sensors on the smartphone are expected to provide crucial data for the study of dedicated Human Computer Interaction during the capture.

Some challenging use cases, like the Fraunhofer's EyeFundusScope (EFS) prototype, are currently requiring real-time feedback to the users so that they can improve the handling of the smartphone during the acquisition, based on computationally low-cost approaches for quality control.

Fraunhofer's EyeFundusScope

Fraunhofer's EyeFundusScope prototype is a hand-held solution to perform risk assessment of retinal diseases such as, Diabetic Retinopathy (leading cause of blindness among the working-age population) and Glaucoma. It is composed by a low cost optical system attached to a smartphone.

The EFS Android App already developed is capable of not only detecting lesions in the retina associated with the disease, such as microaneurysms and exudates but also to determine the diabetic risk level using a decision support system. Its major goal is to facilitate patient access to early treatment.

Diabetic Retinopathy

The increasing prevalence of Diabetes Mellitus in the population is associated with several health issues, one of them is the development of diabetic retinopathy. The asymptomatic profile of the initial progression and the high

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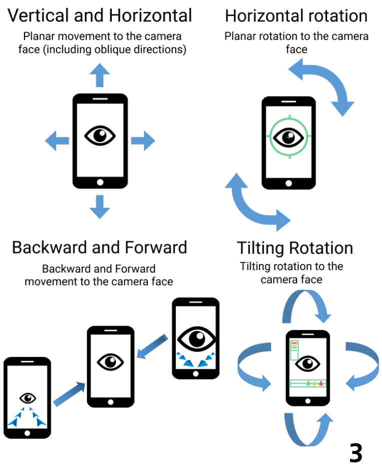

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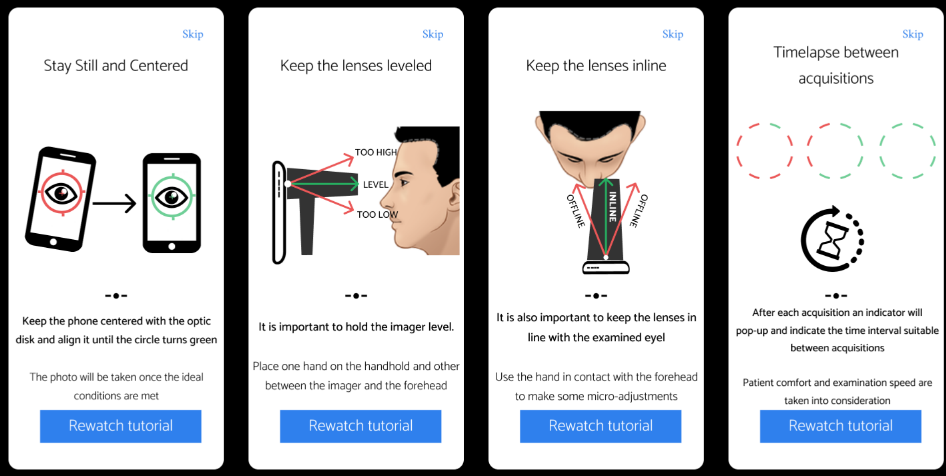

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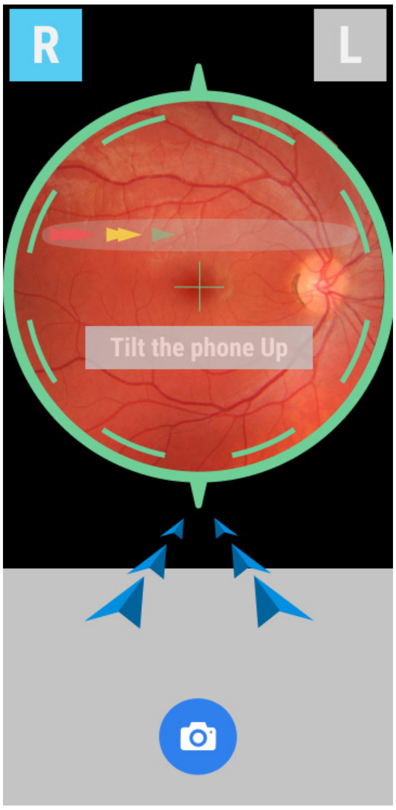

effectiveness of early treatment have motivated the implementation of extensive screening programs covering the diabetic population.

Digital retinal photography is generally easy to learn, and the intention is to encourage any personnel to perform adequate digital photography in a matter of hours.

In order to shorten this learning curve, some improvements regarding the usability of operation with minimal training were created, through the development of a real-time quality image assurance to provide feedback to the prototype operator, improving human-machine interaction.

Graphical User Interface

Inertial Sensor based components where created in order to give the user a proper indication of the handling of the smartphone. The 3-axis were taken into consideration, and to determine which of them are the most appropriate to indicate the movement while the acquisition takes place, Usability Tests must be done.

After experimenting in a Retina simulating phantom, it was clear the most adequate axes that should be monitor were the Z and X-axis. While the Z-axis component (outer green circle) assures that the smartphone is properly aligned with the typical vertical position of the patient, the X-axis component (arrow horizontal bar above the center) gives the user a proper indication of the alignment when the user stands or sits in front of the patient, helping to keep the lenses in line with the examined eye.

In order for the user to comprehend the correct positioning of the smartphone a Tutorial, seen in the figure above, was created explaining the basic principles inherent to a good acquisition.

Furthermore, a time-lapse component (dashed inner green circle) was created so that the user has the correct notion the time it should take between acquisitions on the same eye. Also, an indicator of which eye the user should examine was implemented on top of the Fundus observation screen.

Future components

Y-axis components, that indicate when the smartphone is lower or higher than the visual axis, should be implemented once the EFS App is able to recognize the dark shadows that appear on the top and on the bottom of the image respectively. The purpose is to guide the user to keep the lenses leveled with the examined eye by showing a text box indicating the required movement.

In addition, a proximity based component should be implemented, so that the user can have the correct idea of distance from the lens to the eye. In order to do so, the EFS App should recognize the white hot spot on the top of the image (lens is too close) and a small fundus image (lens is too far). The component should clearly indicate if the user should go forward or backwards towards the eye.

3 *Different types of motion.*

4 *EFS tutorial.*