

AutoFocals 2

Auto Focusing Lenses for Correcting Presbyopia

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Introduction

Presbyopia is a very common side effect of the aging process. It describes the progressively worsening ability to focus on close objects. Currently, the easiest method of correcting this type of degeneration is through the use of reading glasses, or fixed focus lenses that refocus the image for the viewer. However, this is far from a perfect solution. Some drawbacks include that lenses at a fixed focus cannot be used in all situations, and many different glasses are needed for people with varying levels of presbyopia.

In this project, we aim to create a set of auto-correcting glasses for individuals with presbyopia that changes focus depending on what the user looks at.

Problem

As noted, fixed focus lenses for people with presbyopia is not a perfect solution due to the fact that different people have differing levels of presbyopia, and need to choose glasses to fit their needs, as well as the fact that these "reading glasses" cannot be used to view farther objects.



A set of auto-focusing glasses with visible IR rangefinder

We thus need a method of automatically focusing the lens to whatever the user's eyes are pointed at. Currently, there are implementations that utilize rudimentary depth sensors on the frame to detect where the user is looking, but the user's gaze is independent of where the head is pointed.

Implementation

In order to solve this issue, we implement a realsense depth camera for rangefinding, and two Pupil Labs eyetracking cameras in order to determine where the user is looking.



A render of the new head-mounted lens arrangement

The RealSense camera takes a measurement of the distance to the location that the user is looking at, and software subsequently adjusts the lenses to focus accordingly.

This project's specific goal was to mainly build on the AutoFocals' frame, which was originally built on a test frame. There were three subgoals of the new frame:

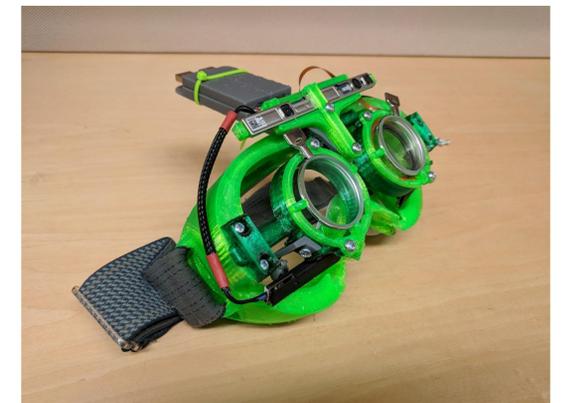
Stability: The new frame had to mount securely to the user's head given quick motions – specifically, the eye tracking cameras had to have the same view of the user's eyes no matter the user's motion.

Adjustability: The frame had to have adjustable IPD to fit different people – from 55mm to 75mm. Additionally, the eye cameras had to be on an adjustable ball mount to properly see the user's eyes.

Better cable management: Cables had to be routed in such a way that they were as unintrusive as possible.

Results

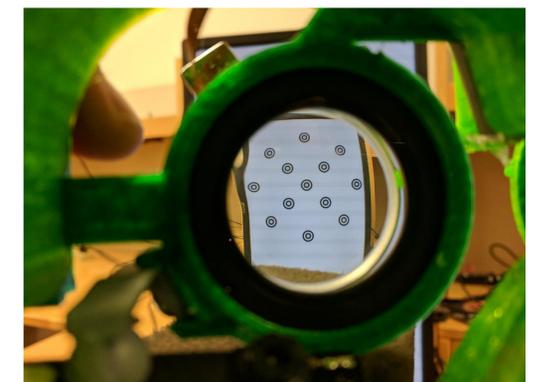
The lenses actually track eyes and focus on the object that the user is looking at. Unlike the previous generation, the headset stay son the head securely, allowing for better gaze direction estimates.



A view of the current autofocals 2

Future Work

- Sleeker, lighter frame while retaining stability on head
- Lighter cables, better cable management
- Different optics – liquid lenses sag slightly under gravity, and can have distortion



Visible distortion in adjustable lens

- Calibration free eye tracking – for better user experience
- Self-powered – to detach from a computer and be actually usable.