Personalized patient interface for optimal alignment with ophthalmic devices for remote monitoring

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PURPOSE

- Patient alignment is a crucial step to obtain acceptable image quality using ophthalmic devices.

- Alignment is traditionally done by an ophthalmic technician or by an automated system, which requires operator training and can be expensive to manufacture.

- In this work, we explore the feasibility of a repeatable and easy to use self-alignment solution.

METHODS

- Personalized patient interface (PPI):
  - A point cloud of participants' faces was acquired using an iPhone X (Apple, Cupertino, CA).
  - Point cloud was used as a basis for a 3D printed, personalized patient interface (Figure 1).
- Study description:
  - Participants: 19 subjects (32 eyes) with a range of ocular pathologies, including age-related macular degeneration.
  - Imaging device: low-cost OCT prototype system [1] with self-triggered acquisition and personalized patient interface (ZEISS, Dublin, CA).
  - Scan type: 5.78 mm x 5.78 mm OCT volumes with 512 A-scans/B-scans, 128 B-scans and 2.77 mm of depth. Acquiring each scan only takes about 1 second.
  - Initial alignment of the system to the subject's pupil was executed by an experienced technician. After which, the optical system's lateral coordinates, reference arm position and refractive error correction were locked.
  - A fixation target (integrated in prototype) was used to guide the subject's gaze.
  - Subjects were asked to self-acquire 3 OCT scans on each eye, retracting from the personalized patient interface between images.

The personalized patient interface creates a comfortable face-rest that restricts the subject's motion, while yielding repeatable positioning of the eye in relationship to the imaging device.

Figure 1 – An example of front (left image) and back (right image) of 3D printed personalized patient interface for self-alignment of patient with imaging device.

Figure 2 – Patient using low-cost OCT prototype system with self-trigged acquisition and personalized patient interface developed at ZEISS, Dublin, CA.

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RESULTS

- A total of 96 OCT scans from 32 eyes were self-acquired.

- A subject matter expert evaluated the OCT cubes and quality maps [2] of all acquired scans to determine the PPI self-alignment success rate.

- In 15 scans, misalignment in one or more directions caused image quality to be compromised, resulting in 0.16 (0.09, 0.25) proportion with 95% confidence.

- 6 cases out of the 15 cases were from 2 eyes whose patients had trouble fixating.

- All 30 eyes that were able to fixate had at least 1 successful scan.

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# of patients	19
# of eyes scanned	32
# of self-acquired scans	96
# of self-scans without misalignment	81
# of failed self-scans due to misalignment only along x- axis (left-right)	3
# of failed self-scans due to misalignment only along z- axis (forward-backward)	7
# of failed self-scans due to misalignment along y and z-axes	2
# of failed self-scans due to misalignment along x and z-axes	3

Table 1 - Summary of self-acquired scans
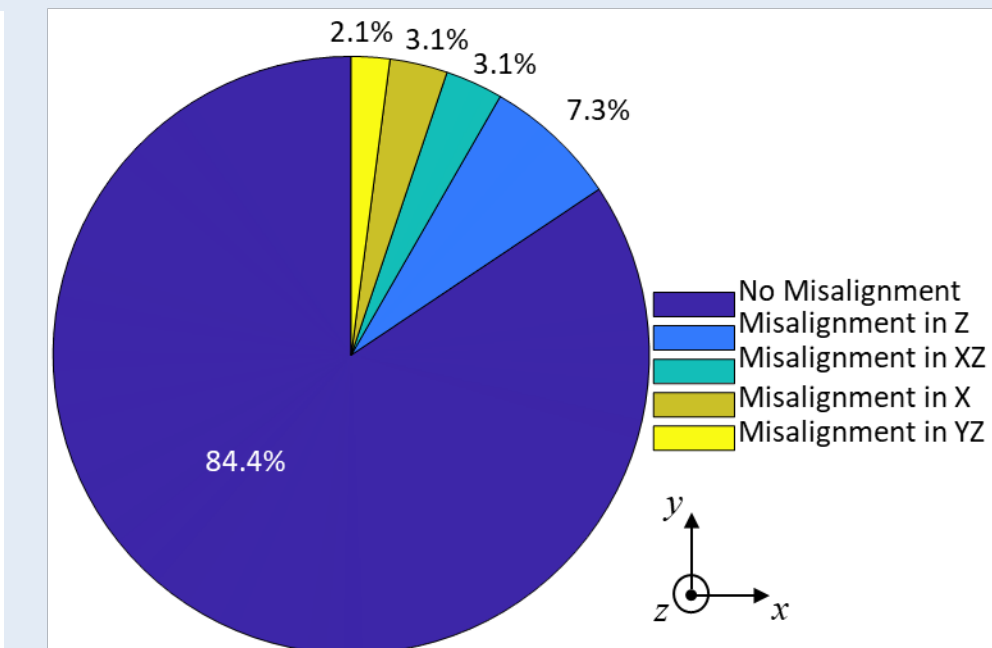
Figure 3 - Overview of self-acquired scans.

CONCLUSIONS

- 100% success rate was achieved using PPI for self-alignment of diseased eyes along with self-acquired 3 repeat scans per eye protocol for eyes with ability to fixate.

- Each scan acquisition with the low-cost OCT prototype only takes about 1 second, which makes the use of three self-acquired repeat scans per eye practical.

- Using PPI for self-alignment could pave the way for personalized ophthalmic imaging and facilitate use cases where expert technicians are not available, such as home monitoring.

REFERENCES

[1] Zacks et al. *IOVS* 2021; 62(8):2135

[2] Bello et al. *IOVS* 2021; 62(8):1881