Accuracy of Hartmann-Shack aberrometry for eye dynamics measurement

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Objective

- To find coherence of wavefront aberrations with blood pulse

Justification

- Wavefront aberrations of the human eye fluctuate in time

- Pulse and heart rate variability have been linked to microfluctuations in accommodation, changes in optical aberrations and longitudinal eye movements
Measures. Aberrations

- Hartmann-Shack wavefront sensor. 2000 frames in 10 seconds (200 Hz)
  - *.bmp files
  - Coordinates of Centers of Gravity (COG)
  - First 15 Zernike coefficients of wavefront
Measures. Pulse

- Blood pulse registered at 100 Hz in 10 seconds
Results

Coherence of Zernike coefficients with blood pulse
Pulse-tilt coherence?

Vertical tilt

Horizontal tilt
Pulse-astigmatism coherence?

45°/135° astigmatism

0°/180° astigmatism
Pulse-sphere coherence?

Defocus

Spherical aberration
Results

Coherence of signals themselves?
Odd-even samples analysis
Signal? Odd-even samples coherence

Vertical tilt

Horizontal tilt

![Graph showing coherence vs frequency](image-url)
Signal? Odd-even samples coherence

45°/135° astigmatism

0°/180° astigmatism
Signal? Odd-even samples coherence

Defocus

Spherical aberration

coherence vs v(Hz)
Conclusion

- No coherence of Zernike coefficients signals themselves for frequencies over 5 Hz

Alternative

- Dynamic analysis of the movement of the COGs of the spots
  - Analysis of time-frequency representations of the blood pulse and the movement in X and Y direction of the COG of the central spot
  - Coherence of the movement in X and Y direction of the COGs of all spots with blood pulse
Central COG analysis

X COG

Y COG
Central COG analysis

Pulse
COGs movement analysis
COG movement-pulse coherence

X COG

Y COG
COG movement-pulse coherence

X-pulse 1 Hz

X-pulse 1.25 Hz

Y-pulse 1 Hz

Y-pulse 1.25 Hz
Conclusions

- No coherence into Zernike coefficients signals themselves for frequencies over 5 Hz. Noise?
- No homogeneous coherence between pulse and COGs movement
- No high coherence of pulse with aberration. Maximum around 0.5
- Is it the appropriate system?
- Saccadic movement?