A High Resolution Wavefront Aberration Correction System Based on MEMS Deformable Mirrors for Retinal Imaging and AO Preview

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Desired Deformable Mirror Parameters for Broad Clinical Use

High Order Aberrations Correction
- 11-14 actuators across pupil \(^1\)
- Low influence function \(^2\)

Imaging Large Percentage of Population
- Up to 53 \(\mu m\) of defocus wavefront correction \(^1\)

Ease of System Integration
- Well matched to average pupil (4-8mm) \(^1\)
- Low Cost

1. Doble, Miller, Yoon, Williams 10 July 2007  Vol. 46, No. 20  APPLIED OPTICS
2. Dubra 19 March 2007 / Vol. 15, No. 6 / OPTICS EXPRESS
MEMS Deformable Mirrors

Multi-DM Key Parameters
- Actuators across pupil: 12
- Interactuator Coupling: 25-35%
- Aperture: 4.9mm
- Stroke: 6µm

New Multi-Drive Electronics
- Resolution: 14 Bits
  → <1nm avg. step for 6 µm DM
- Speed: >10 kHz
- Size: 9” x 7” x 2.5”

Wavefront Congress 2008
Wavefront Aberrations for Human Eye

Doble, Miller, Yoon, Williams 10 July 2007 Vol. 46, No. 20 APPLIED OPTICS
Wavefront Aberrations for Human Eye

95% of Population

6µm DM only

All Aberrations

Zeroed Defocus
Zeroed Defocus & Astigmatism

Doble, Miller, Yoon, Williams 10 July 2007 Vol. 46, No. 20 APPLIED OPTICS
Stroke Amplification within Optical Doubler

Patented Optical Doubler

Multi-DM

S-H SENSOR

Source

1st Zernike

Without Doubler

With Doubler

S1

S2

5th Zernike

6.4 μm P-V

12.8 μm P-V

4.3 μm P-V

8.2 μm P-V

Wavefront Sensor Measurements

AOA Wavescope®
Wavefront Aberrations for Human Eye

6μm DM + Doubler

95% of Population

All Aberrations

Zeroed Defocus

Zeroed Defocus & Astigmatism

Doble, Miller, Yoon, Williams 10 July 2007 Vol. 46, No. 20 APPLIED OPTICS
Badal Optometer for Focus Correction
Wavefront Aberrations for Human Eye

6µm DM + Doubler + Badal

95% of Population

All Aberrations

Zeroed Defocus

Zeroed Defocus & Astigmatism

Doble, Miller, Yoon, Williams 10 July 2007 Vol. 46, No. 20 APPLIED OPTICS

Wavefront Congress 2008
Results from AOSLO without Doubler + Badal

S. Burns, Indiana U. School of Optometry
Summary

Wavefront Correction System with DM + Optical Doubler + Badal capable of high order aberrations
- To be demonstrated in AO-SLO System
- Sufficient Actuator Count and Stroke to Correct 95% Population

Promising for clinical applications: Retinal Imaging & AO Preview
- MEMS benefit from economies of scale
- Compact size matches pupil

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