Blinking Orbital Prosthesis

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Advisor: Professor Pablo Irarrazaval

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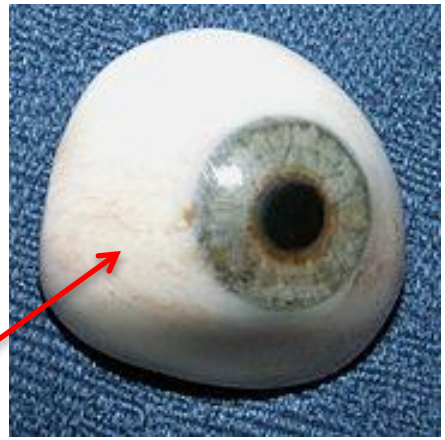
Communicator: Blake Marzella
BWIG: Mike Musser
BSAC: Jeff Groskopf

Orbital Prostheses

- Biomechatronics
- Ocular vs. Orbital

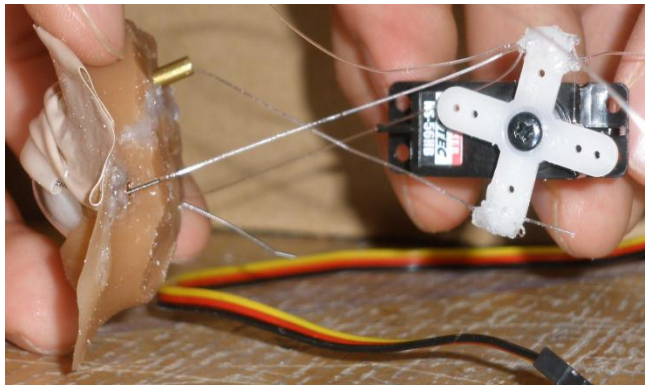


- PMMA – Polymethyl Methacrylate
- Silicone

Previous Work:
Last Semester's Mechanism

Previous Work

- Embedded Cord Tension Mechanism
  - Servo motor with rotating arms operates the mechanism
  - Silicone lid for realistic appearance
  - Closing cord acts as the orbicularis oculi muscle
  - Levator cord replicates the levator muscle



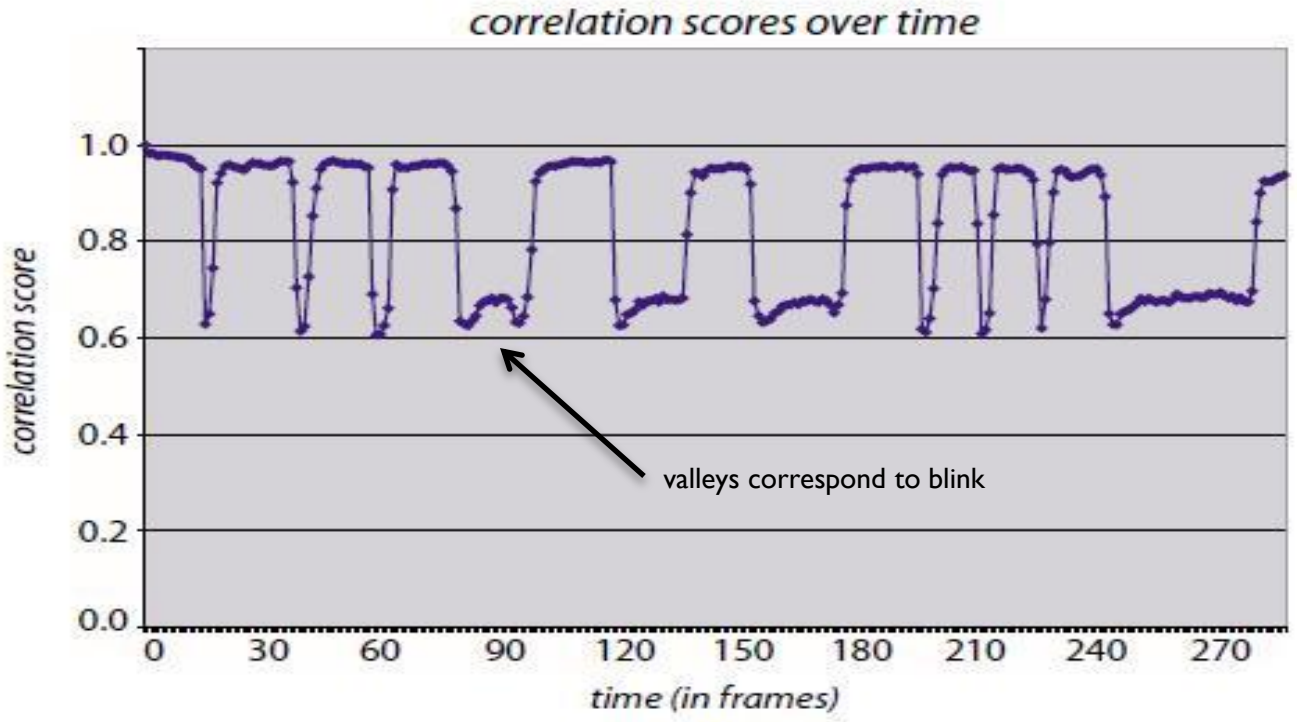
Problem Statement

- Loss of eye and surrounding tissue
  - Disease
  - Injury
  - Genetic defect
- Synchronize the blink of the prosthesis with a healthy eye
- Aesthetically pleasing and realistic appearance

Current Devices

- Has yet to be a fully functional *blinking* prosthetic device.
- Blink can be detected, however:

  Muscle signals, brain signals, eye tracking camera, etc.



Client Requirements

- Synchronization
- Working presentation model
- Modify current mechanism
  - Ideally housed in one compact piece
  - Detachable motor box
- Comply to budget of ≈ $500
- Safety

Mechanism Adjustment

Mesh Levator Cord Testing

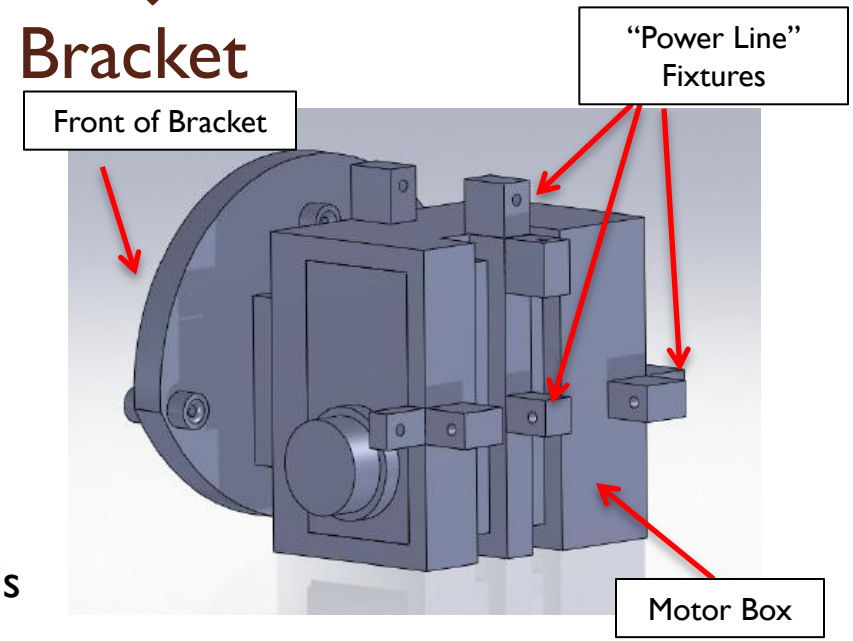
- New Break Load: 750g
- %66 Stronger Cord

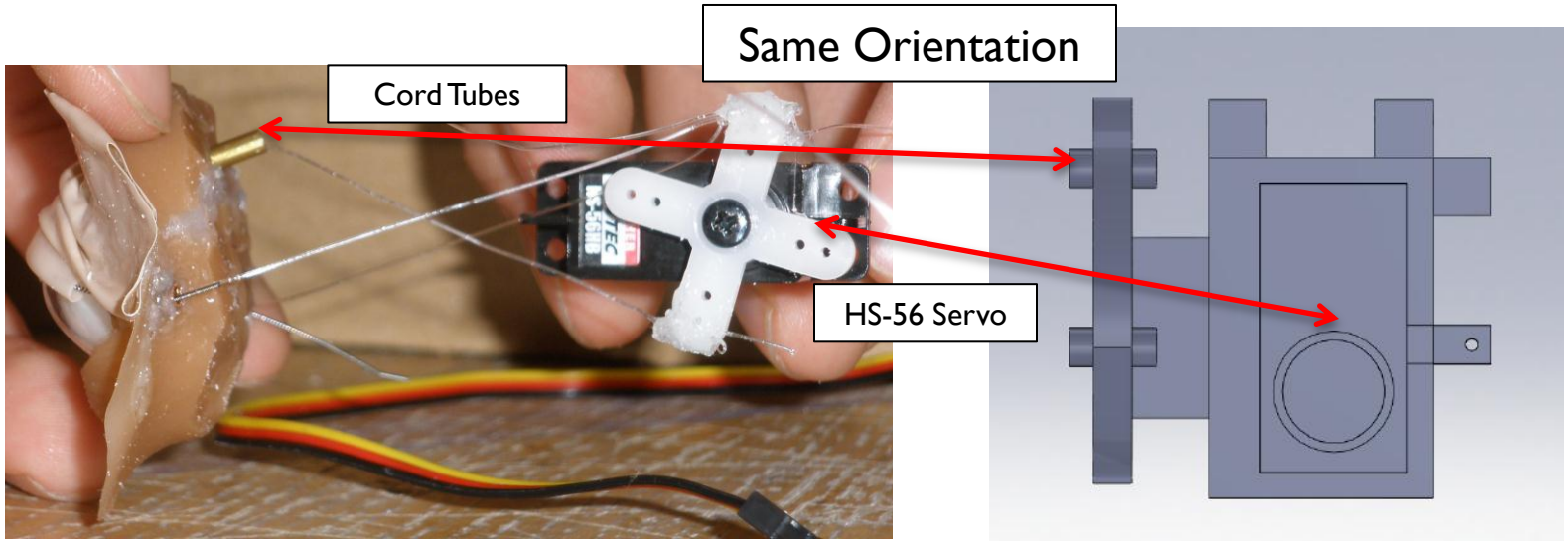
Testing

Mechanism Adjustment

Motor Bracket

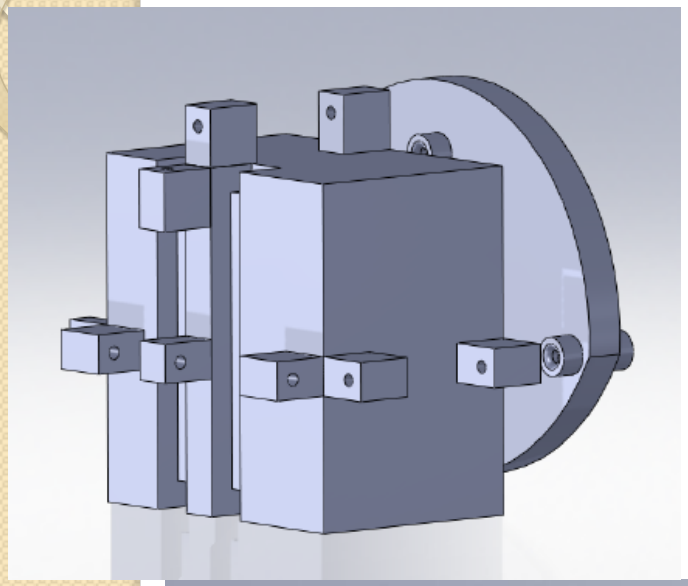
- Incorporated in all synchronization ideas
- Flat Front of Bracket
  - Embedded within silicone
- Back of Bracket
  - Motor Box to fix motor position
  - "Power Line" fixtures to guide cords to motor arm



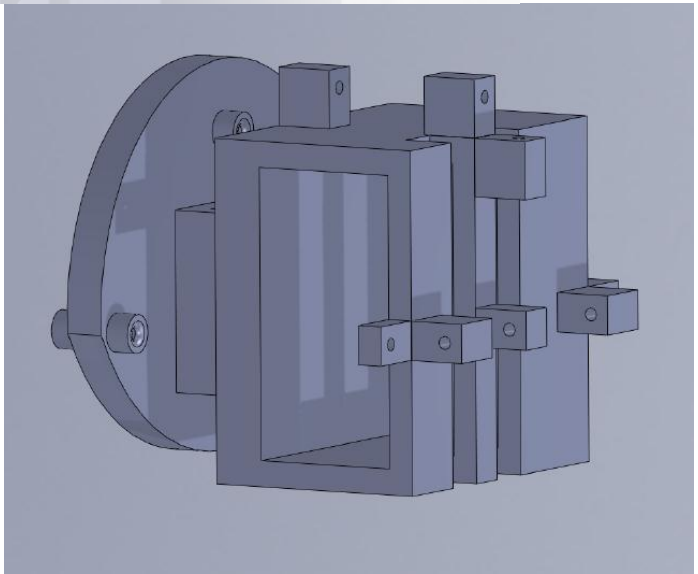


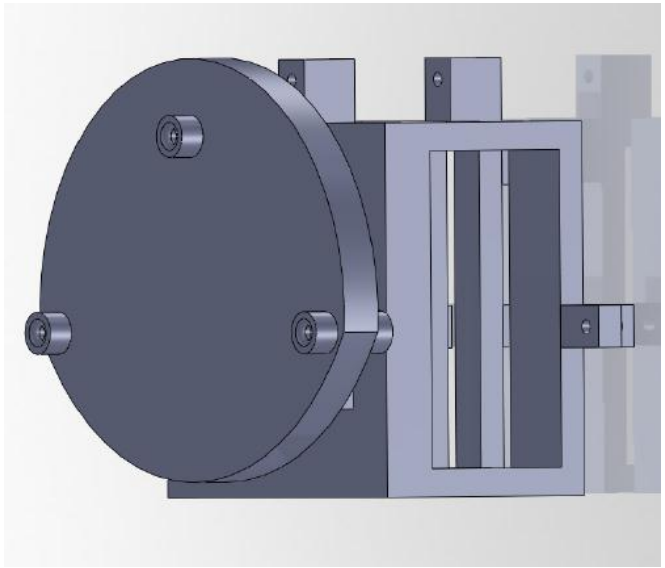
Mechanism Adjustment cont.

Motor Bracket Improvements



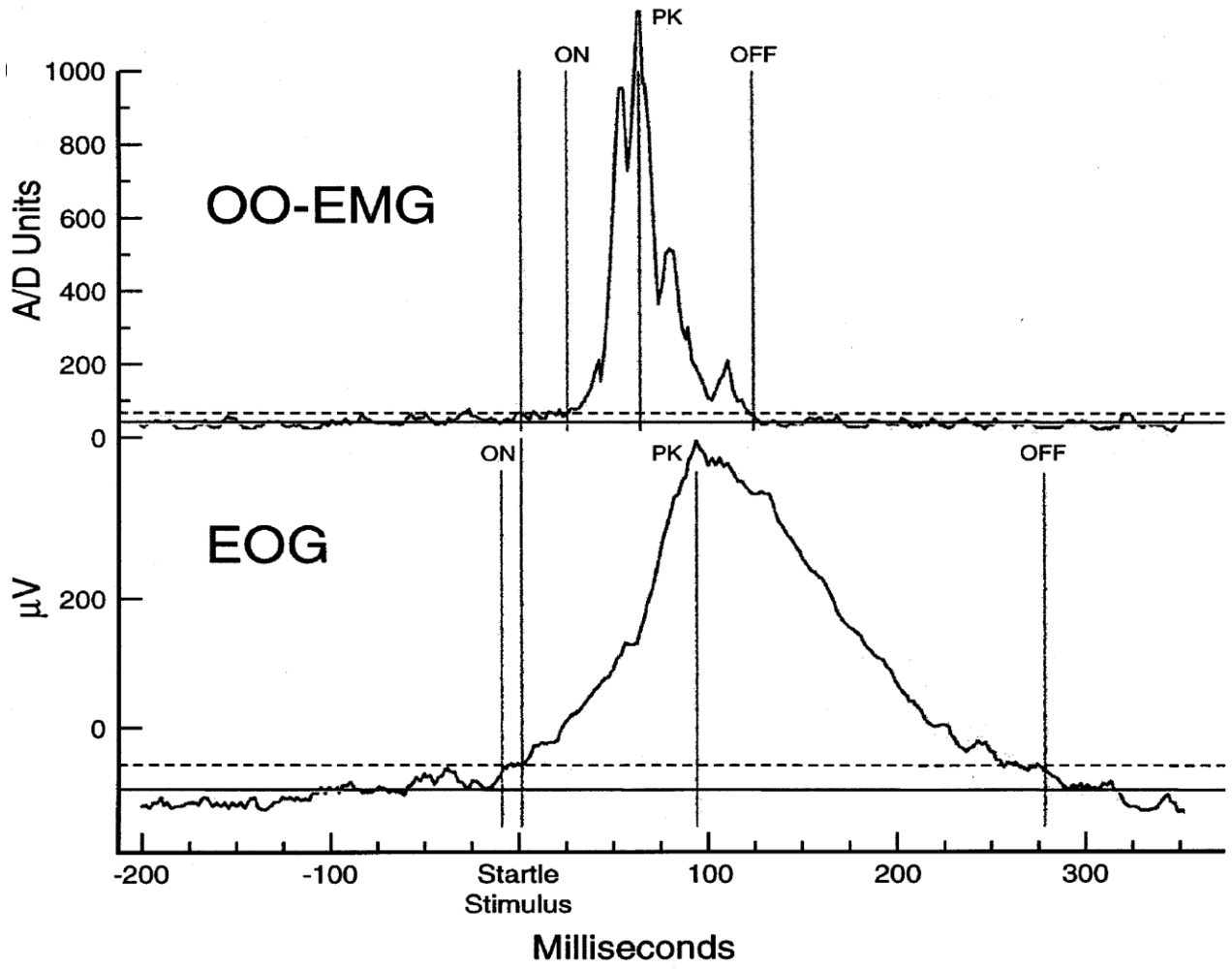
- Smaller Size
- More Stable
  - Greater Tension on Cords
  - Less Structural Burden on Silicone





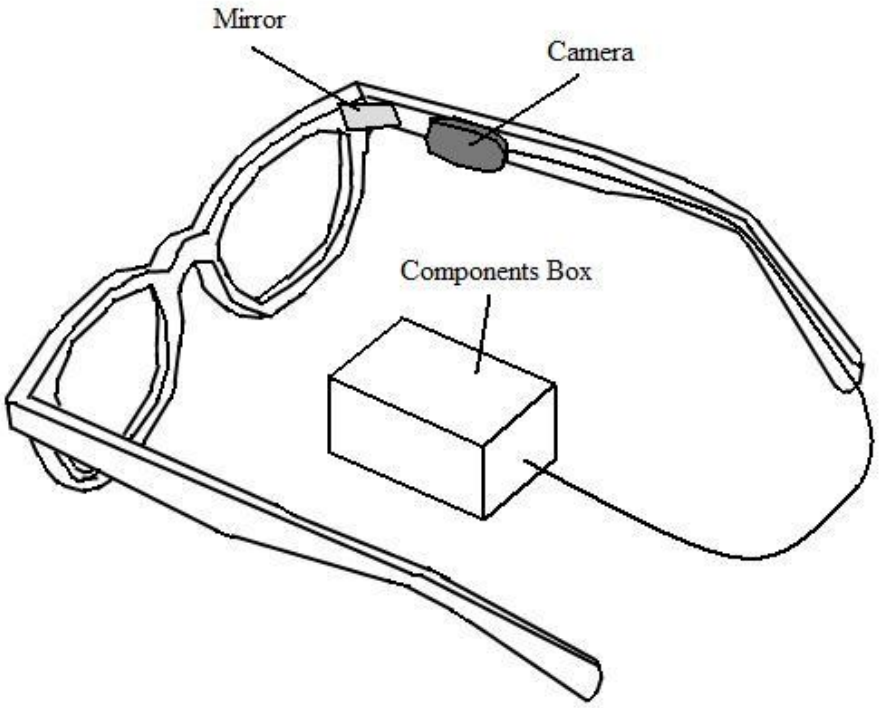
Electromyogram and Electrooculogram

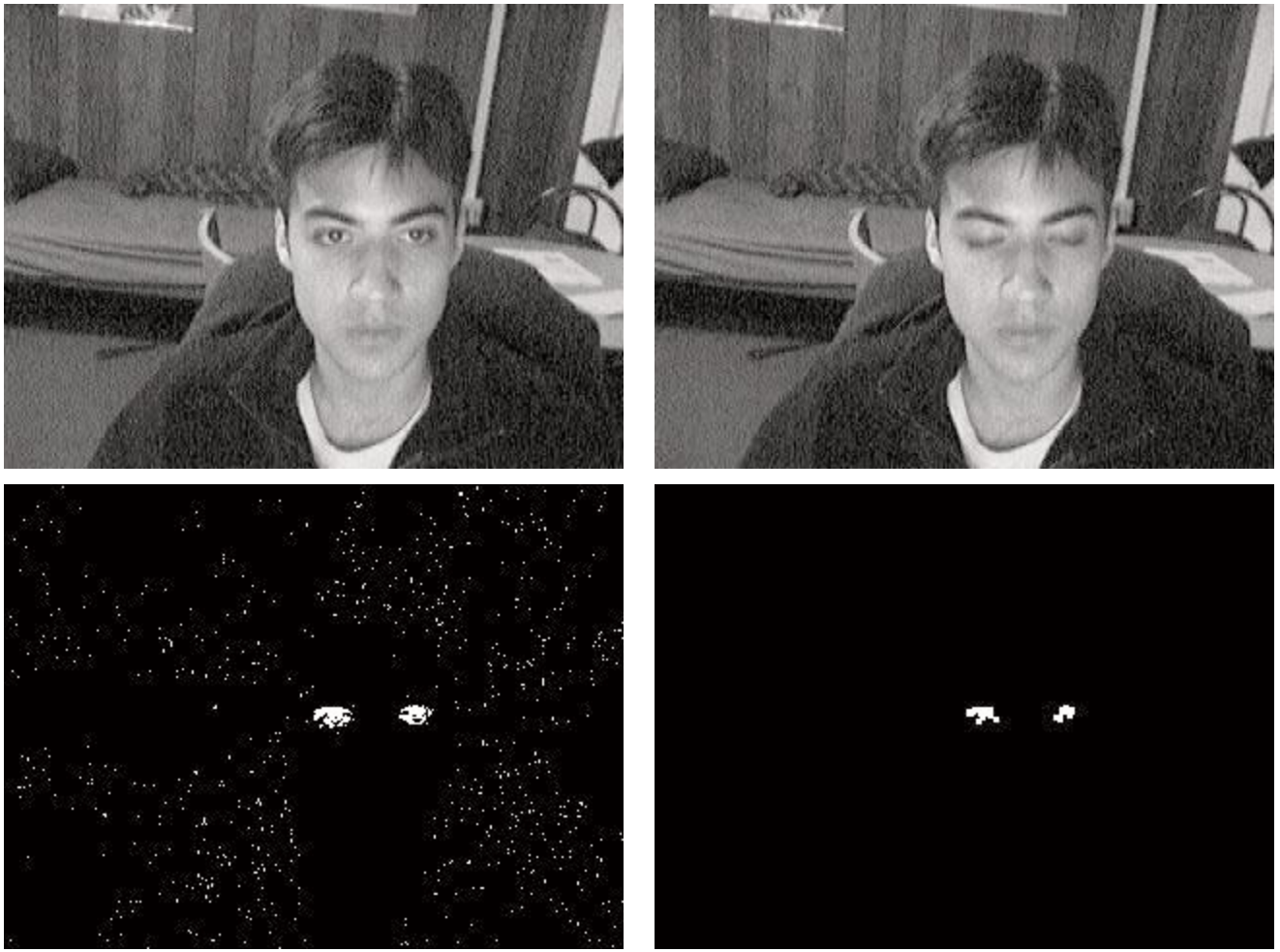
- EMG- potential generated by orbicularis oculi muscle
- EOG – potential generated by vertical movement of eyelid
- Three electrodes, long term, dry, surface
- Requires a bio-amplifier


PK
ON
OFF
1000
800
600
400
200
0
A/D Units
OO-EMG
ON
PK
OFF
EOG
µV
200
0
-200
-100
Startle
Stimulus
100
200
300
Milliseconds

Camera

- Camera focused on the eye
- Image recognition program determines what the open eye looks like, used as template
- When blinking, the image starts to differ from the template
- Has additional hardware requirements

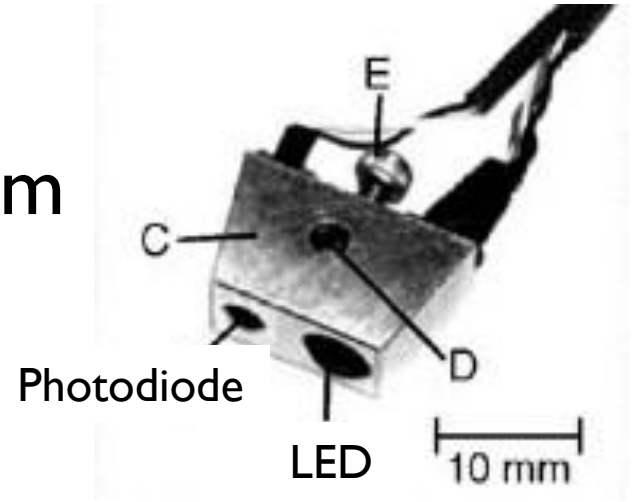




Chau, Michael and Betke, Margrit. "Real Time Eye Tracking and Blink Detection with USB Cameras." *Boston University Computer Science Technical Report* No. 2005-12. May 12, 2005. PDF.

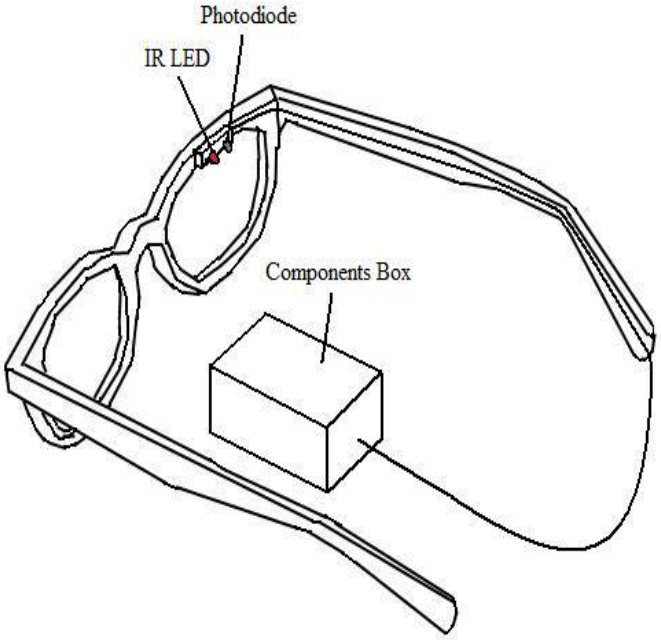
IR LED and Photodiode

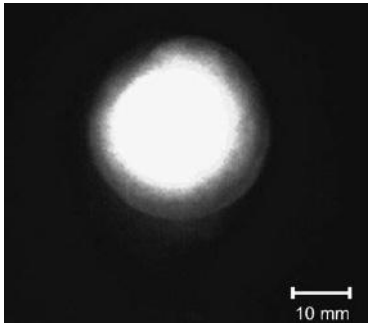
- IR light emitted on eye
- Increased reflection from eyelid
- Voltage in photodiode increases
- Signal sent to Arduino
- Osram IR LED



IR LED and Photodiode

- External interference
- Correct orientation and distance from eye
- Use of glasses
- Easily picks up eyelid movement
- Wide field-of-view with glasses.





Field-of-view area at 20mm

Final Design Selection

Method	Cost	Size	Ease of Use	Safety	Difficulty	Signal Str.	Accuracy	Delay	Weight	Power	Total
Weight	5	5	15	10	10	15	10	15	5	10	100
EOG/EMG	2	2	6	8	5	6	6	12	2	4	53
Camera	4	4	12	10	3	12	8	12	3	5	73
IR-LED	5	5	12	8	9	13	10	12	4	7	85

- Pursuing LED/Photodiode design
  - Easy implementation with mechanism
  - Inexpensive
- EOG
  - Invasive nature
- Camera
  - More complex

Future Work

- Build motor box bracket in the shop or rapid prototyping
- Purchase IR LED Components
- Contact Prof. Bracha for build consultation
- Wire/program Arduino microcontroller

Acknowledgements

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Professor Justin Williams

Professor Vlastislav Bracha

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Questions?