Blinking Orbital Prosthesis

Sean Heyrman, Taylor Milne,
Alex LaVanway, Michael Schmidt

Advisor: Professor Thomas Yen
Client: Dr. Greg Gion

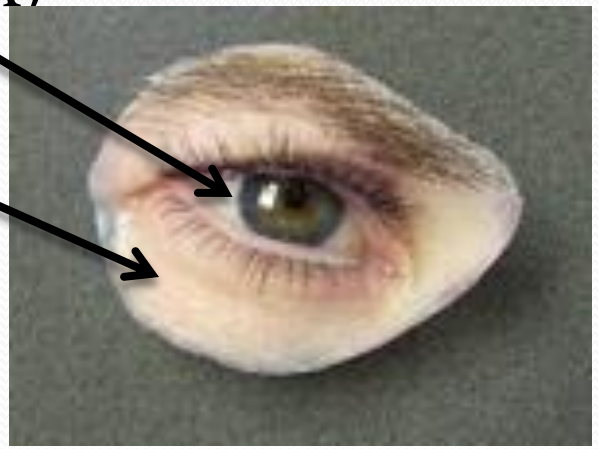
Background

- Prosthesis for the orbital region
- Causes
  - Cancer (retinoblastoma)
  - End stage glaucoma
  - Infection
  - Injury
- Different than ocular prosthetic

Pictures from Gregory Gion, A. V. "The Medical Art Prosthetics Clinic - Orbital Prosthesis." from http://www.medicalartprosthetics.com/content.php?page=prostheses&sec=orbital. (top) and "Prosthetic Eye Picture." from http://upload.wikimedia.org/wikipedia/commons/b/bc/ScleralLens1.jpg (bottom)

Background

- Polymethyl methacrylate (PMMA)
- Silicone-based material
- Recommendations
  - Glasses
  - Look forward



Pictures from Gregory Gion, A. V. "The Medical Art Prosthetics Clinic - Orbital Prosthesis." from http://www.medicalartprosthetics.com/content.php?page=prostheses&sec=orbital.

Problem Motivation

- Current prostheses
  - Analogue of natural eye and surrounding tissue
  - Personalized for each patient
  - Appear entirely natural
- Problem ➔ all form, no function

Problem Motivation

- Blinking Orbital Prosthesis
  - Mechanical eyelids that rapidly open and close
  - Combines life-like appearance with a simulated blink
  - Brings a patient one step closer to normalcy

Current Technology

Static Orbital Prosthesis

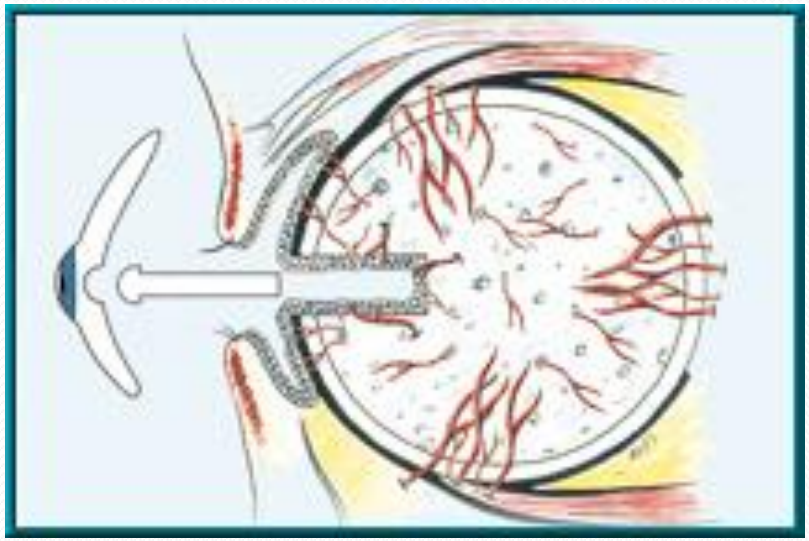
- Silicone orbital prosthetic
- Emulates eye and surrounding tissue
- Motionless

Picture from Gregory Gion, A. V. "The Medical Art Prosthetics Clinic - Orbital Prosthesis." from http://www.medicalartprosthetics.com/content.php?page=prostheses&sec=orbital.

Current Technology

Orbital Implants

- Prosthetic eye
- Integrates with tissue in eye socket
- Provides realistic eye movement
- Only for eye, not surrounding tissue



Picture from Implants, B.-E. O. "Orbital implants and artificial eyes." from http://www.ioi.com/patient/implants.html#.

Current Technology

Fall 2010 Blinking Prototype

- Creates eye blink by use of servo and IR LED sensor
- Design size, accuracy and noise levels need improvement

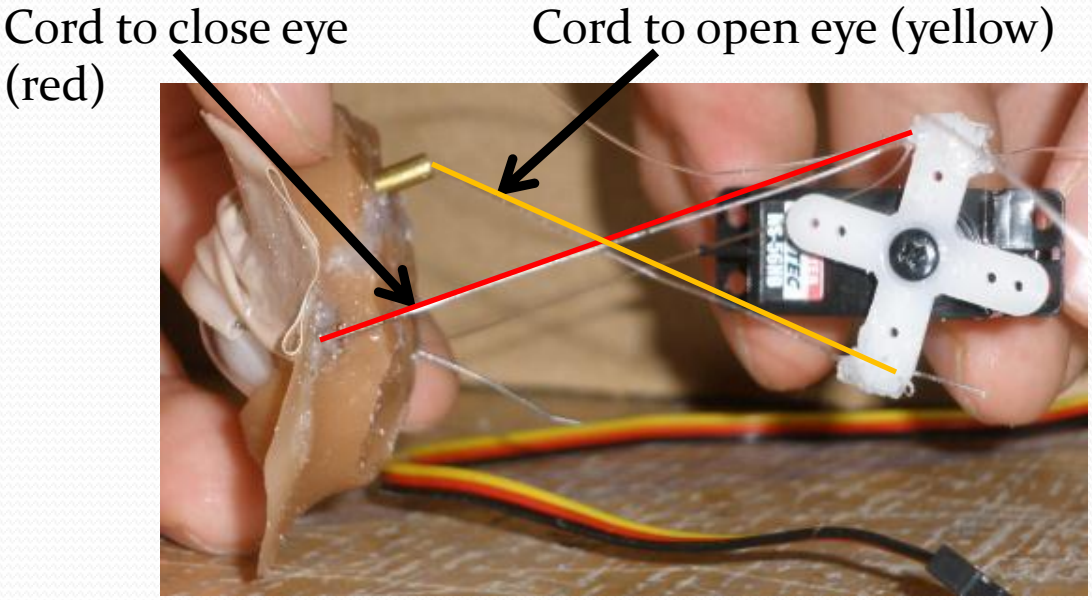
Picture from Justin Cacciatore, J. G., Mike Konrath, Blake Marzella, Michael Musser (2010). "Blinking Orbital Prosthesis."

Design Specifications

- Quiet
- Minimal vibration
- Small
- Easy to produce and maintain
- Life-like blink

Servo Motors

- Motor with position detection
- Current prototype
  - Embedded cord mechanism



Picture from Justin Cacciatore, J. G., Mike Konrath, Blake Marzella, Michael Musser (2010). "Blinking Orbital Prosthesis."

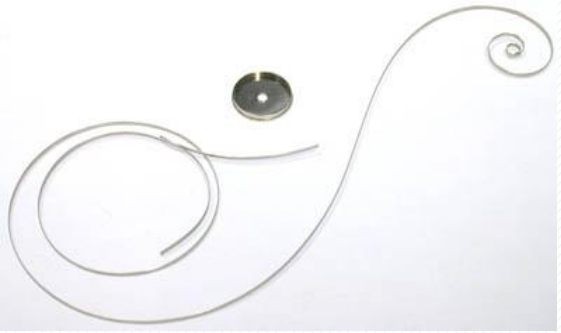
Servo Motors

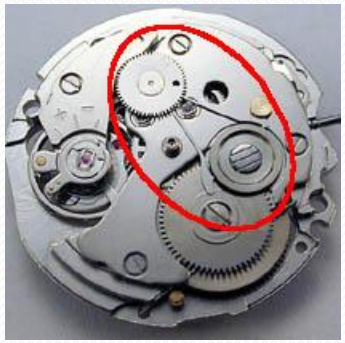
- Advantages
  - Fast
  - Small size
  - Interacts well with electronic detection method
- Disadvantages
  - Excessive vibration and sound

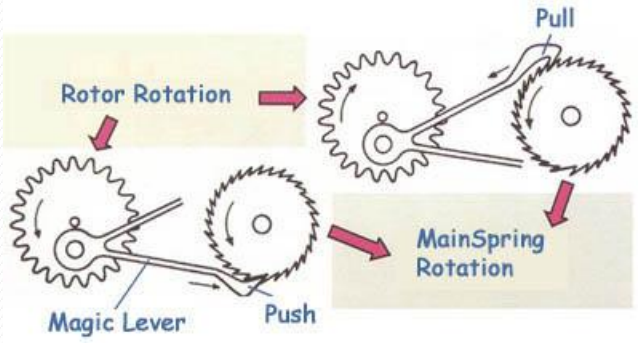
Picture Electronics, P. R. a. "Sub-Micro Servo 3.7g (Generic)." from http://www.pololu.com/catalog/product/1053.

Automatic (self-winding) Watch

- Everyday movement to "self-wind"
- Powered by mainspring
- Rotor ratchets mainspring in both directions







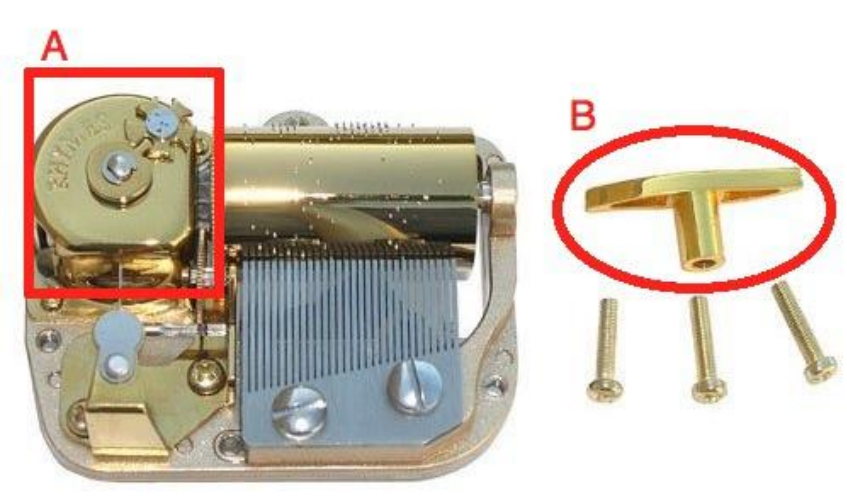
Pictures from Horologyzone. "Basic Knowledge." from http://horologyzone.com/watch/watch-school/watch-history.html.

Watches

- Advantages
  - Very small
  - Fast movement
  - Minimal maintenance
  - No vibration
- Disadvantages
  - “Tick tock” noise
  - Expensive
  - Difficult to modify

Musical Movement

- Key (B) winds spring contained within spring-housing (A)
- Unwinding of the spring causes a gear train to turn
- Governor (not visible) controls speed at which spring unwinds



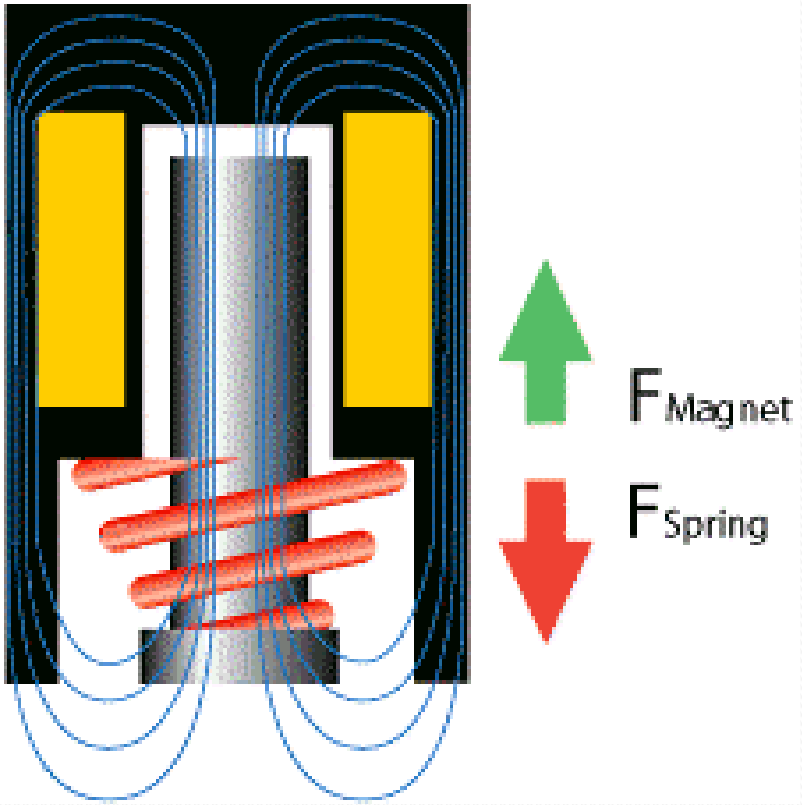
Picture from Amazon.com. "Musical Movement With Beautiful Sound Quality Plays "Blue Danube Waltz"." from http://www.amazon.com/gp/product/images/B0006BCF92/ref=dp_image_0?ie=UTF8&n=2617941011&s=arts-crafts.

Musical Movement

- Advantages
  - Small
  - Quiet
  - Retains energy
  - No vibration
- Disadvantages
  - Requires regular winding
  - Speed
  - Extensive modification needed
  - Price

Solenoid

- Push/pull Solenoid
- Provides direct linear movement for blink



Picture from Robots, S. o. "ACTUATORS - SOLENOIDS." from www.societyofrobots.com/images/actuators_solenoids.shtml.

Solenoid

- Advantages
  - Simple integration of electronic signal to mechanical movement
  - Small
  - Sufficient force
- Disadvantages
  - Variable delay time

Design Matrix

Category	Servo Motor	Music Box Movement	Self-Winding Watch	Solenoids
Speed (30)	30	15	25	20
Sound/Vibration (30)	0	30	10	25
Maintenance (20)	15	15	20	18
Ease of Production (15)	15	0	5	15
Cost (5)	4	0	3	5
Total (100)	64	60	63	83

Force Testing

- Force to pull cords tested
- Average of 3 trials
- Problems
  - Need larger force gauge

	With Lubricant	Without Lubricant
Opening	0.2320 N (+/- 0.0026)	0.6142 N (+/- 0.0186)
Closing	1.5256 N (+/- 0.0010)	Off Scale (>1.5680 N)

Future Work

- Testing
  - Force of a blink
  - Displacement of a blink
  - Synchronization
  - Longevity
- Cost
  - Cost of project to date: $17
  - Estimated cost of final prototype: $50

Acknowledgments

- Dr. Greg Gion (Client)
- Professor Thomas Yen (Advisor)

Questions?

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