Blinking Orbital Prosthesis

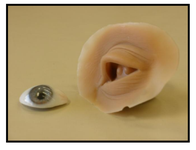
Justin Cacciatore, Mike Konrath, Bret Olson, Blake Marzella
Department of Biomedical Engineering
Advisor: Professor Thomas Yen **Client**: Gregory Gion MMS, CCA

Abstract

People of any age or gender may experience the surgical removal of an eye due to an injury, genetic defect, or disease. The use of an orbital prosthetic allows these individuals gain a sense of self-confidence and a more positive self-image. However, while prosthetics have been developed to create an incredibly realistic and aesthetically pleasing orbital device, they have failed to provide the appearance of functionality of a real eye. That is, the prosthetics are static and cannot blink. Our client desires for us to devise a mechanism which would allow for a prosthetic eye to blink. This mechanism will be used as a model in presentations to illustrate the blinking mechanism's effectiveness and potential for further development. As such, our design does not have to meet the requirements for direct use by a client. However, we intend to expand upon our client's original goal and look forward to the implementation of our mechanism into an actual orbital device. It is our hope that by doing so our blinking mechanism can easily transform from a working theory to the actual implementation of our design for an individual's use in a prosthetic

Client Requirements

- Focus on the mechanics of the blink
- As small as possible
  - Should fit in the cavity of the eye
  - (~30 cubic centimeters)
- Achieve the same speed as a normal human blink.
  - (1 blink lasts~400ms)
- Budget of $500
- End goal should be a model used for presentations
- Blinking mechanism should be quiet



Orbital Prostheses




- The current prostheses are custom made for each patient and are made out of flesh colored silicone and PMMA
- The prostheses are completely static
- Three previous BME design groups:
  - Motor which forces rods to move which then close the eye
  - Electromagnet and neodymium magnet pulls rods to close the eye
  - Balloon catheter lifts a lever which closes the eye, counterweight opens eye

Final Design

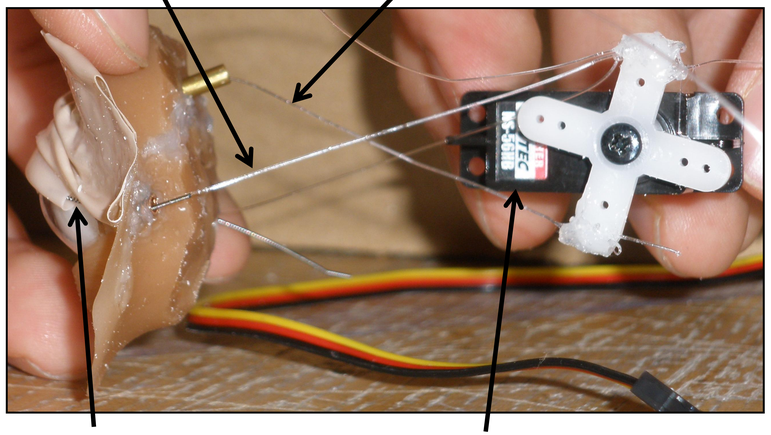
Blinking Mechanism

Closing Cord…

The closing cord runs through the edge of upper eyelid and it is also incased in a metal spring. When tension is applied to it, it causes the eye to close due to the geometry of the eye.

Opening Cord…

The opening cord runs perpendicular to the closing cord and its function is to make the eye open. Its complementary to the closing cord, meaning when the opening cord is in tension, the closing cord is relaxed and vice-versa.



Embedded Spring:

The embedded spring's purpose is to maintain the upper eyelids form. It also helps to disperse the force applied by *opening* cord. It also serves an aesthetic purpose, creating a signature ridge that is characteristic of the human eye.

Micro Servo Motor:

The micro servo motor is set up so that it pulls the cords running through lower edge of the upper eyelid while it releases its tension on the cord that pulls the eye up. Thus, its rotating causes the eye to blink.

Cost Analysis

Item:	**Cost**:
Arduino USB Board	$29.95
Momentary Push Button Switch	$0.50
1CB86 PC Board	$1.99
Detector Plug	$3.29
HS-56HB Servo Motor	$30.94
Styrofoam Display Head	$13.34
Fishing Line	$2.84


http://t3.gstatic.com/images?q=tbn:W-0_XLGM8FfdbM:http://arduino.cc/en/uploads/Main/ArduinoNG.jpg


http://static.sparkfun.com/images/products/08782-04-L_I_ma.jpg

http://servocity.com/assets/images/futm0657.jpg

Total Cost: $82.85

Prosthesis Testing

Time Testing:
Determination of the different speeds of all of the mechanism's components.
- Angular Velocity of Micro Servo: 8.73 r/s
- Average Speed of Blink: 0.33s

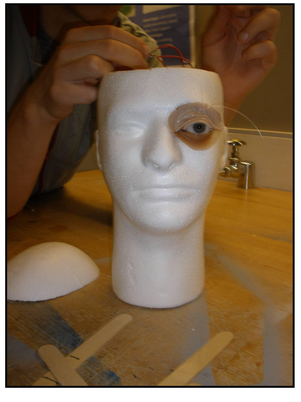
Reliability Testing:
Measurements regarding the quality and durability of our design. To gather this data, we performed our blinking mechanism 50 times and gathered the following data.
- Continuous blinks without error: 15
- Lubrication requirement: 1
- Percentage of complete blinks: 84%

Future Work

Building a patient-ready model
- Minimizing size of Arduino USB board and the servo motor to fit into the cavity of the eye socket.
- Finding a way to power the device internally (i.e. miniature battery)
- Finding a motor that creates less vibrations, noise, and heat.
- Protecting all electrical circuits, to keep the patient safe from shock or hazard.
- When applicable, synchronizing the artificial blink with the blink of the natural eye.

Integration
- Upon making the necessary improvements and extended testing, the mechanism could be used to offer an additional alternative to Mr. Gion's patients.

Production
- Every patient would need a customized model due to the immense diversity of human facial features.



References/Acknowledgements

Mr. Gregory G. Gion, MMS, CCA and the Medical Arts Prosthetics Clinic
Professor Thomas Yen of the University of Wisconsin - Madison
Dr. Mark Lucarelli, Dr. Jim Verhoeve, and Dr. Cat Burkat of the UW Madison Medical School Department of Opthamology