Improved Eye Muscle Model- Curved Muscles

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Objectives

• Model curved muscles

• Analyze muscle side slip on the eye
Curved Muscles Model

Known
- 1- Insertion point on the head
- 2- Tangent point on the eyeball
- 3- Insertion point on the eyeball

Infinite possibilities. How to choose?

Assumption: minimize distance covered by the string on the eyeball (2-3) without friction

Geodesic

• Conditions:
  - 2 belongs to the plane that contains the geodesic
  - 2 belongs to the sphere
  - 2 is a tangent point

• Solution:

\[
\vec{x}_2 = \left( \frac{R}{\|\vec{x}_1\|} \right)^2 \vec{x}_1 \pm \left( \frac{R}{\|\vec{x}_1\|} \sqrt{1 - \left( \frac{R}{\|\vec{x}_1\|} \right)^2} \right) (\vec{n} \times \vec{x}_1^{\prime})
\]

Choose the one that is nearer to the insertion point in the eye (the other solution gives 2')
**Muscle Side Slip**

**Eye Reference Frame**

- **Point to track**
- **Muscle in the current iteration (k)**
- **Muscle in the previous iteration (k-1)**
- **Insertion point on the head (not constant in the eye frame)**
- **Insertion point on the eye (constant in the eye frame)**

\[
\text{sideslip}(k) = \sum_{i=1}^{k} \text{sideslip}_{inc}(i)
\]

\[
\text{sideslip}_{inc}(k) = R\alpha(k)
\]
Side Slip- 45° upwards vertical saccade

Eye Reference Frame
Future Work

• Update the optimal control for the new model
  - New cost function that minimizes effort based on the new model

• Develop an even more biomimetic solution
  - Model the muscle as a mesh (or many curved lines) with several insertion points