Rodent Rotation & Translation Stage

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Abstract

- Research of rodent's retina - eye disease treatment
  - Imaging of precisely aligned eye
  - Rotating eye visualizes entire retina
- Current models:
  - Fail to keep eye at center of rotation (CoR)
  - Require adjustment after each rotation
- Final Prototype
  - 2 degrees of rotational freedom
  - 3 degrees of internal translation
  - Accurately aligns pupil at center of rotation
- Testing conducted:
  - Strength of stage under loading
  - Ease of alignment
  - Effectiveness of alignment - eye deviation
- **Design optimizes alignment/adjustment of specimen with minimal deviation during imaging process**

Problem Motivation

- **Glaucoma** [1]
  - Disease due to optic nerve damage
  - Leading cause of blindness in people over 60 years old
- **Macular degeneration** [2]
  - Macula: focusing central vision in the eye
  - Disease caused by deterioration of the macula
  - Leading cause of vision loss affecting more than 10 million Americans
- Client is conducting research aimed at treating ocular diseases: **Roger's Lab**
  - Approach: imaging rodent *retinas*
- **Requires stage to facilitate imaging process**

Figure 1: Image specimen

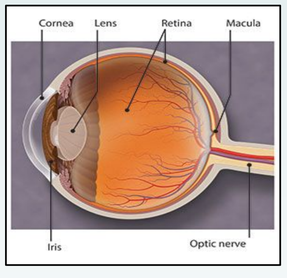

Figure 2: Labeled human eye

Problem Statement

A device providing facile alignment of rodent eyes within the imaging system's field of view as well as rotational freedom for accessibility to a holistic view is called for. This device must provide at least 2 rotational degrees of freedom, pitch and yaw, as well as 3 translational degrees of freedom for the positioning of the eye at the intersection of the rotational axes.

Background

- Rats are the primary test subject
  - Weight = 250-500 grams
  - Length = 17-21 centimeters [3]
  - Environment = 20-25°C and humidity 30%-50% [4]
- Benefits of Researching Rats
  - Frequent reproduction with genetic purity
  - Ocular similarity to human [5]
- Image anesthetized specimen via nose-cone
- Existing products do not keep the rodent's eye in the center of rotation:
  - **Bioptigen RAS:** 2 pivoting, concentric cylinders [6]
  - **Previous Design**: Gyroscope [7]

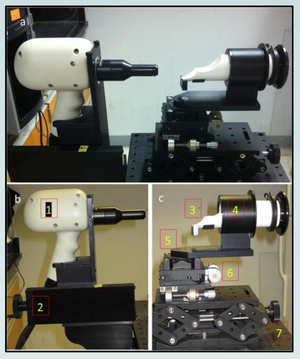

Figure 3: Existing Product by Bioptigen [6]

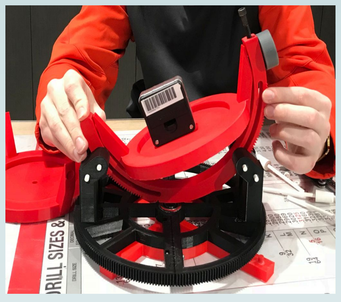

Figure 4: Previous team's design [7]

Design Criteria

- **Ease of adjustment** - Align Eye at Rotational Axes ✓
- **Rotational freedom** - Pitch and Yaw ✓
- **Translational freedom** - X, Y and Z ✓
- **Ease of fabrication**
- **Sterilizability** - Smooth Surfaces
- **Strength** - Support Max Rodent = 500 g ✓
- **Safety** - Rodent and Researcher
- **Simplicity**
- **Cost** - $350 ✓

Final Prototype

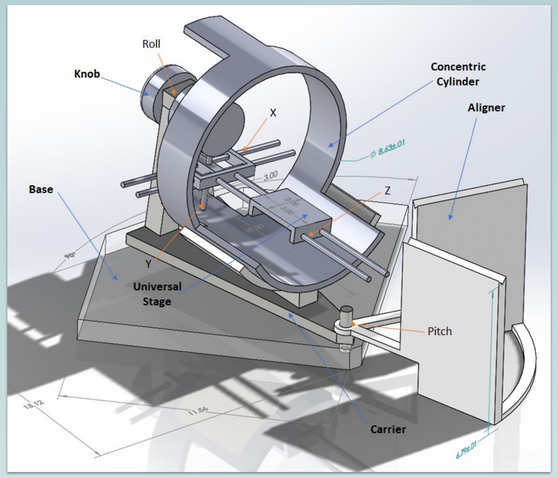

Figure 5: Solidwork drawing of final prototype: **Diamond RRaTS**

- **Five DOF:** Roll/Yaw Rot & X/Y/Z Trans
  - **±80°** Roll - turning knob (conc. cylinders)
  - **±50°** Yaw - pivoting carrier
  - X **±1 in** Y **-2 in** Z **-6 in**
- Held in place via thumb screws, gravity, and friction
- **Universal Template Stage**
  - Sample holder freedom
  - Specimen variety: Rats, mice, individual eyes
- Total cost - **$237.52**
- Base - Acryllic
- Carrier - HDPE
- Concentric Cylinders - PVC
- Internal Translation - Steel and Aluminum
- Aligner - PDA

Future Work

- Design **attachable stages** - various specimens
  - Incorporate Warming Blanket
  - Bite Bar - Restrain specimen
- Implement **motor** for automatic adjustment
- Fabricate using autoclavable materials
- Pair with Lab Cart - External Translation +3 DOF
- Implement with imaging device and validate

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Testing and Results

- Average time to align eye at CoR
  - **59.32 ± 17.55 seconds** (n=7)

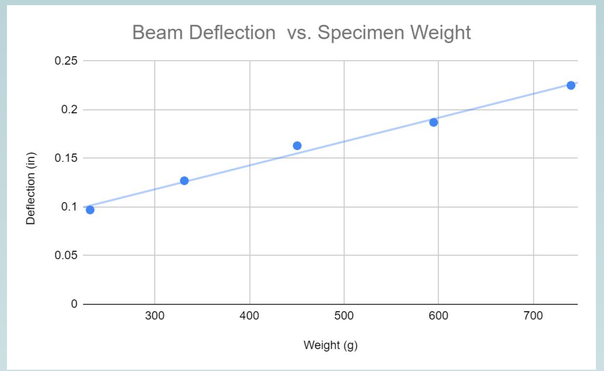

Figure 6: Beam deflection of universal holder under varying load

- Universal Stage centered on Z trans rods at 5 in
- Loaded with increasing mass
- **Rigidity of protruding rods can be improved**

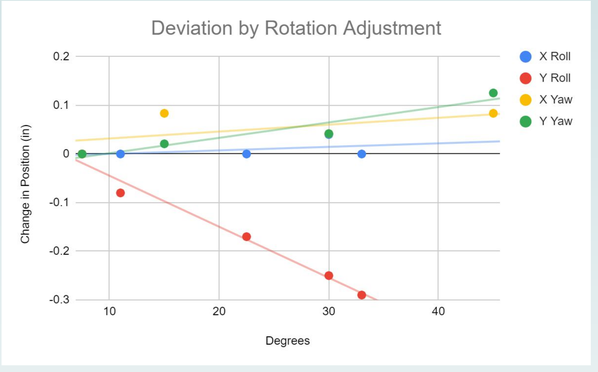

Figure 7: Results of quantifying eye deviation due to rotation following alignment

- Model specimen eye aligned via Aligner
- Deviation along X and Y axes with various rotations
- **Eye moved most in Y due to Roll**
- **Minimal Significant Deviation (Eye ∅ = 0.46 in)**

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