

Rodent Rotation and Translation Stage

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Function

Research of mammalian retinal photoreceptors, conducted via the imaging of rodent model organisms, requires precise alignment of the specimen. 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.

Client requirements

- Design must provide at least 5 degrees of freedom.
- Pupil of animal must adjustable to the intersection of the rotational axes.
- Area near head of rodent must be open and accessible for imaging and anesthesiology.
- Degree of translational precision should be within 100 microns.
- Smooth-finished surfaces for facile sterilization between imaging procedures.
- Removable holders of different sizes for different specimens.

Design requirements

1. Physical and Operational Characteristics

- a. **Performance requirements:** The device should keep the center of the axis at the pupil of the rodent's eye, despite the 5 degrees of freedom it will be available to move in. This device will be used whenever the rat's photoreceptors are being imaged. The top of the device should be open to allow easy access for imaging and loading of the animal as well as anesthesia.

- b. **Safety:** This device should be equipped to securely hold an anesthetized rodent model organism in accordance with any animal research treatment guidelines applicable to studies in which this device is used.
- c. **Accuracy and Reliability:** The device must provide movement in 5 degrees of freedom, while keeping the middle of the pupil at the center. Each of these movements should allow a maximum error of 100 microns.
- d. **Life in Service:** The device must be able to support a specimen of up to 1 pound, keeping it stationary for up to an hour at a time. In addition, the device must remain functional following exposure to direct, imaging light for up to one hour at a time. Furthermore, it must not degrade with cleaning/sterilization after use with each specimen. The body of the device should maintain functionality according to these conditions for 5 years, whereas the easily-replaceable sample holders should have a life in service of at least 1 year.
- e. **Shelf Life:** This device should be storable with humidity between 35% - 70% and temperature between 10°C - 30°C and continue to function properly. If electronic components are implemented, the power-source/battery should be functional after at least one year.
- f. **Operating Environment:** During operation, the design may be exposed to lighting, necessary for the imaging procedures, that could increase temperature to 35°C for the extent of the imaging process. Furthermore, anesthetized rodents will be held within the design, so the material and ergonomics of the rodent specimen holder must be carefully considered.
- g. **Ergonomics:** The device should allow for easy rotation and translation of the specimen on the stage.
- h. **Size:** The device should be no bigger than 25 cm cubed and should be easily portable. The device should implement an open design concept.
- i. **Weight:** The device should not exceed 10kg to allow for easy transport and movement around the lab.
- j. **Materials:** The device should remain within the budget of \$350, so the material cost should not exceed this value. The device should be made of materials that are easy to clean and contain little to no crevices where dirt and other things in a lab can fall into.
- k. **Aesthetics, Appearance, and Finish:** Aesthetic appearance of the device is not a primary concern, as functionality takes precedence. The design must have a smooth finish that lends itself to facile cleaning and sterilization.

2. Production Characteristics

- a. **Quantity:** 1 unit will be required for use with each imaging system. Requirement for interchangeable specimen holders would limit a requirement for multiple stages as the imaged specimen is changed.
- b. **Target Product Cost:** Initial production budget set at \$350.

3. Miscellaneous

- a. **Standards and Specifications:** There are no international or national standards and this project does not require FDA approval because it will be used in a research setting.
- b. **Customer:** The client would like the device to have swappable holders for different sizes of specimens and that the holder should be symmetrical. There should be a cutaway area for a warming blanket for the animals. The design should have an open concept to allow for easy access to the specimen such that eye drops and anesthesia may be administered.
- c. **Patient-related concerns:** As the design is intended as a research tool for the study of rodent model subjects and tissue specimens, patients are unrelated.
- d. **Competition:** The RAS system, created by Bioptigen (now owned by Leica Microsystems), is the primary competitor in this area. This device utilizes concentric cylinders, as well as a pivoting element, to provide rotational degrees of freedom.