

Product Design Specification

Rodent Rotation and Translation Stage Device

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Function:

A stage to more precisely position a subject's eye at the center of rotation for easier capture of photoreceptors via microscope.

Client requirements:

- 5 degrees of freedom: If the x-axis is in the direction orthogonal to the pupil, then rotation about the y and the z is required along with translation on all three axes.
- Minimum stage adjustment with 100 micron precision.
- Modular design that allows interchangeable stages for different viewing subjects.
 - Subjects include a detached human eye (2.4 cm diameter, 7.5g) [1], a thirteen lined ground squirrel (33 cm long and 227g) [2], and a white mouse (12.5 - 20 cm long and (12 - 30g) [3].
- Sterilizable between uses via alcohol wipes

Design requirements:

1. Physical and Operational Characteristics

a. Performance requirements:

- The device should operate with 5 degrees of freedom keeping the center of rotation about the eye.
 - Degrees of freedom: If the x-axis is in the direction orthogonal to the pupil, then rotation about the y and the z is required along with translation on all three axes.
- The device shall be able to support a weight of 3.0 kg.
- The device will be used on average for 1.0 hour per day in a sterile environment by operating technicians.
- The device shall allow for interchangeable stages that accommodate different sized subjects.
- The device shall allow a warming device to keep the viewing subject at body temperature.

b. Safety:

- The device shall be sterile and protect the operating technician from animal contamination.
- The device shall withstand drops of 1.0 meter without breaking into shards.

c. Accuracy and Reliability:

- The device will be manipulated by hand such that a microscope can focus on a photoreceptor as small as one micron.
- The device shall support minimum translational motion of 100 microns.

d. Life in Service:

- The device shall maintain optimal function through 500.0 hours of use.

e. Shelf Life:

- The device shall maintain optimal function through 10.0 years in storage at room temperature.

f. Operating Environment:

- The device shall operate between -10.0 and 50.0 degrees celsius.
- The device shall operate between 20.0% and 90.0% humidity.
- The device shall be non-absorbable for water and bodily fluids.
- The device shall be non-photosensitive.

g. Ergonomics:

- The device shall provide simple rotational and translational movements of the stage.

h. Size:

- The device shall not have crevices or open gaps that inhibit cleaning and maintenance.
- The device shall not exceed the following dimensions: 30.0 cm x 30.0 cm x 50.0 cm.

i. Weight:

- The weight shall not exceed 5.0 kg, to provide easy accessibility and movement throughout the lab space.

j. Materials:

- The device shall contain non absorbing surfaces and must be assembled in a way that limits the number of small creases.
- The materials cost must be within a budget of \$250.

k. Aesthetics, Appearance, and Finish:

- Aesthetics, appearance and finish are not important in this device as it will be used and operated in a research setting.

2. Production Characteristics

a. Quantity:

- 1 unit is needed

b. Target Product Cost:

- The project budget is \$250, which includes costs of manufacturing and testing a prototype. Similar existing products cost over \$4,500 [4].

3. Miscellaneous

a. Standards and Specifications:

- This is a custom device being used in a research setting; there are no international or national standards by which to abide.

b. Customer:

- The customer would prefer this device be modular for the use of interchangeable stages to account for varying imaging subjects.
- The customer wants the device to connect to the stabilization table.

c. Patient-related concerns:

- The device must be sterilizable by alcohol wipes between uses.
- There is no storage of patient data involved in this device.

d. Competition:

- Narishige Mag-2 head holding device with angle adjuster for mice [5].
- US Patent #5337178: Tilttable Optic Microscope Stage [6].
 - This stage gives three degrees of freedom. The patent mentions that translational adjustments may be required after rotational movement.

PDS References:

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3. L. Ballenger, "Mus musculus (house mouse)," Animal Diversity Web, 1999. [Online]. Available: http://animaldiversity.org/accounts/Mus_musculus/. [Accessed: 21-Sep-2018].
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