Portable Laser Guidance System

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Abstract

Purpose: To design and build a system capable of identifying celestial bodies with a laser while mitigating the possibility of shining the beam into someone's eye.

Problem Formulation

The NAU Physics and Astronomy Department often gives talks about the night sky to large groups of people. The presenter uses a laser pointer to point out celestial objects throughout the presentation. The preferred laser is too powerful to be operated directly by hand as if the beam were to make contact with someone's eye, instant blindness would occur.

Need: A System capable of pointing out celestial bodies while removing the possibility of causing blindness.

Objectives:

- Controllable laser pointer mechanism
- Laser pointer mounting elevation above ground greater than 6' 5"
- Pointer resolution at ½°
- Collapsible to fit in cargo compartment of a small car 48"x12"x12"
- Weight - One person mobility 100 lbs
- Rapid response time 24°/second

Constraints:

- Must operate in safe manner i.e. no possibility of laser beam pointing into a person's eyes
- Laser must toggle on and off upon user command
- Laser unit must be removable from device
- Must remain within allowable budget
- Must comply with all local, state, and federal regulations

Proposed Design

The final design is made up from four main components: the tripod, the turret, the battery box, and the laser housing. Both the tripod and turret are purchased items. The turret was modified with two electrical slip rings to pass power across the spinning axes. One of which limits the power to the laser to 20° above the horizon. This is the main safety feature of the design. The housing is made from several components detailed in the diagram below.

Main System Components

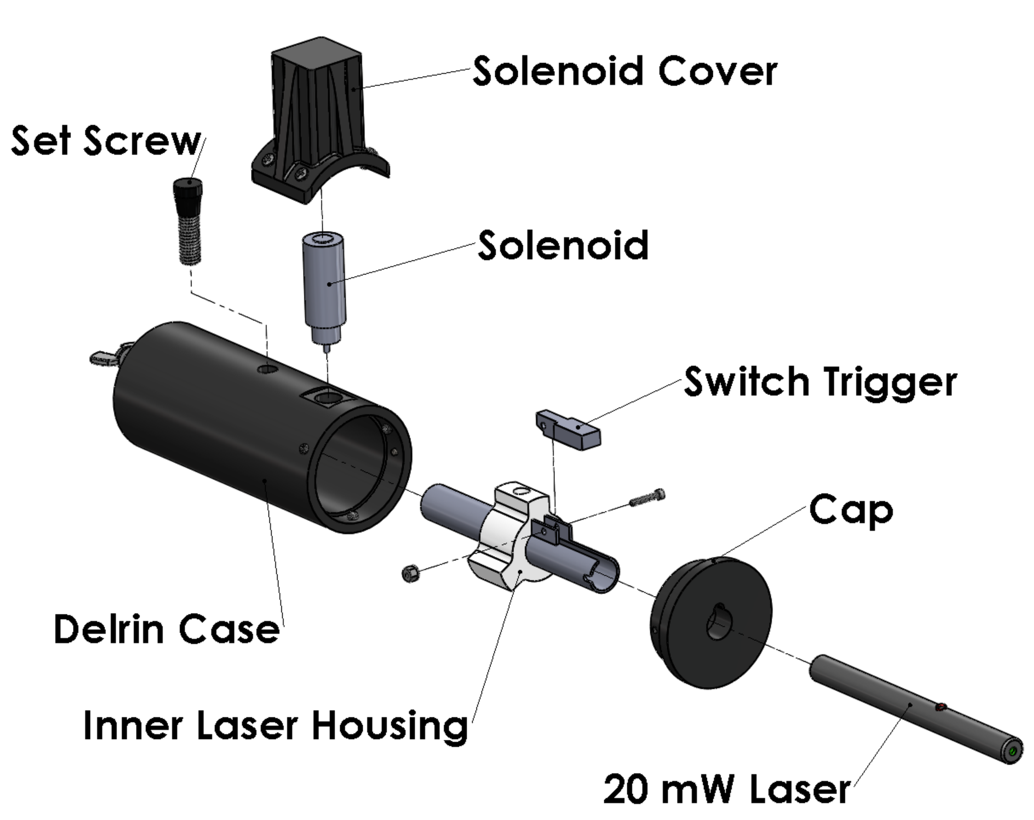

Figure 1: Laser Housing

Figure 3: Turret Assembly

Figure 5: System Assembly

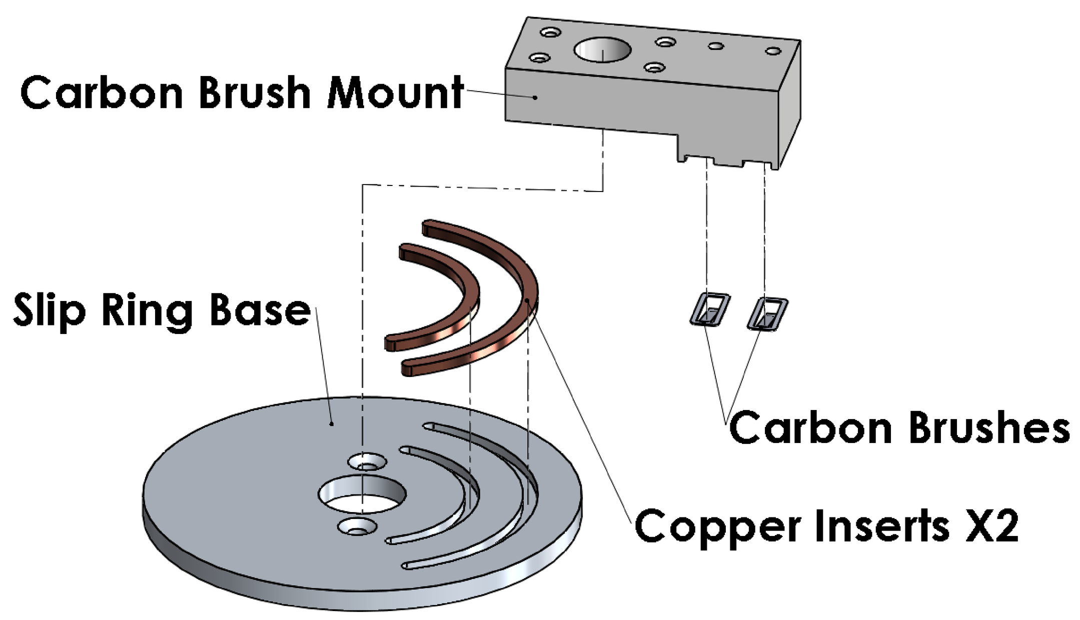

Figure 2: Sliding Contact

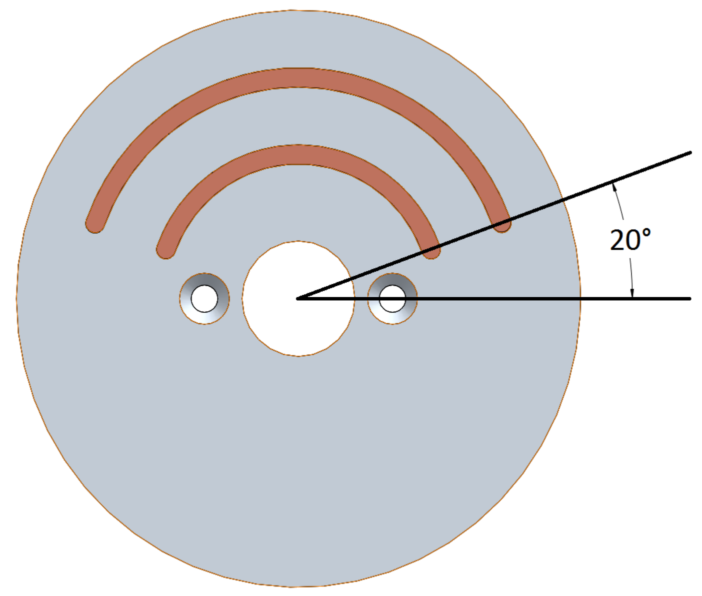

Figure 4: Slip Ring

Prototype Fabrication

Many custom parts were fabricated to build the final design. The most important of which are listed below with a small description of the fabrication process for each.

- **Slip Ring – limits power to laser to 20° above horizon**
  - Copper inserts – cut using CNC milling and hand written code
  - Slip ring base – cut using CNC milling and hand written code
  - Carbon Brush mount – PVC on manual mill
- **Housing – houses laser assembly**
  - Delrin case – hollowed out with manual lathe
  - Solenoid cover – Rapid prototyped
  - Inner laser housing– Manual milling and welding
  - PVC Brace – CNC milling with hand written code
  - Switch Trigger – Manual milling
- **Battery Box – Houses battery**
  - 30 caliber military ammunition can – Dremel cutting and grinding, drilling
  - Aluminum battery restraining clamps – bent in metal brake, manual cutting and grinding
  - Steel tripod pin housing – manual milling and drilling, hand grinding
  - Aluminum tripod pin – manual lathe turning, manual milling and drilling, polishing
  - Digital volt meter - soldering

Testing & Results

Two main requirements needed to be tested. First the battery life of the system must be sufficient to last through the length of a normal presentation with no significant loss of power in typical cool night time weather conditions. Secondly the laser was required to shut off when it dropped below 20° from the horizon.

Testing: Both requirements were tested by constantly running the system around in off axis circles for an hour and a half. Significantly longer than the system will be used for any one presentation. This test was conducted both indoors and outdoors in cool night time conditions.

Results: In both tests the system functioned normally with out any notable loss of power.

Cost Analysis

The development of this system was funded by the NAU Physics and Astronomy Department. The original budget was set at $3000. Below is a generalized cost breakdown.

Component Category	Cost [$]
Camera Turret	861.00
Davis & Sanford 78" Tripod	163.00
Construction Materials	43.46
Electrical Supplies	494.04
Hardware	128.96
Casing	75.06
Grand Total	1765.52

Conclusions

After the completion of the design build the client tested it and was satisfied with the operation of the system and was excited to use it in his upcoming presentations.

References

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Engineering Design