Hel10s Solar Solutions

EML 4501 - Fall 2021
Group 10: Joshua Brett, Daniel Drew, Jacob Jenkins, Wasif Kamal, Robert Principato, Justin Rietberg, Malone Stanley

Abstract

The design of the Hel10s Solar Solutions heliostat was based on a Hedgehog Concept prioritizing low cost and ease of manufacturing/assembly. The construction of each subsystem was optimized with this goal in mind to produce a heliostat that satisfied the customer needs. The mirror subsystem was designed using four thin, lightweight mirrors secured to the frame in slots that slide on and off to minimize assembly and replacement time. Each mirror has a dedicated stepper motor to control azimuth angle. The entire frame is oriented using two linear actuators about a custom universal joint, allowing the adjustment of elevation and azimuth of all four mirrors simultaneously. This not only reduces the total number of motors needed, but also eliminates shading between mirrors. The frame is mostly comprised of PVC, making it modular, lightweight, and cost-effective. The structure is anchored by burying the PVC legs, giving it extra support against wind forces without a significant impact on cost or manufacturing time. The heliostat module is also able to fold parallel to the ground when wind speeds exceed the safe operating threshold, preventing damage. The central computer uses an open-source solar positioning algorithm to track the Sun and sends signals to a microcontroller on each module to adjust the motors accordingly. This eliminates the need for delicate and expensive sensors on each module and reduces tracking errors due to ambient weather conditions.

Category	Price
OTS Parts	$274.37
Modified OTS Parts	$2.46
Raw Materials	$213.00
Manufacturing Labor	$218.50
Assembly Labor	$12.36
Energy Consumption	$0.16
Total	$720.85

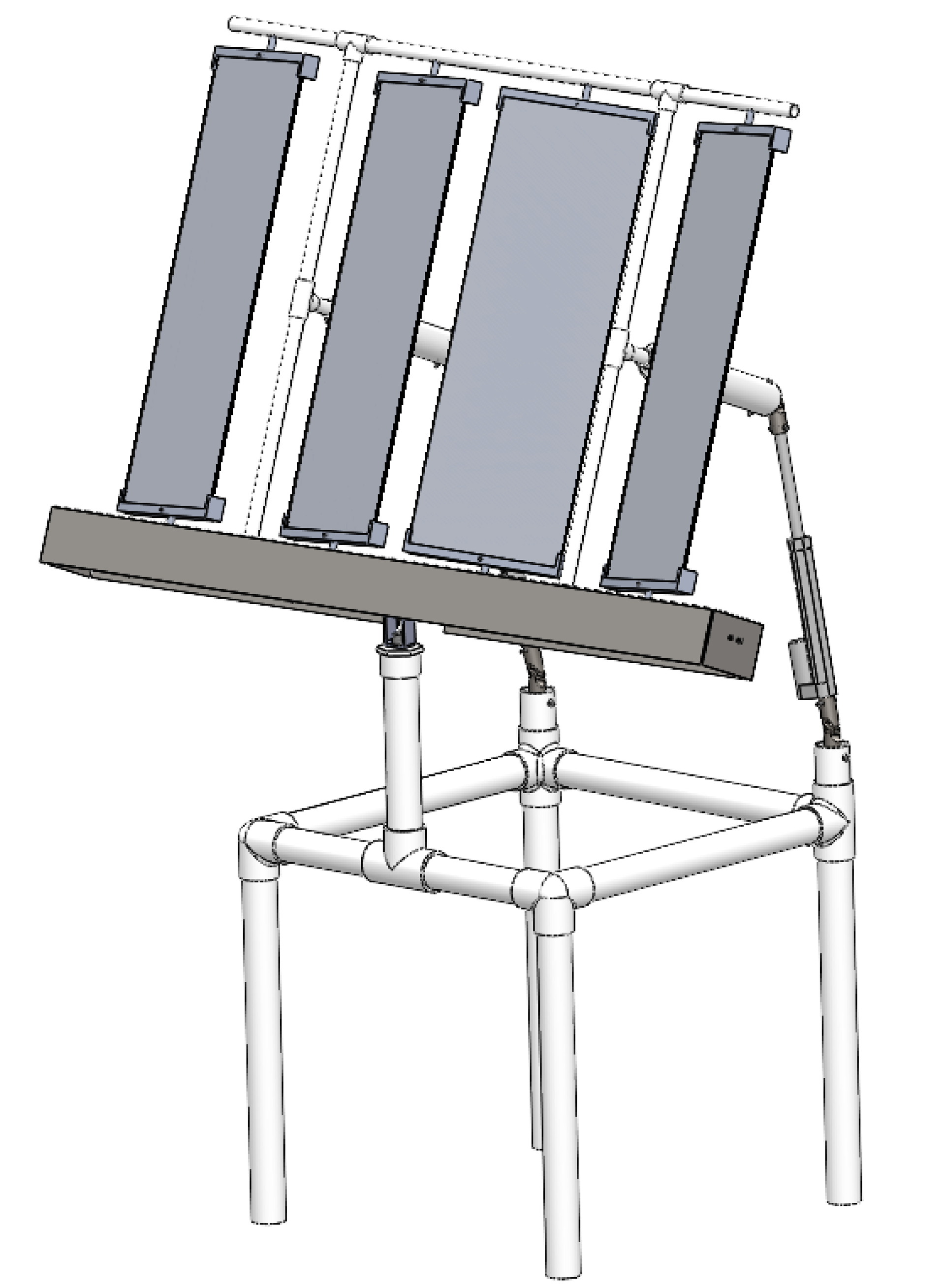
Fig. 1 Full Assembly

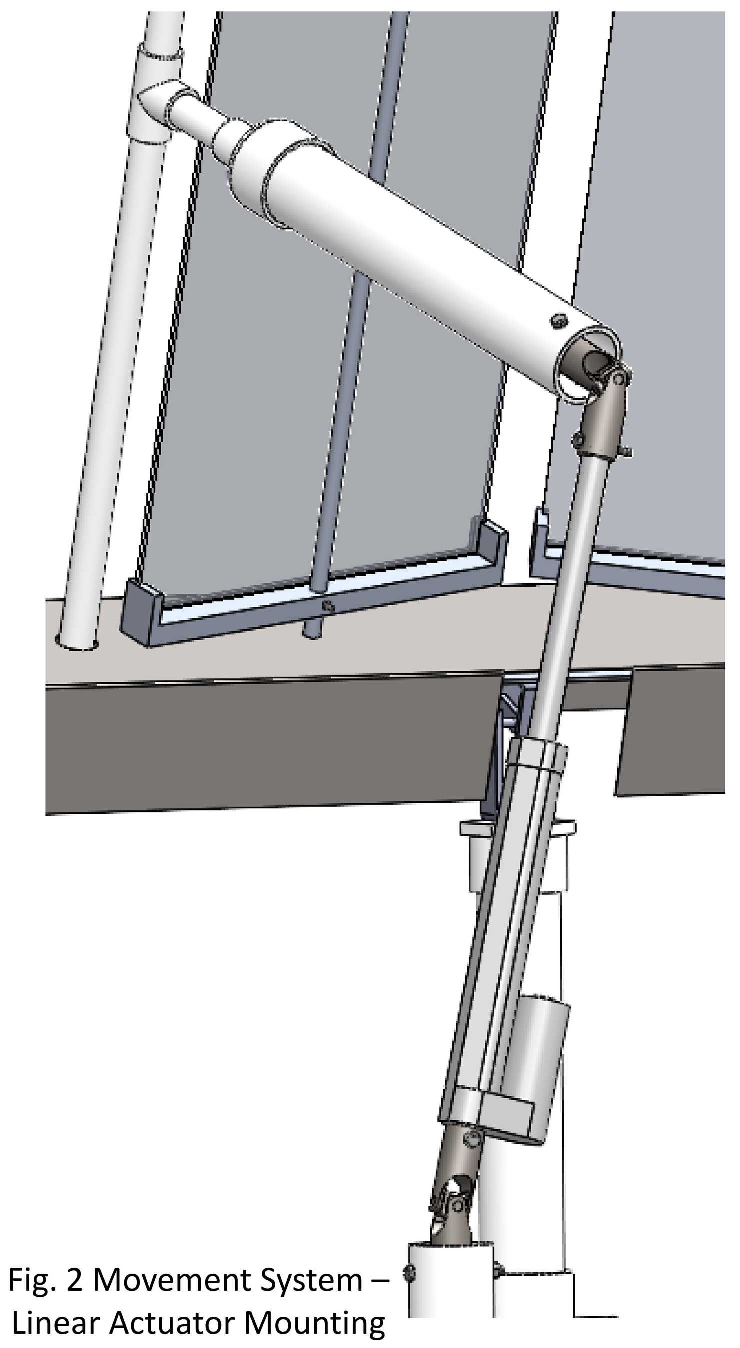
Fig. 2 Movement System – Linear Actuator Mounting

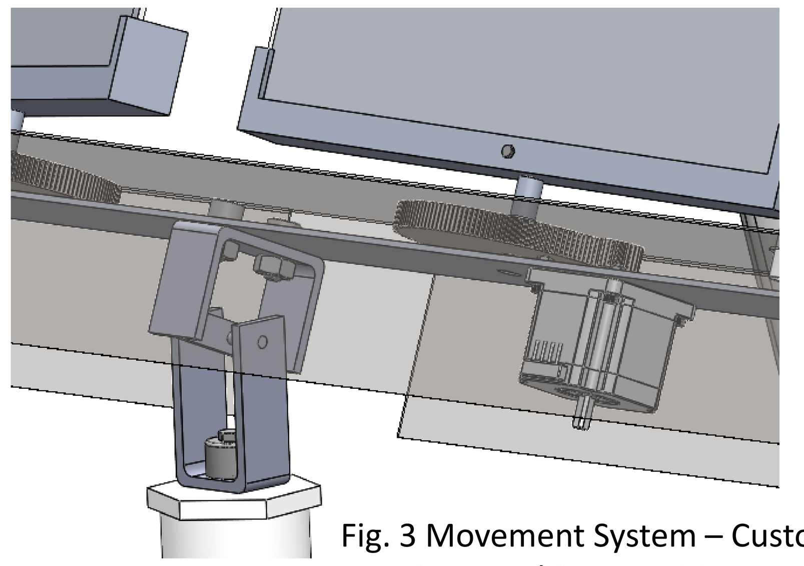
Fig. 3 Movement System – Custom Joint and Stepper Motor

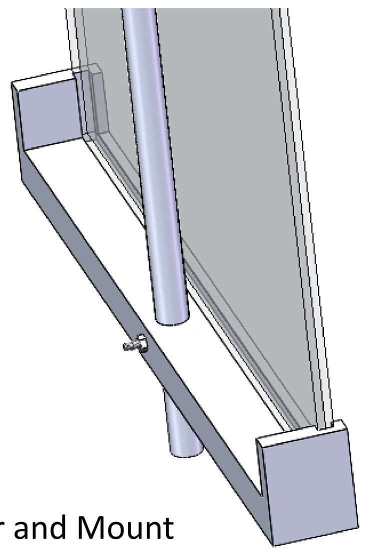
Fig. 4 Mirror and Mount

Product Functionality

The Hel10s Solar Solutions heliostat module is designed for deployment near Las Vegas, Nevada in a concentrated solar power plant, where approximately 2,000 of these modules would be installed. Their combined power output of 1 MW will be used to drive a methane reforming reactor operating at 1,000 °C by focusing solar energy onto a 100 m high central receiver. Each module has 1 m^2 of reflective area from four mirrors. These modules incorporate a robust design that can survive the ambient conditions for over 20 years before requiring replacement parts.

Subsystems

- **Mirror and Mount**
  The mirror is used to reflect solar energy to the central receiver, and its mount secures it to the movement system. The mirror is an OTS part with aluminum reflective surface that slides into an aluminum slot on the bottom, with a second slot installed overhead. Both slots are secured to a round bar actuated by the movement system.
- **Movement**
  Each mirror has a dedicated stepper motor to rotate it in the azimuth direction. The entire mirror frame is tilted in azimuth and elevation about a custom universal joint by two linear actuators.
- **Control**
  The heliostat tracks the sun and orients itself accordingly using a solar positioning algorithm installed in a computer in the central tower, eliminating the need for each heliostat to have its own tracking hardware. A Raspberry Pi Zero W microcontroller installed on each module receives signals from the central computer and commands each motor to keep sunlight focused on the central receiver.
- **Frame Structure**
  The frame is mostly made of PVC, reducing cost, weight, and manufacturing/assembly time. The structure legs are buried to prevent the module from sliding or tipping.

Hel10s Solar Solutions

EML 4501 - Fall 2021
Group 10: Joshua Brett, Daniel Drew, Jacob Jenkins, Wasif Kamal, Robert Principato, Justin Rietberg, Malone Stanley