Dual-Wing Heliostat

EML 4501 Fall 2021: Group 8
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Abstract

The dual-wing heliostat team believes in the beauty of simplicity. With fewer parts that can be easily assembled and readily sourced, this team aims to make solar thermal power generation more accessible. This design was built upon the vision of a full, sparkling solar field. Each module is controlled with its own microprocessor board which takes in local data from each heliostat and reports this information back to the central tower, allowing the central tower controller to optimize the entire solar field for maximum efficiency.

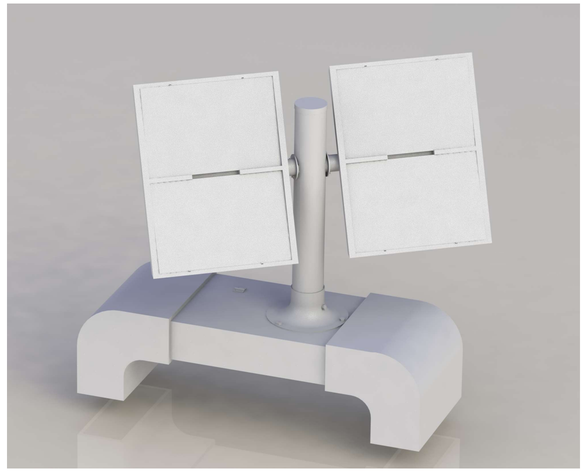
The module's reflectors are mounted in a "window-pane" arrangement, with their corners tilted in towards a central vertex, giving useful light focusing ability to flat mirrors. The mounts which support these reflectors can be injection-molded as one piece, lending them to large-scale manufacturing. These mounts are slid onto either end of a cross-bar, and bolted on. The structural core of the dual-wing heliostat module consists of two PVC pipes, one acting as a central pillar and axis for azimuthal rotation, and the other as a cross-bar which rotates the reflectors altitudinally to reflect sunlight. The motor which controls altitudinal motion sits within the central pillar to protect it from the harsh desert. The base is made of square PVC tubing to offer a cost-effective but stable support for the design. The dual-wing heliostat may be small in scale, but the realm of possibility is as large as a desert solar energy field.

Functionality

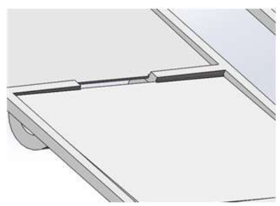
A heliostat is a device which directs sunlight toward a specific point, regardless of the sun's position overhead, which is typically done by moving a reflective surface. Using many heliostats, a receiver they are collectively aimed at can reach temperatures exceeding 1000 °C, allowing this thermal energy to be harvested.

Control of the heliostats is provided externally and sent wirelessly to a receiver housed in the base of the heliostat: additionally, a controller within the heliostat confirms the heliostat position and provides feedback to the central tower for error-tracking, allowing for further optimization of heliostat aiming no matter where a given heliostat is installed. The four silver-backed mirrors of the reflector are angled to be slightly concave, reducing dispersion of light for heliostats that are within 50m of the receiver tower.

Full Assembly



Angled Reflectors



Early concepts for the reflector had concavity to reduce dispersion of light. This is done with flat mirrors by mounting them at an inwards angle, enhancing focusing at distances up to 50 m.

Reflector Mount Snap-fits

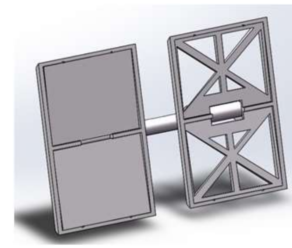
The mirrors are held against the angled reflector mount surface using snaps-fits, which are molded as part of the mount. Snap-fits reduce assembly time and ensure that mirrors can be removed easily.

Cost Overview

Category	Cost
OTS Parts	$ 29.89
Modified OTS Parts	$ 19.48
Raw Materials	$ 53.07
Manufacturing Labor	$ 4.32
Assembly Labor	$ 8.46
Energy Consumption	$ 0.45
Total:	$ 115.62

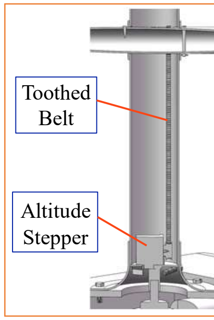
Sub-Assemblies

Reflector



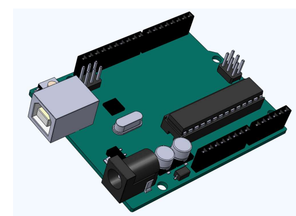
The reflector is composed of four silver-backed mirrors mounted with a slight inwards tilt. The frame holding them is injection-molded PEI plastic, which has rings that are bolted to the actuation cross-arms.

Actuation



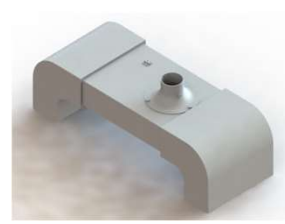
The actuation subsystem consists of two PVC pipes mounted vertically and horizontally, the latter being the cross-arms to hold the reflectors. The vertical pipe rotates via a geared motor at its base, whereas the horizontal pipe rotates using a pulley and motor mounted inside the vertical pipe.

Controls

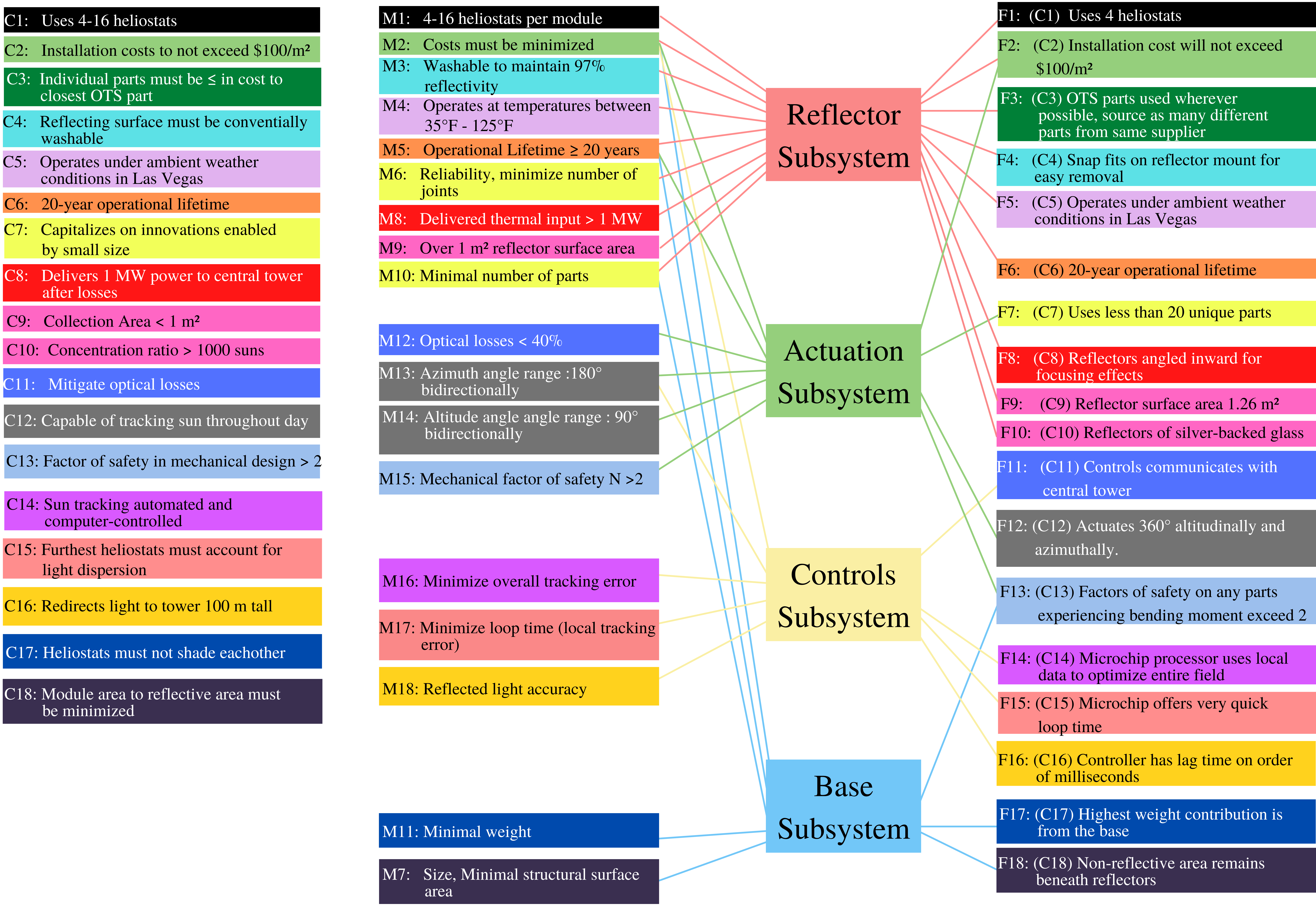


The controls system has a microprocessor which is used to translate positioning signals received from the central tower into inputs to the actuation motors through a motor control relay. It also sends position data back to the central tower to allow positioning error to be assessed.

Base



The base of the heliostat is molded PVC. It houses the controller and azimuthal-rotation motor. It features two feet which are buried during installation (pipes not pictured for size), ensuring the heliostat will not be blown out of place or tip over due to wind forces on the reflector.



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