Educational Solar Tracking System

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Abstract

Photovoltaic solar panels are used as alternative energy source that is separate from the electrical grid. Using a solar tracking system allows for solar panels to maximize the amount of energy captured. The goal of this project is to provide mechanical engineering students a solar tracking systems and hands on learning experience for renewable energy courses. The primary objective is to build a tracking system that is manual in North-South direction and automatic motor assisted tracking in East-West direction, but can be shifter to manual when desired. The final prototype of our design has a solar tracking array with two solar panels, perched on a square frame. The design is angled by flat steel rods that can be adjusted North-South. The East-West tracking is accomplished by the panels being on a metal shaft and using a step motor and hand crank connected to a worm gear to move the panels.

Problem Formulation

Goals

- To design and construct a system capable of tracking the sun.
- Design a system with manual and automated tracking systems.

Need

Current solar tracking systems are intimidating to students.

Constraints

- Budget
- Operating space
- Flagstaff weather
- Building abilities and processes available to the team.

Objectives

Objective	Measurement Basis	Units
Inexpensive	Unit cost of production	Dollars
Efficiency	Solar energy over electrical energy	Joules/Joules
Low Maintenance	Time until first replacement parts	Days
Manufacturability	Number of moving parts	Parts
Build Quality	Stress times strain	N/m^2
Relatively light weight	The weights of the solar panels	N

Numerical Results

- The range for the effective solar panel angle in East-West direction is from 30 degree to 150 degree.
- The range for the solar panel angle in North-South direction is from 23 degree to 60 degree.
- The distance between two panels is 8 feet.

Engineering Design

Proposed Design

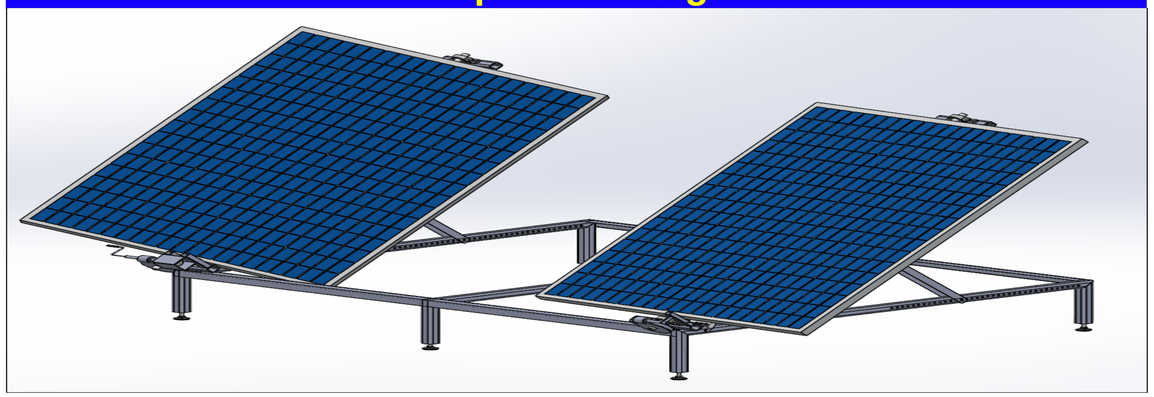

Figure 1: Isometric view of the proposed design

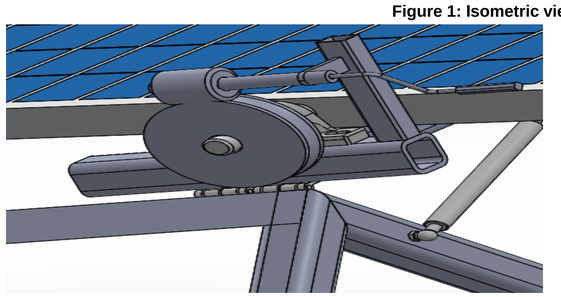

Figure 2: Hand crank in detail

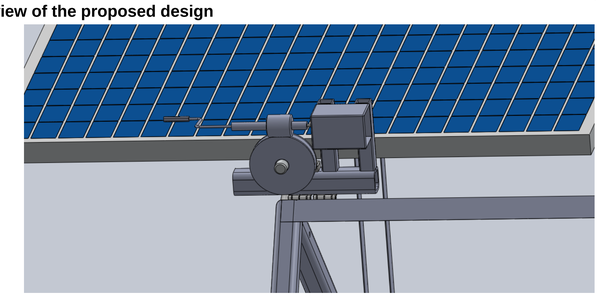

Figure 3: Automatic system in detail

The proposed design holds two solar panels one that has a motorized tracking system while the other is controlled manually. Two solar panels can be adjusted separately to better understand the concepts of solar tracking systems. Both panels can be adjusted manually in the North-South axis of tracking with a sliding mechanism.

Prototype Fabrication

The fabrication of our design all took place in the machine shop located here on campus.

The Base Frame

- Consists of 1”x1” square steel tubing with 18 holes on each side.
- These square tubing sections were welded together with 1.25”x1.25”angled steel bar.

The Angle supports

- Consists of two 1”x1”x74” square steel tubing to hold the bearings for the solar panel frame.
- Two 1”x1”x48” steel plates were cut with a small pin hole on the bottom for the sliding mechanism.
- These two parts form the triangle of the upper solar panel frame which the solar panel sits on.

Motor Housing/Manual Crank

- L bracket on left side to hold motor
- L bracket on right side with bearing to hold manual crank

Figure 5: Side view of prototype

Testing and Results

- 18 holes for North-South tracking.
- Change the hole position every 10-15 days.
- Motor rotates clockwise for a full rotation every 15 minutes.
- Solar panel rotates 2.5 degrees.
- Solar panel rotates from 30 degrees to 150 degrees.

Cost Analysis

Part	Cost	Justification
1.25” x 1.25” Angle Bar	$98.09	Framework
1” x 1” Square Tubing	$180.00	Framework
1” Solid steel rod	$13.71	Solar panels
Hardware	$20.00	Connection of top and bottom frames
Worm and Spur Gears	$311.92	Rotation
Motor and Control Panel	$597.00	Tracking system
Bearings	$311.92	Rotation

Total Cost: $1,532.64

Conclusion

- We calculated the optimized slope angle to maximize incident beam radiation which was 36 degrees.
- We constructed a solar panel array capable of tracking the sun both manually and automatically.
- By selecting a worm and gear system the solar panel on the left side effectively tracks the sun.
- The solar panel array cost approximately $1500.

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