Dual Axis Solar Tracker

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**Appendix C**

**Summary**:

The concept behind this dual axis solar tracker includes an analog circuit which uses NPN/PNP Bipolar Junction Transistors, Operational Amplifiers, Photodiodes, and MOSFETs which direct motors to adjust the solar panel to point towards the sun. When there is a sufficient current difference in the photodiodes produced by differing sunlight intensities incident upon the photodiodes, the sensor circuit produces a high at the ENABLE output along with a digital high or low determining the direction of movement at the LEFT/RIGHT output. The signal is then sent through the logic circuit which determines which MOSFETs to turn on, and applies the correct voltage levels to the associated MOSFET drivers. This driver circuit then provides the drive to turn on or off the MOSFETs in the h-bridge. The h‑bridge will only activate the motor when opposite corner MOSFETs are turned on. The motor will then adjust the panel to point towards the location of the sun until there is no longer a significant difference between the currents produced by the photodiodes. In this way, two photodiodes control the motor which rotates the panel around the base’s vertical axis while the other two photodiodes drive the motor which tilts the panel up and down.

**Primary Constraints**:

When looking at the limitations for the schematic, the main constraint was limiting the total power of the system while the motors were not in use. Another constraint includes the logic allowing for the motors to be on and turn in one or both directions, or to “freeze” the motors so there are no unexpected changes in the position of the panel due to gravity or mechanical pushes of any kind. The structure was also designed so that there would be no catastrophic failures in terms of the physical movements that the structure can make. In other words, the base is free to turn and turn as necessary. There is no point at which the motors cannot turn the motors anymore. This was done to both simplify the design process as well as ensure that the lifetime of the device is as long as can be made. This feature, as well as all of the others in the design can be scaled up or down to any degree without losing functionality, making the design extraordinarily adaptable.

**Economic Constraints**:

**Initial costs:**

|  |  |  |
| --- | --- | --- |
| Component | Quantity | Price |
| SFH2505 | 4 | $2.76 |
| 2N3904 | 4 | $0.12 |
| 2N3906 | 4 | $0.14 |
| LM741 | 2 | $1.76 |
| LM311 | 10 | $1.40 |
| FDS4410 | 8 | $2.63 |
| 7400 | 2 | $3.00 |
| 3 foot long, 1 inch square tubing | 2 | $40.26 |
| 2 feet × 2 feet aluminum sheet | 1 | $14.36 |
|  |  |  |
|  |  | **Total Cost = $66.43** |

**Final costs:**

|  |  |  |
| --- | --- | --- |
| Component | Quantity | Price |
| SFH2505 | 4 | $2.76 |
| 2N3904 | 4 | $0.12 |
| 2N3906 | 4 | $0.14 |
| LM741 | 2 | $1.76 |
| LM311 | 10 | $1.40 |
| FDS4410 | 8 | $2.63 |
| 7400 | 2 | $3.00 |
| 3 foot long, 1 inch square tubing | 2 | $40.26 |
| 2 feet × 2 feet aluminum sheet | 1 | $14.36 |
| Additional Hardware | X | $4.46 |
| Spray Paint | 1 | $10.70 |
|  |  |  |
|  |  | **Total Cost = $66.43** |

|  |  |  |
| --- | --- | --- |
|  | **Estimated Time** | **Actual Time** |
| **Circuit** | 4 Weeks | 10 Weeks |
| **Structure** | 2 Weeks | 4 Weeks |

**Manufacturing on a Commercial Basis**:

If this product were to be made on a larger scale, many different aspects of the process would be changed. It wouldn’t be unreasonable to assume that most of the individual components necessary to build the product would be attained at a lower cost than shown above. The cost would in fact be far cheaper, probably close to half as much. This would drive down the cost of production of the devices to around $30, and even less if only the tracking system was to be manufactured, assuming that the customer already owned the base and panel. These devices could then be sold at an extremely low price when compared to similar products, which cost hundreds of dollars. A realistic consumer price would be around $100. This low price would help to increase demand for the product every year, meaning larger portions of the market every year. To start off, the company producing these trackers would most likely sell less than 1,000 a year, with the numbers going up from there.

The profits from a company producing about 1,000 trackers a year and selling about 1,000 trackers a year would be somewhere around $70,000. This would only be near the beginning of the company, and the numbers would most likely increase dramatically after the first few years.

The consumers who purchase the devices wouldn’t really notice any cost difference because it doesn’t really cost the user anything to run the device. Since the solar panel is harvesting energy from the sun, it can provide all the energy needed to run the electronics without losing a significant amount of the energy that the solar panel itself would provide.

**Environmental**:

There are no foreseen environmental impacts associated with the manufacturing of this product that would add to the environmental issues already in place. The only real potential impact of this project would be the possible clearing of land to allow for multiple large-scale trackers to be placed in one area. This, however, is not yet a realistic threat due to the fact that currently, this design is intended for small, residential systems, not large-scale incorporation.

**Manufacturability**:

No issues come to mind when looking at the manufacturing of the circuit board, aside from having a buck and boost converter added onto the PCB to allow for the necessary voltage levels to run all of the components.

As far as the structural components, any larger scale designs would have to be modified to allow for an even distribution of the weight of the solar panel on the stand. This may require two pivot points spaced an even distance away from the stand which would require an additional brace to go from these pivot point to the stand. Also, the larger scale designs would require motors with more torque to account for the additional weight.

**Sustainability**:

The only maintenance required for this design would be occasional checking of the waterproof seals enclosing the circuitry so as to keep the harsh outside environment out of the equation. On the whole, this design is extremely environmentally friendly, and would have almost no negative impact upon the natural world.

In order to upgrade the design, one might house the motors inside the shaft of the base in order to keep the motors from unnecessary wear. Another upgrade would be finding a more efficient mechanism to replace the ball and socket joints.

**Ethics**:

This project does not present any ethical implications regarding the manufacturing or use of the product.

**Health and Safety**:

There are no known issues regarding health and/or safety with this project.

**Social/Political**:

This project does not currently present any social or political issues.

**Development**:

AutoCAD (computer aided design) was used for the layout of the structure, and the use of this program drastically helped in the design process.