Tecnológico de Monterrey

E1: Problem definition (individual)

Helio Dual-Axis Solar Tracker

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Background

Solar energy is essential as the world moves toward clean, renewable energy. Solar panels are one of the most efficient renewable ways to convert sunlight into electricity, but fixed panels are limited to the light they can receive because they cannot follow the sun's movement during the day. As a result, they tend to fail to capture the maximum sunlight possible, which decreases their possible maximum efficiency. Solar trackers could solve this problem by adjusting the panels angle to keep them directed toward the sun UV rays, significantly boosting energy production by up to 40% compared to fixed systems (Jaafar et al., 2024)

State-of-the-Art

In recent years, solar tracking technology has advanced, particularly in dual-axis trackers, which offer movement in two directions. Key developments include:

Technology Feature	Description	Reference
Advanced Control Systems	Algorithms precisely calculate the sun's position to optimize energy capture.	(AL-Rousan et al., 2018)
IoT Integration	Real-time monitoring and remote control enhance maintenance and functionality.	(Ansari et al., 2021)
Efficient Motors	Low-power motors improve movement precision and reduce energy consumption.	(Shang & Shen, 2023)
Lightweight Materials	Durable and lightweight materials extend the lifespan of trackers, especially outdoors.	(Kumar et al., 2023)
AI Integration	AI-driven weather predictions help improve efficiency by adjusting settings based on environmental data.	(None Nzubechukwu Chukwudum Ohalete et al., 2023)

Even with these advancements, dual-axis trackers are still not widely used due to high costs and mechanical complexity (Shang & Shen, 2023).

Specific Problem to Solve and Its Relevance

Dual-axis solar trackers are often underutilized due to high costs and complexity, limiting solar efficiency. An affordable design, like the 3D printed tracker we are proposing to develop, will make it an affordable, solving these limitations, creating a more accessible solution that benefits both commercial and residential users, like the tracker developed in this study (Shang & Shen, 2023), could significantly enhance renewable energy production. This model's payback period is approximately 1.4 years, making it a solution for reducing emissions and supporting climate goals while keeping everything affordable and logical to invest in, especially in small- and medium-scale applications (Shang & Shen, 2023).

Added-Value Proposal

- **Higher Efficiency**: Increases energy production by up to 40% compared to fixed systems (Jaafar et al., 2024).
- **Cost Reduction**: The design with materials that are not expensive will lower costs of production and maintenance if required. (Shang & Shen, 2023).

- **Design:** 3D printed with open-source, patent-free models, that will allow global accessibility and high scale reproducibility. The design is going to have the possibility to be scaled to fit any solar panel dimensions by simply adjusting the model's scale, making it adaptable for various applications.
- **Market Reach**: The global solar tracker market is projected to grow from $10.32 billion in 2024 to $22.87 billion by 2029 at a CAGR of 17.3%, driven by rising demand for renewable energy and efficient solar technology. (Solar Tracker Market by Axis & Application - 2030 | MarketsandMarkets, 2024).

*CAGR = compound annual growth rate

Product Market

- Commercial Large Scale Solar Farms (long term startup project)
- Homeowners with solar panels looking to increase their energy savings while making just a little investment to maximize the already implemented infrastructure.
- Developing Regions: Areas with high sunlight exposure but limited electricity production sources.

Contextual Elements.

- **Social**: Community growth by improving access to clean energy, promoting energy independence, and helping reduce energy shortage supply.
- **Political**: Aligns with governmental goals to increase renewable energy use and reduce dependency on fossil fuels and further environment carbonization. (Capital Clash X McKinsey - Google Drive, 2024)
- **Economic**: Offers medium-term savings by increasing solar energy output and reducing the investment payback period (Shang & Shen, 2023).
- **Cultural**: Environmental responsibility with any community.
- **Environmental**: Increases solar power production, reducing GHG and supporting international climate goals (Capital Clash X McKinsey - Google Drive, 2024).

The project we are proposing promotes human dignity by making clean energy affordable, accessible and better, it will improve quality of life and address electricity access to remote regions. Access to clean energy is part of the right to a healthy environment, and future. While we're also supporting the following SDGs:

- **Goal 7: Affordable and Clean Energy** – Expanding access to efficient solar technology.
- **Goal 13: Climate Action** – Helping reduce emissions.

Reflection

We are all aiming to enhance solar energy efficiency while maintaining the cost low, achievable by developing an affordable dual-axis solar tracker (investigated and checked that it is way better than a single axis tracker). We both recognize the potential to increase energy production by up to 40% at certain daytime and the importance of making this technology accessible to everyone and making it high scale and reproducible.

However, their proposal focuses on using just 2 stepper motors and gears, while keeping everything small, they also want to use 3D printing to reduce costs, which I had considered as well. They provided a different market analysis but still on an upward trend, indicating that the solar tracker market is in a growing sector, so it maintains the potential that I mentioned. They also didn't mention any payback period of the investment for their design, I think that's a key aspect that needs to be mentioned, due to its economic viability for small and medium-scale users.

Their inclusion of specific references and recent studies and china universities adds credibility to their proposal. Comparing our projects, I realize that incorporating innovative manufacturing methods like 3D printing and making everything high scale reproducible could make my design better.

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