KFUPM Design Expo

Solar Panel Efficiency Enhancement Through Smart Cooling and Cleaning System

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Introduction

- **Background**

In the global pursuit of a more sustainable future, renewable energy, particularly solar power, takes center stage. However, challenges such as heat and dust adversely affect the efficiency of solar energy, impeding its widespread adoption. Overcoming these obstacles is pivotal to advancing the transition to sustainable energy practices and inspiring broader participation. Our senior design project is dedicated to the development of innovative solutions aimed at mitigating the impact of heat and dust on solar power generation.

- **Objective of Project**

To create a device that mitigates the obstacles that investors worry about before adopting solar panels. That is efficient and require minimum maintenance and upkeep. Increasing the efficiency in power generation and return on investment.

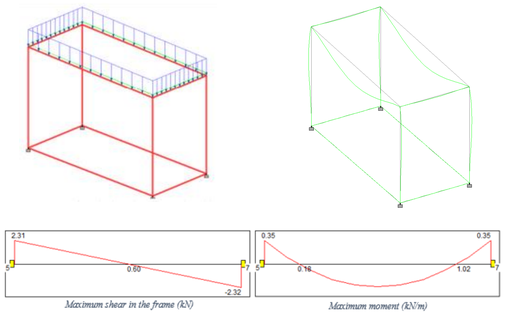
- **Goals**
  - Environmentally sustainable
  - Automated system
  - Solar panel efficiency and lifespan preservation

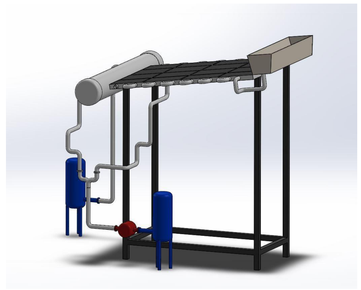
- **Constraints**
  - Area of the solar panel 1.2x0.54 m^2
  - Materials able to withstand loads and weather conditions
  - Heat transfer capability
  - Control screen integration

- **Specifications**
  - Maintain the Solar panel temperature between 25° and 40° C.
  - Real-time data analysis, data transmission should be of at least 5 seconds or less.
  - Safety Factor is 1.4 dead and 1.6 for live.
  - Power Consumption (Pump) should be less than 10 W
  - Power output 100 W or more based on the size of solar panels.

Methods and Techniques

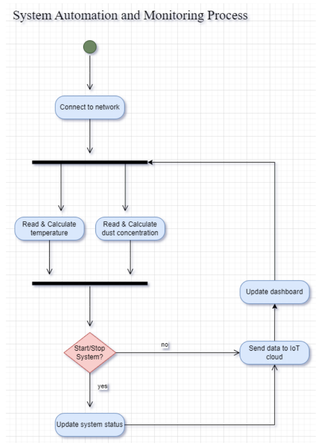
- **Physical Design**





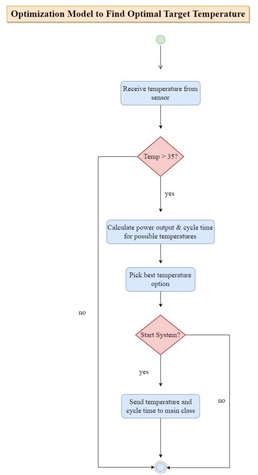
The design was made considering the mass of solar the panel, aluminum block, and copper pipes as a dead load with safety factor of 1.4. and the water as live load with factor 1.6. The solid works was used to design and combines the important components such as the frame, PV panel, cooling block, tanks, and pump to create a clear guideline for the fabrication.

- **System Design**



An activity diagram showing the flow of the main class of the program. The process works by connecting to an IoT cloud through Wi-Fi which is used to update the dashboard from the input received by the sensors. The input also determines the next system state after going through the objective function.

The objective function evaluates the current temperature by comparing it to a range of potential lower temperatures. This evaluation aims to strike a balance between optimizing power generation through enhanced efficiency and minimizing cycle time to lower the temperature. Essentially, It seeks to determine the precise and most effective temperature at which the system should operate for optimal performance.



Result and Validation

Metric #	Metric	Unit	Target	Meet / Does not meet
1	Solar panel temperature	° C	25° C < T < 40° C	Met
2	Safety Factor	%	1.4 for dead, 1.6 for live	Met
3	Power Consumption (Pump)	W	< 10 W	Met
4	Data Transmission	Sec	< 5 Sec	Met

Upon testing and evaluating the prototype against the set metrics, it showed to confirm its satisfaction of all criteria. The results affirm its capability to meet the intended objectives, reflecting the effectiveness of the design and development process.

Conclusion

By developing more tools to motivate individuals and companies to invest in renewable energies, the transition to these sources will be smoother and faster, resulting in a cleaner, healthier environment.

Acknowledgment

We express our sincere gratitude to all who supported us on this journey – to Qamar and Al-Khuwaitem who helped us fabricate the prototype, and to Dr. Al-Maraj who pushed us to be our best. We are also grateful to our families for their unwavering support.