

OPTIMIZATION OF SOLAR PANELS USING DUAL-AXIS SOLAR TRACKER FOR AQUAPONIC SYSTEM POWER SUPPLY

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ABSTRACT

Solar energy is an abundant and environmentally friendly renewable resource; however, its utilization efficiency is highly dependent on the angle and position of the panels relative to sunlight. This study aims to design and evaluate a dual-axis solar tracker system based on Arduino Uno to optimize solar energy absorption for a 50 Wp solar panel used as the power supply for an aquaponic system. The system employs two linear actuators to automatically adjust the panel's orientation in alignment with the sun's trajectory. Test results show that the system successfully tracks solar movement with a 100% success rate and increases power efficiency by 42.98% and current output by 45.21% compared to a static panel setup. The average daily power output from the solar tracker system reaches 25.98 W, significantly higher than the 18.17 W produced by the static system. A 12V 25Ah battery can power the aquaponic system for up to 32 hours, and its full charge time is reduced to approximately 11 hours with the solar tracker, compared to 17 hours using a static panel. These findings demonstrate that the dual-axis solar tracker significantly enhances energy conversion efficiency and supports the sustainability of aquaponic systems without reliance on conventional electricity sources.

Keywords: solar energy, dual-axis solar tracker, 50 Wp solar panel, aquaponics, energy efficiency.