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Implementation and Automated Data Acquisition of a Dual-Axis Offset Parabolic Solar Concentrator

This study presents the implementation and experimental data evaluation of a solar radiation concentrator using a recycled offset parabolic antenna coupled to a dual-axis tracking mechanism. Data acquisition is fully automated through an integrated sensor network and datalogger system. System control is performed by an ESP32 microcontroller, a NEO-6M GPS module, and pulse-driven (PWM) digital servomotors executing the Solar Position Algorithm (SPA). Experimental data logging is carried out every 5 minutes using 8 Type-K thermocouples (interfaced via MAX6675 digital amplifiers) distributed across a 10×15 cm stainless steel receiver plate, 2 current sensors for electrical power monitoring, and a meteorological station measuring wind speed and atmospheric pressure. The concentrator features a geometric concentration factor of $C = 28.68$ and an optical efficiency of $\eta_o = 68.4\%$.

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