

# RANCANG BANGUN *SOLAR TRACKER SINGLE AXIS AUTO MANUAL MODE* BERBASIS IoT

## ABSTRAK

Pemanfaatan energi surya kerap kurang optimal pada instalasi panel statis, sedangkan sistem pelacak matahari (*solar tracker*) otomatis konvensional berbasis sensor cahaya (LDR) rentan mengalami pergerakan acak (*hunting effect*) yang memboroskan daya saat cuaca berawan. Penelitian ini bertujuan untuk merancang bangun *Solar Tracker Single Axis Auto Manual Mode* berbasis *Internet of Things* (IoT) guna meningkatkan stabilitas mekanik dan efisiensi pemantauan energi. Sistem ini diotaki oleh mikrokontroler ESP32 yang terintegrasi dengan motor servo presisi tinggi DS3230 sebagai aktuator, sensor INA219 untuk akuisisi data kelistrikan, serta panel surya berkapasitas 10 WP dengan beban lampu DC 12V. Pengendalian sudut kemiringan dan pemantauan data tegangan serta arus secara *real-time* dilakukan melalui antarmuka aplikasi Blynk. Pengujian sistem dilakukan di area terbuka selama 10 jam operasional (07.00 – 17.00 WIB) dengan skenario pergerakan penambahan sudut 9° per jam, dari posisi 45° (Timur) hingga 135° (Barat). Hasil pengujian deviasi sudut aktuator yang divalidasi menggunakan *water pass* digital hanya sebesar 0,27°. Sistem ini berhasil mencatatkan daya keluaran puncak (*peak power*) sebesar 4.217,97 mW (4,21 Watt) pada sudut 99° pukul 13.00 WIB. Penggunaan mode *Auto-Manual* terbukti secara efektif mengunci posisi panel sesuai lintasan waktu matahari meski terjadi fluktuasi intensitas cahaya secara tiba-tiba, sehingga mengeliminasi konsumsi daya mekanik yang sia-sia dan mengoptimalkan penyerapan energi secara keseluruhan.

**Kata Kunci:** *Solar Tracker, Internet of Things, ESP32, Mode Auto-Manual, Efisiensi Energi.*

# ***DESIGN AND IMPLEMENTATION OF IOT-BASED SINGLE AXIS SOLAR TRACKER WITH AUTO- MANUAL MODE***

## ***ABSTRACT***

*The utilization of solar energy is often suboptimal in static panel installations, whereas conventional automatic solar trackers based on light sensors (LDR) are prone to random movements (hunting effect) that waste power during cloudy weather. This research aims to design and build an IoT-based Single Axis Solar Tracker with Auto-Manual Mode to improve mechanical stability and energy monitoring efficiency. The system is driven by an ESP32 microcontroller integrated with a high-precision DS3230 servo motor as the actuator, an INA219 sensor for electrical data acquisition, and a 10 WP solar panel with a 12V DC lamp load. The tilt angle control and real-time monitoring of voltage and current data are carried out through the Blynk application interface. System testing was conducted in an open area for 10 operational hours (07:00 – 17:00 WIB) with a movement scenario of an additional 9° angle per hour, from a 45° (East) to a 135° (West) position. The test result of the actuator angle deviation, validated using a digital inclinometer, was only 0.27°. The system successfully recorded a peak power output of 4,217.97 mW (4.21 Watts) at an angle of 99° at 13:00 WIB. The implementation of the Auto-Manual mode proved to be highly effective in locking the panel position according to the sun's time trajectory despite sudden fluctuations in light intensity, thereby eliminating wasted mechanical power consumption and optimizing overall energy absorption.*

**Keywords:** *Solar Tracker, Internet of Things, ESP32, Auto-Manual Mode, Energy Efficiency.*