IOTRICITY S02

Name Loading...

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Solar Panel Monitor

GREEN HOUSE | QUESTION NO: 3

PROBLEM STATEMENT

Green House, No-3
Solar Panel Monitor: Implement an IoT system to monitor a solar panel array: track voltage/current output and optimize panel tilt via a motor.

- Solar panels in fixed positions fail to capture sunlight effectively throughout the day.
- This results in **15–25% lower efficiency**.
- Users also lack **real-time monitoring** of panel output, making it difficult to track performance.

OBJECTIVE

- ❑ Design a dual-axis **automated tracker** to maximize solar exposure.
- ❑ Simulate **voltage and current monitoring** to demonstrate performance metrics.
- ❑ Integrate cloud infrastructure, enabling remote monitoring in future rounds.
- ❑ Showcase energy optimization through **smarter panel tilt adjustments**

WHY IT MATTERS?

- **Growing energy demand** requires efficient renewable solutions.
- **Fixed solar installations** often waste significant energy due to seasonal and daily angle changes.
- Efficient solar tracking can generate **up to 50% more electricity annually** (dual-axis).
- This project is aligned with **sustainable development goals (SDG 7: Affordable & Clean Energy)**.
- Real-time monitoring provides:
  - Fault detection in panels.
  - Performance benchmarking.
  - Preventive maintenance alerts.

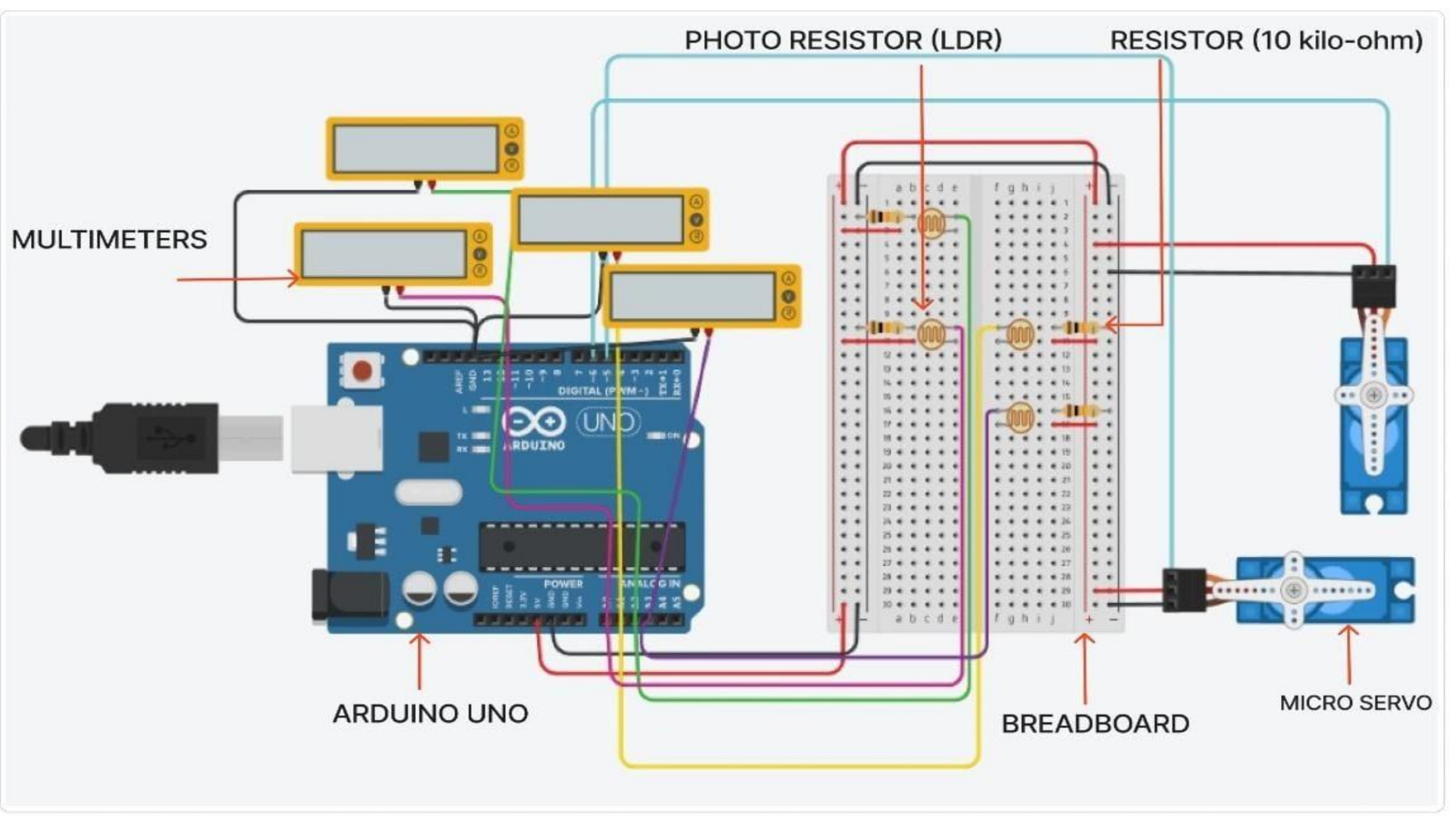
OUR BIG IDEA

- **Dual-Axis Tracking:** LDR sensors + servo motors auto-align panels with sunlight.
- **Cloud Monitoring:** Voltage, Current & Power sent to IoT cloud for live dashboard + remote access.
- **Smart Logic (ML):** Predicts optimal tilt using weather data; reduces unnecessary movements.
- **Predictive Maintenance:** Alerts for dust, shading, or panel faults via IoT notifications.
- **Scalability:** Manages single homes to large solar farms; compares efficiency of fixed vs tracking panels.
- **Green Impact:** Boosts efficiency (20–40%), reduces carbon footprint, supports clean energy goals.

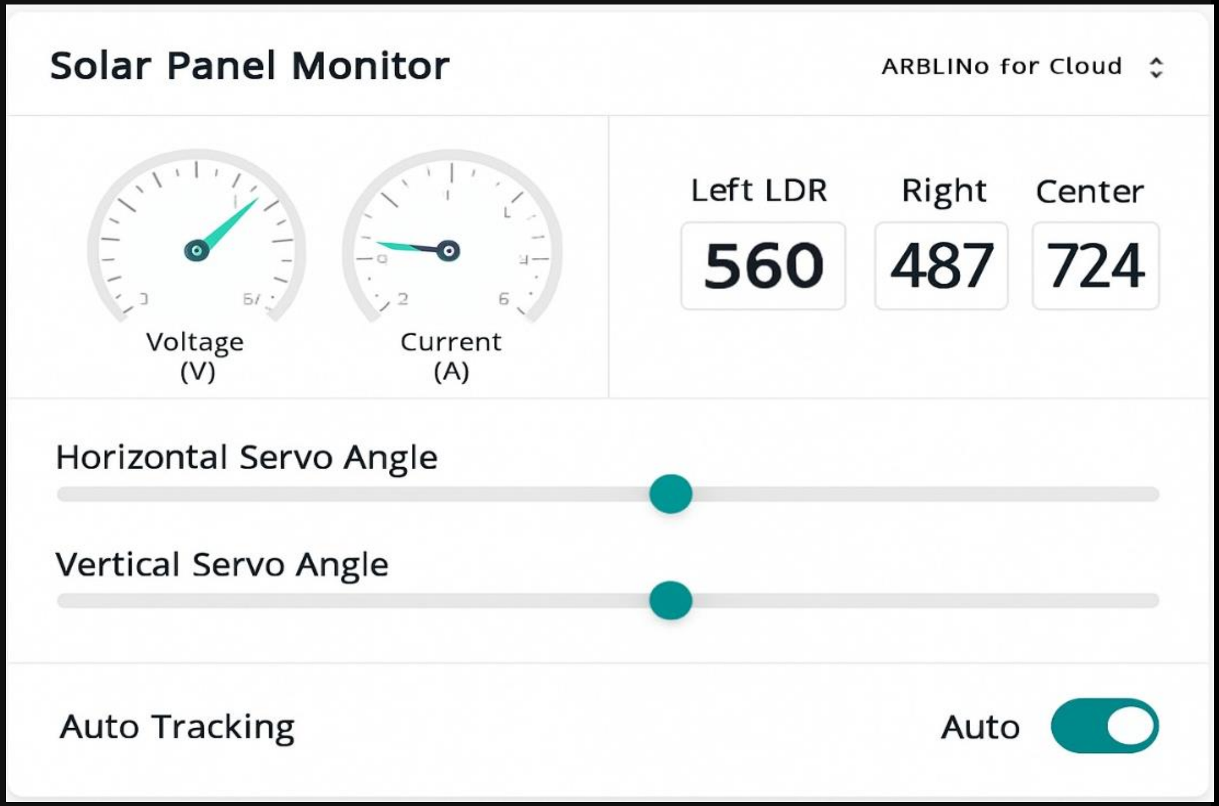
WHY IT’S COOL?

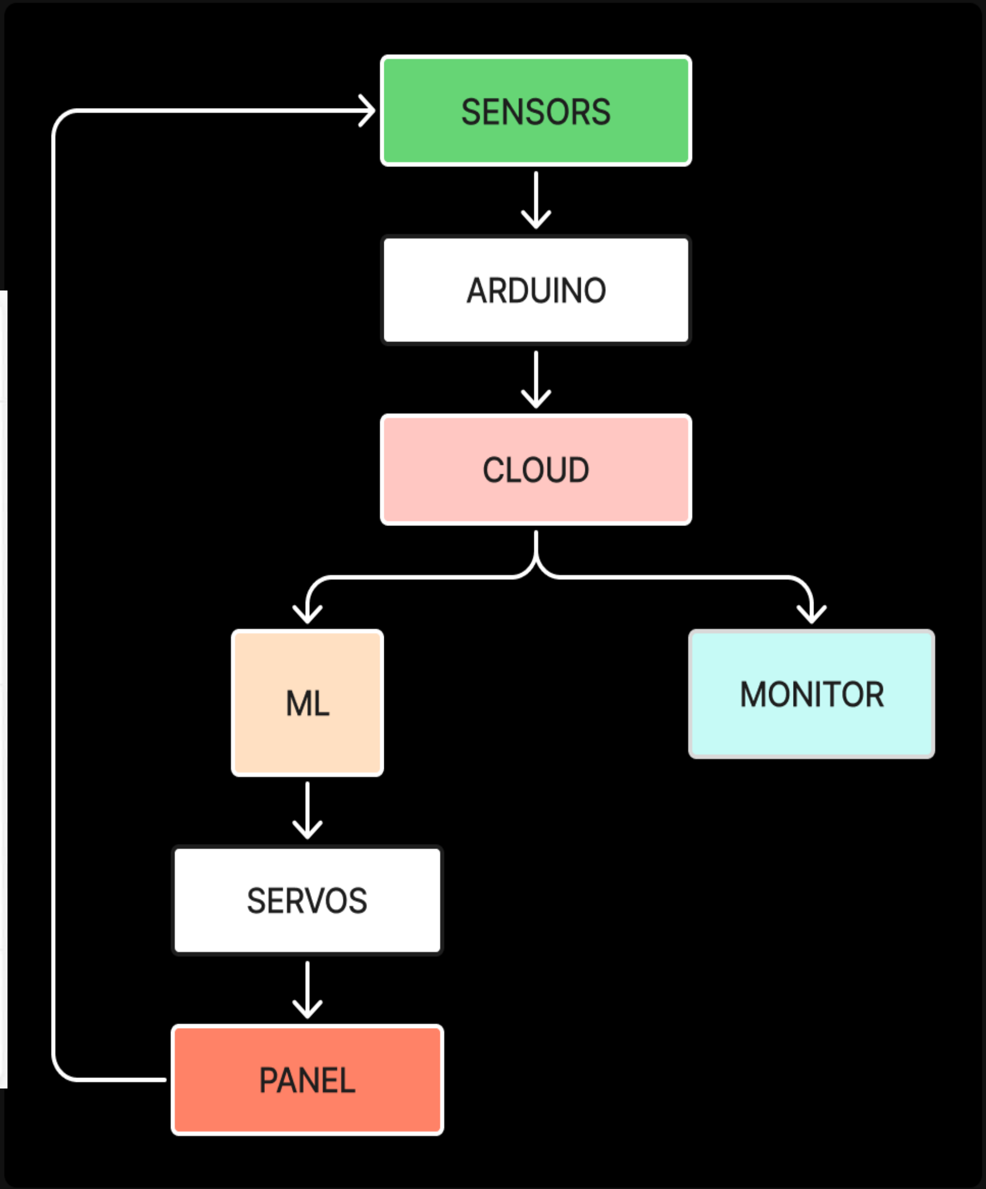
- **Higher Efficiency:** Increases solar energy output by 20–40% through smart tracking.
- **Anytime, Anywhere Monitoring:** Cloud dashboard gives real-time Voltage, Current, Power, and Tilt data.
- **Intelligent System:** ML-powered predictions + auto-reset at night minimize energy loss.
- **Self-Aware:** Detects dust, shading, or faults and alerts users instantly.
- **Eco-Friendly Impact:** Supports clean energy adoption and reduces dependency on fossil fuels.
- **Scalable & Future-Ready:** Works for households, industries, and large solar farms alike.
- **Budget-Friendly:** Prototype cost is only around **₹1500–2200**, making it affordable and scalable for real-world use.

CIRCUIT DIAGRAM



Dashboard & FLOWCHART





TECHNOLOGY STACK

HARDWARE

- **Arduino Uno** – Microcontroller for control & IoT connectivity
- **4 × LDR Sensors** – Detect sunlight intensity (North, South, East, West)
- **2 × Servo Motors (SG90)** – Control panel tilt (horizontal & vertical)
- **Voltage Sensor Module** – Measures panel output voltage
- **Current Sensor (INA219)** – Tracks current & power generation
- **Supporting Components:** Resistors, wires, breadboard, power supply

SOFTWARE

- **Arduino IDE** – Coding, compiling, uploading firmware
- **Tinker CAD** – Circuit design & simulation (prototyping stage)
- **IoT Cloud Platforms** – Arduino IoT Cloud for dashboard & remote monitoring
- **Programming Language:** Arduino C++ (.ino sketches).
- **ML/Analytics:** Edge ML for predictive tilt optimization & data analysis.

CHALLENGES & SOLUTIONS

- **Challenge 1 – Accuracy of Sun Tracking:**

  LDR readings fluctuate due to noise and shadows.

  Solution: Implemented smoothing, calibration, and dead-zone logic to stabilize servo movements.
- **Challenge 2 – Power Consumption:**

  Servo motors can consume more energy than the tracking gain.

  Solution: Optimized movement logic → panel only adjusts when significant difference is detected.
- **Challenge 3 – Cost & Scalability:**

  Advanced trackers are often expensive and not feasible for households.

  Solution: Designed a low-cost prototype (~₹1500–2200) using basic components, scalable to larger farms.

REFERENCES & PROJECT LINKS

- M. Abdin & W. Zubair, *“Design and Implementation of Dual-Axis Solar Tracking System,”* IEEE Xplore, 2020.
- S. Kalogirou, *“Solar tracking systems: Principles and applications,”* Renewable Energy, Elsevier, 2014.

- Arduino Documentation – Click Here
- Github Respository- Click Here
- Tinkercad Stimulation (YT Link)- Click Here