

## IoT Based Solar Tracking System with Automatic Dust Monitoring System

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### Abstract

The most plentiful energy source available to all living things on Earth is solar energy. One way to generate power from sunshine is via the Solar Tracking System. This form of electricity generating uses renewable natural resources. It just needs the most sunshine possible to produce energy. This system tracks light levels to their maximum. By tracking the sun's movement and modifying the panel's angle and orientation accordingly, the technology maximises the effectiveness of solar panels. Using a dust sensor and a nozzle to spray water on the panel when there is a greater accumulation of dust, the cleaning system is used to remove the accumulated dust from its panel surface. Furthermore, the dust sensor continuously tracks the amount of dust accumulating on the panels and, if needed, initiates an automated cleaning procedure. Wi-Fi is used to transfer the system's data through Node MCU, allowing for real-time monitoring and analysis. The suggested system improves the efficiency of solar energy collection.

**Keywords:** Solar; Energy Efficiency; Solar Panels; Sunlight Tracking; Renewable Energy.

### 1. Introduction

The world is moving towards more sustainable energy sources, and solar energy is leading this change. Solar radiation is directly converted into electrical energy by solar panels.[2] Semiconductor materials, particularly silicon, are used primarily in the fabrication of the panels.[1] A clean, abundant, and sustainable power source is provided by solar energy, but optimal energy absorption is essential to the system's performance. On the other hand, build up of dust and debris on solar panels can drastically lower their energy output, resulting in lower productivity and higher maintenance expenses.[3] Internet Of Things (IOT) solar tracking system that is coupled with an automated dust monitoring system to meet this difficulty. This state-of-the-art system optimises the use of solar energy by accurately measuring the movement of the sun and maintaining the cleanliness of the panels through automatic maintenance and real-time monitoring. Sensor and the Internet of Things-based solar tracking system tracks the sun's path and increases the energy efficiency with its ability to optimize energy

production reduce maintenance cost and increase panel lifespan. [2,4]. Block Diagram is shown in Figure 1.

#### 1.1. Scope

- **Optimised Energy Production:** Accurately track and align with the sun's movement to optimise the harvesting of solar energy.
- **Real-time Monitoring:** Keep an eye on dust buildup, energy output, and solar panel performance all the time [5].
- **Automated Maintenance:** To guarantee maximum panel efficiency, cleaning mechanisms are triggered to remove dust and debris.
- **Remote Control and Management:** Keep an eye on system performance, send and receive alerts and notifications, and remotely control and manage solar tracking systems.

#### 1.2. Objectives

- The primary goal of this research is to use

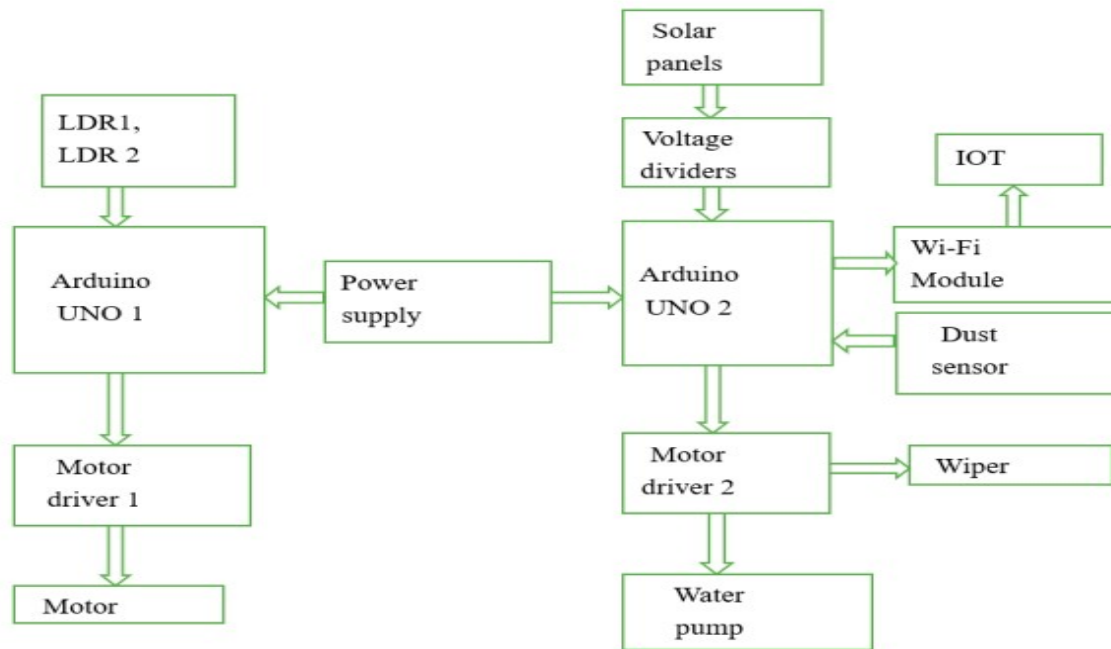
tracking and cleaning techniques to boost the solar panel's efficiency.

- By maximising sunshine exposure and upholding cleanliness, the solar tracking system with automatic dust monitoring seeks

to maximise solar panel efficiency.

- Create a system for solar panels that tracks the sun's path. Outperforming other solar tracking systems in terms of accuracy and efficiency.

## 2. Methodology



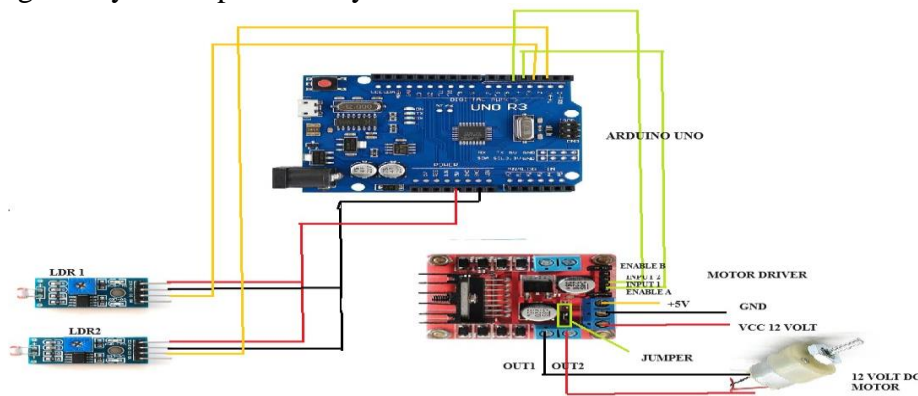
**Figure 1** Block Diagram of IoT Based Solar Tracking and Cleaning System

A mechanical device called a single axis solar tracking system revolves solar panels from east to west in order to track the sun's movement and maximise energy usage. The mechanism of operation involves a motorised mechanism that gradually rotates the panels to face the light's intensity, tracking its daily course from east to west. The LDR1 and LDR2 sensors on the Arduino Uno controller unit sense the position of light intensity and send signals to the motor to change the angle of the panel in response to changes in light intensity. When the light intensity on LDR1 surpasses that of LDR2, the panel rotates to face LDR1 and vice versa. This is why the solar panel is fixed to a single-axis rotating tracking frame. The tracking frame's rotation is powered by a 30 rpm gear motor that draws power from the motor driver. The fixed resistor and the light-dependent resistor (LDR) make up the lighting sensor. The supply voltage is 12 volts, and the controller cannot

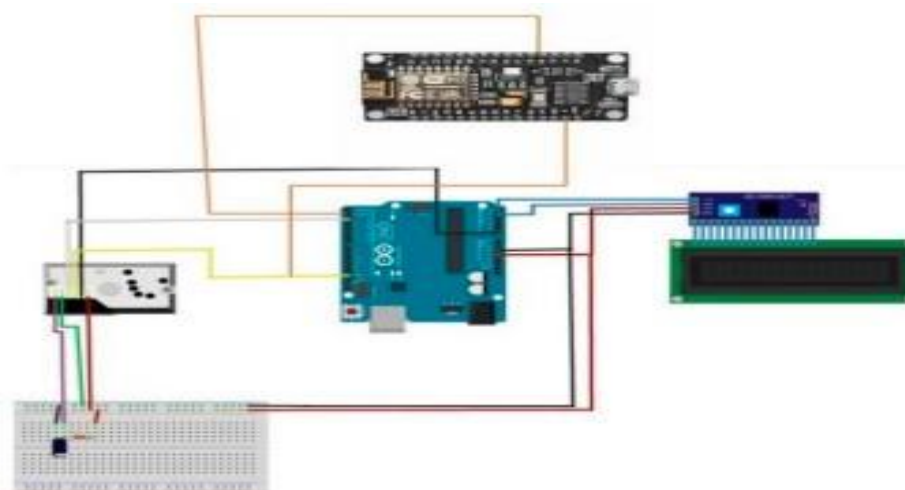
be directly connected to the voltage of the LDR. Ref [1-5]. Thus, the voltage of the LDR is read using the voltage divider method. As the motor cannot be turned on and off during the day, the voltage difference between two LDRs is compared to the sensitivity. When the voltage difference between two LDRs is bigger, the solar tracking system is designed to revolve in either the Clock wise (CW) or Counter clock wise (CCW) direction, based on the higher voltage. The motor rotates in the appropriate direction. When necessary, a successful cleaning method should be used with the fewest requirements. There are three main components to the suggested structure. The first section is the sensing section, which uses an optical air quality sensor (GP2Y1010AU0F) to detect dust particles. This sensor operates in conjunction with a phototransistor that was arranged diagonally and an infrared emitting diode. With this setup, the mean of the dust reflection

will be used to identify the presence of dust surrounding the solar panel surface. Ref [6-9]. This method is highly effective and sensitive enough to identify minute. This method works very well and can pick up very small particles, such as dust. The Arduino UNO, the project's brain, is the second component. The Arduino Uno microcontroller processes the impacts of collected dust on the output power and measures the PV panel output in real time. The windscreen wiper system, which is the third component of the project, is managed by the microcontroller using a relay that is powered by solar

energy generated by photovoltaic cells. When the dust level hits  $35 \mu\text{g}/\text{m}^3$ , the wiper on the solar panel begins to wipe. The wiper began to wipe and clean the panels once the water pump began to pump water out of the water tank or container. The ESP8266 Wi-Fi module node MCU demonstrates the voltage of each panel and the density of dust on them are displayed in the telegram by the Wi-Fi module node MCU (ESP8266), also able to see the same values on an LED display after obtaining them via IOT (Telegram).



**Figure 2 Schematic diagram of Tracking**



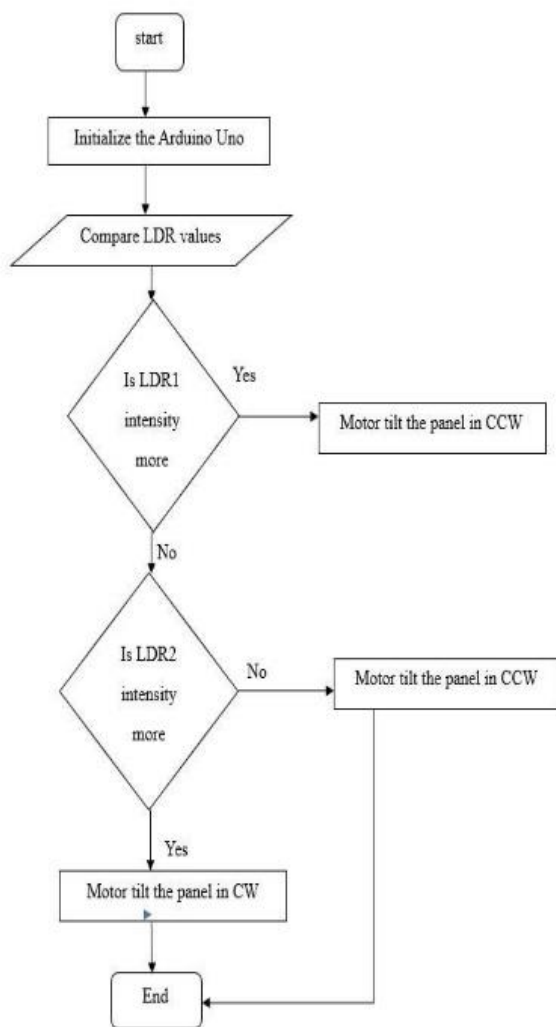
**Figure 3 Schematic Diagram of Cleaning**

Based on fig.3. at the end of the solar panels, LEDs are fixed in opposite direction. The digital inputs of the Arduino Uno are connected to the LDR's input

and linked to a motor driver so that the motor's direction and speed can be adjusted based on the intensity of the light that falls on the solar panel.

Based on fig. 2. the Arduino Uno controller is coupled to a dust sensor (GP2Y1010AU0F) to display the voltage level and dust density of the solar panel. Node MCU is connected to the Arduino pins. The module's LCD is fixed on the lower right corner and a wi-fi network (ESP8266) is connected so that prototype or IoT devices can be built. Monitoring the voltage level and dust density solely on a mobile device through Telegram.

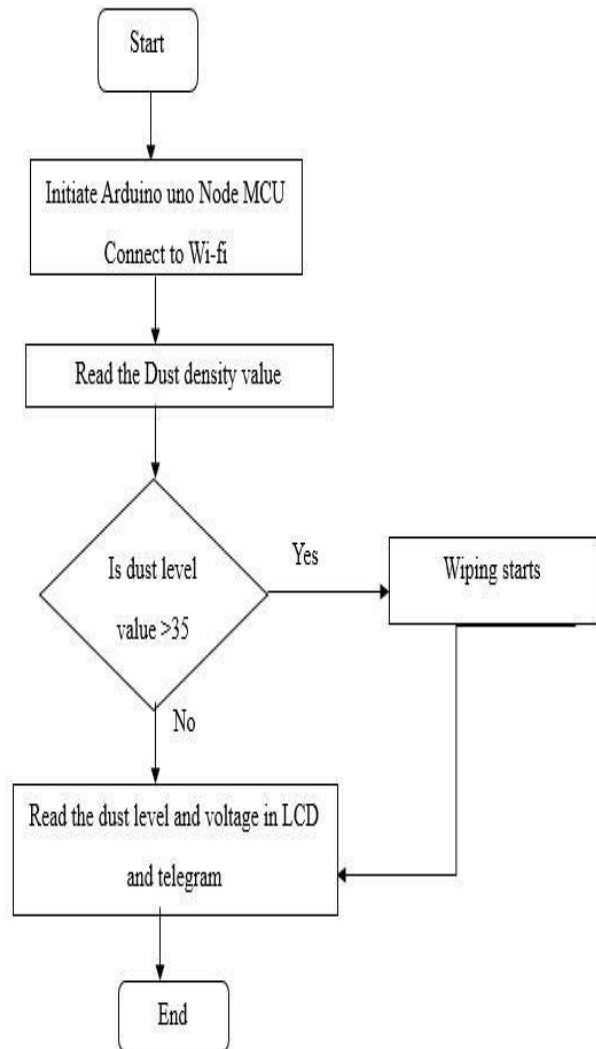
### 2.1. Flowchart



**Figure 4 Flowchart of Tracking System**

The automated solar tracking system that is being suggested has a handcrafted, straightforward architectural design that includes a solar panel. Here, 50 watt solar panel modules are utilised, producing

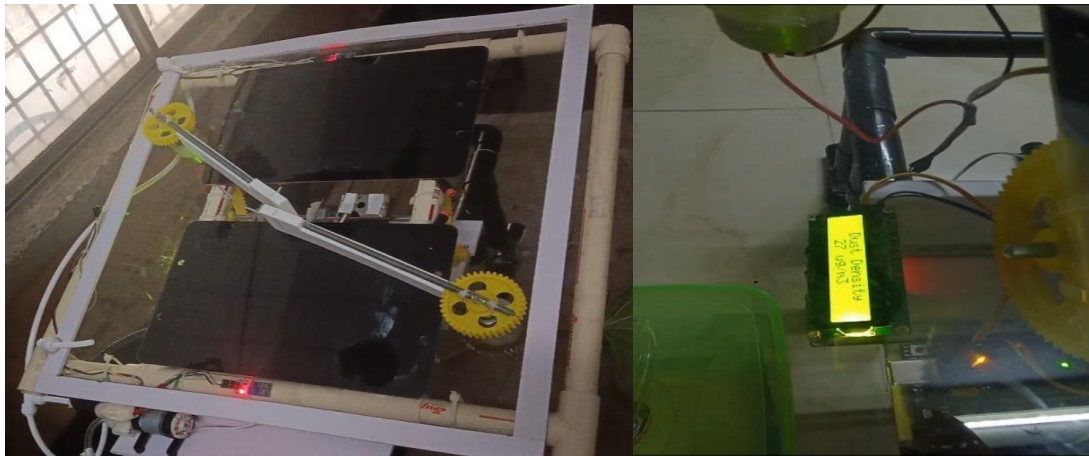
an output voltage of 24 volts and a current of 2.2 amps. Table 1 output shown in result.



**Figure 5 Flowchart of Cleaning system**

The solar panel's output is dependent on the amount of light it receives from the sun. The output voltage is unaffected by variations in sunshine. The microprocessor and LCD monitor the amount of light falling on the solar panel, and the system is configured to begin recording the amount of dust that falls on the panel. The automatic dust monitoring system is put into place; it continuously measures the dust level and initiates wiping when the dust density level rises above 35ug/m<sup>3</sup>. Wiping begins, cleaning the surface of the solar panel. Tracking System and Cleaning System are shown in (Fig 4 & Fig 5).

### 3. Result



**Figure 6 Working Model**

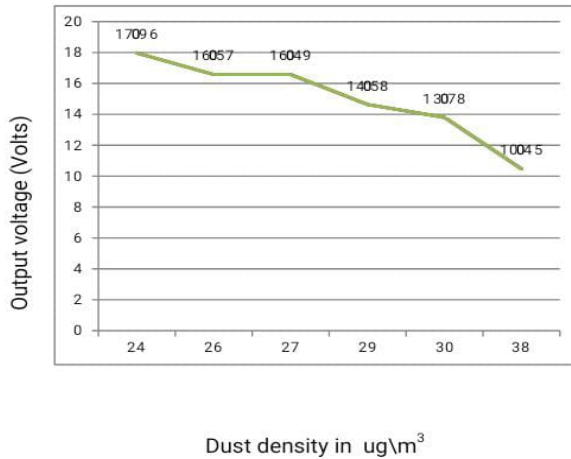


**Figure 7 Output Seen in Telegram**

**Table 1 Output**

TIME (pm)	PANEL-1(VOLTS)	PANEL-2(VOLTS)	TOTALVOLTAGE(V)	DUST $\mu\text{g}/\text{m}^3$
12:30	7.28	7.30	14.58	29
12:50	8.23	8.26	16.49	27
01:00	8.30	8.27	16.57	26
01:30	9.01	8.95	17.96	24
02:00	5.26	5.19	10.45	38(wiping)
2:30	6.87	6.91	13.78	30
3:00	7.14	7.20	14.34	29

### 3.1. Graph



**Figure 8 Hypothetical Graph**

Graphs Shows that hypothetical graph (Figure 8) representing the relationship between voltage and density. voltage in y axis that is vertical axis and dust density in x axis that is horizontal. When dust density increases, voltage output decreases, demonstrating the negative impact of dust accumulation on solar panel performance. (Refer Figure 6 & 7)

### 4. Discussion

The efficiency of solar panels could be maximised by combining a solar tracking system with an automated dust monitoring system. The system for monitoring dust would identify the accumulation of dust and initiate cleaning procedures to sustain peak efficiency, guaranteeing steady production of energy. Over time, more energy production and lower maintenance costs are anticipated as a whole.

### Conclusion

This study describes an IOT-based solar tracking system with an automated dust monitoring system. Because of this feature, the system can be used in arid regions. This suggested system consists of two parts: tracking and cleaning. The cleaning part uses a water nozzle and wiping to remove dust from the surface, and the second part rotates the solar panel frame in both clockwise and anticlockwise directions to maximise energy efficiency. The suggested system is inexpensive and has a straightforward construction because it only has two 45-degree inclined axes and a solar panel that tracks the sun.

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