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# Arduino Based Solar Power System with Automated Cleaning Wiper

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**ABSTRACT:** The solar power project integrates photovoltaic panels with an Arduino microcontroller for optimal energy conversion. The Arduino system employs smart algorithms to monitor critical parameters like voltage, current, and temperature using various sensors. A key feature is the inclusion of an automated cleaning wiper system, driven by DC motors, strategically positioned to combat dust accumulation on solar panels. In regions like India, where dust can reduce power output by 50-60% in a month, this system proves vital. By conducting regular cleaning cycles, the wiper system minimizes power loss to 5-10%, offering an economically feasible solution to enhance the overall efficiency of solar PV systems in dust-prone areas.

## I. INTRODUCTION

In recent years, the escalating environmental concerns stemming from the combustion of fossil fuels have reached a critical juncture, exacerbated by the alarming trends of global warming and extreme weather events. This has spurred a concerted global effort to seek out viable alternative energy sources that can alleviate our dependence on fossil-based fuels. Among these alternatives, solar energy has emerged as a frontrunner, offering a sustainable pathway to mitigate the adverse effects of traditional energy sources. By harnessing the abundant radiant energy of the sun, solar power presents a compelling solution, converting sunlight into electricity through the innovative technology of photovoltaic (PV).

Solar power, renowned for its direct conversion of sunlight into electricity, operates through two primary methods: photovoltaic's and concentrated solar energy. Photovoltaic systems directly capture sunlight using solar cells, while concentrated solar energy employs reflective surfaces to concentrate sunlight onto a small area for power generation. Initially deployed for small to medium-scale applications, ranging from handheld calculators powered by single solar cells to off-grid rooftop PV systems for remote residences, solar energy has undergone a remarkable expansion. This expansion is underscored by the plummeting cost of solar electricity, leading to the proliferation of grid-connected solar photovoltaic systems numbering in the millions. Concurrently, utility-scale solar power stations with capacities reaching hundreds of megawatts are being established worldwide, underscoring the scalability and versatility of solar technology.

The affordability and efficiency of solar photovoltaic technology have positioned it as a compelling low-carbon, cost-effective means of harnessing renewable energy from the sun. However, despite the growing demand for solar PV modules, significant challenges persist that impede their widespread adoption. Research endeavors have predominantly focused on optimizing the characteristics of semiconductors utilized in solar cells, yet the overall efficiency of PV systems remains constrained within the range of 15–20%. Moreover, various losses are inherent in power generation using solar panels, including shading loss, wiring loss, sun tracking loss, and the particularly notable challenge of soiling loss.

imperative to uphold high power output levels and ensure the economic viability of solar PV systems. Soiling loss emerges as a critical impediment, particularly in tropical regions where environmental factors such as dust, dirt, and other particulate matter accumulate on the glass surfaces of PV modules. These accumulations diminish the power output of solar panels, necessitating interventions to mitigate soiling losses. Given the substantial demand for solar power in tropical countries like India, addressing this issue has become

## II.RELATED WORK

Several arduino based solar power system measurement projects have emerged aiming to provide efficient monitoring and optimize solutions. These systems typically utilize with arduino microcontrollers coupled with various with sensors such as voltage current temperature sensors to measure parameters like solar panel output battery voltages and overall systems. Through data logging and analysis this set up offers insights into energy generation consumption and storage enabling users to make informed decisions about system maintenance.

An Arduino-based solar power system integrates Arduino microcontrollers with solar panels, batteries, and other components to create an efficient and sustainable energy solution. The Arduino microcontroller serves as the brain of the system, managing power flow, monitoring energy production and consumption, and controlling various devices such as inverters and charge controllers. Sensors connected to the Arduino can collect data on solar irradiance, battery voltage, and system temperature, enabling precise monitoring and optimization of performance. This system can be programmed to automatically adjust power output based on environmental conditions, ensuring maximum efficiency and reliability. Additionally, it can be configured to communicate data remotely via Wi-Fi or GSM networks, allowing users to monitor and control their solar power system from anywhere. With its flexibility, scalability, and affordability, an Arduino-based solar power system presents a versatile solution for both off-grid and grid-tied applications, empowering individuals and communities to harness the sun's energy for sustainable living.

## II. METHODOLOGY

An arduino based solar power system typically involves several components solar panels to capture sunlight charge controller to manage the energy flow batteries for energy storage an inverter to converter dc to ac power on sensors to monitor systems performance the arduino serve as a controller hub. Collecting data from sensors controlling the charge controller and inverter based on programmed logic. The solar system comprises of a solar panel arduino microcontrollers and sensors. For this system to operate there must be emission of light through sun. The LDRs serve as the sensors to detect the intensity of light entering the solar panels. The LDR sends the information to the arduino microcontroller. The serve motor circuit is then constructed .the servomotor has 3 pins of which the Positive side is connected to the ground. The data point on the servomotor is connected to the antilog point on the microcontroller.

III. IMPLEMENTATION



Fig 4.1 arduino based solar power system with automated cleaning wiper

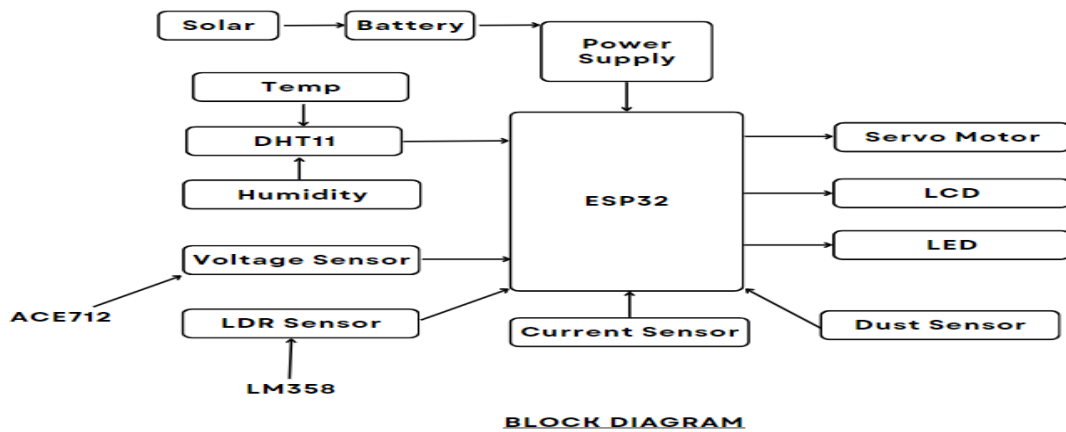


Fig 4.2 arduino based solar power system with automated cleaning wiper block diagram



**Working:** In the developed system, four main parameters are measured: temperature, light intensity, voltage, and current. Each parameter is crucial for understanding the performance of the solar panel and optimizing its operation. Temperature is measured using a dedicated temperature sensor. This sensor is specifically designed to provide accurate temperature readings, allowing the system to monitor the thermal conditions affecting the solar panel. By tracking temperature variations, the system can assess the impact of heat on panel efficiency and overall performance. Once the parameters are measured, the Arduino processes the analog input signals and converts them into digital output values. These values are then displayed on a Liquid Crystal Display (LCD) screen in a user-friendly format. The LCD screen provides real-time feedback on the temperature, light intensity, voltage, and current values, allowing users to monitor the performance of the solar panel at a glance. The system is powered by an electrical supply, typically sourced from a battery or a solar panel system. This power supply ensures that the system's components receive the necessary power to operate effectively. By harnessing electrical energy, the system can continuously monitor and display key parameters, enabling users to make informed decisions regarding solar panel maintenance, optimization, and overall system performance.

An Arduino-based solar power system typically involves using an Arduino microcontroller to monitor and control various aspects of the solar power system, such as tracking the position of solar panels for maximum sunlight exposure, managing power generation, storing energy in batteries, and controlling power distribution. The Arduino can interface with sensors to gather data like sunlight intensity, battery voltage, and energy usage, then make decisions based on that data. It can also communicate with other devices or systems, like sending alerts or data to a user interface or a central monitoring station. Overall, it provides flexibility and customization options for optimizing the efficiency and functionality of the solar power system.

#### IV. EXPERIMENTAL RESULTS

TIME INTERVAL	SOLAR POWER OUTPUT(before cleaning)	SOLAR POWER OUTPUT( after cleaning)
Dust sensor	98 mg/m <sup>3</sup>	79 mg/m <sup>3</sup>
	110 mg/m <sup>3</sup>	91 mg/m <sup>3</sup>
	118 mg/m <sup>3</sup>	117 mg/m <sup>3</sup>
	192 mg/m <sup>3</sup>	122 mg/m <sup>3</sup>
	146 mg/m <sup>3</sup>	106 mg/m <sup>3</sup>
	Temperature	Humidity
Dth11 sensor	36.4 <sup>0</sup> C	

#### V. CONCLUSION

In conclusion the implementation of an automated cleaning wiper system for solar panel represents pivotal step forward in overcoming challenges associated with soiling losses and optimizing the efficiency of solar power systems. The expected outcomes encompassing enhanced energy production energy reliability cost effective and improved safety. This article implemented a solar panel tracking system with the aim to track the position of the sun for better efficiency of the solar panel. In addition, our work can be executed on an industrial scale which be beneficial to developing countries like Nigeria and Sub Sahara Africa countries. Our recommendation for future works is to consider the use of more sensitive and efficient sensors which consume less power, and which are also cost effective. This would increase the efficiency while reducing cost

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