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Solar Radiation Instrumentation And Related Parameters Study

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Abstract: *The increasing demand for clean and sustainable energy has positioned solar power as a vital component of future energy strategies. This project presents the development of a solar radiation measurement and monitoring system using an Arduino Uno, a pyranometer, and a DHT11 temperature-humidity sensor. Real-time data on irradiance, temperature, and humidity is recorded to assess solar availability in Jangaon, Telangana during May 2025. Data analysis confirms a strong correlation between sensor output and solar conditions, validating the system for practical applications like site assessment and agricultural planning.*

Keywords: *Pyranometer, Solar Radiation, Arduino, DHT11 Sensor, Calibration*

I. INTRODUCTION

Solar energy is one of the most promising forms of renewable energy due to its abundance and sustainability. The effective utilization of solar energy, particularly in photovoltaic (PV) systems, heavily depends on accurate data related to solar radiation. In regions like Jangaon, Telangana, which experience high solar irradiance throughout the year, solar energy can play a pivotal role in reducing reliance on conventional energy sources and promoting clean energy.

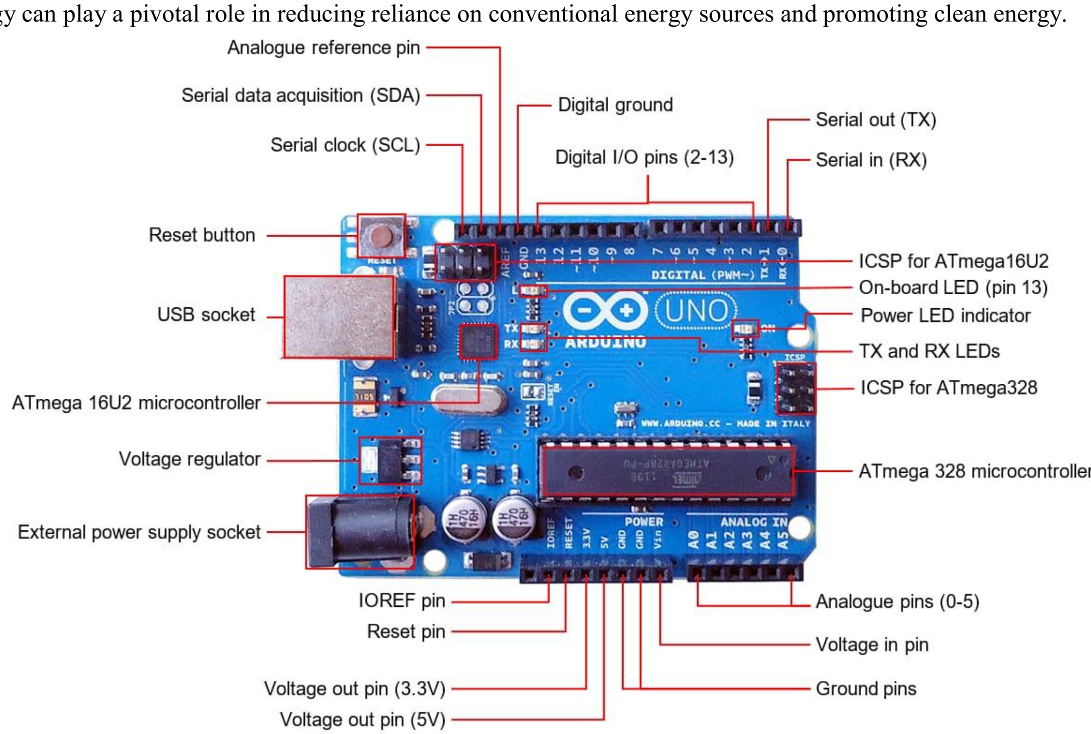

Fig. No 1: Arduino parts

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This project is centered around building an Arduino-based solar radiation monitoring system that utilizes a pyranometer for irradiance detection and a DHT11 sensor to log temperature and humidity. The Arduino Uno serves as the data acquisition unit, reading sensor data in real-time and outputting results to a serial monitor. The primary aim is to collect and analyze solar radiation data to support solar panel alignment, agricultural forecasting, and energy production modeling.

Additionally, this system can be adapted for academic, research, and industrial applications, where continuous environmental monitoring is crucial. The scalability and low cost of the system make it ideal for deployment in rural or semi-urban locations with limited access to high-end meteorological tools.

II. LITERATURE REVIEW

Solar radiation measurement and prediction are vital areas of research due to their role in maximizing the efficiency of solar energy systems. Over the past decades, several methods and technologies have emerged for real-time monitoring and forecasting of solar irradiance.

M. R. Al Rashidi et al. (2011) proposed a mathematical model to estimate the I-V characteristics of solar cells, which serves as a foundation for understanding PV behavior under varying radiation conditions. Arindam Bose et al. (2012) introduced an automated solar tracking system using AVR microcontrollers to dynamically align solar panels for maximum exposure. Their work showed a notable increase in system efficiency compared to static installations.

The use of fuzzy logic controllers for Maximum Power Point Tracking (MPPT), as demonstrated by Mohsen Taherbaneh et al., illustrates the growing interest in intelligent control systems. These methods have been integrated with real-time sensing to improve energy output under varying conditions such as cloud cover and partial shading.

Platforms like Arduino and Raspberry Pi have democratized access to environmental monitoring by offering flexible and affordable tools for data acquisition. Numerous studies have documented successful implementations of Arduino-based monitoring for solar radiation, temperature, humidity, and light intensity.

This literature sets the stage for the current project, which combines sensing, calibration, and computation into an integrated monitoring system.

III. METHODOLOGY

A. Hardware Used

- Arduino Uno
- Pyranometer (analog voltage output)
- DHT11 Temperature-Humidity Sensor
- Serial Monitor

B. Formula Used

The Global Horizontal Irradiance (GHI) is calculated using:

$$GHI = DNI \cdot \cos(\theta z) + DHI$$

Where:

GHI = Global Horizontal Irradiance (W/m²)
DNI = Direct Normal Irradiance (W/m²)
DHI = Diffuse Horizontal Irradiance (W/m²)
θ_z = Solar Zenith Angle (degrees)

C. Sample Calculation:

At 12:00 PM, assuming:
DNI = 1000 W/m²
DHI = 180 W/m²

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$\theta_z = 10°$
Then:
Cos(10∘) = 0.9848
GHI=1000·0.9848+180=984.8+180=1164.8 W/m

D. Circuit Schematic

Below is the block diagram illustrating the solar radiation monitoring system. The diagram shows the connection between the Arduino Uno, the pyranometer sensor, the DHT11 sensor, and the serial monitor where the readings are displayed.

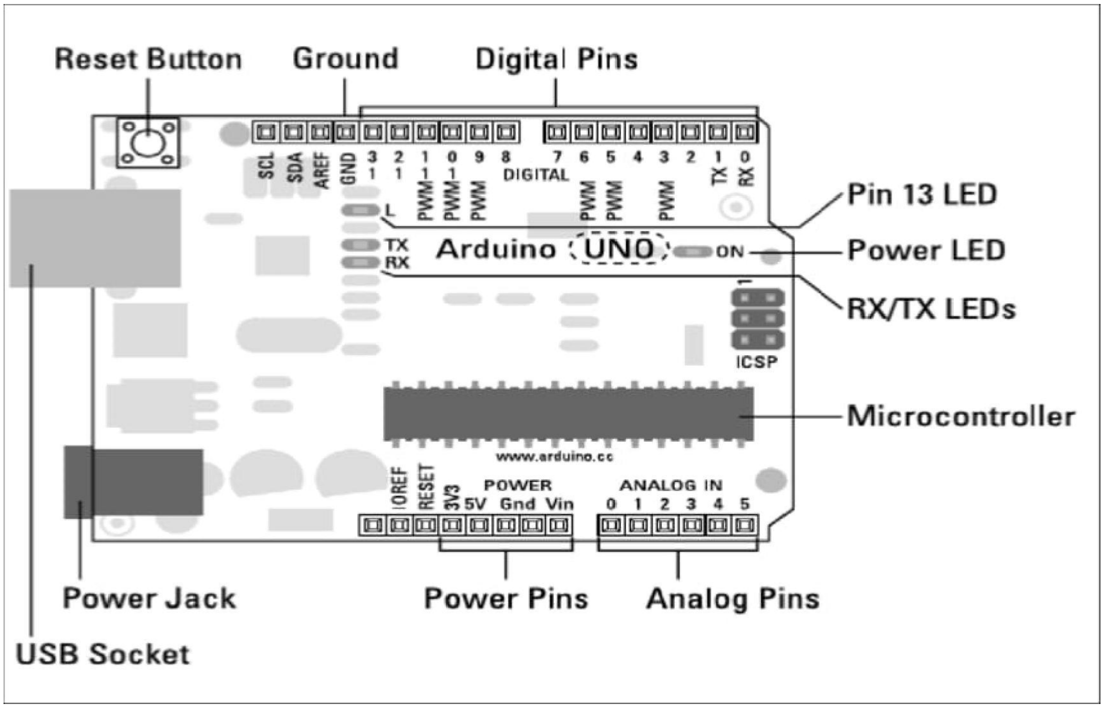

Fig. No 2: Arduino board

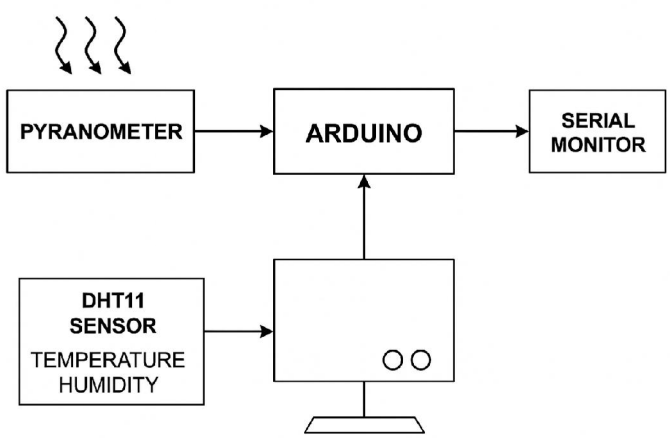

Fig. No 3: System Block Diagram

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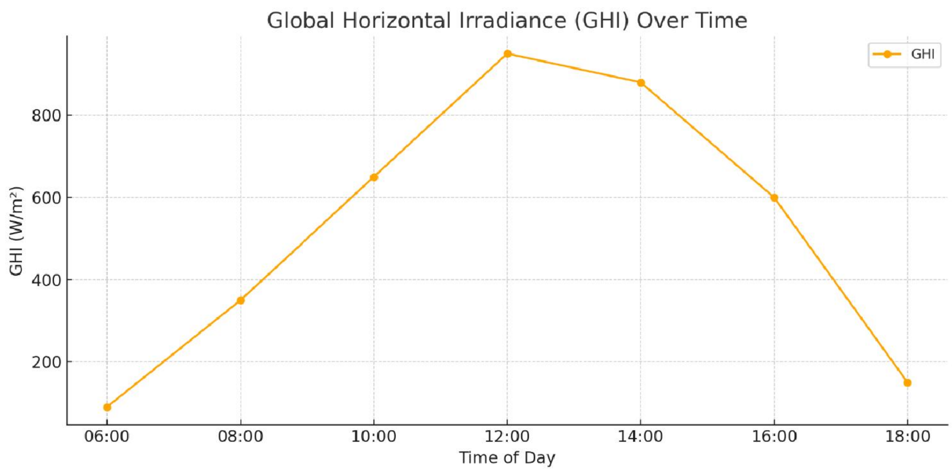
IV. RESULTS AND ANALYSIS

Table I: Solar Radiation Over Time

Time	GHI (W/m²)
06:00	90
08:00	350
10:00	650
12:00	950
14:00	880
16:00	600
18:00	150

Graph I: GHI vs Time



Observation:
The GHI increases during the morning, peaks at noon, and decreases in the evening. The trend shows clear-sky conditions typical of summer.

V. CONCLUSION

This Arduino-based solar radiation monitoring system offers a reliable, scalable, and cost-effective solution. Real-time monitoring of solar parameters allows better understanding of site-specific solar potential. This system is ideal for educational institutions, agricultural planning, and feasibility studies for solar PV deployment. Future work may integrate cloud connectivity and data logging.

Given the high solar potential in Jangaon, this system can be a valuable tool for planning and optimizing solar PV installations, solar thermal systems, and related renewable energy applications. Future enhancements could include remote data logging, GSM integration, and expanded sensor arrays for comprehensive solar resource assessment.

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