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AI-IOT FUSION BASED SOLAR PANEL PROTECTION

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Abstract: This paper, AI-IoT Fusion Based Solar Panel Protection, integrates Artificial Intelligence (AI) and Internet of Things (IoT) technologies to enhance the safety, efficiency, and durability of solar panels. Using Arduino, various sensors, and ThingSpeak cloud integration, the system monitors environmental and operational parameters such as current, voltage, temperature, humidity, and sunlight intensity. It also detects tilt or fall conditions using an accelerometer. An AI-powered machine learning model predicts potential failures, sending alerts to a user's mobile application. The solution addresses challenges like physical damage, performance degradation, and operational inefficiencies, ensuring optimal energy harvesting and proactive maintenance.

1. INTRODUCTION

Solar energy is a leading renewable energy source, yet solar panels are susceptible to issues like environmental wear, physical damage, and inefficiencies due to shading or alignment problems. Existing systems lack intelligent, proactive monitoring mechanisms that predict failures before they occur. This project leverages IoT for real-time data collection and AI for predictive analytics, creating a smart solution for solar panel protection.

Solar power facilities must be monitored for optimum electric-ity output. This helps to restore economic power production from power plants by replacing defective star panels, looking for con-tact's and alternating those issues with sludge accumulated on out-put reducing panels and shaking wire. However, we recommend machine-controlled Internet of Things (IoT), which is basically an alternative Energy viewing gadget that enables automated alternatives energy consumption from anywhere, on the internet. We choose AT super controllers focusing mainly on mega controllersto comply with solar battery requirements. Our technology monitors the solar battery in real-time and transmits the capacity per-romance of the IoT system via the internet. We have a habit of using IOT Thing Speak to send alternate energy parameters tohe IoT

Thing Speak server's net. It now displays these metrics in user-friendly graphical user interface and alerts the user when the performance limit is reached. This allows for easy remote observation of star plants while also ensuring optimal power production.

Aayushi ''Adriano dependent solar monitoring gadget," given byNitin Ingole at the 2014 International Conference on Science and Technology for Sustainable Development (ICSTSD). If the testing reveals a fault in the panels, the client will get the best performance from the panels. If your IoT sensors or other equipment develop problems that you don't have a way to verify, you'll have to depend on them [1]. Kabalci This article offers a rapid control infrastructure for a wind turbine and solar panel array-based sustainable energy production system. An unregulated six-pulse rectifier converts the DC turbine's output voltage to the AC output voltage of the wind turbine [2]. The charge voltage to the battery bank was provided by a hybrid system of renewable energy sources (RES) on the DC-bus, which generated voltages from wind turbines and solar panels. The current and voltage measurements of each renewable source are the focus of the tracking platform. Microchip's 18F4450 microcontroller calculates and interprets the appropriate values of the constructed sensor circuit. The cir-substances under which they are being utilized the processed data is subsequently sent to a PC via USB, where it is stored in a data-base, and the device is monitored automatically. Viewable appscreated using Microsoft Visual Studio. The web platform allows the system administrator to view the quantity of power generated and the current condition of each renewable energy source at glance. The recorded data will be handled by the tracking soft-ware's programmed visual interface, which will assess the con-stant, weekly, and monthly values of each measurement individually.[3] Jiju K suggested the creation of Android-basedonline renewable energy monitoring and control systems. In thisprocedure, the Bluetooth interface of an Android tablet or phonies utilized as a data communication connection with the power conditioning device's digital hardware. Bluetooth's disadvantages include slower communication speeds, inadequate data security, and shorter battery life. The low-power design of Bluetooth limitsthe data transmission speed. H OhnishiAsH [4] demonstrated the importance of the telecom sector in society is growing, as demon-strafed by the exponential development of ebusiness and ‘‘dot-com” companies. In order to meet economic needs, the power-supply Infrastructure utilised to provide utilities throughout this time period must be highly reliable as well as flexible. In this regard, one of the defining characteristics of contemporary net-works is that traditional telecommunications systems produce more heat than networking systems. As a result, even if the power supply to telecommunications equipment is relatively steady, it is possible for a device to fail to owe to heat-related circumstances.

2. LITERATURE SURVEY

This paper reviews the integration of renewable energy systems with Industrial IoT (IIoT) through Artificial Intelligence (AI). It examines various studies focusing on the design and monitoring of solar-powered wireless sensor nodes in diverse IIoT settings, particularly outdoors. Proposed distributed network architecture, underpinned by open-sourcetechnologies, aims for efficient solar power harvesting and data acquisition on solar radiation and ambient parameters. This data aids in devising estimation techniques to predict solar panel voltage outputs, optimizing energy utilization of solar-powered sensor nodes. The discourse extends to photovoltaic plants, emphasizing continuous monitoring and fault detection for operational safety and reliability. Reviewed works advocate embedding and IoT for remote sensing, fault detection, and diagnosis, addressing challenges posed by undetectable faults. Furthermore, the paper explores AI's transformative potential in the broader energy sector, impacting electricity production, distribution, energy storage, and efficiency. The synergy of AI, IIoT, and renewable energy systems is underscored as conduit for enhancing energy management, operational transparency, and deploying cost-effective solutions for complex industrial challenges, significantly bolstering the efficiency and intelligence of industrial production and services.

Today our society needs more energy for day-to-day activities due to rapid globalization and industrialization. In order to minimize the stress and dependency on fossil fuel, the most sustainable way is to harness suns energy. Solar energy is characterized by low cost, environment friendly, does not require frequent maintenance and most importantly, negligible maintenance cost. However, there is a requirement of monitoring solar installation in order to maximize the output power by setting real-time angles with the suns position. This can be easily done by the

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adoption of IoT technologies. The Internet of Things is often utilized in the measurement of solar energy for efficiency. It's also utilized to maintain the solar plant's health. The cost of renewable energy technology is decreasing throughout the globe, which encourages the construction of large-scale solar plants. Automation of plant observation on such a large scale of preparatory deployments requires sophisticated systems reliant on Internet connections since the majority of field units are situated in isolated, remote locations and therefore are not overseen from a central office. The project is based on the use of the most up-to-date, cost-effective method for remotely monitoring a solar plant performance by the inclusion of IoT. It can assist with plant maintenance, problem diagnostics, and real-time monitoring 2021 Elsevier Ltd. All rights reserved. Selection and peer-review under responsibility of the scientific committee of the International Confer-once on Nan electronics, Nan photonics, Nanomaterials, Nan bioscience & Nanotechnology.

The Internet of Things has a vision in which the internet extends into the real world, which incorporates everyday objects. The IoT allows objects to be sensed or controlled remotely over existing network infrastructure, creating opportunities for pure integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. This technology has many applications like Solar cities, Smart villages, Micro grids and Solar Street lights and so on. As Renewable energy grew at a rate faster than any other time in history during this period. The proposed system refers to the online display of the power usage of solar energy as a renewable energy. This monitoring is done through raspberry pi using flask framework. Smart Monitoring displays daily usage of renewable energy. This helps the user to analysis of energy usage. Analysis impacts on the renewable energy usage and electricity issues.

Presently we are invading in a new period of modernisms i.e., Internet of Things (IoT). By using the IoT supervising solar energy can greatly enhance the performance, monitoring of the plant. It is a technique to keep track of the dust assembled on the solar panels to induce the maximum power for active utilization. The amount of output power of the solar panels depends on the radiation hit to the solar cell. All the panels are attached and the sensors are precisely connected to the central controller which supervises the panels and loads. Thus, user can view the current, voltage and sunlight.

3. EXISTING SYSTEM

This method involves the hands-on cleaning of solar panels by a human operator who utilizes appropriate cleaning tools. The operator visually assesses the cleanliness of the panel's surface and continues cleaning until it meets the desired standards or until all dust and debris are removed. Solar power plants typically consist of multiple panels installed at heights ranging from 12 to 20 feet or even higher above the ground. This makes the cleaning process extremely time-consuming and challenging. It poses risks to both the required cleaning time and the safety of the personnel involved.

Manual cleaning of solar panels often involves the use of cleaning fluids like cleansers or gels, which can reduce surface transparency if not applied correctly. Additionally, photovoltaic (PV) panels are vulnerable to physical damage that cannot always be prevented during manual cleaning. To aid in the proper cleaning of solar panels, several useful tools can be employed. Specialized rotating brushes are commonly used to remove dirt and grime from the panel's surface. Simple cleaning tools, such as those used for car windshields, may also be effective in this process.

Solar panels face multiple challenges, including environmental damage, operational inefficiencies, and lack of real-time failure detection. Traditional monitoring systems are reactive, often identifying issues only after significant damage has occurred. This leads to increased maintenance costs, reduced energy output, and shortened panel lifespan. A system is needed to continuously monitor solar panels, predict potential failures, and alert users for timely intervention..

4. PROPOSED SYSTEM

The AI-IoT Fusion Based Solar Panel Protection integrates various hardware components with a robust AI algorithm running on a central server or laptop. Key features include:

Solar Panels: Collect renewable energy during daylight hours.

Energy Storage System: A battery bank or energy storage device to store excess energy.

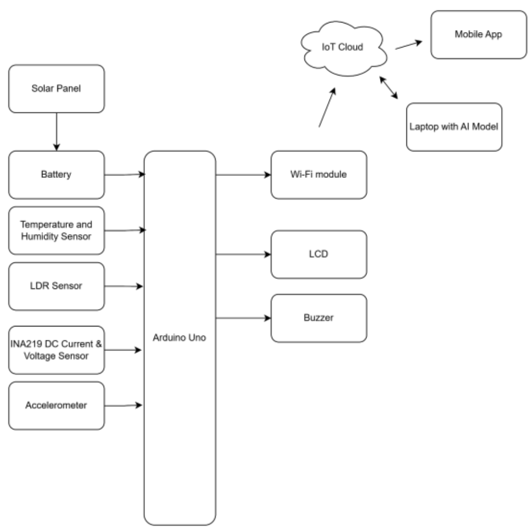
Arduino Controller: Controls the system, collects data from sensors, and communicates with the cloud.

IoT Module: A Wi-Fi module (like ESP8266) transmits data to a cloud platform for remote monitoring.

AI Algorithms: Machine learning models predict energy production and consumption, helping in dynamic optimization.

Sensors: Measure light intensity, temperature, and other parameters that affect solar panel efficiency (e.g., LDR, temperature sensor).

LCD or Mobile Interface: Provides data display and user interface.



Working Flow Steps

Data Collection:

Sensors (INA219, DHT11, LDR, and accelerometer) gather data on energy output, environmental conditions, and physical stability.

Data Transmission:

Sensor data is sent to the ThingSpeak cloud platform via a Wi-Fi module.

Data Analysis:

AI machine learning models on a laptop analyze the data to predict potential failures and performance issues.

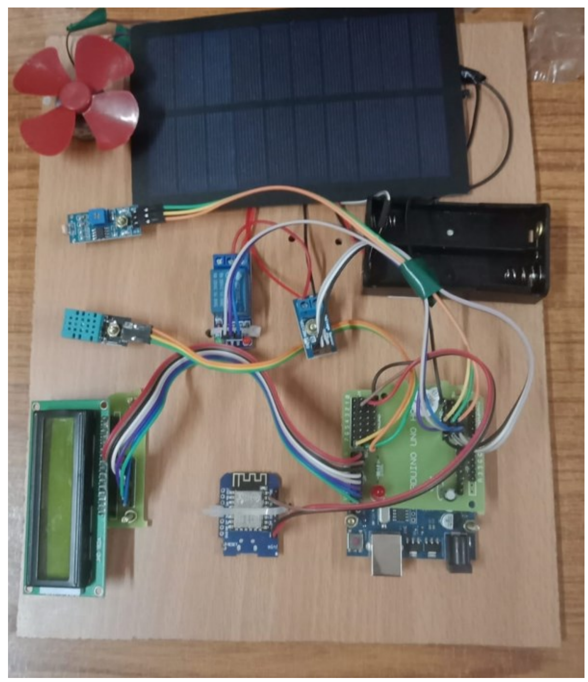
Alerts and Notifications:

Predictions and anomalies are sent as alerts to a mobile application.

Local Feedback:

Critical issues trigger a buzzer and display warnings on an LCD.

5. RESULT



6. CONCLUSION

The AI-IoT Fusion Based Solar Panel Protection system provides a smart, reliable, and cost-effective solution to ensure solar panel safety and efficiency. By leveraging IoT for data collection and AI for predictive analytics, the system bridges the gap between traditional monitoring methods and modern, intelligent technologies, paving the way for sustainable and reliable renewable energy solutions

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