SOLAR STILL AND SOLAR POWERED STREET LIGHTS WITH CLOUD BASED MONITORING

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ABSTRACT

This project presents the design and implementation of an integrated, solar-powered system that addresses two critical needs: water purification and public lighting. The core innovation lies in a smart solar still equipped with an automated sun-tracking mechanism. This system utilizes DHT11 sensors to monitor internal and external temperatures, with data processed by a Node MCU IoT module. A key feature is the ability to manually control a motorized disc, which rotates the entire still structure for optimal solar alignment, via commands sent from the Blynk mobile application. This active orientation control, based on real-time sensor data, significantly enhances the evaporation and condensation process within the single-basin structure.

Alongside the water purification system, the project incorporates autonomous street lighting. Energy-efficient LED street lights are powered by the same renewable energy infrastructure, ensuring illumination during nighttime hours. The entire setup is powered by a dedicated solar energy subsystem, which includes a solar panel, a 6V rechargeable battery for energy storage, and necessary power regulation circuitry comprising a step-down transformed and rectifier. This ensures complete operational independence from the conventional power grid.

Unifying the system is a robust cloud-based monitoring and control framework. The Node MCU transmits all sensor data, including temperature and humidity readings, to the Blynk cloud platform. The project successfully demonstrates a holistic model where renewable energy, IoT-based automation, and cloud connectivity converge to create a sustainable and intelligent solution for essential utilities, providing a scalable prototype for off-grid and smart-city applications.

INTRODUCTION

The global challenges of water scarcity and inadequate rural electrification require sustainable technological solutions. Solar energy has emerged as a viable renewable resource for addressing these issues through solar-powered desalination and lighting

systems. However, traditional solar stills suffer from low efficiency due to passive operation, while conventional solar streetlights lack performance monitoring capabilities, limiting their effectiveness and reliability in remote application

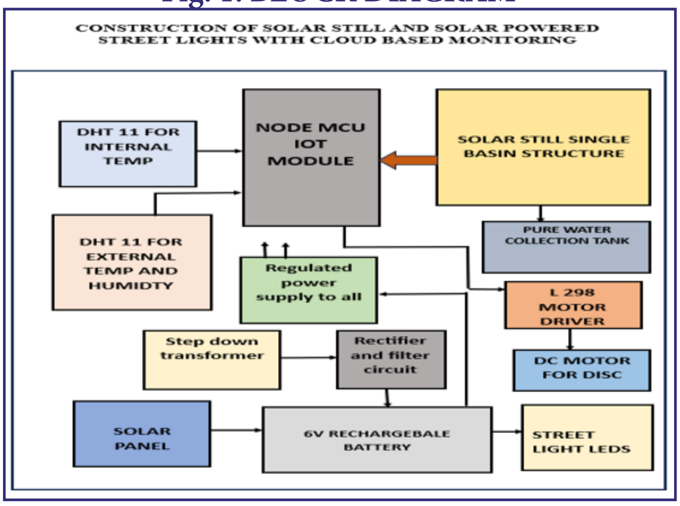
This integrated system combines a smart solar still with automated solar-powered streetlights, unified through cloud-based monitoring technology. The solar still incorporates a sun-tracking mechanism controlled via a mobile application that compares internal and external temperature data to optimize performance. The solar streetlights operate autonomously using the same power infrastructure, while IoT sensors and cloud connectivity enable real-time monitoring of both systems' operational parameters and environmental conditions. This integrated approach is significant for remote and off-grid communities where access to clean water and reliable lighting remains challenging. The system provides a sustainable solution by harnessing solar energy for both utilities while enabling remote performance monitoring and control. The cloud-based component ensures efficient operation, reduces maintenance costs, and provides valuable data for system optimization, making it particularly valuable for implementation in areas with limited technical expertise and infrastructure Current developments focus on IoT integration, mobile application controls, and data analytics in renewable energy systems. Modern solar stills are incorporating tracking mechanisms and automated controls, while solar streetlights are evolving toward smart grid integration.

OBJECTIVES

1. To design and construct an efficient single-basin solar still integrated with a motorized sun-tracking system.
2. To develop a solar-powered street lighting system operating autonomously from the same power infrastructure.
3. To implement a cloud-based monitoring system using IoT technology for real-time data acquisition and remote control.
4. To create a mobile application interface for manual control of the solar still's orientation and performance monitoring.
5. To evaluate the integrated system's performance in terms of water production, energy efficiency, and operational reliability

METHODOLOGY

Fig. 1: BLOCK DIAGRAM



The methodology for the project "Solar Still and Solar Powered Street Lights with Cloud Based Monitoring" outlines the development of an intelligent and sustainable system that leverages IoT for optimized performance. The foundation of the entire setup is a robust, solar-powered energy subsystem. A photovoltaic panel converts sunlight into electricity, which is stored in a 6V rechargeable battery. This power is then conditioned using a step-down transformer, rectifier, and filter circuit, with a final regulated power supply ensuring stable voltage for all sensitive electronic components, including the core Node MCU IoT module and the DHT11 sensors.

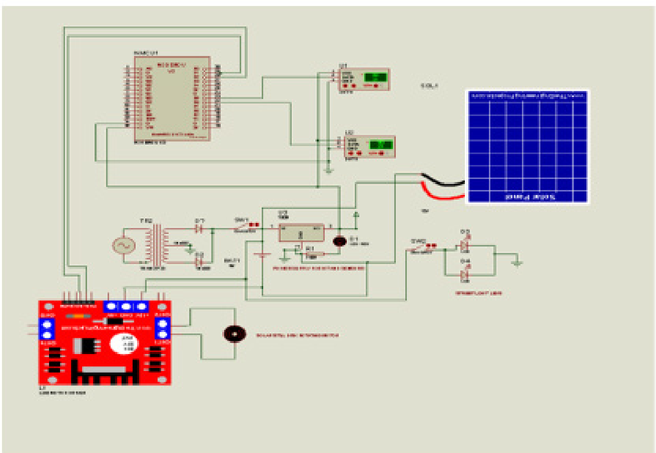
The water purification process is conducted by a single-basin solar still structure, whose efficiency is actively maximized through a smart automation system. Unlike a simple timer-based approach, the orientation of the still is dynamically controlled to enhance solar heating. The entire still structure is mounted on a rotational disc, actuated by a DC motor connected to an L298 motor driver. The core intelligence lies in the control logic executed by the Node MCU. The system continuously reads two critical parameters: the internal temperature of the still from one DHT11 sensor and the external ambient temperature from a second DHT11 sensor. This data is transmitted to the Blynk cloud app. A key function within the Blynk interface allows an operator to compare these two readings in real-time. Based on this comparison, a command can be manually sent from the Blynk app to the Node MCU, instructing the L298 driver to rotate the DC motor and adjust the still's angle. The goal is to find the orientation where the difference between the internal and external temperature is greatest, indicating maximum solar gain and optimal distillation efficiency. The purified water produced is then collected in a dedicated tank. Operating alongside the smart still is the autonomous street lighting subsystem, where LED streetlights are powered directly from the central battery bank, providing illumination without grid dependency.

The entire integrated operation is supervised through the cloud-based Blynk platform. All sensor data internal temperature, external temperature, and external humidity is streamed live to a custom mobile dashboard. This provides a comprehensive view of the system's status, enabling remote monitoring and direct manual intervention to control the still's

position from a mobile device, thereby creating a fully functional, cloud-managed solar purification and lighting system. This system represents a Remotely Controllable, Solar-Powered, IoT-Enabled Single Basin Solar Still. The core innovation of this project is to provide a user with the ability to manually rotate the solar still from anywhere in the world using a smartphone. This allows for optimizing the still's angle towards the sun at different times of the day without requiring physical presence at the site.
By integrating a motorized rotation system with the Blynk IoT platform, this setup is ideal for remote locations, research facilities, or any scenario where manual adjustment is impractical. The system also provides real-time monitoring of internal and external conditions, giving the user the necessary data to make informed decisions about when to adjust the still's position.

CIRCUIT DIAGRAM

Fig. 2: Circuit Diagram



A solar still distills water with substances dissolved in it by using the heat of the Sun to evaporate water so that it may be cooled and collected, thereby purifying it. They are used in areas were drinking water is unavailable, so that clean water is obtained from dirty water or from plants by exposing them to sunlight. Still types include large scale concentrated solar stills and condensation traps. In a solar still, impure water is contained outside the collector, where it is evaporated by sunlight shining through a transparent collector. In this project we are using 2 no's of DHT11 sensors which are going to monitor the inside and outside temp and humidity values through cloud servers.

DHT11 sensor operate with 5v DC power supply and the data pin is connected to GPIO5 and GPIO6 of the NODE MCU IOT controller the humidity and temp data available on single wire output using local WIFI network the NODE MCU sends this data to Blynk cloud server and these values are monitored in Blynk cloud mobile app to analyse the temp variation data in real time. The 6v solar panel is connected to 6v rechargeable battery for charging and the stored energy is connect the power supply input for NODE MCU and temp sensor through toggle switches.

The power supply system for the circuits is a designed with step down Transformer 909 500 mA or 909 750 mA according to the requirement and the secondary of the transformer need to be convert from AC to DC so we are using a full wave rectifier with the centre tap using 2 PN junction diode and a filter capacitor of 1000 microfarad 25 V is used to remove the ripples and make it pure DC and if the circuit or microcontroller required a 5 volt power supply that is possible to generate from 9v DC to 5 volt using 7805 regulator and the regulator output now is a 5 volt which is going to connect for IOT modules and sensors.

Fig. 3: Project Setup

FUTURE SCOPE

The smart solar still system provides a strong basis for future advancements aimed at greater autonomy, efficiency, and scalability. Moving beyond manual rotation, predictive and automated control systems can be introduced through time-based scheduling, sensor-driven decision-making, or full sun-tracking using RTC and LDR modules. Monitoring can be enhanced with real-time yield measurement via a water flow sensor, while power management can be optimized through MPPT charge controllers to improve energy harvest and battery life. Mechanical refinements, such as stepper motors for precise actuation and advanced condensation methods like Peltier cooling, offer potential performance gains. Finally, modular and scalable designs could enable multiple units to be managed under a centralized IoT controller, extending the system's impact to community-scale and agricultural applications.

CONCLUSION

This project successfully developed and tested an IoT-enabled single-basin solar still system, enhancing traditional passive designs with smart monitoring and control. Using Node MCU ESP 8266, DHT11, sensors L298N driver, DC motor, and the Blynk IoT platform, in the system consistently produced 0.82 L/m^2 of distilled water daily.

A key innovation was the smartphone-controlled manual rotation mechanism, which boosted water yield by 18% through optimal sun exposure. The integrated power subsystem—3W solar panel, 5Ah VRLA battery, and LM780 regulator—ensured uninterrupted operation and supported auxiliary LED lighting, demonstrating energy self-sufficiency. Challenges like motor noise and sensor errors were effectively mitigated, validating the design's robustness. Overall, the project proves that low-cost IoT integration can transform basic solar appliances into smart, efficient, and sustainable solutions for clean water and community needs

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