DHYUTI JALA SHODHAN: A SOLAR POWERED WATER PURIFIER SYSTEM FOR REMOTE VILLAGES

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Keywords:

Solar-powered water purification, multi-stage filtration, TDS monitoring, Arduino-based system, Low-cost rural water treatment.

Introduction:

Access to safe drinking water remains a major challenge in rural and remote areas due to contamination and unreliable electricity supply. Conventional purification systems depend on grid power and are often expensive, making them unsuitable for low-income communities. To address this issue, **Dhyuti Jala Shodhan** is proposed as a solar-powered water purification system designed for off-grid applications. The system utilizes renewable solar energy with battery backup to ensure continuous operation during low sunlight or nighttime. It employs a multi-stage filtration process consisting of sediment filtration, activated carbon filtration, and ion exchange resin to remove suspended particles, odour, harmful chemicals, and dissolved salts. A TDS sensor is integrated for real-time water quality monitoring, with output displayed on a 16×2 LCD. An Arduino-based controller ensures efficient operation, low power consumption, and system reliability. The system is portable, cost-effective, and user-friendly, making it suitable for rural households. By combining renewable energy and efficient filtration, it provides a sustainable solution for safe drinking water and improved living standards.

Objectives:

- To develop a low-cost and portable water purification system for rural and remote areas.
- To design an energy-efficient system powered by solar energy with battery backup.
- To implement a multi-stage filtration process for effective removal of impurities.
- To integrate real-time water quality monitoring using a TDS sensor.
- To ensure reliability, ease of use, and minimal maintenance for rural users.

Methodology:

1. The system operates using solar energy combined with filtration and monitoring units. A 12V, 20W solar panel converts sunlight into electrical energy, which is regulated by a solar charge controller to charge a 12V, 7Ah battery. The battery provides backup power during low sunlight conditions.
2. A 12V DC pump draws water from the source and directs it through the filtration stages. The first stage is a sediment filter that removes large particles such as sand and dust. The second stage is an activated carbon filter that eliminates chlorine, odour, and organic impurities. The third stage uses ion exchange resin to reduce dissolved salts and improve water quality.
3. A TDS sensor is placed after filtration to measure water quality. The sensor is interfaced with an Arduino Nano, which processes the data. A buck converter steps down voltage from 12V to 5V for safe operation of the Arduino and LCD.
4. The processed data is displayed on a 16×2 LCD, providing real-time feedback. The purified water is collected in an output tank. The system is compact, energy-efficient, and suitable for rural deployment.

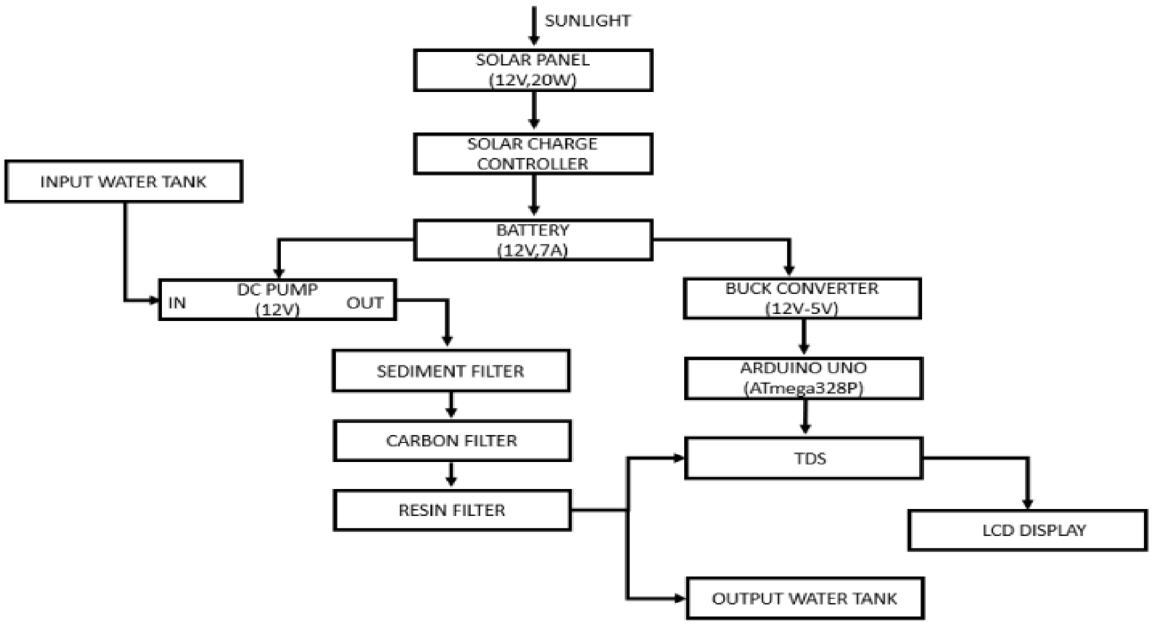

Figure 1: Block Diagram of the Proposed System

Result and Conclusion:

The system successfully demonstrates solar-powered water purification using multi-stage filtration. It effectively removes suspended particles, odour, and dissolved impurities, improving water quality for drinking. The TDS sensor provides real-time monitoring, allowing users to verify purification performance. The Arduino-based control system ensures stable and low-power operation. The system operates efficiently using solar energy with battery backup, ensuring continuous performance even during low sunlight conditions. It is capable of producing approximately 4–5 litres of purified water.

Overall, the project provides a cost-effective, eco-friendly, and sustainable solution for rural water purification. It highlights the practical use of renewable energy for essential applications.

Project Outcome & Industry Relevance:

1. This project offers a practical solution for decentralized water purification in rural and off-grid areas. It is relevant to industries involved in renewable energy, water treatment, and rural development.
2. The system can be adopted by NGOs, government agencies, and startups focusing on sustainable solutions. It aligns with smart village initiatives and can be scaled for community use.
3. The integration of embedded systems, sensors, and solar power demonstrates interdisciplinary application in electronics and environmental engineering. It also has potential for commercialization as a low-cost household purifier.

Working Model vs. Simulation/Study:

1. This project involves the development of a physical working model. A complete hardware prototype has been successfully designed and implemented, integrating solar power generation, battery backup, and a multi-stage water filtration unit. The system includes a DC pump for water flow, sediment, carbon, and resin filters for purification, and a TDS sensor for real-time water quality monitoring.
2. An Arduino-based control system processes sensor data and displays real-time information on a 16×2 LCD. The system operates effectively under solar power with battery support, demonstrating practical feasibility for rural and off-grid applications.

Project Outcomes and Learnings:

- Gained practical experience in designing and implementing embedded systems using Arduino.
- Learned integration of sensors (TDS) with real-time monitoring and display systems.
- Understood solar power systems, battery management, and energy-efficient design.
- Developed knowledge of water purification techniques and filtration technologies.
- Improved skills in circuit design, system integration, and troubleshooting.
- Learned the importance of cost optimization and user-centric design for rural applications.

Future Scope:

The system can be further enhanced by incorporating higher-capacity solar panels to increase water output and efficiency. Advanced battery management systems can be implemented to improve backup performance and battery life. Future improvements may include the use of more efficient pumps for higher flow rates and better durability. Automation features such as automatic water dispensing, touchless operation, and scheduled purification cycles can enhance user convenience. Additional sensors like pH, turbidity, and temperature sensors can be integrated for comprehensive water quality analysis. Data logging and optional IoT-based monitoring can be introduced for remote supervision. The system can also be scaled to serve multiple households or small communities by increasing tank capacity and filtration throughput. Use of improved filtration materials can further enhance purification efficiency while maintaining low cost. Overall, the project has strong potential for expansion into a smart, scalable, and commercially viable rural water purification solution.