IJIREEICE ISSN (O) 2321-2004, ISSN (P) 2321-5526

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering

Impact Factor 8.414 ⁙ Peer-reviewed & Refereed journal ⁙ Vol. 14, Issue 3, March 2026

DOI: 10.17148/IJIREEICE.2026.14311

SOLAR-POWERED SMART IRRIGATION SYSTEM

Ratnadeep Raju Maske[1], Aadesh Babusing Rathod[2], Nagesh Shankar Koshkewar[3], Dipali Bhagwan Athilkar[4], Aditya Sidhharth Wankhade[5], Prof. Rajendra Bhombe[6], Prof. Saurabh Bagde[7]

Students, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[1-5]

Associate Professor, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[6]

Assistant Professor, Electrical Engineering, Guru Nanak Institute of Engineering and Technology, Nagpur, India[7]

Abstract: The increasing demand for sustainable agricultural practices has highlighted the importance of renewable energy in irrigation systems. Traditional irrigation methods that depend on grid electricity or diesel engines are often costly, environmentally harmful, and inaccessible in rural areas with limited power supply. A solar-powered irrigation system provides a clean, economical, and reliable alternative by utilizing photovoltaic (PV) panels to convert solar energy into electricity. This energy is used to operate a water pump that supplies water to the fields through drip or sprinkler irrigation methods. The system reduces dependency on fossil fuels, lowers operational costs, and ensures continuous water supply during critical farming seasons. Additionally, solar irrigation systems are eco-friendly, require minimal maintenance, and support sustainable agricultural development in remote and off-grid regions. This project demonstrates the integration of renewable energy technology in agriculture, contributing to energy conservation, food security, and rural empowerment.

1. INTRODUCTION

The Automatic Solar Smart Irrigation System is an eco-friendly solution that combines solar power with advanced technology to optimize water usage in agriculture. It uses solar panels to power irrigation systems, thereby reducing dependency on non-renewable energy sources. Smart sensors monitor soil moisture and environmental conditions and automatically adjust irrigation schedules to ensure crops receive the appropriate amount of water. This system improves water management, enhances crop productivity, and promotes sustainable farming practices.

1.1 Aim

To design and implement an efficient, eco-friendly, and cost-effective solar-powered irrigation system that utilizes renewable energy to support sustainable agricultural practices.

1.2 Objectives

1. Utilize solar energy for irrigation systems.
2. Reduce dependency on fossil fuels and conventional electricity sources.
3. Promote sustainable agricultural practices.
4. Encourage the use of clean energy in farming to reduce environmental impact.
5. Reduce operational costs.
6. Minimize electricity usage.
7. Ensure efficient water management.
8. Optimize water distribution using timers or sensors to prevent over-irrigation and conserve water resources.
9. Improve accessibility in remote areas.
10. Provide reliable irrigation solutions in rural or off-grid areas where power supply is limited or unavailable.

2. METHODOLOGY

The methodology of the solar-powered irrigation system involves systematic steps from design to implementation. First, a detailed survey of the agricultural field is carried out to determine water requirements, crop types, and the most suitable irrigation method such as drip or sprinkler irrigation. The solar resource availability of the region is assessed in order to properly size the photovoltaic (PV) system. Based on the water demand and total dynamic head, which includes the depth of the water source and delivery height, a suitable DC or AC submersible pump is selected.

International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering
Impact Factor 8.414 ⁒ Peer-reviewed & Refereed journal ⁒ Vol. 14, Issue 3, March 2026
DOI: 10.17148/IJIREEICE.2026.14311

Next, solar PV panels are designed and installed to supply adequate power, and a Maximum Power Point Tracking (MPPT) controller or inverter is integrated to ensure efficient energy utilization. The pump is connected either directly to the PV array in a direct drive system or through a battery or water storage tank to maintain continuous water supply. The piping network and irrigation layout are then developed to distribute water evenly to crops across the agricultural field.
The system is tested under field conditions to evaluate flow rate, efficiency, and reliability. Important operational data such as solar radiation levels, pump performance, and water discharge are monitored during the testing process. Finally, cost analysis and maintenance requirements are evaluated to ensure long-term sustainability and economic feasibility. This stepwise methodology ensures that the solar irrigation system is technically feasible, economically viable, and environmentally sustainable.

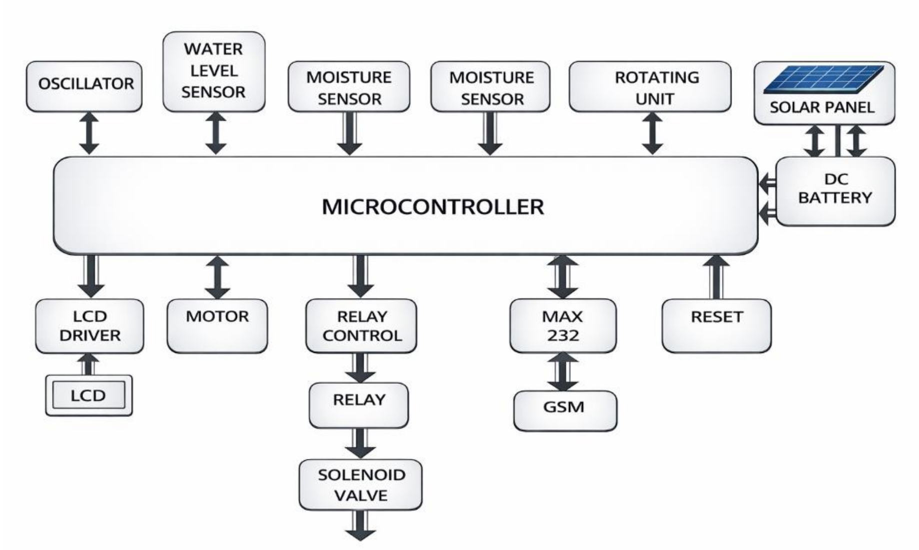

Chart -1: Block Diagram

3. CONCLUSION

A solar-powered irrigation system is a sustainable, cost-effective, and reliable solution for modern agriculture. By using renewable solar energy to pump and distribute water, farmers can reduce dependence on grid electricity and diesel fuel while lowering operating costs. Although the initial installation cost may be higher than conventional irrigation systems, the long-term benefits such as minimal maintenance, zero fuel expenses, and a lifespan of approximately 20–25 years make it a worthwhile investment. Additionally, solar irrigation systems support environmental protection by reducing carbon emissions and promoting the use of clean energy technologies. Overall, solar-powered irrigation is an efficient and eco-friendly technology that improves farm productivity, ensures reliable water availability, and supports sustainable agricultural development.

REFERENCES

[1] International Renewable Energy Agency (IRENA). (2016). *Solar pumping for irrigation: Improving livelihoods and sustainability.*
[2] Food and Agriculture Organization (FAO). (2017). *Solar powered water lifting for irrigation.*
[3] International Electrotechnical Commission. (2011). *IEC 62253: Photovoltaic pumping systems — Design, qualification and performance measurements.*
[4] Ahmed, N. M., et al. (2023). Reliability and performance evaluation of a solar PV-powered underground water pumping system. *Scientific Reports.*
[5] Habib, S. (2023). Technical modelling of solar photovoltaic water pumping systems: Design considerations and optimization.
[6] Dlimi, S., et al. (2024). Modeling, simulation and efficiency assessment of a direct-coupled photovoltaic water pumping system.
[7] Lilhare, A. S. (2024). Maximizing solar water pump efficiency: Exploring MPPT techniques for PV water pumping.
[8] Anbuchandran, S., et al. (2024). MIWO-based MPPT for PV systems driving induction-motor water pumps.
[9] Wanyama, J., et al. (2023). Development of a solar-powered smart irrigation control system (Smart Irri-Kit): Design and evaluation.
[10] Design and performance evaluation of a solar water pumping system — A case study (2016/2017).