Development Of an Automatic Solar Powered Pump with Water Level Sensing

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Abstract: Agriculture is the backbone of many developing countries, and efficient irrigation plays a vital role in improving crop productivity. This paper presents a Solar Powered Automatic Irrigation System using Arduino and GSM technology that utilizes renewable solar energy for water pumping and irrigation management. The system employs solar tracking through LDR sensors, soil moisture monitoring, GSM communication, and automated pump control to reduce human intervention and optimize water usage. The generated solar energy is stored in a battery and used to operate the irrigation system efficiently. The proposed solution provides a cost-effective, eco-friendly, and reliable approach for smart agriculture and water resource management.

KEYWORDS- Solar Irrigation System, Arduino, GSM Module, Soil Moisture Sensor, Solar Tracking, LDR Sensor, Renewable Energy, Smart Agriculture, Water Pump Automation, Sustainable Farming.

INTRODUCTION

Agriculture requires a continuous and reliable water supply to ensure healthy crop growth and increased productivity. In many rural areas, farmers face challenges such as irregular electricity supply, water wastage, and manual irrigation practices. Solar energy has emerged as an effective alternative energy source for agricultural applications due to its availability, sustainability, and low operating cost. The proposed solar-powered automatic irrigation system integrates solar tracking, soil moisture sensing, GSM communication, and automated water pumping to improve irrigation efficiency. The system automatically monitors soil conditions and allows farmers to control irrigation remotely through mobile communication, reducing labor requirements and enhancing water conservation.

RELATED WORK

Numerous irrigation automation systems have been developed using solar energy, wireless communication, and sensor networks. Existing systems mainly focus on soil moisture monitoring, automated water pumping, and remote irrigation management. Some solutions utilize GSM technology for communication, while others employ web-based monitoring using IoT platforms. Solar photovoltaic pumping systems have gained popularity due to their ability to operate independently of grid electricity. However, many existing systems either lack solar tracking mechanisms for maximum energy utilization or provide limited remote control capabilities. Therefore, integrating solar tracking, GSM communication, and automated irrigation control within a single system can significantly improve agricultural efficiency and water conservation.

LITERATURE SURVEY

Several researchers have proposed solar-powered irrigation and automated farming systems to improve agricultural productivity and water management. Researchers have demonstrated photovoltaic water pumping systems that utilize solar energy as an alternative to conventional electricity and diesel-powered pumps, reducing operational costs and environmental impact. Kim and Evans developed wireless sensor-based irrigation systems that monitor soil conditions and optimize water usage through automated control. Chaitali R. Fule and Pranjali K. Awachat introduced a real-time irrigation system using wireless sensor networks for efficient water management. K. Prathyusha and M. Chaitanya Suman proposed embedded systems for drip irrigation automation using soil moisture sensing technologies. Other studies focused on solar-powered pumping systems integrated with ESP32 controllers, temperature sensors, humidity sensors, and moisture sensors to automate irrigation decisions while providing remote monitoring through web servers. These works demonstrate the effectiveness of combining renewable energy and automation technologies for modern agricultural applications.

EXISTING METHOD

Traditional irrigation systems rely heavily on manual operation and conventional power sources for water pumping. Farmers often switch pumps on and off manually, leading to excessive water consumption, inefficient irrigation scheduling, and increased labor requirements. Existing solar-powered irrigation systems provide basic pumping functionality but may lack automated soil monitoring, solar tracking, and remote communication features. Furthermore, dependence on grid electricity and diesel-powered pumps increases operational costs and environmental impact. These limitations reduce irrigation efficiency and create challenges in maintaining optimal soil moisture conditions for crops.

PROPOSED METHOD

The proposed Solar Powered Automatic Irrigation System integrates solar energy generation, solar tracking, soil moisture sensing, GSM communication, and automated water pumping. LDR sensors continuously monitor sunlight intensity and direct the solar panel toward maximum illumination using a stepper motor controlled by Arduino. The generated energy is stored in a battery through a charging circuit and used to power the irrigation system. A soil moisture sensor measures moisture content in the agricultural field and sends data to the Arduino controller. Based on the soil moisture level, the controller activates the GSM module, which informs the user about irrigation requirements through SMS notifications. The farmer can remotely control the water pump by sending SMS commands from any location. This approach minimizes water wastage, reduces labor effort, and improves crop productivity through efficient irrigation management.

SYSTEM ARCHITECTURE

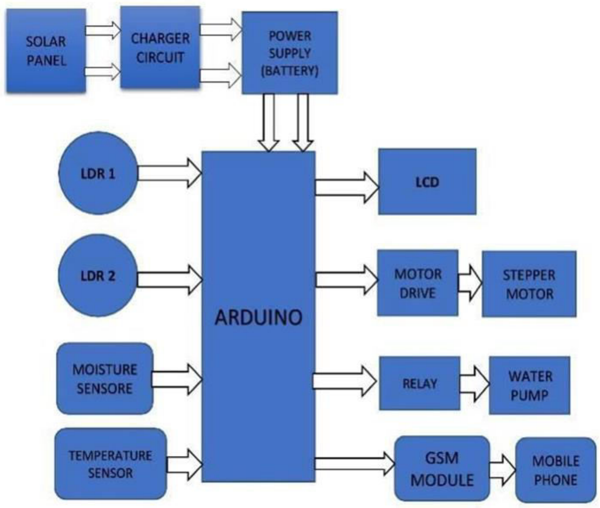

Fig.1 System Architecture

MODULE DESCRIPTION

Solar Panel Module: The solar panel converts sunlight into electrical energy and serves as the primary power source for the irrigation system. The generated energy is stored in a battery for continuous operation.

Charger Circuit Module: The charger circuit regulates and stabilizes the voltage generated by the solar panel before charging the battery. It protects the battery from voltage fluctuations and extends battery life.

LDR Sensor Module: The Light Dependent Resistor (LDR) sensors detect sunlight intensity and help determine the optimal direction for solar panel positioning. They improve solar energy harvesting efficiency.

Arduino Controller Module: The Arduino microcontroller acts as the central processing unit of the system. It receives sensor data, controls the stepper motor, operates the water pump, and manages GSM communication.

Motor Driver Module: The motor driver controls the movement of the stepper motor based on commands from the Arduino controller. It enables solar panel tracking toward maximum sunlight.

Stepper Motor Module: The stepper motor rotates the solar panel according to signals received from the motor driver, ensuring maximum solar energy collection throughout the day.

Relay Module: The relay functions as an electronic switch that controls the operation of the water pump based on Arduino commands. It enables safe and efficient switching of high-power devices.

Soil Moisture Sensor Module: The soil moisture sensor measures the water content in the soil and continuously sends readings to the Arduino controller for irrigation decision-making. It helps maintain optimal moisture levels for crop growth.

GSM Communication Module: The GSM module enables communication between the irrigation system and the farmer through SMS notifications. It allows remote monitoring and control of the water pump from any location.

LCD Display Module: The LCD displays sensor readings and system status information, providing users with real-time monitoring of irrigation conditions. It improves system usability and monitoring efficiency.

Water Pump Module: The water pump supplies water to agricultural fields and is automatically controlled according to soil moisture levels and user commands. It ensures efficient irrigation while reducing water wastage.

RESULTS AND DISCUSSION

The proposed solar-powered automatic irrigation system successfully utilized solar energy for water pumping and automated irrigation management. The LDR-based solar tracking mechanism efficiently positioned the solar panel toward maximum sunlight, resulting in improved energy generation. The soil moisture sensor accurately monitored field conditions and enabled automatic irrigation control, while the GSM module facilitated remote communication and pump operation through SMS. Experimental observations indicated significant reductions in water wastage, labor requirements, and dependency on conventional electricity sources, making the system suitable for sustainable agricultural applications.

CONCLSUION AND FUTURE SCOPE

The Solar Powered Automatic Irrigation System provides an efficient and environmentally friendly solution for agricultural water management. By integrating solar tracking, soil moisture monitoring, GSM communication, and automated pumping, the system reduces human effort, conserves water resources, and improves crop productivity. The use of renewable solar energy minimizes dependence on conventional electricity and lowers operating costs. In the future, weather forecasting, IoT-based cloud monitoring, artificial intelligence-driven irrigation scheduling, and mobile application integration can be incorporated to further enhance system intelligence and agricultural efficiency.

REFERENCES

1. Y. Kim and R. G. Evans, "Software Design for Wireless Sensor-Based Site-Specific Irrigation," *Computers and Electronics in Agriculture*, Vol. 66, pp. 159–165, 2009.
2. W. R. Anis and H. M. B. Metwally, "Dynamic Performance of a Directly Coupled PV Pumping System," *Solar Energy*, Vol. 53, pp. 369–377, 1994.
3. W. Lawrance, B. Wichert, and D. H. Gridge, "Simulation and Performance of a Photovoltaic Pumping System," *Power Electronics and Drive Systems*, Vol. 1, pp. 513–518, 1995.
4. Chaitali R. Fule and Pranjali K. Awachat, "Design and Implementation of Real Time Irrigation System Using a Wireless Sensor Network," *International Journal of Advance Research in Computer Science and Management Studies*, Vol. 2, Issue 1, 2014.
5. K. Prathyusha and M. Chaitanya Suman, "Design of Embedded Systems for Automation of Drip Irrigation," *International Journal of Application or Innovation in*

Engineering and Management, Vol. 1, Issue 2, 2012.

6. Haley M. and M. D. Dukes, "Evaluation of Sensor Based Residential Irrigation Water Application," *ASABE Annual International Meeting*, Minneapolis, Minnesota, 2007.
7. Odeh I., Yohanis Y. G., and Norton B., "Economic Viability of Photovoltaic Water Pumping Systems," *Solar Energy*, Vol. 80, pp. 850–860, 2006.
8. Kamel K. and Dahl C., "The Economics of Hybrid Power Systems for Sustainable Desert Agriculture in Egypt," *Solar Energy*, 2005, pp. 1271–1281.
9. "A Report on Solar PV Applications in India," Center for Study of Science, Technology and Policy, 2006–07.
10. S. G. Malla, C. N. Bhende, and S. Mishra, "Photovoltaic Based Water Pumping System."
11. Babburi, S. Privacy-Preserving Collaborative Framework with Auditable Federated Learning.
12. Gaddam, S. Integrating Analytics into the Development Process: Bridging the Gap between Data Insights and Design Execution.
13. Immadi, S. K. (2025). Optimizing ERP for Human Capital Management. Applied Research for Growth, Innovation and Sustainable Impact, 377–384. https://doi.org/10.1201/9781003684657-63
14. Reddy, S. K. R. Developing a Modular AI Framework to Enhance Scalability and Personalization in Next-Generation Reward Platforms.
15. Poojari, R. INTELLIGENT SYSTEMS+B108 AND APPLICATIONS IN ENGINEERING.
16. Mahimalur, R. K., Vasgam, M., & Manoharan, D. Devops Lifecycle Management And Cloud Migration Assessments: A Security-Driven CICD Perspective.
17. Viswanathan, V. (2023). AI-Augmented Decision Intelligence for Enterprise Systems: Integrating Cognitive Analytics for Resource and Talent Optimization.
18. Agrawal, A. M., Gajula, S., Shinde, R. P., Shah, H., & Ghosh, H. (2025, July). Machine Translation for Long Sequences with Enhanced Attention Mechanisms. In 2025 5th International Conference on Electrical, Computer and Energy Technologies (ICECET) (pp. 1-6). IEEE.

19. Maturi, S. Y. (2021). Blockbond hardening: Securing pooled-hash protocols against traffic tampering, MITM hash-rate hijacking, and template coercion. International Journal of Communication Networks and Information Security, 13(3), 718–728.
20. Adabala, P. K. (2024). Utilizing predictive analytics to improve efficiency and decision-making in ERP-connected supply chains. International Journal of Intelligent Systems and Applications in Engineering, 12(22s), 2465
21. Kavuri, S. (2026). An Explainable Machine Learning Framework for Predicting Software Defects in Large-Scale Software Systems. 2026 IEEE 5th International Conference on AI in Cybersecurity (ICAIC), 1–6. https://doi.org/10.1109/icaic67076.2026.11395777
22. Venkata Pavan Kumar Gummadi. (2023). MuleSoft Batch Processing: High-Volume Streaming Architecture. Computer Fraud and Security, 50–57. https://doi.org/10.52710/cfs.886
23. Shashank, A. (2025). Self-Healing Data Pipelines for Enhanced Reliability: A Paradigm Shift in Enterprise Data Management. Journal of Computer Science and Technology Studies, 7(8), 1097-1104.
24. Susarla, R. S., Boyapati, P. K., & Kandula, S. T. R. (2025, July). Cloud-Based Secure Data Storage in Smart Cities Using Central-Smoothing Hypergraph Neural Networks. In 2025 IEEE 4th World Conference on Applied Intelligence and Computing (AIC) (pp. 279-284). IEEE.
25. Boyapati, P. K. Building a centralized data operations hub for healthcare enterprise integration. IJSAT-Int. J. Sci. Technol. 16 (2). https://doi.org/10.71097/IJSAT.v16.i2.3219