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Smart Irrigation System with Hybrid Power Generation using SCADA

Darade Aryan Maruti, Jagtap Rohit Vijay, Khairnar Vedant Vilas, Prof. Kanawade M. V
Department of Electronics and Telecommunication
Amrutvahini Sheti and Shikshan Vikas Sanstha Amrutvahini Polytechnic, Sangamner, Ahmednagar, Maharastra, India

Abstract: *This project presents a Smart Irrigation System powered by hybrid energy sources, integrated with SCADA (Supervisory Control and Data Acquisition) for real-time monitoring and control. The system utilizes renewable energy sources such as solar and wind to generate power, ensuring sustainability and reducing dependency on the grid. It automates irrigation based on soil moisture levels, temperature, and humidity, optimizing water usage for agricultural fields. The SCADA system provides a user-friendly interface to monitor environmental conditions, control water pumps, and receive alerts, enabling efficient and remote farm management. This project aims to promote sustainable agriculture, conserve natural resources, and reduce manual intervention through automation and smart energy utilization.*

Keywords: SCADA

I. INTRODUCTION

Efficient irrigation and sustainable energy usage are crucial for modern agriculture. Traditional systems often rely on manual control and grid electricity, which can lead to inefficiencies, water wastage, and increased operational costs. This project proposes a Smart Irrigation System powered by hybrid energy sources, such as solar and wind, ensuring continuous and eco-friendly operation. The system is automated using a Programmable Logic Controller (PLC), which controls irrigation based on real-time data from environmental sensors. A SCADA (Supervisory Control and Data Acquisition) system is integrated to remotely monitor and manage the entire setup, providing real-time data visualization and control capabilities. This combination of renewable energy, automation, and remote monitoring enhances resource management, reduces human intervention, and promotes sustainable farming practices.

II. LITERATURE REVIEW

Several research studies and projects have explored the integration of automation and renewable energy in irrigation systems to improve agricultural efficiency. Traditional irrigation systems often lack intelligence and depend heavily on manual control, leading to excessive water usage and energy consumption.

Recent developments have introduced PLC-based automation, which offers high reliability and flexibility in controlling irrigation based on sensor data like soil moisture, temperature, and humidity. Studies have shown that PLC systems can significantly reduce water wastage and ensure timely irrigation.

In parallel, the use of SCADA systems in agriculture has gained attention for its ability to remotely monitor and control irrigation activities. SCADA provides a user-friendly interface for data visualization, logging, and control, making it ideal for large-scale or remote farming operations.

On the energy side, various works have focused on using solar and wind energy to power agricultural systems. Hybrid power generation enhances system reliability and reduces dependence on non-renewable energy sources.

Combining these technologies—hybrid renewable energy, PLC automation, and SCADA monitoring—has been proposed as a highly effective solution for developing smart irrigation systems. However, comprehensive implementations integrating all three components are still limited, highlighting the need for projects like this to advance sustainable and intelligent agricultural practices.

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III. ACTUAL METHODOLOGY FOLLOWED: -

The project began with a detailed analysis of system requirements and the selection of suitable components, including solar panels, a wind turbine, a PLC, SCADA software, environmental sensors (soil moisture, temperature, and humidity), a water pump, and associated control devices. A hybrid power generation system using solar and wind energy was designed to ensure a sustainable and uninterrupted power supply. This setup included a charge controller and battery to manage power flow and storage efficiently. The selected sensors were integrated with the PLC, which was programmed using ladder logic to monitor real-time environmental parameters. Based on the soil moisture readings, the PLC was configured to automatically control the irrigation pump. A SCADA system was then developed to interface with the PLC, enabling real-time monitoring, manual control, and data logging through a user-friendly graphical interface. Once the system was fully integrated, it was tested under various conditions to ensure proper functionality and reliability. The final step involved fine-tuning the system by adjusting thresholds and timing to optimize water usage and power efficiency, as well as validating SCADA alarms and logging features for better fault detection and system monitoring..

3.1 Impact of this project:

The implementation of a Smart Irrigation System with Hybrid Power Generation using PLC and SCADA has a significant positive impact on both agriculture and the environment. By automating irrigation based on real-time soil and weather conditions, the system ensures efficient water usage, helping to conserve one of the most vital natural resources. The use of renewable energy sources like solar and wind reduces dependency on conventional power, lowering energy costs and promoting eco-friendly practices. Additionally, remote monitoring and control through SCADA minimize the need for manual labor, making it highly beneficial for farmers in remote or large-scale agricultural fields. Overall, this project contributes to sustainable farming, resource conservation, and the adoption of modern automation technologies in agriculture.

IV. FUTURE SCOPE

The Smart Irrigation System with Hybrid Power Generation using PLC and SCADA holds vast potential for future development and large-scale implementation. In the future, the system can be enhanced by integrating IoT (Internet of Things) for cloud-based monitoring and control, enabling farmers to access real-time data and operate the system from smartphones or web applications. Machine learning algorithms can be applied to predict irrigation schedules based on weather forecasts and crop types, further improving efficiency. The power system can also be expanded to include biomass or hydro energy for improved hybrid generation. Additionally, integrating fertilizer automation (fertigation) and water quality monitoring can make the system even more intelligent and comprehensive. With government support and wider adoption, this system can play a key role in promoting smart, sustainable, and technology-driven agriculture.

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