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The Role of Automation in Modernizing Irrigation Practices and Smart Farming: A Comprehensive Review

Sanket S. Katte[1,*], Sanket U. Gaikar[2], Rushikesh J. Gujar[3], Kajal R. Chimane[4], Shruti Gour[5]

Abstract

The development of a "Smart Farming Using Automation" system that functions in three modes—timer, soil moisture, and PH sensor—for the farmer's advantage is the focus of this study. An automated drip irrigation system with a PLC is described in this paper. Using sensors for soil moisture and pH. The soil moisture sensor's function is to calculate how much water is required for irrigation. A PLC uses the solenoid valve to control the water supply when the moisture content is either at the right level or lower. Depending on the pH level of the soil, a fertiliser supply system is also incorporated into the water irrigation system. This study focuses on the system of agriculture that can be used to control the parameters of an agricultural area. Observation from carrying out this study demonstrates effective use of water for crops, reduction in losses resulting from climate change, and appropriate application of fertiliser in the agricultural field. The Mitsubishi FX3 PLC platform is used to implement the suggested automation strategy in real time. The demand for efficient irrigation systems has increased due to water constraint and the desire for higher agricultural output. In this work, we suggest an automated drip irrigation system that precisely controls and manages the irrigation process using a PLC. The PLC is connected to a network of sensors that are integrated into the system to monitor temperature, humidity, soil moisture content, and weather. After processing the sensor data, the PLC applies pre-programmed logic-based programming to regulate the irrigation system's valve, solenoid valve, and other components.

Keywords: Automation, Mitsubishi FX 3 PLC, soil moisture sensor, PH sensor, solenoid valves

INTRODUCTION

Watering crops or plants with a Mitsubishi programmable logic controller (PLC) is a cutting-edge and effective way to practise "smart farming." With drip irrigation, water is directly delivered to plant roots via a system of emitter-equipped tubes or pipes. A sensor measures the moisture content and pH of the soil, and the system releases water to each plant in a precisely controlled amount. A PLC, on the other hand, is a digital based on computers control system that uses logic-based programming to automate a range of functions. The utilisation of a PLC in combination with a smart farming system can yield accurate regulation of the quantity, timing, and duration of watering each plant, leading to optimal plant development and water efficiency. To make sure that the plants receive the proper amount of water at the correct time, the PLC can be configured to monitor and manage several

***Author for Correspondence**
Sanket S. Katte
E-mail: sanketskatte@gmail.com

[1–4]UG Scholar, Department of Electrical Engineering, KJ's educational institute trinity college of engineering and research, Pune, Maharashtra, India
[5]Assistant Professor, Department of Electrical Engineering, KJ's educational institute trinity college of engineering and research, Pune, Maharashtra, India

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parameters, including the pH and moisture content of the soil. The automation of solenoid valves, valves, and other irrigation system components can be achieved by integrating the PLC with sensors, actuators, and other devices. Improved plant health and growth, less water waste, increased water efficiency, and remote monitoring and management of the irrigation process are just a few advantages of integrating a PLC into an automatic drip irrigation system. The system may be customised and programmed to fit crop requirements, soil conditions, and environmental factors, making it a flexible and scalable solution for agricultural and horticulture applications. All things considered, Smart Farming Using Automation offers an advanced and cutting-edge method of irrigation that maximises plant development while preserving water resources. It does this by providing accuracy, efficiency, and automation. Being among the most precious natural resources, water is the basis of agricultural systems and agricultural. Previous papers employed pairs of modes: Timer mode & Moisture sensor mode, pH sensor mode & Moisture sensor mode, and Timer mode & pH sensor mode. In this article, all three techniques are merged. The key benefit is that the crop's water and fertiliser supply can be managed, saving time and resources while also increasing output. After the PLC receives the sensor's data, it compares it to a preset value. The system will automatically complete the work based on the analysis's findings.

Global population increase and food scarcity are the two biggest obstacles to sustainable development. The world's problems can have practical answers thanks to cutting-edge technology like mobile internet, IoT, and artificial intelligence (AI).

Related Studies

Approximately 70% of freshwater is used for farming. A considerable volume of fresh water is wasted in farming due to the current timer-based techniques. Harshith et al described the creation of an automated irrigation system using a PLC that can adjust the daily irrigation volume based on crop variety and climate variations [2]. The system adjusted the daily irrigation quantities based on plant requirements using basic sensors. PLCs can sense water levels directly, and by adjusting the irrigation schedule to the measured conditions, they can save a significant quantity of water.

The design of an autonomous irrigation system controlled by a programmable logic controller is presented by Steffi et al [3]. Their goal is to use a renewable energy source to increase productivity while lowering water and electricity usage, so helping farmers overcome their challenges and increase profits. With the aid of software known as SCADA (supervisory control and data acquisition), which uses a PLC (programmable logic controller) to perform the regulating action, farmers would be able to monitor and manage the irrigation system from a single location.

Ravi Kant Jain created a web-based application and Internet of Things (IoT) powered smart drip irrigation system. Additionally, the web application is made to allow the user to perform the necessary actions when using drip irrigation. With the help of his programme, farmer can provide the garden with the right amount of water from the pump. This can be achieved by including several sensors in the system to monitor the temperature, humidity, and soil moisture levels. The sensors then send the data to the micro-controller, which uses it to accurately estimate the plants' water requirements. Through a web application, this type of system may be seen and operated on an Android mobile device from any location [4].

Smart agriculture is the application of new technology to crop management to facilitate automated systems, resource optimisation, and remote monitoring [5]. Introducing intelligence to automatic irrigation systems by either enhancing irrigation decision-making using intelligent control techniques like fuzzy logic or neural networks, or by enhancing irrigation modelling or control using deep learning or machine learning techniques, which require the incorporation of large amounts of data into the analysis. By administering water when, where, and when it's needed, intelligent irrigation systems aim to boost agricultural productivity while lessening the environmental impact of crops [6].

Mohamed et al demonstrated the use of robots and unmanned aerial vehicles (UAVs) to perform a variety of tasks in real-time utilising the Internet of Things, artificial intelligence (AI), deep learning (DL), machine learning (ML), and wireless communications. These tasks include harvesting, seedling, weed detection, irrigation, spraying agricultural pests, and livestock applications [7]. Furthermore, because a 5G mobile network can link a huge number of devices per square kilometre and allows for high-speed data transfer of up to 20 Gbps, their work highlights the significance of adopting 5G networks in the development of smart systems.

Modern smart monitoring and irrigation control techniques that have been applied recently for irrigation scheduling were examined by Bwambale et al. To improve irrigation scheduling in open field agricultural systems, their study assisted researchers and farmers in selecting the optimal irrigation monitoring and control technique [8].

Vij et al. [9] suggested a sustainable irrigation strategy that was created by setting up a distributed wireless sensor network (WSN), in which every area of the farm would be covered by different sensor modules that would communicate data on a single server.

Sensors Importance

Numerous sensors were installed in the smart irrigation system to track water levels, irrigation effectiveness, climate, etc. On-farm weather variations as well as changes in soil and yield characteristics can be measured and tracked by the sensors. As a result, the sensors can collect various data that will be utilised to analyse agricultural legislation and help with decision-making. These intelligent sensors track changes in the health of the crops, soil, and livestock. They also help to improve the amount and quality of agricultural output. Two sensors, one for minimum humidity and the other for maximum humidity, control it. A different valve is used to irrigate each sample. The PLC oversees the valves. When the maximum humidity is attained, the PLC closes the valve that feeds the relevant sample. The PLC switches off the main power supply after each sample has achieved its maximum relative humidity. The PLC stops the main pump when each sample reaches its maximum humidity level. The system has undergone successful design, construction, and testing. Every element in the smart system is measured and observed by sensors; for instance, specific sensors are used for soil health monitoring to track variables like compaction, moisture content, phosphate content, and nutrient levels. Typical sensors included in smart agricultural networks include soil moisture sensors, which track changes in soil moisture, soil temperature sensors, which detect changes in soil temperature, air temperature, soil pH value, humidity, and N, P, and K sensors, among others [12–15].

Depth Detector for Water Level in Soil

The depth of the water level in the soil can be determined using a water depth sensor. A water depth sensor is a great tool for irrigation. This sensor will undoubtedly assist in measuring the soil's water content, which will ultimately aid in determining how much water must be applied to the crops during irrigation. This will guarantee that there is no scarcity of water for the crops in the fields and that there is no supply of excess water [11].

Programmable Logic Controller (PLC)

Allen Bradley (AB) PLCs, which are programmed with software and data files to store I/O and other internal values, are used in this instance as programmable logic controllers (PLCs). Only one type of data could be stored in these various data files. While this PLC made using instructions simple, it presented a problem when it came to logically combining various data kinds based on their functions. For example, in machine control, a motor might have separate data types for its start, stop, speed, and alarm codes. From the perspective of this project, the Allen Bradley PLC is the best since it has a scale block, which allows the programme to be completed in fewer steps, reducing complexity, and increasing accuracy. PLC will be powered by a 24V DC source. The PLC includes actual programming stored in it.

Mayuri et al used a Programmable Logic Controller (PLC) to control the level of moisture in the soil in an irrigation system that uses renewable energy sources. The soil moisture sensors function as a feedback element, and a PLC is triggered in response to the signals they receive to regulate the amount of water that is over- and under-watered, ultimately leading to water optimisation. Thus, they can regulate the appropriate amount of water needed for crops to grow healthily, which aids in good crop output. They have valves in their system that they can turn on or off. who can be simply mechanised using PLC [5].

Technologies of Communication

The communication technologies that are being utilised in conjunction with the deployment of IoT devices may be seen as essential to achieving successful operations. It is also possible to view the use of communication technologies as being in line with the context in which they will be employed. Two categories could be used to group the primary IoT technologies for irrigation. One might be thought of as the node-functioning devices that have low energy consumption, forward or transmit modest amounts of data over short distances. As a result, the other gadgets are the ones with high energy consumption that can send massive volumes of data across large distances. Wireless protocols are widely available for use in Internet of Things communication, and they can be used to categorise devices based on whether they communicate over long or short distances [16,17].

Process Algorithm

In the everyday agriculture industry, irrigation is the most labor-intensive task and a significant cultural tradition. There are sensors and techniques available to detect when plants might need water, so this can be done automatically. Automation entails cutting costs, increasing manufacturing speed, and making efficient use of available resources. The development of a PLC system for automatic plant irrigation is the primary goal of this research. Another goal of this project is to turn on and off the motor and transmit farmers short message services (SMS). In our project, numerous sensors are employed. There are bioelectrodes, soil moisture sensors, and temperature sensors. We can ascertain the soil's amount of moisture thanks to these sensors. A pumping motor will pump water if it's dry. Plant nutrient content is measured using bio electrodes. PLC is the primary controlling device in this system. The PLC continuously monitors the pumping motor, which pushes water into the field until it is saturated. A PLC is a type of control system that continuously checks the condition of an input device and decides how to regulate the state of an output device by using a programme. "Programmable Logic Controllers," or PLCs, are employed in production procedures. As previously stated, the goal of this study is to create a low-cost PLC-based irrigation controller that uses basic sensors to autonomously adjust its irrigation schedule based on the weather. The working mechanism is presented in Figure 1 and Figure 2.

By utilising photographs to account for all four parameters—soil moisture, temperature, NPK soil component, and crop quality—this automated watering system is now more effective and efficient. Incorporating weather forecasts will also aid water management.

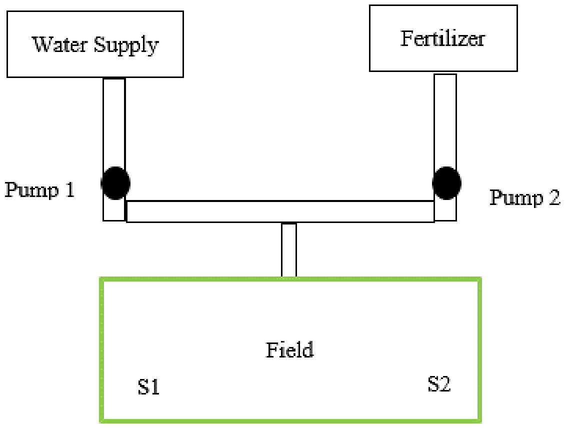

Figure 1. Block diagram of smart farming using automation.

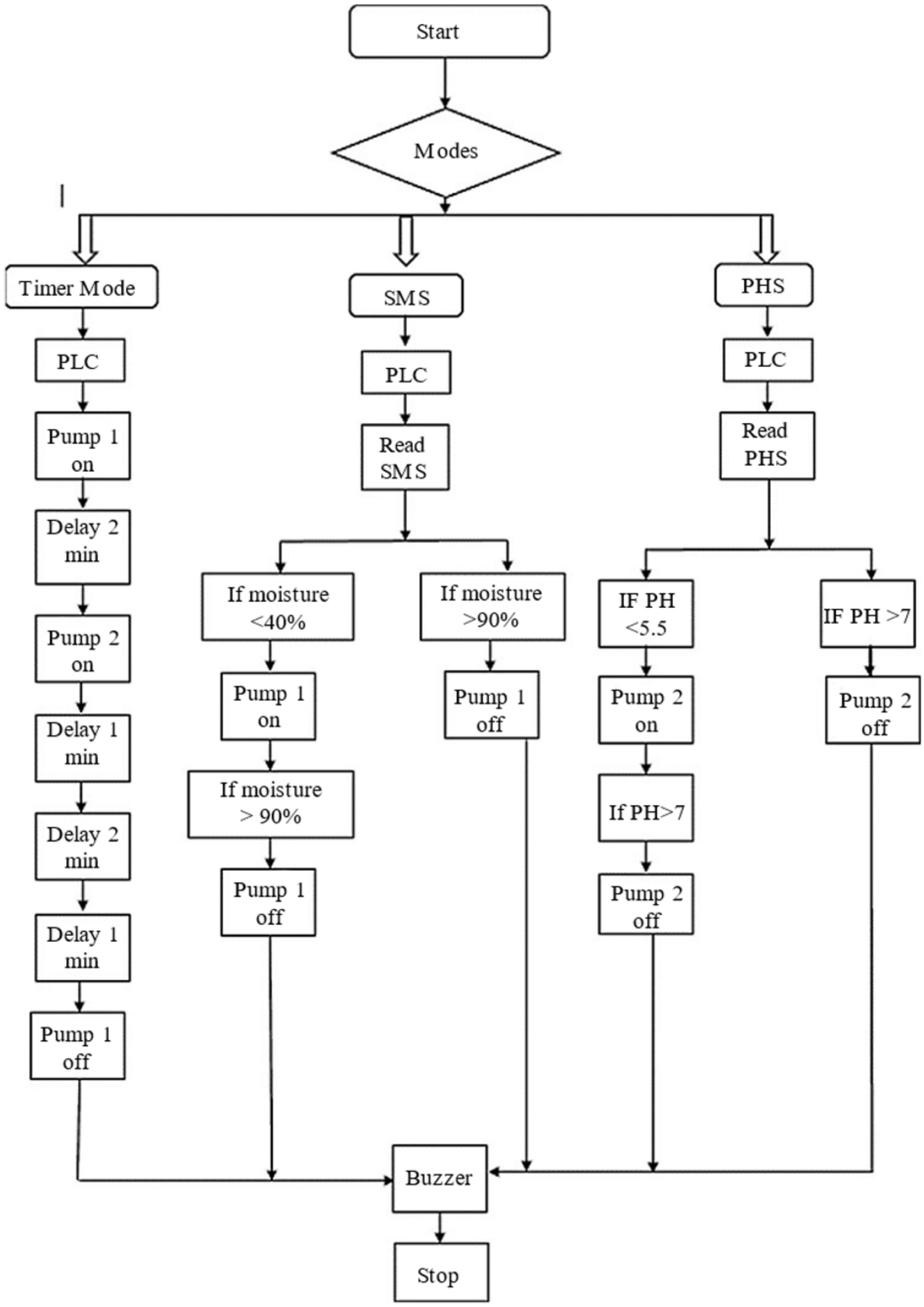

Figure 2. Flow chart of smart farming using automation.

CONCLUSION

We applied our understanding of plc in this project. We discovered that the agricultural process is beneficial to farmers in terms of both land and crop development. In conclusion, there are several benefits for contemporary agriculture from the usage of PLC (Programmable Logic Controller) in smart farming automation systems. PLC-controlled systems give farmers exact control over the distribution of nutrients and water, which promotes enhanced crop quality, higher crop yields, and efficient water use. Optimising irrigation schedules and lowering labour requirements are made possible by automation and remote monitoring capabilities, which also enable ease of operation and real-time modifications. PLC-controlled drip irrigation systems' potential is further increased by integration with cutting-edge technologies like precision agriculture, the Internet of Things, and renewable energy sources. In general, the potential for expanded use of PLC in Smart Farming systems is bright.

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