

SMART IRRIGATION SYSTEM FOR PRECISION FARMING

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Abstract—Agriculture has been the main driver of the economy and has been the source of the major livelihood of the communities. Out of the essential elements of agriculture, irrigation is the one which is a turning point for the crop productivity and overall efficiency. The output of an irrigation-planned farm will be quality and quantity of the yields depending on how well the setup has been optimized. But, water shortage is the biggest thorn in the side of the modern irrigation system. In most cases, conventional irrigation methods result in the use of more water than required, and also, they lack a good monitoring system and their efficiency levels are always low. The problem with traditional irrigation can be fixed by implementing a smart irrigation system utilizing precision farming. In fact, it is a farming method in which Internet of Things and Artificial Intelligence are used to facilitate the process of irrigation in such a way that it becomes automated and efficient. The system is built around a micro controller that interacts with various sensors such as a soil moisture sensor, a DHT11 temperature and humidity sensor, a rain sensor, and a float switch for the continuous collection of environmental and soil parameters. On the basis of these conditions, the control system selects the relay that controls the pump to supply the water. Thus, the water flow is only carried out when it is necessary. In addition, the system keeps a record of the data in the cloud and links it to the mobile applications for monitoring. Moreover, the data may be converted into graphs or tables, and the user may also remotely operate the irrigation process from his/her device if it is his/her wish. Besides, AI-based predictive analysis can be used in place to determine irrigation needs via local weather forecast and soil parameters. The experiment results show that the water used in the system is much less while the soil moisture is maintained at an ideal level which will later lead to the increased productivity of crops. This research is a step towards bridging the gap between traditional farming and precision agriculture through proof of concept of IoT-enabled smart irrigation systems.

I. INTRODUCTION

Water shortages and the use of inefficient agricultural methods are still among the biggest problems standing in the way of the achievement of sustainable food production. The most common irrigation methods are usually done manually and under fixed schedules. This results in the watering of the plants with more or less water than necessary by 100%, which results in the wastage of

water, decrease in crop yields, and increase in company costs. In the farm sector, promising technologies such as Internet of Things, smart sensing-based solutions, and data-driven decision-making are gaining prominence rapidly and are seen as the main drivers of sustainable farming. Environmental sensing and automated control in a Smart Irrigation System allow water delivery to be adjusted to the soil and climatic conditions based on the real-time data instead of using predetermined schedules.

This project mainly contains such as soil moisture sensors, temperature and humidity sensors, wireless communication modules, and micro controller based control units are some of the components of the system which ensure that irrigation takes place only when and where it is needed. In addition, integrating cloud platforms and mobile applications gives farmers the opportunity to know what's going on in their fields, get notifications, and change irrigation parameters on the fly from any location.

This research describes the conceptualization and realization of a Smart Irrigation System for Precision Agriculture, whose main goal is water usage optimization and crop yield increase by means of intelligent automation. The system under consideration is sensor-based and uses feedback and data processing algorithms for the regulation of water flow in accordance with real-time field data. The work is committed to pushing the irrigation industry forward, thus, it also targets the alleviation of the tedious manual labor, and the implementation of sustainable agricultural practices.

II. LITRATURE SURVEY

A number of researchers have come up with different ways to automate irrigation by using micro controllers, sensors, and wireless communication technologies. These experiments emphasize on the irrigation efficiency, saving water, and lessening the work of humans in the agricultural practices. The paper presents a review of the pertinent existing systems, their operation, pros, cons, and the ways in which the proposed Smart Irrigation System surpasses them.

“GSM Based Automated Irrigation Using Sensors” authored by Subalakshmi, Anu Amal and Arthireena- has presented the design of an automated irrigation system

that incorporates a PIC16F877A micro controller with soil moisture, and temperature sensors. The system automates the water pump operation based on sensor readings and thus, the crop can receive the required irrigation even without the presence of a human being. The GSM module allows the farmer to receive an alert in real-time via an SMS whereas the LCD display can be used to check the functioning of the system as well as the sensor readings. Such a system saves water, eases the work of the farmers, and is eco-friendly as it contributes to the conservation of nature[1] .

Jawad Awawda and Isam Ishaq created an IoT-based intelligent irrigation system by combining soil moisture, temperature, and water level sensors with cloud connectivity. By means of the web dashboard, the system allows for real-time monitoring and automated water control. The primary goal of the system is to minimize water consumption and enhance crop yield by implementing irrigation based on the collected data[2].

Sharmin Akter and pinkirani mahanta built a smart irrigation system that automatically waters the plants when the soil is dry using Arduino UNO, soil moisture sensor, relay, and DC pump. The system manages the water flow very efficiently without the need for a human, thus it saves both water and irrigation time. The system could be a great tool for the effective and resource-saving irrigation of small-scale areas such as gardens and nurseries.[3].

Marco Del-Coco and Marco Leo examined how machine learning can be utilized in intelligent irrigation systems and offered a typical layout representing the integration of the layers for sensors, data processing, and decision-making. The paper identifies the problems of few annotated datasets and difficulties in scaling up solutions from the lab to the field. It points out the need for the creation of efficient and versatile ML models as a way of not only saving water but also increasing agricultural productivity[4].

IV .OBJECTIVE

Precision agriculture is going to be the world of agriculture.

Among the main objectives of precision agriculture is the employment of available resources up to their maximum with minimum resources wastage. The main objectives for this system:

- Using IoT technologies to automate the irrigation process and save farmers time and money spent on this process.
- Cut the farmers spending on water and electricity by managing the available re-sources with maximum efficiency.

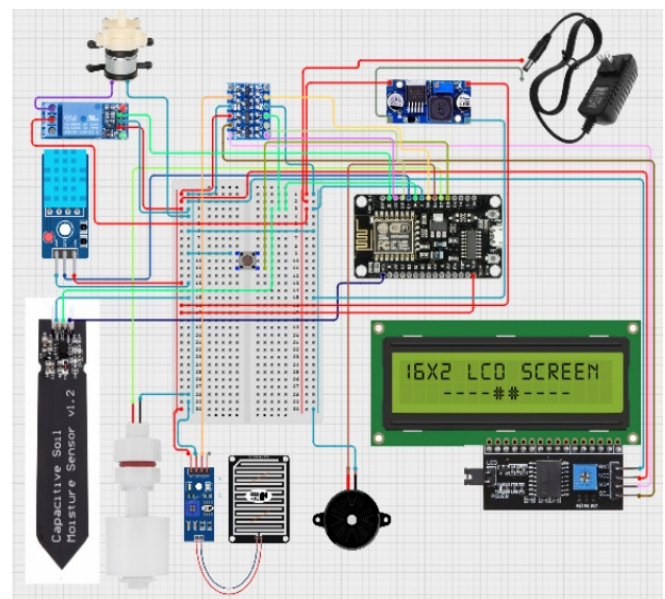
- Managing The water resource by addressing water scarcity without impacting the crops health.
- Maintain the farmers up to date with fields and crops real time status

V .PROPOSED SYSTEM

The main objective of the suggested Smart Irrigation System for Precision Farming is to save water that is used in agricultural fields through a method of automatic irrigation that adjusts itself depending on a number of environmentally friendly parameters. The system basically consists of different types of sensors, a micro controller, and IoT technology that are used to measure the state of the ground and the atmosphere in the outdoor environment in real time and water the crops if needed. The entire structure is made up of three significant levels which are: the sensing layer, the control and processing layer, and the actuation and feedback layer.

A. SYSTEM ARCHITECTURE:

Fig. 1. Architecture of the Proposed Model



Node MCU(ESP8266) is the main micro controller of the system, which is the reason why the device has Wi-Fi and low power consumption. The Node MCU interfaces with various environmental sensors to collect data in real-time, processes the data, and takes irrigation actions if the codes or threshold values set in advance are violated. The system thus initiates the watering of the crops in an automated and accurate manner by turning the water pump on through a 2-Channel Relay Module.

Besides the local display of all the sensor data, machine status, and user alerts on a 16x2 I2C LCD, they can be sent wireless to a remote dashboard or cloud application

for viewing. The device is powered by a regulated 5V main source that comes from a buck converter, which lowers the 12 V DC input to the correct voltage and thus ensures the power supply is safe and stable.

B. HARDWARE COMPONENTS:

1. **NodeMCU(ESP8266):** Acts as the main micro controller unit with a built-in Wi-Fi module for data processing and wireless communication.
2. **Soil Moisture Sensor:** Provides the soil moisture content in real-time to figure out the water needs.
3. **DHT11 Sensor:** Helps temperature and humidity measurement in the environment for analysis.
4. **Rain Sensor:** Confirms the presence of rain to stop irrigation automatically during wet conditions.
5. **Float Switch:** Shows the situation of the water tank, thus stopping the pump from operating when the tank is empty.
6. **Relay Module:** Facilitates the turning on/off of the 220V AC water pump controlled by the user through electrical isolation in a safe manner.
7. **16×2 I2C LCD Display:** Shows the live sensor readings along with the system status locally.
8. **Buzzer:** Gives real audible alerts like in the case of water shortage or rain detection, etc.
9. **Logic Level Shifter:** Transforms the 5V output of the sensor into 3.3V logic that is compatible with NodeMCU.
10. **Buck Converter:** Changes the 12V DC input into 5V to be used for the system components.

VI. WORKING PRINCIPLE

1. The principle of the "Smart Irrigation System for Precision Farming" application is the situation observation of nature and the automated control of the water supply system in order to achieve the most efficient irrigation of water. Several sensors deployed in the field constantly monitor soil and weather parameters. The micro controller receives this data and manages irrigation.

2. Node MCU(ESP8266) is the main unit that is connected with all the sensors and actuators. A soil moisture sensor is used to determine the amount of water in the soil. The sensor gives out an analog signal that is directly proportional to the soil moisture level. The DHT11 sensor provides information about ambient air temperature and humidity, and a rain sensor is used to detect raindrops. The float switch observes the level of water in the storage tank and stops the pump from operating when the tank is empty.

3. During the field testing, the Node MCU calls periodically on sensors for required data. The soil moisture value that is recorded is then compared with the threshold predefined. It thus transpires that when the soil moisture level is lower than the threshold and no rainfall is recorded, the controller sends the command to the 2-

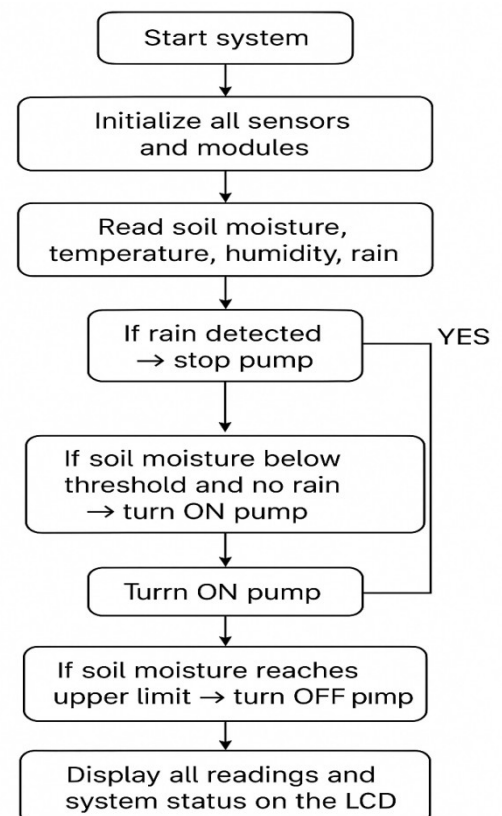
channel relay module to turn on the AC water pump. Water is then used for irrigation up to the point when the soil moisture returns to the set upper threshold level, whereupon the pump is switched OFF by the relay module.

4. The power for all parts is taken from a buck converter that converts 12 V DC down to 5 V thus providing a stable operation. To prevent the controller from being damaged by over-voltage, a logic level shifter is used to match the voltage levels between 5V sensors and the Node MCU, which is 3.3V.

5. In the event of rainfall, the system ceases irrigation automatically in order not to waste water. Also, when a float switch indicates a low water level in a water-tank, the Node MCU cuts off the pump and turns on the buzzer to notify the user. At the same time, a 16x2 I2C LCD is used to show real-time data to the user.

A. ALGORITHM:

Fig. 1. Algorithm of the proposed model



VII. DISCUSSION

The smart irrigation system underwent testing in the open field conditions and it accomplished its goals perfectly. Sensors of soil moisture, temperature, humidity, and rain gave the exact data, so the Node MCU could operate the water pump on its own.

The installation performed the task of saving water very well as it watered the soil only when the earth was dry and it stopped watering the soil when it rained. The experiment was a water-saving measure by 30–40% in comparison with traditional irrigation.

The float switch was able to stop the pump from operating when the water tank was empty and the buzzer and 16x2 LCD were giving real-time alerts and data. To sum up, the system was found to be dependable, user-friendly, and efficient for precision farming.

VIII. CONCLUSION

The IoT-based smart irrigation system in the automated watering method decides the watering by itself with the help of real-time soil and weather data. It is a water-saving device that does not allow the over-irrigation of the soil and gives the alerts through the buzzer and LCD. Apart from being a reliable and simple-to-use device, the system also contributes significantly to the area of sustainable agriculture. The system is an impactful demonstration of the eventual tech that can turn the farm into a more efficient one, conserve the earth's resources, and reduce human labor simultaneously.

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