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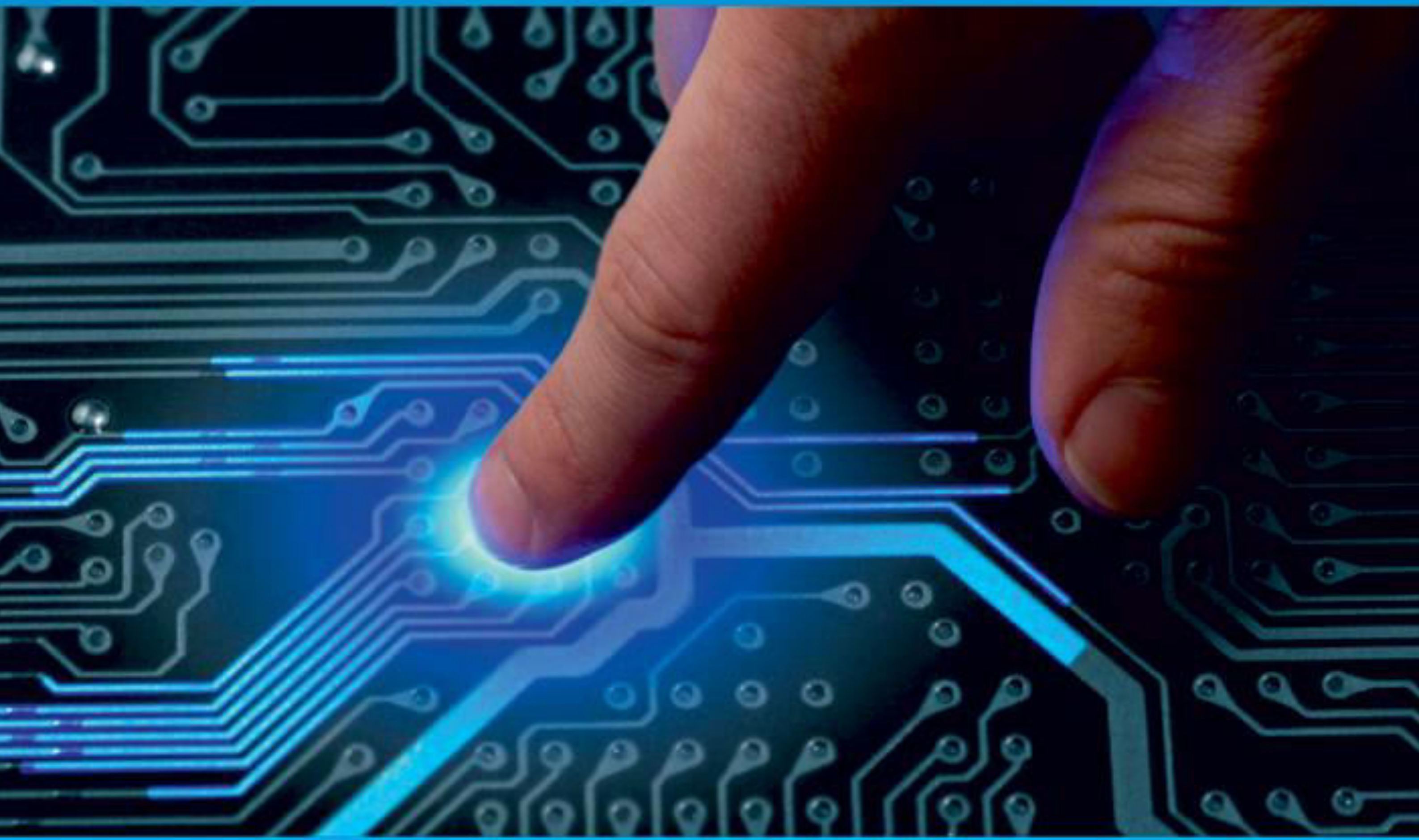

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Smart Irrigation System Utilizing AI for Precision Agriculture

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ABSTRACT: The integration of IoT technologies in agriculture has revolutionized various industries, including smart cities, health, grids, and homes. This paper explores the potential of machine learning and IoT data analytics in agriculture, focusing on the prediction model of tomato disease using IoT systems. The paper also conducts a local survey to understand farmers' perceptions of emerging technologies and their impact on precision agriculture. It also discusses the challenges faced in integrating these technologies into traditional farming methods. The paper highlights the power and capability of computing techniques in agriculture, including the potential for improved production and quality, despite the limitations of traditional farming approaches.

KEYWORDS: Data, AI, Sensors, Irrigation, Soil, Crop, Water, Visual, Using, Usage.

I. INTRODUCTION

The Smart Irrigation System, a cutting-edge solution utilizing AI, IoT, and sensor technologies, aims to improve agricultural practices by enabling precise and data-driven irrigation management. The system uses a camera for visual inspection, soil moisture sensors, and pH sensors to detect plant diseases and pest infestations, allowing for targeted treatment and reduced crop losses. AI algorithms analyze sensor data in real-time to determine optimal irrigation schedules and nutrient dosages. The system delivers water and fertilizers directly to plant roots, maximizing efficiency and minimizing runoff. IoT technology enables remote monitoring and control, allowing farmers to access real-time data and receive alerts on their smartphones or computers. This allows them to make informed decisions, such as adjusting irrigation schedules or applying treatments, thereby optimizing crop yield while conserving water and resources. The Smart Irrigation System represents a significant advancement in precision agriculture, offering sustainable solutions to enhance crop productivity, conserve resources, and mitigate environmental impact.

Smart Irrigation using AI is a project aiming to revolutionize traditional agricultural practices by incorporating advanced technologies for precise irrigation management. The system uses a network of sensors, including a camera for visual inspection, soil moisture sensors, and pH sensors, to collect real-time data on plant health and soil conditions. The data is processed by a microcontroller, triggering actions through relay-controlled pumps and batteries. The AI algorithms analyze this data to determine irrigation needs, optimize resource usage, and promote healthier crop growth. Agriculture forms the backbone of our society, providing sustenance and livelihoods for billions worldwide. However, traditional farming methods often suffer from inefficiencies in water usage and inadequate monitoring of plant health, leading to suboptimal yields and resource wastage. To address these challenges, the Smart Irrigation System utilizing AI offers a cutting-edge solution that leverages the power of technology to transform agricultural practices.

By harnessing the capabilities of AI, IoT, and sensor technologies, this system enables precise and data-driven irrigation management tailored to the specific needs of crops and soil conditions. The integration of a camera for visual inspection allows for early detection of plant diseases and pest infestations, facilitating targeted treatment and minimizing crop losses. Soil moisture sensors and pH sensors provide critical information on the moisture levels and nutrient balance of the soil, guiding irrigation and fertilization strategies

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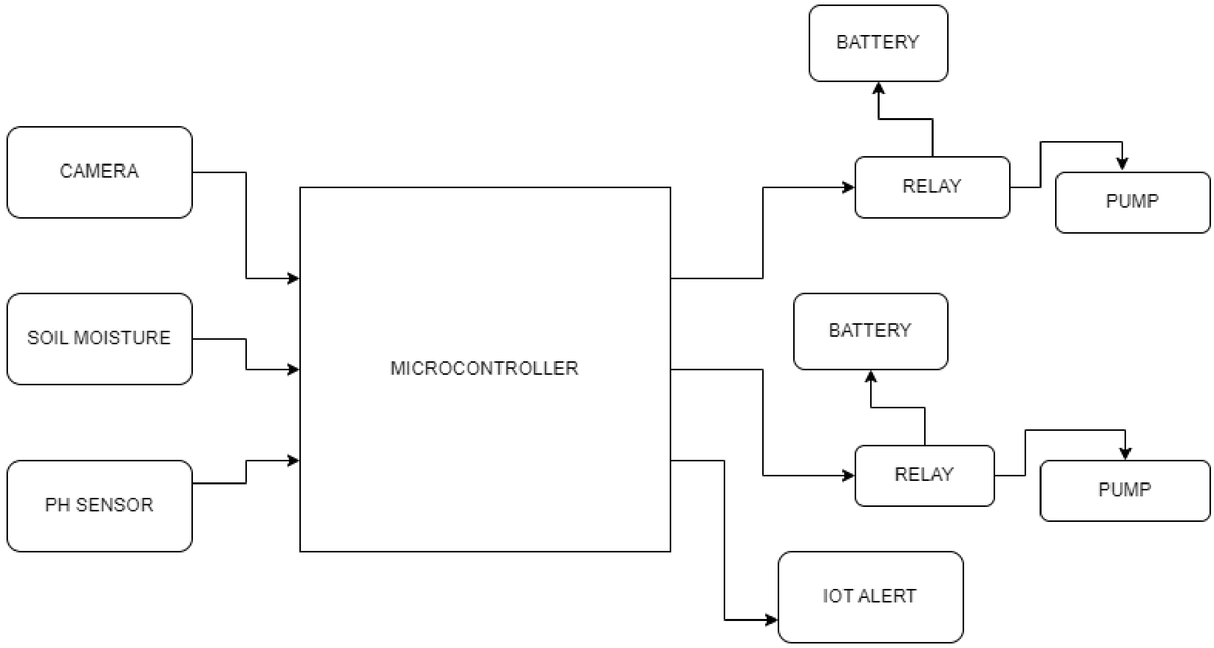

II. RELATED WORKS

An intelligent IOT sensor coupled precision irrigation model for agriculture 2022 G.S. Prasanna Lakshmi a, P.N. Asha b, G. Sandhya c, S. Vivek Sharma d, S. Shilpashree e, S.G. Subramanya d The irrigation scheduler may focus on agricultural requirements like irrigation water quantity and time conservation when its efficiency is monitored. The two model parameters that are thought to have the most effects on how often plants need to be watered are temperature and time; for both plants, the best periods to water are between 9:30 a.m. and 12:00 NN.

Intelligent IoT-multiagent precision irrigation approach for improving water use efficiency in irrigation systems at farm and district scales" 2021 " Andrés-F Jiménez a b, Pedro-F Cárdenas a, Fabián Jiménez c" The fourth industrial revolution in agriculture aims to automate traditional practices using modern smart technologies, such as electronics, computation, and the internet of things. This paper presents an intelligent IoT-multiagent precision irrigation approach for improving water use efficiency in irrigation systems. The study was conducted in the large-scale irrigation and drainage district of Chicamocha and Firavitoba, Colombia, where water is distributed from the Chicamocha riverbed. The system uses an intelligent irrigation agent to autonomously prescribe and apply water amounts based on agronomical criteria. The methodology was applied to eleven pump stations that supply water to 5911 fields. Using a MQTT protocol, hundreds of irrigation agents report water prescriptions and crop characteristics to a master agent in each station. The master agent creates a regional irrigation map and negotiates water resources based on supply availability. The results show that irrigation amounts are correctly applied, improving water use efficiency."

" IoT-enabled edge computing model for smart irrigation system" 2022 "S. Premkumar EMAIL logo and AN. Sigappi" For the irrigation system that is full of potentially wise choices, elements like plant kind, soil, climate, humidity, temperature, and soil moisture need to be taken into account. While the sensor network senses additional variables like temperature, humidity, and soil wetness, ontology—a branch of metaphysics that studies the essence of being—inquires about the kind and characteristics of the plant, soil, and environment. Based on ontology and other previously mentioned parameters, the trained machine learning model forecasts the watering decisions.

III. METHODOLOGY

Working Principle:

This sensor mainly utilizes capacitance to gauge the water content of the soil (dielectric permittivity). The working of this sensor can be done by inserting this sensor into the earth and the status of the water content in the soil can be reported in the form of a percent.

This sensor makes it perfect for executing experiments within science courses like environmental science, agricultural science, biology, soil science, botany, and horticulture.

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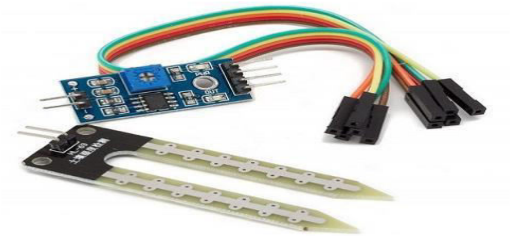
Specifications:
The specifications of this sensor include the following.
The required voltage for working is 5V
The required current for working is <20mA
The type of interface is analog
The required working temperature of this sensor is 10°C~30°C

Soil Moisture Sensor Applications:



The applications of moisture sensors include the following.

Agriculture
Landscape irrigation
Research
Simple sensors for gardeners

Water Pump:

The water pump can be defined as a pump that uses principles like mechanical as well as hydraulic throughout a piping system to make a sufficient force for its future use. They have been approximately in one structure otherwise another because of early civilization. At present these pumps are utilized within a wide range of housing, farming, municipal, and manufacturing applications.

The DC 3-6 V submersible water pump is a low-cost, small-size submersible pump motor as shown in Figure 5. It operates from a 2.5V to approximately 6V power supply. It can take up to 120 liters per hour with a very low current consumption of 220mA. The tube pipe is connected to the motor outlet, submerged in water, and powered it.
the motor of the water pump whereas others can be energized by other kinds of drivers like gasoline engines otherwise diesel.

The water pump is a portable device and can be applied in several household applications. These pumps are used for pumping a huge amount of water from one place to another. The main purpose of a water pump is versatility. A quality pump that can be selected carefully may be perfect for draining water from a low-flooded region, refilling the swimming pool, and bathtub, and circulating pesticides otherwise fertilizers.

Types of Water Pumps
Water pumps are classified into two types namely **positive displacement** and **centrifugal.** These pumps are mainly designed to supply water from one location to another constantly.

Relay:

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A Relay is a simple electromechanical switch. While we use normal switches to close or open a circuit manually, a Relay is also a switch that connects or disconnects two circuits. But instead of a manual operation, a relay uses an electrical signal to control an electromagnet, which in turn connects and disconnects another circuit.

9V Battery:

This is a General-purpose 9V Original HIW marked Non-Rechargeable Battery for all your project and application needs. As we experienced the use of this battery in our testing lab for various purposes, we can assure you the best quality, long life, and genuineness of this battery among all options available in the market at this cost.
Its Universal 9V battery size and connecting points; it is useful in many DIY projects as well as household applications and they can easily be replaced and installed; the same as you would an AA battery or an AAA battery.

PH Sensor:
This pH sensor is commonly used to test the pH of a liquid as it measures the hydrogen-ion activity in water-based solutions. Wherever acidity and alkalinity testing is required, it is frequently employed in the chemical.
businesses, pharmaceutical industry, dye industry, and scientific research. This kit's drive board works with both 9V systems. It's also very easy to work with Arduino and Raspberry Pi.

IV.IMPLEMENTATION

A neural network is a type of machine learning model based on the human brain's structure and operation. Artificial neurons, or nodes that are interconnected and process information before making decisions based on that information, make up neural networks.

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A convolutional neural network (CNN) is frequently utilized in Object Detection Capture Generation to extract image features. Due to its capacity to capture spatial hierarchies of image features, a CNN is a type of neural network ideal for image recognition tasks.

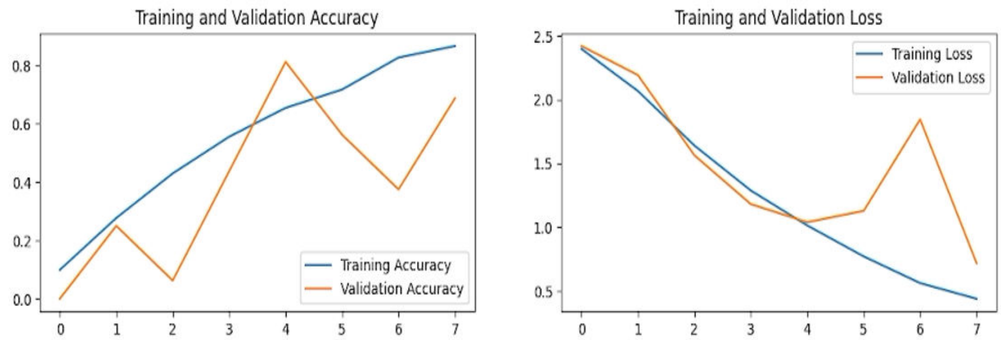
The main operation that a CNN network uses for everything is the convolution operation. This operation is the foundation for the Convolutional Neural Network. As you can see, the image is made up of several pixels. The image pixels in the upper-left corner are our primary focus. We focus on the shaded area in green, which has 3x3 pixels and a center pixel value of 6.

The labeled convolution filter for a 3x3 matrix is the one we are employing on the image. A kernel is another name for this filter. In this instance, the kernel used is the Sobel Gx kernel. You can see the values of the kernel. On the image's upper side, you can also see the convolution process.

Now, by calculating the element-wise dot product, the kernel adds up the values of the green-shaded region and the kernel. Applying the kernel or filter to the source pixel values and performing element-by-element multiplication precedes the sum calculation. The following is the convolutional operation:

The first value of the filter and the green-shaded pixels are 3, respectively. As a result, when we add them up, we get -3. The multiplications of subsequent elements, and so on, are then computed.

V. RESULTS



Continuous refinement and development of AI algorithms can improve the system's ability to analyze complex data sets and make more accurate predictions regarding irrigation needs and plant health. Incorporating additional sensors such as leaf temperature sensors or nutrient sensors can provide more comprehensive data for precise irrigation and fertilization management. Implementing automation and robotics technology can further streamline agricultural operations, reducing the reliance on manual labor and increasing efficiency. Utilizing advanced data analytics techniques and predictive modeling can enable the system to anticipate future irrigation requirements and optimize resource allocation accordingly. Designing the system to be scalable and accessible to small holder farmers and agricultural communities in developing regions can help address food security challenges and promote sustainable agriculture practices globally.

VI. CONCLUSION

In conclusion, the implementation of a smart irrigation system utilizing AI represents a significant advancement in precision agriculture, offering a transformative solution to conventional farming challenges. By seamlessly integrating sensor technologies, AI-driven algorithms, and IoT capabilities, the system enables precise irrigation management, targeted nutrient application, and proactive crop health monitoring. This not only optimizes water usage and resource allocation but also enhances crop productivity, resilience, and sustainability. Ultimately, the adoption of such innovative technologies holds the promise of revolutionizing agricultural practices, promoting environmental stewardship, and ensuring food security for future generations.

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