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Automated Fruit Disease Detection and Smart Irrigation System Using YOLOv8

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Abstract - This project presents a Automated Fruit Disease Detection and Smart Irrigation System Using YOLOv8 for precision agriculture. A USB camera is used to continuously monitor fruits on the trees, and the YOLOv8 deep learning model is employed to detect and track fruit growth and maturity in real time. Along with visual monitoring, a soil moisture sensor is used to evaluate soil dryness, and a pH sensor is used to measure soil acidity or alkalinity to assess soil quality. Based on the sensor readings, the system automatically controls a DC water pump.

When the soil moisture level falls below a predefined threshold, the DC pump is switched ON to provide irrigation, and it is turned OFF once optimal moisture is reached. And GSM is used for message alert. The combined use of image-based fruit monitoring and soil condition analysis enables better crop management, improved yield, and efficient water usage. This system supports intelligent decision-making in smart farming by integrating deep learning, sensor-based monitoring, and automated irrigation.

***Key Words*:** YOLOv8, Automated Fruit Disease Detection, Smart Irrigation System, Precision Agriculture, Deep Learning

1. INTRODUCTION

Agriculture forms the backbone of the economy, and ensuring crop health and efficient resource utilization is essential for improving yield and sustainability. One of the major challenges faced by farmers is the timely detection of fruit diseases and proper irrigation management. Traditional methods depend on manual observation, which is time-consuming, labor-intensive, and often inaccurate. This project presents a Automated Fruit Disease Detection and Smart Irrigation System using YOLOv8 that uses modern technologies like image processing and sensor-based monitoring.

2. LITERATURE SURVEY

This paper reviews various fruit yield prediction methods, including image-based and sensor-based techniques.It highlights the importance of computer vision in improving accuracy and efficiency in agriculture. This paper introduces Faster R-CNN, a deep learning model for accurate object detection using region proposal networks. It improves detection accuracy but requires higher computational resources. This paper presents the YOLO algorithm for real-time object detection using a single neural network. It offers high speed and efficiency compared to traditional detection methods. This study focuses on detecting fruits even when they are partially hidden using advanced segmentation techniques. It improves accuracy in challenging conditions like occlusion. This paper develops a system for detecting and tracking fruits using multi-view cameras and 3D reconstruction. It enhances fruit localization and counting accuracy in greenhouse environments.

3. EXISTING SYSTEM

In traditional farming systems, fruit monitoring and irrigation management are mainly performed manually by farmers. Farmers visually observe the plants to estimate fruit growth, maturity, and health condition. This method depends heavily on the farmer's experience and may not always provide accurate information about fruit development. Similarly, irrigation is often done using manual watering or timer-based irrigation systems without considering the real-time condition of the soil. Soil moisture levels are usually estimated by physical inspection, and soil pH is tested separately in laboratories rather than being monitored continuously in the field. Due to the absence of automated monitoring systems, farmers may face problems such as improper irrigation, water wastage, and difficulty in accurately predicting fruit maturity. These traditional methods require significant human effort and may not provide efficient crop management.

Inefficient water usage, dependance on human experience, separate soil testing methods, lack of automation are the limitations of existing system.

4.PROPOSED SYSTEM

The proposed system is an Automated Fruit Disease Detection and Smart Irrigation System Using YOLOv8 developed using Raspberry Pi and Python programming. The system integrates modern technologies such as deep learning, sensor-based monitoring, automation, and communication systems to improve agricultural efficiency, reduce manual effort, and enhance crop productivity.

The block diagram of the proposed system is shown in below Fig 1.

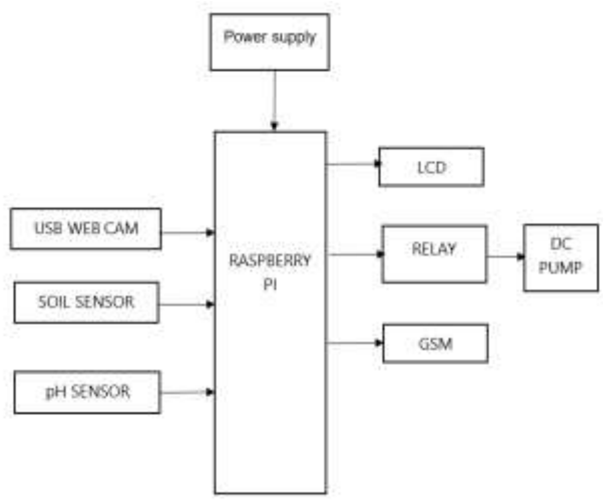

Fig 1: Block diagram of proposed model

It consists of a power supply unit, Raspberry Pi, USB camera, soil moisture sensor, pH sensor, relay module, DC pump, LCD display, and GSM module. The system begins with the power supply unit, which provides a stable and regulated voltage to all components. A step-down transformer converts the 230V AC input into low voltage AC, which is then rectified, filtered, and regulated to obtain a constant 5V DC supply. This regulated power is used to operate the Raspberry Pi, sensors, and other modules.

At the core of the system is the Raspberry Pi, which acts as the central processing unit. It controls all operations including image processing, sensor data acquisition, decision making, and communication.

A USB Web camera is connected to a Raspberry Pi to continuously capture images of fruits directly from the tree. These images are processed using the YOLOv8 deep learning algorithm, which is capable of identifying specific visual patterns associated with fruit diseases. The model is trained using a dataset of diseased fruit images, enabling accurate detection and classification of various diseases in real time. After detecting the disease using the image processing system, the Raspberry Pi uses the GSM module to send an alert to the farmer. The alert is sent in the form of an email, which includes the captured image of the diseased fruit along with the detected disease name. This helps the farmer to take immediate action and prevent further crop damage.

To address irrigation inefficiencies, the system incorporates a soil moisture sensor that continuously measures the water content in the soil. The sensor provides digital output values in the form of 0 and 1, where 0 indicates dry soil and 1 indicates sufficient moisture. These values are read by the Raspberry Pi in real time. When the moisture level falls below the predefined threshold (value = 0), the system automatically activates a relay module, which turns ON the DC water pump to supply water to the plants. Once the soil reaches the optimal moisture condition (value ≥ 1), the Raspberry Pi deactivates the relay, turning OFF the pump. This automatic irrigation mechanism ensures efficient water usage, prevents wastage, and maintains proper soil moisture for healthy plant growth.

In addition to moisture monitoring, a pH sensor is used to measure the acidity or alkalinity of the soil, which plays a crucial role in nutrient absorption and plant development. The pH sensor communicates with the Raspberry Pi through serial communication. Multiple readings are taken to ensure accuracy, and the final value is compared with the ideal range of 6.5 to 8.5. Continuous monitoring of pH levels helps maintain soil health and supports optimal crop growth.

For local monitoring, the system includes a 16x2 LCD display with an I2C interface, which shows real-time values of pH and water status. The water status is displayed as “YES” when sufficient moisture is present (value = 1) and “NO” when the soil is dry (value = 0). This allows farmers to easily understand the current irrigation condition directly from the field.

This ensures that farmers are immediately informed about crop health issues, even if they are not physically present. They can take timely actions such as applying pesticides or removing infected fruits, thereby preventing the spread of disease and minimizing crop loss.

The entire system operates in a continuous loop, where image capture, disease detection, sensor monitoring, irrigation control, display updates, and alert generation are performed repeatedly. The integration of these technologies creates a comprehensive smart agriculture solution. Overall, the proposed system offers several advantages, including:

- Reduced water wastage
- Minimal human intervention
- Accurate and early disease detection
- Efficient irrigation based on real-time soil conditions
- Improved crop growth and productivity

By combining image processing, embedded systems, and communication technologies, the system provides a reliable, efficient, and scalable solution for modern smart farming applications.

5.RESULTS

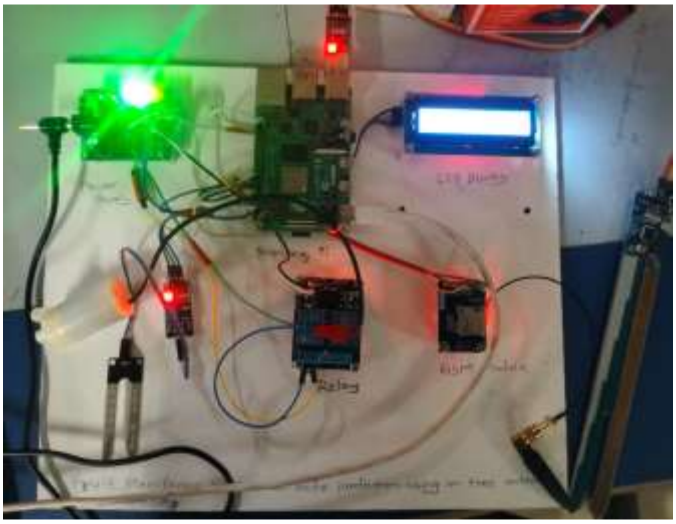

Fig 2. Experimental Hardware Setup

The Fig 4.2 shows the complete hardware implementation of the proposed smart fruit monitoring and automated irrigation system. The setup consists of a Raspberry Pi, soil moisture sensor, pH sensor, relay module, DC water pump, GSM module, and LCD display. The Raspberry Pi acts as the central controller, processing sensor data and controlling the irrigation system. The hardware components are interconnected to enable real-time monitoring and automatic irrigation based on soil conditions.

Fig3: LCD Display showing the results of pH values , and presence of water

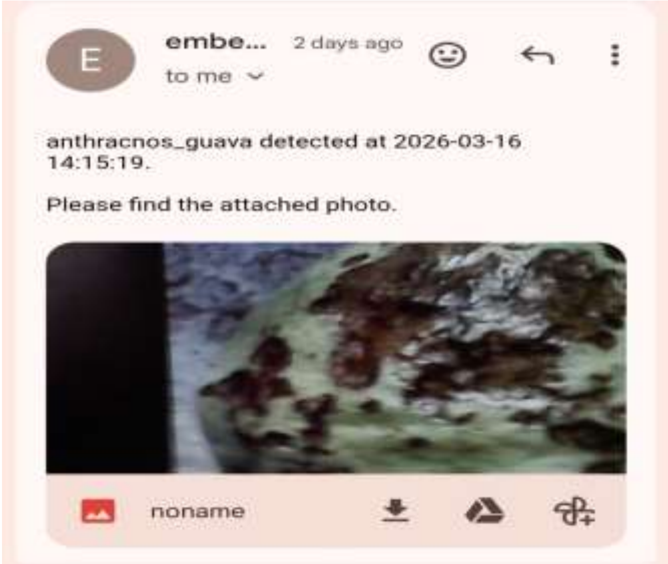

Fig 4. Emergency alert to the farmer contains the name of the disease and photo of affected fruit

6. CONCLUSION

The project “Automated Fruit Disease Detection and Smart Irrigation System using YOLOv8 ” was successfully designed and developed. An automated fruit disease detection system using image processing techniques based on the YOLOv8 deep learning algorithm was developed. A smart irrigation system that “automatically manages water supply based on real-time soil conditions using moisture and pH sensors” was developed. It was working good. The proposed system achieved automated disease detection, efficient irrigation control, and timely alert notifications. The results showed that the system worked effectively and provided reliable performance under real-time conditions.

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[3] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You only look once: Unified, real-time object detection," in Proceedings of the IEEE Fig. 4. (a) Ground truth yield map obtained at harvest (05/10/2021). (b) Predicted yield map obtained 1 week before harvest (28/09/2021). (c) Predicted yield map obtained 4 weeks before harvest (06/09/2021). (d) Prediction error obtained 1 week before harvest (28/09/2021). (e) Prediction error obtained 4 week before harvest (06/09/2021). Computer Society Conference on Computer Vision and Pattern Recognition, 2016. doi: 10.1109/CVPR.2016.91.

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