IOT BASED AGRICULTURE PESTICIDE SPRAYING ROBOT

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Abstract:

India is a significant agricultural nation, with three percent of its population involved in farming. As climate conditions and other resources become favourable, farmers are able to cultivate more crops in their fields. However, to ensure high-quality and efficient production, certain skills and support are necessary. Plant diseases are seen as abnormalities or disruptions in the normal functioning of plants, which lead to specific symptoms. Phytopathogens are typically defined as bacteria from various species that can cause these diseases.

Most of the disease symptoms appear on the leaves, stems and branches of plants. Therefore, detection of diseases and infections in crops is important for good and successful farming. This can be done by taking pictures of ideas with a camera and analyzing them using machine learning techniques. This indicates disease on leaves, stems or plants. It also indicates that the area is infected and estimates the pesticide effect caused by the specific pesticide sprayed on the infected area.

This is important for effective pesticide use. This will benefit the farmers as it can be controlled from anywhere without the need to work in the field and without access to pesticides. It is not affected by health.

Key Words: IOT, Convolutional Neural Network (CNN), ROBOT.

1. INTRODUCTION

Agriculture is the backbone of India. There are approximately 215.6 million mu of irrigated agricultural land in my country. Economic research has shown that the country needs to increase the level of agricultural mechanization. Increased productivity plays an important role in pest

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control. The Pesticide Spraying Robot is an innovative technology that offers an efficient and precise solution for agricultural pest control. Designed to navigate fields and orchards autonomously, these robots are equipped with advanced sensors, mapping technology, and spraying mechanisms. They play a crucial role in optimizing pesticide application by targeting specific areas that require treatment, reducing pesticide usage, and minimizing environmental impact [1].

These robots utilize various sensing technologies, including cameras and proximity sensors, to identify crops, detect pests, and determine the optimal spraying locations. With the help of mapping algorithms and real-time data analysis, they can create a detailed map of the field, allowing for accurate and targeted pesticide application. The spraying mechanism of the robot is designed to deliver pesticides in a controlled and precise manner. The robot's spraying arms or nozzles can be adjusted to ensure the right amount of pesticide is applied to the specific areas infested with pests, avoiding excessive use or wastage. This targeted approach not only saves resources but also minimizes the exposure of non-targeted plants, beneficial insects, and the environment to pesticides [2].

Additionally, these robots often employ advanced technologies such as artificial intelligence (AI) and machine learning algorithms. By analyzing data collected from the field, they can identify patterns, monitor pest populations, and optimize spraying schedules based on the severity of infestations. This data-driven approach enables farmers to make informed decisions, improve pest management strategies, and maximize crop yields.

The Pesticide Spraying Robot not only increases the efficiency of pest control operations but also offers several benefits over traditional methods. It reduces the physical labor required for manual spraying, improves the accuracy and uniformity of pesticide application, and enhances overall productivity. Moreover, it contributes to sustainable farming practices by minimizing pesticide residues, reducing the environmental impact, and promoting a healthier ecosystem [3].

As the development and adoption of agricultural robotics continue to progress, the Pesticide Spraying Robot represents a significant advancement in precision farming techniques, providing farmers with a reliable and effective tool for pest control while promoting sustainable and environmentally friendly agricultural practices. The work aims on the design, development and

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fabrication of the demonstration unit of "IOT BASED AGRICULTURE PESTICIDE SPRAYING ROBOT."

2. OBJECTIVE

1. Construct a model capable of pesticide spraying in agricultural activities.
2. To develop six wheeled structure robot that can move in different terrains.
3. To develop remote control system using cloud platform.
4. A manipulator that contains a spray nozzle.
5. Model must be able to perform following tasks:
    - 5.1 Disease detection using image processing algorithm.
    - 5.2 Temperature and humidity monitoring.
    - 5.3 Live video streaming and monitoring with IoT.
    - 5.4 Pesticide spraying
    - 5.5 Pesticide level monitoring
6. Quality and health monitoring of farm.

3. METHODOLOGY

To spray the liquids of pesticide on the crops to protect them against insects while travelling in the field with help of sprayer. In the first stage, the harvest is carefully and regularly monitored. Affected plants are then identified and photographs of the affected plant parts are taken with a scanner or camera. These objects are then pre-processed, transformed and grouped. These images are then sent as input to the processor, which compares the images. If the photo is contaminated, spray it using a sprayer with an insecticide. Pesticide sprayer is used to spray pesticides on the target areas of contaminated crops. The plan is based on two alternating bottles filled with pesticide valves precisely controlled. This provides a consistent pesticide flow and accuracy that is unaffected by varying fluid characteristics and flow conditions. This arrangement is ideal for pesticide spraying and is shown in figure 3.1. Ground-based pesticide spraying robots use a variety of mechanisms to apply pesticides, including sprayers, booms, and nozzles.

Robotic systems can be equipped with advanced sensors and mapping technology to navigate agricultural fields and identify specific areas requiring treatment, similar to the functionality of drones. Once a target area is identified, the robot can utilize its spraying mechanism to accurately

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and precisely apply pesticides. The webcam integrated into the robot model enables real-time scanning of trees up to 3 feet tall. The live feed captured by the device is transmitted via Wi-Fi to the video processor.

The video processor, powered by the ESP32, employs a specialized algorithm for video processing. This algorithm automatically analyzes the crop, primarily focusing on the leaf area, to determine the presence and quantity of pests using advanced video processing techniques. Pre-processing and segmentation are applied to the video to eliminate unwanted distortion and noise, while also decomposing the captured image into distinct components for identification purposes. Morphological operations are then utilized to facilitate video processing based on the morphology of insects, enabling the robot to spray different insecticides according to the species encountered.

To enhance the quality of the video, de-noising is conducted through a two-stage process involving erosion and expansion. Washing techniques are employed to eliminate pixels that are falsely detected as pests. Furthermore, the video is expanded to recover the pixels representing insects. The algorithmic code incorporates the pest count analysis, determining the appropriate timing for insecticide spraying based on the severity of infestation. Even though the text has been rephrased, it is always good practice to cite the original source if the information or ideas are derived from a specific publication or author.

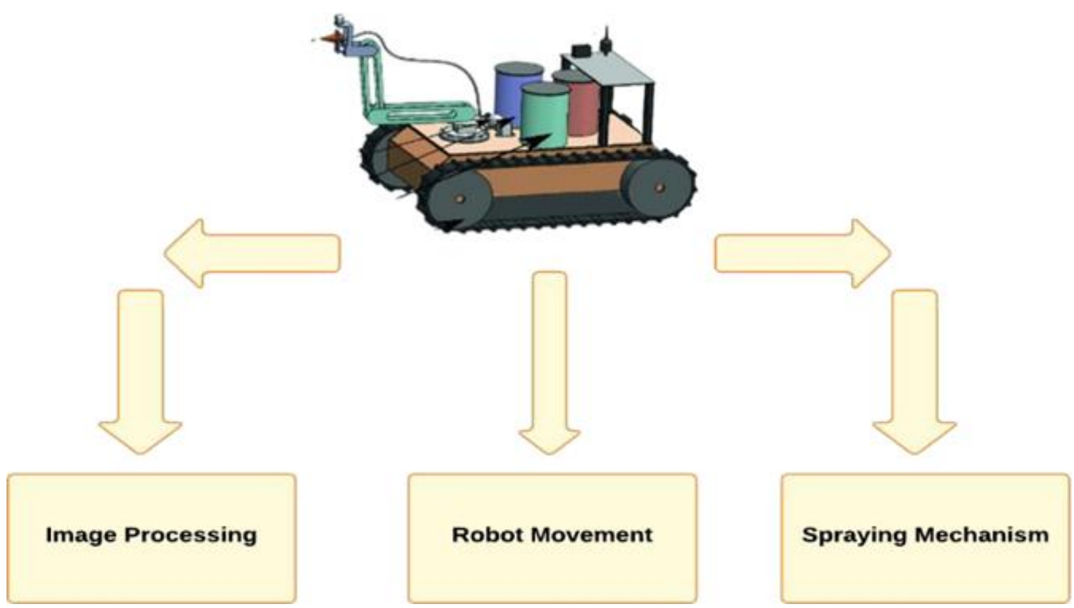

Figure 3.1: Working Principle

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Regardless of the type of pesticide spraying robot, it is important to ensure that the robot is calibrated correctly and that the appropriate amount of pesticide is applied [4]. This requires careful consideration of factors such as wind speed, humidity, and temperature, as well as the type of crop or vegetation being treated. Additionally, it is important to ensure that the robot is properly maintained and that all safety protocols are followed to prevent accidents or environmental contamination.

3.1 Robot Movement Motors are used to move the robot, which are controlled electronically by a microchip with the assistance of a motor controller IC. The transmitter and receiver module receives signals from the input and sends them to the controller, which in turn spins the motor. By receiving the signal, the wheel motors are turned on and off by controlling the main controller IC [5].

A motor driver IC is an integrated chip often used in robotics to control motors. The motor driver IC acts as the interface between the robot's microprocessor and the robot's motor. The most commonly used motor driver ICs are L293D, L293NE, etc. Like the L293 series. These ICs are designed to control 2 DC motors simultaneously. The L293D has two H-bridges. The H-bridge is the simplest circuit used to control a low current motor. We all know that their microcontroller cannot run DC motors. Because the current they give to the output pin is not enough to drive a small DC motor. Most microcontroller I/O pin outputs 20mA-40mA current. The GPIO pin of the Arduino Uno can deliver 40mA of continuous current, but 40mA is still not enough to drive a DC motor. RC cars typically use a motor driver to control the movement of the car. The motor driver receives signals from the remote control and translates them into specific actions, such as moving forward, backward, or turning left or right. The specific type of motor driver used in an RC car may vary depending on the design of the car and the requirements of the motor.

However, many RC cars use a type of motor driver called an H-bridge. An H-bridge is a circuit that allows the motor to be controlled in both directions (forward and reverse) and with variable speed. It consists of four switches (usually transistors) arranged in a specific configuration. The motor is connected to the center of the circuit, and the switches control the current flow to the motor to make it move in the desired direction. In an RC car, the H-bridge is typically controlled by a microcontroller, which receives signals from the remote control and adjusts the switches in the motor driver accordingly.

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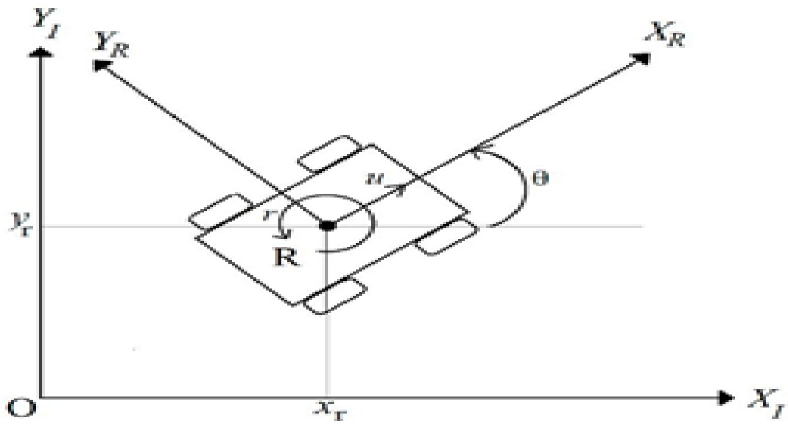

Figure 3.2: Robot movement

3.2 Pesticide Spraying Mechanism

Sprayer is a device used to spray liquid. In agriculture, a sprayer is a device that sprays of herbicides, pesticides, and fertilizers to agricultural crops. Sprayers come in a variety of sizes, from mobile devices (usually backpacks with spray guns) to towing sprayers that are attached to a tractor, to self-propelled equipment similar to tractors. A nozzle is a device designed to control the direction or characteristics of a fluid flow (specially to increase velocity) as it exits (or enters) an enclosed chamber or pipe. Plant protection applications are the most important applications in plant production. Use a sprayer to complete the application of pesticide products. The use of fungicides, insecticides and pesticides is one of the most important activities in agriculture. Conventional pesticides cause a conflict between economic growth and environmental protection in agriculture. Spraying equipment has been continuously improved in recent years. It is not just the sprayer for the use of pesticides, but the type and area of vegetation, the area of plant leaves, and the height of the crop, not all of them are related to the application of plant protection products.

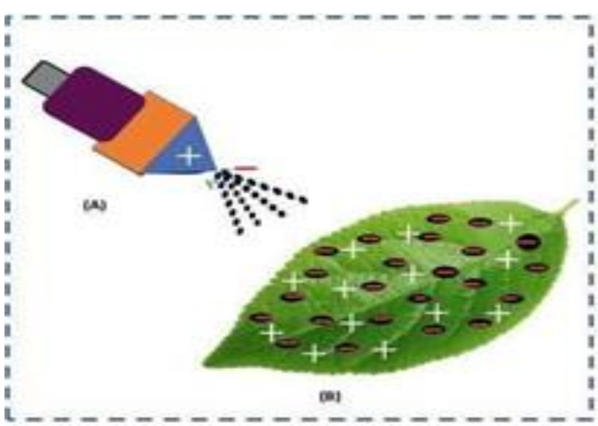

Figure 3.3: Pesticide Spraying Mechanism

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The volume of plants is very important for better results. From this perspective, the progress of agricultural spraying has only begun in the last few years. Robotic and automated spraying technologies such as variable speed sprayers, drone sprayers and electrostatic sprayers are being developed to improve pesticide use, reduce pesticide use, and use real-time, cost-saving and protective equipment. There are 5 basic spray patterns: Fan, Solid Flow, Solid Cone, Hollow Cone, and Fog/Mist. Flat fan nozzles are used for spreading most pesticides and some pesticides that do not require foliar penetration and coating. Nozzles create a flat oval spray pattern with tapered edges.

The pump is the heart of the sprayer and is important in creating the flow of the sprayer and the output of the sprayer. Because many spray situations require different sizes and flow rates, using the right pump is essential to achieve the desired results. Besides considering the spray, the pump needs to be strong enough to withstand harsh chemicals that can cause excessive wear and tear. Although pumps with added corrosion protection are more expensive, they are a popular choice because of their Pumps durability. They are usually ground-operated or driven by a main or auxiliary engine, a power take-off shaft, or a hydraulic pump. Regardless of the type of pump, the necessary flow rate must be provided at the desired pressure. Enough spray liquid should be pumped to supply the gallons per minute (gpm) required by the nozzles and the tank agitator, with a reserve capacity of 10 to 20 percent to allow for flow loss as the pump becomes worn. Unfortunately, pumps lose efficiency for a number of reasons, such as drive friction or leakage. When estimating the pump horsepower needed for an application, efficiency of 40 to 60 percent should be assumed. Pump quality is important when choosing a pump. Nozzle capacity, hydraulic agitation, and the need to tackle the aforementioned work are considerations.

3.3 Image Processing

The images are processed using machine learning techniques to detect and classify different plant health conditions, identifying signs of pest infestations or diseases. By analyzing parameters like leaf color, shape, and texture, the system can differentiate between healthy and affected areas. This data is then used to guide the robot's spraying mechanism, ensuring that pesticides are applied only where necessary, thereby minimizing chemical usage and reducing environmental impact. The integration of image processing with IoT capabilities allows for continuous monitoring and precise, automated pesticide application, enhancing crop protection and overall yield [5].

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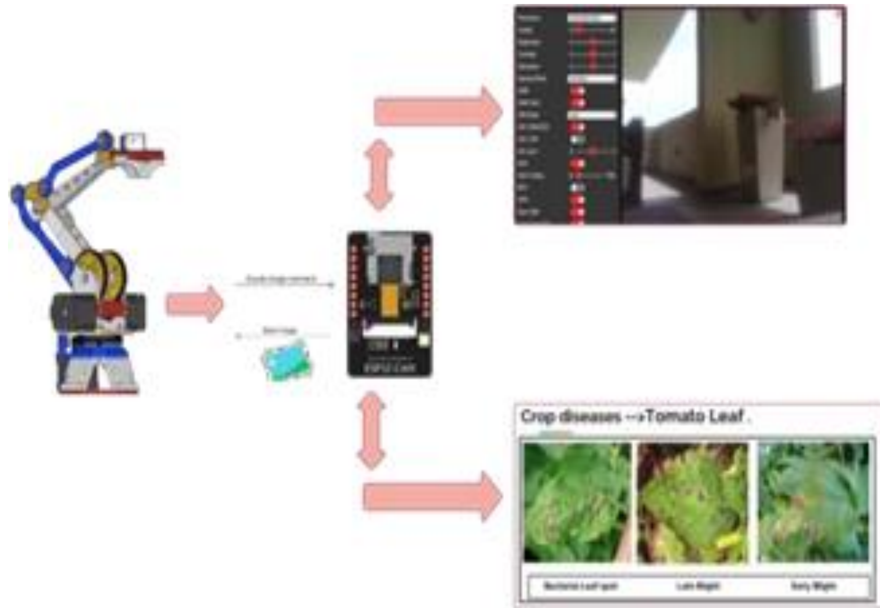

Figure 3.4: Image processing

3.4 Streaming methodology

Streaming is the continuous transmission of audio or video data from a server to a client. In simple terms, streaming is what happens when a consumer watches TV or listens to a podcast on a connected device. With streaming, media played on the user's device is stored remotely and sent over the Internet for a few minutes at a time. Streaming is real time and works better than downloading files. The ESP32-CAM is a very inexpensive, small camera based on the AI thinker's ESP32-S chip. Basically, it has an OV2640 camera embedded in an ESP32 module with several GPIOs to which devices can be connected, and a micro SD card slot that can be used to store images from the camera photo.

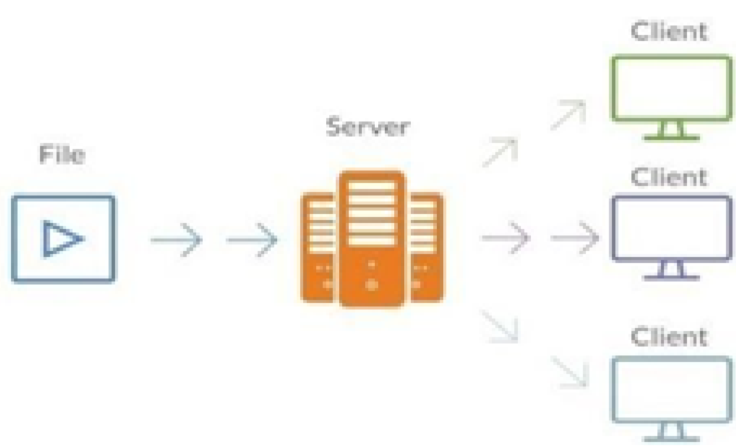

Figure 3.5: Streaming methodology

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3.5 Plant Disease Detection Using CNN

A Convolutional Neural Network (CNN) is a deep learning algorithm designed for image recognition and processing tasks. It is a type of neural network that is inspired by the structure and function of the visual cortex in the brain. CNNs are particularly effective for image classification tasks, such as recognizing faces, detecting objects in images, and identifying patterns in medical images. They have also been applied to other fields, such as natural language processing, speech recognition, and time series analysis. The key feature of a CNN is its ability to learn hierarchical representations of input data. In an image classification task, for example, the first layer of a CNN may learn low-level features, such as edges and corners, while the deeper layers learn more complex features, such as shapes and textures.

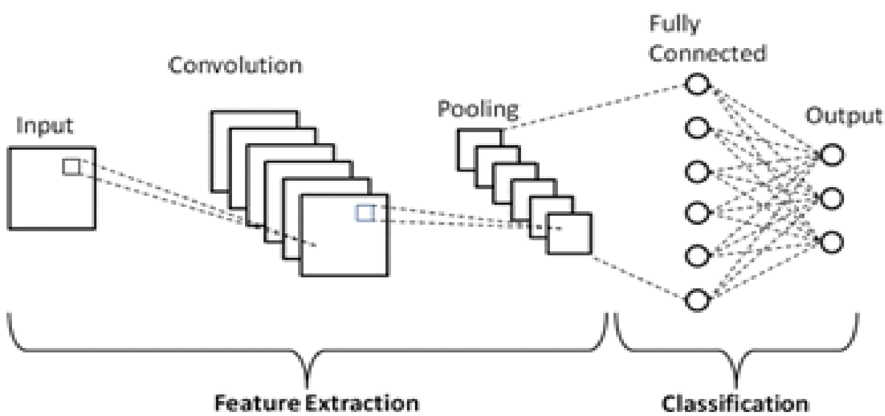

Figure 3.6: Convolutional Neural Network Architecture

This hierarchical learning enables the CNN to achieve high accuracy on complex image classification tasks. The CNN architecture typically consists of several layers, such as convolutional layers, pooling layers, and fully connected layers. The convolutional layers apply a set of filters to the input image to extract features, the pooling layers reduce the size of the feature maps, and the fully connected layers classify the input into the output classes. The architecture can be customized by adjusting the number of layers and the hyperparameters, such as the number of filters, the filter size, and the learning rate, to optimize the performance of the model [6].

Overall, CNNs have become an important tool for image processing and recognition, and have been used in a variety of applications, including self-driving cars, medical image analysis, and security systems. The first level of the algorithm involves separating healthy plants from affected

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plants, and the second level of the algorithm focuses on detecting disease in plant leaves. An efficient and fast system has been developed using PYTHON software. Farmers will benefit from the introduction of disease detection tools. The results obtained with this method are suitable for small and large crops. More importantly, the results are accurate and the disease can be detected in a very short time. This technology relies heavily on deep learning and neural networks. In this study, a deep convolutional neural network was used to identify diseased and healthy leaves.

3.5 IoT Platform

The Internet of Things (IoT) platform is a software framework that facilitates the development and deployment of IoT solutions. The IoT platform enables the collection, analysis and exchange of data from connected devices and provides a set of tools for building and managing IoT applications. It provides a scalable and secure infrastructure to connect, manage and process data from various IoT devices. The main goal of an IoT platform is to provide seamless connectivity and interoperability between different IoT devices, applications, and networks.

IoT platforms can support a variety of applications, including smart homes, smart cities, industrial automation, agriculture, and healthcare. Blink Cloud is a cloud-based IoT platform that provides tools for building and managing IoT applications. It is designed to make it easier for developers to create connected devices and mobile apps that can monitor and control multiple hardware devices. Blynk Cloud offers several features and services that allow developers to quickly and easily build IoT applications.

Conclusion:

The development of the IoT-based agriculture pesticide spraying robot demonstrates significant potential to enhance agricultural practices by offering a more efficient, precise, and automated approach to pesticide application. By integrating IoT technology, the robot can monitor real-time data related to environmental conditions and pest presence, ensuring pesticides are applied only when necessary, reducing wastage, and minimizing environmental impact. This innovation not only optimizes pesticide usage but also helps safeguard crops from pests, leading to improved crop yields and sustainable farming practices. Future work could focus on enhancing the robot's adaptability to different terrains and crop types, further refining the IoT sensors for greater accuracy, and integrating machine learning algorithms to improve decision-making capabilities for autonomous operation. Overall, this project marks a significant step towards smarter, more sustainable agriculture.

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