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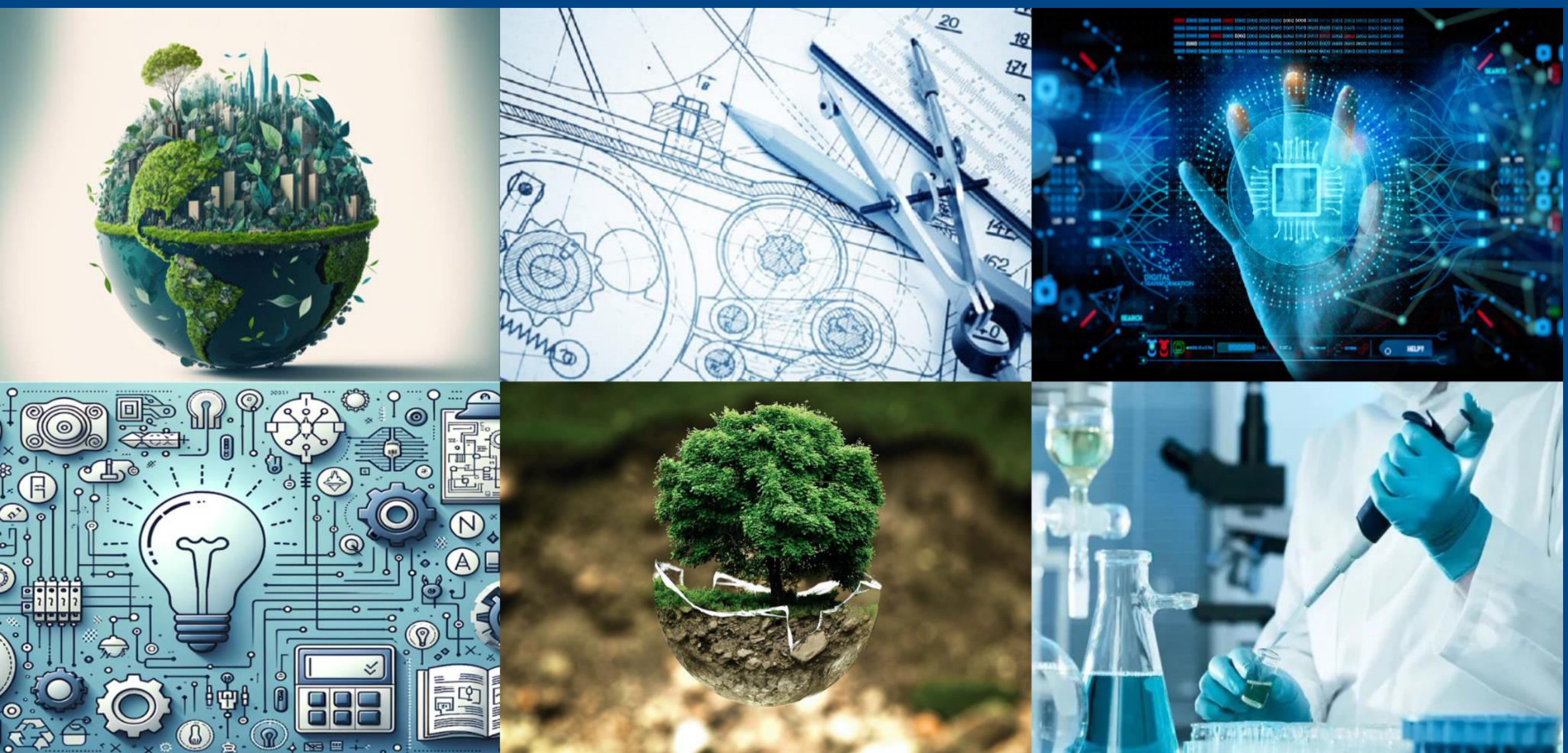

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Multi-Purpose Agricultural Bot using Raspberry PI

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ABSTRACT: Agriculture plays a vital role in sustaining human life by providing food, feed, and fuel. The integration of robotics into agriculture has revolutionized farming practices, improving productivity and reducing labour requirements. This paper focuses on developing a multipurpose agricultural robot that automates essential tasks such as seed sowing, pesticide spraying, and disease detection. The Agricultural bot is designed to accurately perform seed sowing operations and spray pesticides efficiently, minimizing human effort. A key feature of this system is to detect plant diseases using a camera module and machine learning techniques, gives cost-effective solution to address challenges in modern agriculture.

KEYWORDS: Seed Sowing, Pesticide spraying, Disease Detection, Machine Learning, Raspberry Pi.

I. INTRODUCTION

About 60% of Indians are employed in agriculture, which also contributes 20% of the nation's GDP. Agriculture is the foundation of the Indian economy. India, the second-largest owner of arable land in the world, has long depended on agriculture to provide its own and the world's food needs. However, the agricultural industry has encountered many challenges in the last few decades. Due to industrialisation and urbanisation, agricultural labour has decreased, which has increased employment costs and led to a scarcity of workers in rural areas. These issues, together with the growing complexity of modern farming practices, have made the employment of intelligent, automated technologies necessary in order to preserve output, reduce expenses, and improve sustainability.

Today, one of the biggest problems facing farmers is the inability to properly and quickly detect plant diseases, which are brought on by a number of pathogens, including bacteria, viruses, and fungus. Traditional disease detection techniques mostly rely on manual observation, which is difficult, subjective, and prone to mistakes, particularly in the early stages of infection when visual signs are negligible or non-existent. The misuse or overuse of chemical pesticides, which leads to environmental damage, higher costs, and declining crop quality and yield, is often the consequence of detection delays. Additionally, a crucial pre-harvest procedure, seed sowing necessitates accuracy and consistency for optimal production, which can be challenging to accomplish by hand across large fields.

The creation of a Multipurpose Agricultural Robot (Agri-Bot) is suggested as a solution to these constraints. Early plant disease detection, targeted pesticide spraying, and accurate seed sowing are just a few of the vital farming tasks that this low-cost, intelligent, and autonomous robotic system seeks to accomplish. With a Raspberry Pi as its central processing unit, this robot uses machine learning and image processing techniques to precisely detect diseased plants and apply the right amount of pesticide, reducing waste and increasing efficiency. Additionally, the robot has an automatic seed-sowing mechanism that guarantees even distribution. increasing the possibility for crop establishment and growth.

II. LITERATURE SURVEY

M. Arun and Priyanka .S [1] proposed about the system that uses robotics and is able to move around the field autonomously and plough the farm. Along with this, the system performs tasks like sowing the seeds and irrigating the field. Obstacle detection is done using ultrasonic sensors. Obstacle detection is possible only for objects in a range of 10 cm. For irrigation, the required information is obtained through temperature sensors. The farmer can give the control and give directions with the help of options given on the web pages.

Nikesh Gondchawar and Prof. Dr. R. S. Kawitkar, [2] proposed IoT based Smart agriculture the main aim was to develop smart robot using IoT and automation. The robot developed controlled and carries out tasks like weeding, spraying, moisture sensing and bird and animal scaring. Also, the system provides two modes of operation namely manual mode and automatic mode. In manual mode the farmer can control the system through an android application

Shalini S and Kalaiselvi S [3] have designed the robot consists of two motor drivers. One is for driving the robot and the other is operation of the shaft that is connected with the soil moisture sensor that helps to measure the humidity of the soil. This connection is in turn connected to the microcontroller which is connected with a Bluetooth model which helps the farmer to give input using an android application. Relay switches are used for operation of pesticide and water pumps. The robot consists of a GSM model which alerts the farmer about the field condition and the disease in the SMS form.

Vijay Kumar V and Vani K S [4] discussed about multipurpose bot which performs various farming operations like ploughing the soil, sowing seeds, making the field in plain by using a leveller, watering the crops, fertilizing them and monitoring by using a camera. The monitoring system keeps the track of various parameters like drip irrigation, fertilizing, maintaining temperature, removal of extra water (during floods) and keeping track of crop growth. The extra water during floods can be removed and stored in tanks for future use that is water harvesting.

Siddharth Gupta and Rushikesh Devsani [5], proposed the system to seed at specific locations with definite space between two seeds and positions while seeding. In the system a microcontroller controls the entire operation and performs various activities like seed sowing, mud levelling. This bot consists of two modes, namely seed sowing mode and cutting mode. The seed sowing mode consists of digging, seed sowing and levelling of mud whereas the second mode consists of sprinkling and crop cutting.

III. METHODOLOGY OF PROPOSED SURVEY

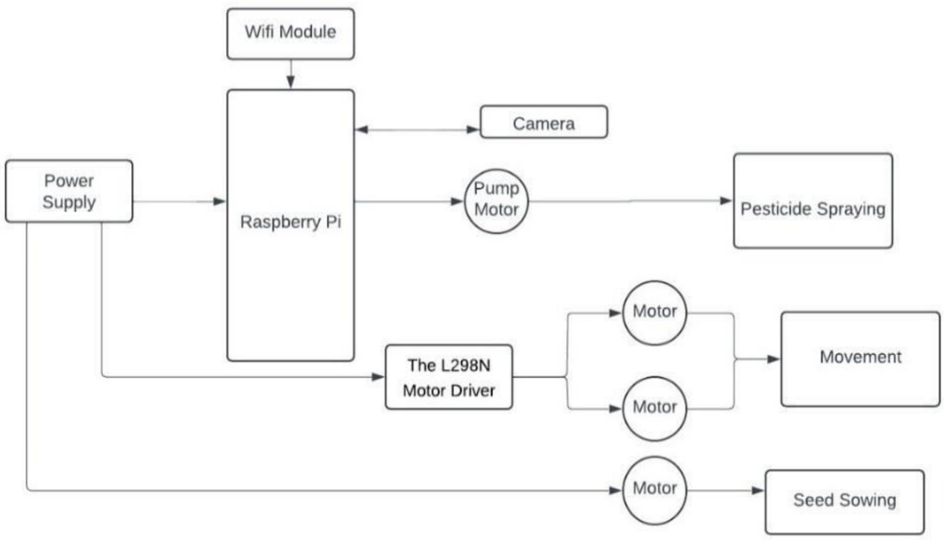

Figure 1 : Block Diagram Of Multi- Purpose Agricultural Bot

The block diagram for the suggested Agriculture-Bot is shown in the above picture. An essential component of the Agribot's monitoring system is the Raspberry Pi. It oversees and manages every aspect of the bot's operation. To take a picture of the leaves, a camera is attached to the Raspberry Pi. The robot is controlled manually over Wi-Fi. Batteries are used to power the robot. All other parts, including motors and motor drivers, depend on this battery to function. With the aid of a camera module, the bot is designed to carry out tasks including sowing, pesticide application, and leaf disease diagnosis. An essential component of the agriculture-bot's monitoring system is the Raspberry Pi.

It has a number of GPIO pins that can be connected to the electronic components to control them. The direction and motion of BO Motors are controlled by the Raspberry Pi, which is connected to the L298N motor driver. When the motor is turned on, the seed sowing mechanism begins, releasing seeds at predetermined intervals. The technique guarantees even dispersion and accurate placement in the soil. When a disease is detected by the camera module using machine learning, the motor driver also makes it easier to spray pesticides. The motor driver triggers the mechanism, which permits the pesticide to be sprayed from the container whenever an instruction is given to do so.

A Webcam is used to take a picture of the leaves, process it, and determine if the leaves are healthy or sick. A robot that roams the agricultural field. Takes pictures of the plants. Machine learning can be used to develop efficient image processing algorithms. The algorithms' initial stage involves differentiating the healthy crop from the damaged crop, and their second goal is to detect the crop disease. The appropriate dosage of pesticide will be administered following the diagnosis of the condition. The insecticide will be sprayed on the sick plant by the bot.

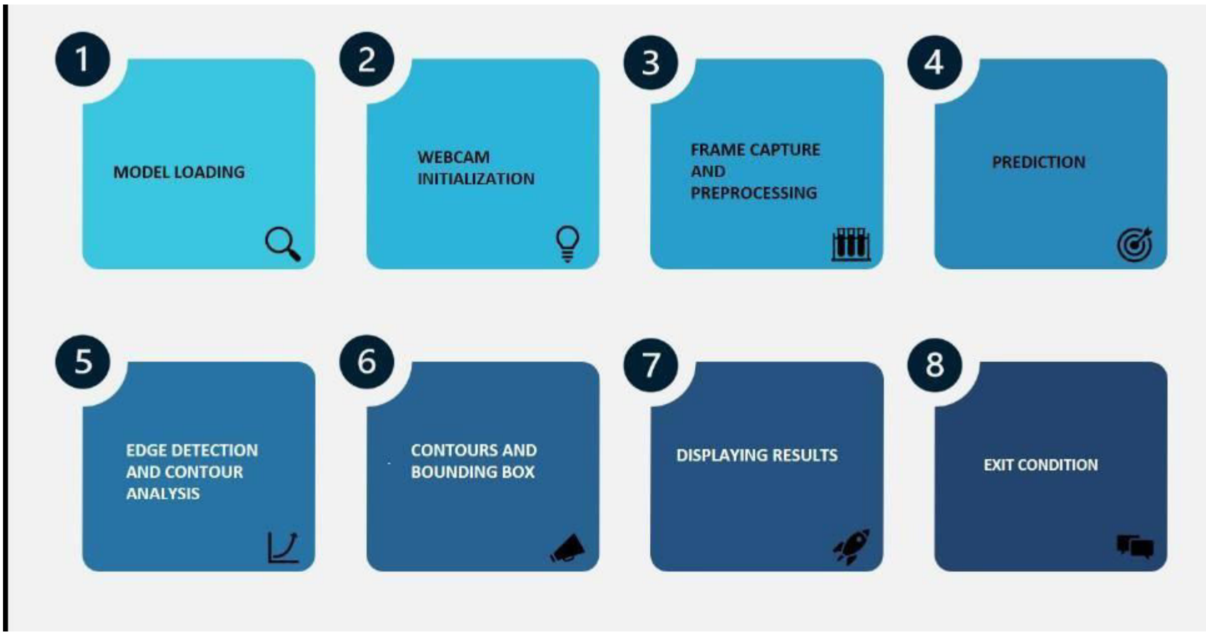

Figure 2: Flow Chart of Leaf Disease Detection

The picture shows the exact steps involved in a computer vision research that was probably centred on utilising a webcam to detect or analyse objects in real time. A pre-trained machine learning or deep learning model is put into the system for inference at the start of the procedure, known as Model Loading (Step 1). The camera is then turned on to begin recording video in real time during Webcam Initialisation (Step 2). Frame Capture and Pre-processing (Step 3) comes next, in which every video frame is taken out and altered (e.g., scaled, normalised) to satisfy the input specifications of the model. The pre-processed frame is fed into the model in Prediction (Step 4) so that objects can be categorised.

In order to improve the accuracy of object boundary identification, the result is then adjusted using Edge Detection and Contour Analysis (Step 5). In Step 6, contours and a bounding box are created to visually identify the things that have been recognised in the frame. After that, the system moves on to Step 7, "Displaying Results," where the user is shown the bounding boxes and classification results displayed on the video stream. The program is then gently terminated by implementing an Exit Condition (Step 8), typically in response to a command or key press. This project demonstrates how computer vision techniques can be implemented in real time while combining image processing, machine learning, and user interaction.

IV. RESULT

The IoT-based Multipurpose Agriculture Bot was thoroughly tested in real-world conditions and demonstrated reliable and efficient performance across its core functions: leaf disease detection, targeted pesticide spraying, automated seed sowing, and field navigation. The integration of mechanical systems with intelligent software enabled the bot to perform essential agricultural tasks with accuracy and consistency. Real-time disease detection was achieved using a camera module and a CNN model deployed on a Raspberry Pi, processing images with Python and OpenCV to identify 33 types of plant diseases. This allowed early intervention and reduced the need for manual inspection. Based on detection results, the pesticide spraying system activated only when diseased plants were found, minimizing agrochemical usage and environmental impact while ensuring precise application. The automated seed sowing system, driven by a DC pulse generator and motorized dispenser, released seeds at regular intervals, improving sowing accuracy and reducing labor. The navigation system, powered by BO motors and an L298N driver, ensured smooth movement even on uneven terrain, with both manual (Bluetooth/Wi-Fi) and autonomous control options. The Raspberry Pi acted as the central controller, managing all operations in real time. Overall, the bot functioned cohesively and reliably, making it suitable for deployment in small to medium-sized farms and contributing to smarter, more efficient agriculture.

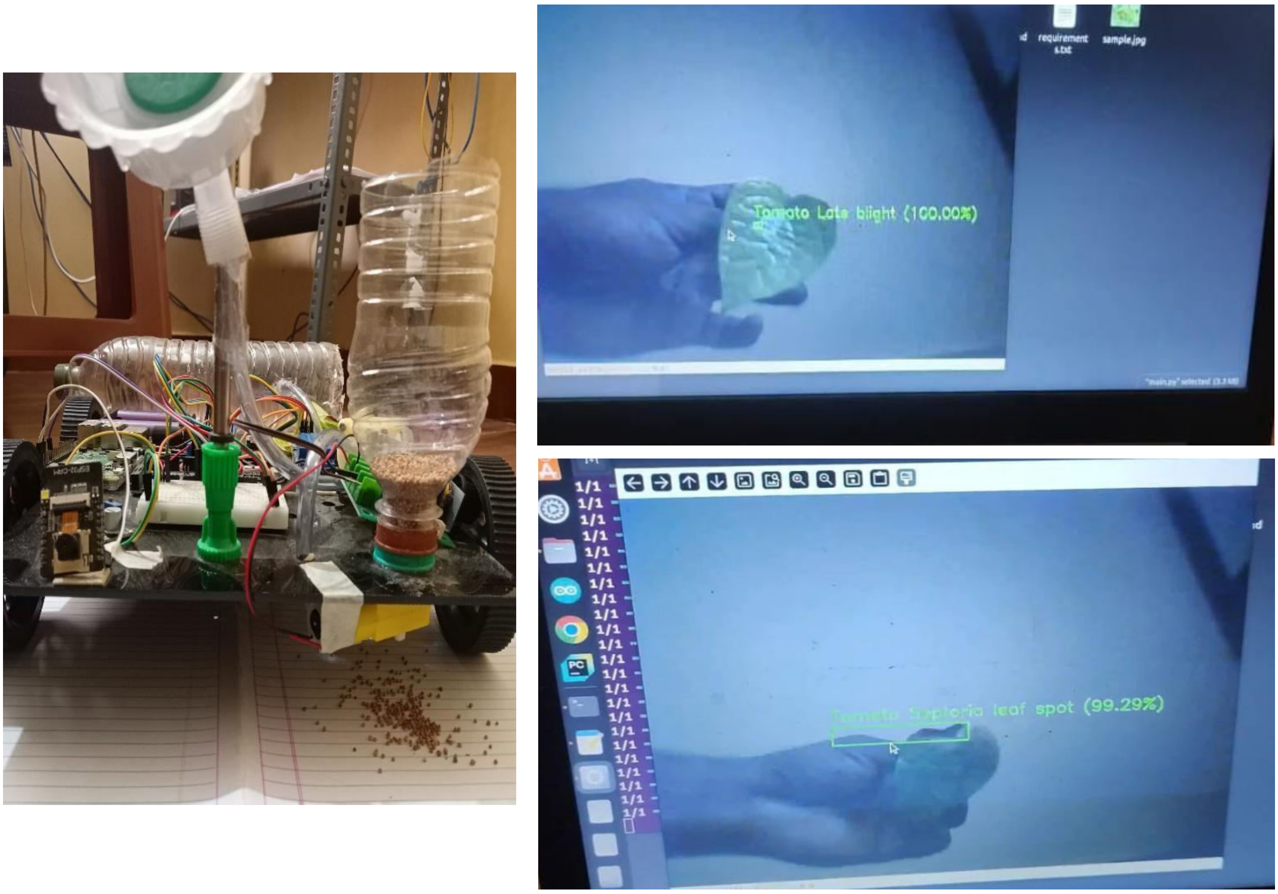

Figure 3: Disease Detection and Seed sowing

The image shows the prototype of our Multipurpose Agri Bot, designed for automating essential farming tasks. The bot is mounted on a four-wheel chassis and integrates multiple components to perform functions such as seed sowing, pesticide spraying, and crop monitoring. On the right side, a plastic container is used as the seed dispenser, which accurately releases seeds in measured quantities. At the centre, a vertical pipe connected to a spray mechanism is mounted to facilitate pesticide spraying.

The image shows the successful implementation of the leaf disease detection module, a core component of our Multipurpose Agri Bot. The system uses a Raspberry Pi integrated with an ESP32-CAM module or a USB camera to capture real-time images of plant leaves in the field. The captured image is processed using a pre-trained machine learning model, which identifies and classifies plant diseases based on visual symptoms. In the screenshot, the system has correctly identified a diseased tomato leaf with "Tomato Late Blight" and has displayed the result on the screen. This indicates the high accuracy of the classification algorithm used, which was trained on a dataset of various plant leaf images labelled with corresponding disease types.

V. CONCLUSION AND FUTURE WORK

The multifunctional Agri Bot was effectively created and put into use to help farmers with crucial agricultural duties like, spraying pesticides, planting seeds, and identifying plant diseases early on. The bot increased field operations' accuracy and efficiency while lowering manual labour costs and saving time. The system demonstrated intelligence and practicality for real-time farming applications through the integration of Raspberry Pi, camera modules, sensors, and machine learning. Its early detection of plant diseases enables prompt response and can shield crops from serious harm. All things considered, the bot provides small and medium-sized farmers with an intelligent and affordable option.By improving the disease detection model with a bigger and more varied dataset, the Agri Bot can be further enhanced in the future. Autonomous mobility across vast expanses can be achieved by adding GPS or camera-based navigation. For precision farming, additional environmental sensors, such as those for pH, temperature, and soil moisture, can be added. It is possible to create a mobile application for remote control and monitoring. The bot will be more sustainable with the installation of solar panels, and farmers will find it easier to use if voice command capabilities in local languages are included.

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