RES MILITARIS Social Science Journal

RASPBERRY PI-POWERED ROBOTIC FARMING COMPANION FOR PLANT HEALTH MONITORING USING ADVANCED IMAGE PROCESSING TECHNIQUES

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ABSTRACT

More intelligent and productive agricultural techniques are being made possible by the combination of robots and sophisticated image processing in agriculture. This paper describes the design and development of a robotic farming companion that runs on a Raspberry Pi and can monitor plant health using cutting-edge image processing methods. The robotic device is intended to go over agricultural fields on its own. It will take pictures of the crops and analyze them instantly to find early indicators of illness, nutrient shortages, or insect infestations.

The robot uses machine learning techniques to interpret the collected photos and detect irregularities in plant health, using the processing capabilities of the Raspberry Pi. Through an intuitive interface, the technology gives farmers meaningful information, facilitating prompt interventions and minimizing the need for human inspection. By reducing crop loss from problems that go unnoticed, real-time data gathering and analysis not only improves crop management but also boosts production.

The study shows how robots and image processing may be used to achieve precision agriculture, providing a scalable and affordable answer to today's agricultural problems. The system's accuracy in identifying plant health problems is shown by the experimental findings, highlighting its importance in advancing efficient and sustainable agriculture methods. This creative strategy is a major advancement in smart farming, giving farmers the means to maximize crop health and productivity while preserving resources.

I. INTRODUCTION

1.1 INTRODUCTION:

Agriculture is a profession from long ago. It plays a vital function in our day-to-day lives. Food is a fundamental human necessity. A sufficient quantity of production is required to distribute meals across a large population. A vast majority of people in India reside in rural regions where agriculture is the primary source of income for people. Consequently, agriculture is the main driver of the Indian economic system as a whole. Therefore, it is now essential to increase first-rate manufacturing on a daily basis. It is essential to monitor crops and vegetation and to take early action to regulate them. Numerous responsibilities include soil preparation, sowing, applying fertilizer and manure, irrigation, identifying diseases, applying pesticides, harvesting, and garage work. Among them, applying the right quantity of insecticides requires careful consideration. Pesticides, sometimes referred to as crop protection products, are used to draw in, entice, and destroy pests. In order to kill pests, weeds, or illnesses on plants, pesticides are made either sometimes using organic methods or occasionally using hazardous chemicals. India is a cultivated nation where agriculture provides jobs for almost 70% of the population. Farmers have an enormous array of options when it comes to selecting a variety of appropriate plants and identifying plant-specific insecticides. Plant disorder leads to a significant decrease in the quantity and quality of agricultural products produced. The study of visually discernible patterns in plant life is closely related to the study of plant diseases. Monitoring plant health and disease plays a critical role in the productive production of plants on farms. In the past, plant disease monitoring and analysis were done manually utilizing data from specific experts in the field. This requires an excellent volume of labor in addition to an excessive quantity of processing time. The plant disease diagnosis procedure may make use of picture processing technology. Most of the time, disease signs are visible on the fruit, stem, and leaves. Many methods are now available to boost manufacturing

output while requiring less labor from humans. Technologies have advanced greatly and permeated every industry, including agriculture. such example of such innovation is the agricultural robot. An agricultural robot is a machine designed to carry out diverse agricultural operations. It handles a variety of agricultural duties. This lowers labor costs, boosts yield, and requires less human work. so one is able to eat healthful meals. These days, deep neural networks are extensively used in both academia and business as the cutting edge of machine learning models in a range of fields, including natural language processing and image analysis. Slowly but surely, these advancements hold great promise for medical imaging technologies, medical data analysis, medical diagnostics, and healthcare overall. We provide a brief summary of current developments in machine learning as they relate to medical image processing and analysis, along with some related difficulties. Conventional machine learning techniques were the norm long before deep learning was used. as SVM, Logistic Regression, Decision Trees, and Naive Bayes Classifiers.

Another name for these algorithms is flat algorithms. Here, "flat" denotes that these techniques are often not applicable directly to the raw data (text, images,.csv files, etc.). A preprocessing procedure known as feature extraction is required.

These traditional machine learning algorithms may now employ the representation of the provided raw data as the outcome of feature extraction to complete a job. As an example, consider the division of the data into many groups or categories.

Feature extraction often involves a great deal of complexity and in-depth understanding of the issue area. For best results, this pre-processing layer has to be adjusted, tested, and improved across a number of rounds. Deep Learning's artificial neural networks are on the opposite side. The Feature Extraction phase is not necessary for them. The layers have the ability to independently and directly learn an implicit representation of the raw input. Here, many layers of artificial neural networks are used to create an increasingly abstract and compressed representation of the original input. The outcome is then generated using this condensed representation of the input data. One possible outcome is the categorization of the incoming data into distinct classes.

1.1 BLOCK DIAGRAM:

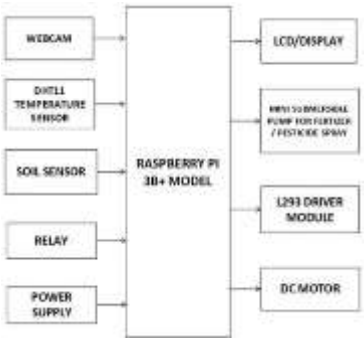

Figure.1: Block Diagram

FUNCTION OF THE COMPONENTS:

RASPBERRY PI 3B+ MODEL:

The Raspberry Pi 3 Model B+ is the latest product in the Raspberry Pi 3 range, boasting a 64-bit quad core processor running at 1.4GHz, dual-band 2.4GHz and 5GHz wireless LAN, Bluetooth 4.2/BLE, faster Ethernet, and PoE capability via a separate PoE HAT The dual-band wireless LAN comes with modular compliance certification, allowing the board to be designed into end products with significantly reduced wireless LAN compliance testing, improving both cost and time to market. The Raspberry Pi 3 Model B+ maintains the same mechanical footprint as both the Raspberry Pi 2 Model B and the Raspberry Pi 3 Model B.

DHT11 TEMPERATURE & HUMIDITY SENSOR:

The DHT11 is a commonly used Temperature and humidity sensor that comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. DHT11 is a low-cost digital sensor for sensing temperature and humidity. This sensor can be easily interfaced with any micro-controller such as Arduino, Raspberry Pi etc… to measure humidity and temperature instantaneously.

DHT11 humidity and temperature sensor is available as a sensor and as a module. The difference between this sensor and module is the pull-up resistor and a power-on LED. DHT11 is a relative humidity sensor. To measure the surrounding air this sensor uses a thermistor and a capacitive humidity sensor.

SOIL MOISTURE SENSOR:

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimeter dimension of soil moisture needs eliminating, drying, as well as sample

weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology.

L293 DRIVER MODULE:

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit (IC).The l293d can drive small and quiet big motors as well, check the Voltage Specification at the end.

MINI SUBMERSIBLE PUMP:

Submersible pumps are efficient for pumping out septic tanks. Fluid is transferred into hoses to storage tanks and taken to a treatment facility. Submersible pumps are often used to pump excess water from work sites or flooded basements on construction sites. They can also be used to pump. Submersible pumps are centrifugal pumps whose hydraulic components (pump casing, impeller, diffuser element) are flooded by the fluid handled. Usually, this type of pump is not fitted with a suction line. A submersible pump whose motor is arranged above the floor is referred to as a vertical shaft submersible pump

RELAY:

A power relay module is an electrical switch that is operated by an electromagnet. The electromagnet is activated by a separate low-power signal from a micro controller. When activated, the electromagnet pulls to either open or close an electrical circuit. The relay module function is mainly to switch electrical devices and systems on or off. It also serves to isolate the control circuit from the device or system being controlled.

WEB CAM:

A webcam is a video camera which is designed to record or stream to a computer or computer network. They are primarily used in video telephony, live streaming and social media, and security. Webcams can be built-in computer hardware or peripheral devices, and are commonly connected to a device using USB or wireless protocols. Webcams have been used on the Internet as early as 1993, and the first widespread commercial one became available in 1994. Early webcam usage on the Internet was primarily limited to stationary shots streamed to web sites. In the late 1990s and early 2000s, instant messaging clients added support for webcams, increasing their popularity in video conferencing. Computer manufacturers also started integrating webcams into laptop hardware. In 2020, the COVID-19 pandemic caused a shortage of webcams due to the increased number of people working from home.

JUMPER WIRES:

Jumper wires are electrical wires with connector pins at each end. They are used to connect two points in a circuit without soldering. You can use jumper wires to modify a circuit or diagnose problems in a circuit. Further, they are best used to bypass a part of the circuit that does not contain a resistor and is suspected to be bad. This includes a stretch of wire or a switch. Suppose all the fuses are good and the component is not receiving power; find the circuit switch. Then, bypass the switch with the jumper wire. How much current (I) and voltage (V) can jumper wires handle? I and V rating will depend on the copper or aluminium content present in the wire. For an Arduino application is no more than 2A and 250V. We also recommend using solid-core wire, ideally 22 American Wire Gauge (AWG).

9V BATTERY:

This is General purpose 9V Original HW Non-Rechargeable Battery for all your project and application needs. As we experienced the use of this battery in our testing lab for various purpose, 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.

DC MOTOR:

A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical

energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electro mechanical or electronic, to periodically change the direction of current in part of the motor.

II. LITERATURE SURVEY

1. The Leaf Disease Diagnosis and Pesticide Spraying Using Agricultural Robot that Plant diseases have created an immense post-effect scenario as it can significantly reduce agricultural products in terms of both quality and quantity. Early detection of pests is a big issue that concerns planting crops. First phase includes plant observation keenly and frequently. Then the infected plants will be identified and photographs will be collected using camera for the infected portion of the plants. Then these images are pre-processed, transformed and clustered further sent to the processor as input, and the images are compared by the processor.

On the basis of literature review carried out and find a need to develop a system which gives the better ways to control the production of crops, the modified robot checks the disease with help of image processing and also check the temperature of the plant and moves forward to check the other plants. The proposed system will identify the plant disease and it will display the name of the disease.[1]

2. In this Literature an Agricultural robot is used to move around the field and captures the image of the leafs and perform the disease detection operation. Using soil sensor soil moisture can be measured. Here DHT11 Temperature and humidity sensor are used to measure the plant health. A camera is placed and it captures the images that is transferred to the system. The captured images are run on Raspberry pi for detection of the disease. The infected disease name will be displayed. After the detection of the disease pesticide sprayer is used for spraying of the pesticide. The main objective of this literature is to reduce the cutting of plants and helps the proper detection to identify the plants disease, so that the pesticides are spared on effected plants.[2]

III. OUTPUT PANEL:

This Output Panel is used to give comments about the code.

1) If the code is successfully complied or any error occurs.

2) If the code has been successfully uploaded to the board.

Figure 2: Output panel

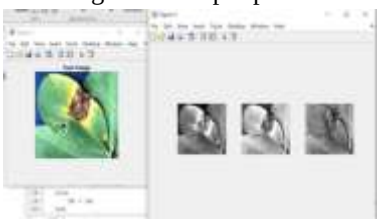

Figure 3: Image Capturing and preprocessing

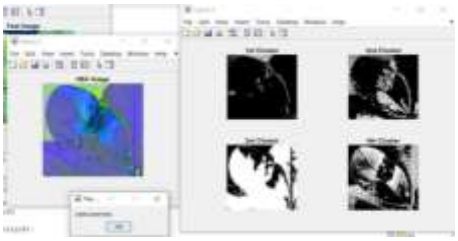

Figure 4: Decomposing the Captured image

Figure 5: Result Terminal

3.1 PROGRAM FLOWCHART:

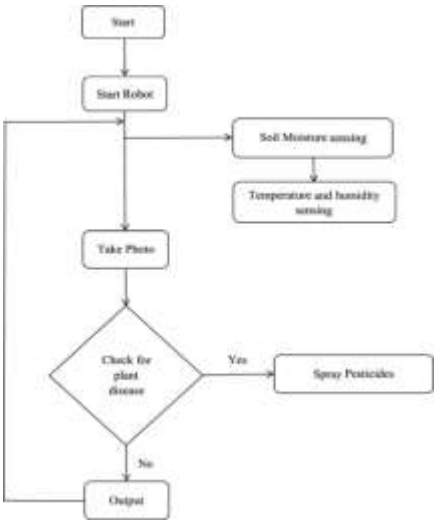

Figure 6: Program Flowchart

IV. PROJECT WORKING & RESULT

4.1 CIRCUIT DIAGRAM:

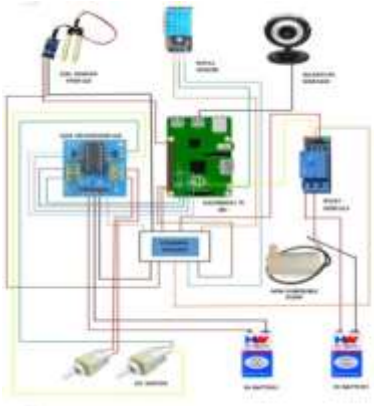

Figure 7: Project Circuit Diagram

4.2 RESULT:

4.2.1 PROJECT MODULE:

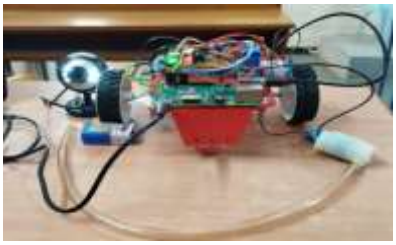

Figure 8: Project Module

4.2.2 WORKING:

1. The module "Raspberry Pi based Forming robot with plant health indication using image processing", works on image processing which detects the disease of the plant.
2. The robot moves, checks for the plant and captures the effected image of leaf, then the captured image is processed for detection of disease and gets clustered. Then further it is transferred to the system and the disease of leaf is displayed.
3. With the use of Soil sensor the module checks the moisture of the soil, using DHT11 sensor the Temperature and Humidity are measured.
4. If any disease is detected then the robot spray's the pesticides to that infected plant.

4.3 ADVANTAGES:

• Reducing direct exposure to pesticides and the human body and improve production efficiency.
• Good coverage and penetration, high capacity, and options to spray at high or low volumes.
• This increases the productivity and reduces cutting of plants whether to carry on or to cut the plant leaves with knowing the plant disease.
• Nowadays, image detection or image processing is widely used in a wide range of agricultural tasks. These jobs include soil assessment, irrigation, leaf analysis, weed detection, pest control, disease recognition, vegetation measurement, monitoring plant growing, and fruit/food grading.

4.4 DISADVANTAGES:

• Drift hazards, unsuitable for windy conditions or for use in small areas, and high cost.
• It costs a lot of money to make or buy robots, Energy cost and maintenance.
• They need maintenance to keep them running.
• The robots can change the culture / the emotional appeal of agriculture.
The high cost of research and development.
• Lack of access to poor farmers.

4.5 APPLICATIONS:

- This project module utilized for agricultural purpose where the farmers can make use of it.
- This project module used for identifying the exact plant disease using image processing on plant health.
- This module used for increasing the productivity and reduces cutting of plants whether to carry on or to cut the plant leaves with knowing the plant disease.

V. FUTURE SCOPE & CONCLUSION

CONCLUSION:

A revolutionary approach to contemporary agriculture is represented by the creation of a robotic farming companion powered by a Raspberry Pi that combines robotics, image processing, and machine learning to improve plant health monitoring. Through autonomous field navigation, high-resolution picture capture, and real-time analysis to identify early indicators of disease, nutritional deficits, and insect infestations, this device greatly eliminates the need for human crop inspection. Farmers are able to precisely and promptly take action to safeguard their crops because of the high precision with which plant health concerns are identified via the integration of powerful image processing algorithms.

The system's real-time monitoring feature gives farmers vital information that helps them manage crops more effectively and reduce losses. A broad spectrum of agricultural businesses, from small farms

to large-scale plantations, may now use this technology due to the cost-effectiveness of the Raspberry Pi core processing unit. In addition to increasing the effectiveness of plant health monitoring, the robotic companion encourages sustainable farming methods by lowering the need for chemical treatments and facilitating more focused interventions.

Furthermore, the system's potential for broad adoption is highlighted by its scalability and flexibility to various crop varieties and agricultural situations. Climate change, resource scarcity, and the need for increased productivity have put agriculture under growing pressure, so finding creative solutions is crucial to maintaining food security and sustainability.

To sum up, the robotic farming companion that runs on a Raspberry Pi and can interpret images is a big step forward for precision agriculture. This technology enables farmers to increase yields, cut waste, and support more sustainable farming methods by offering a dependable, effective, and scalable tool for plant health monitoring. The future of food production will be significantly shaped by the use of robots and artificial intelligence (AI) in agriculture, as technology advances.

FUTURE SCOPE:

- We can build robots exactness of identification of leaf shading effectively by utilizing high quality camera.
- Wire-less System. We can make this module remotely by utilizing RF connectors.
- This module can additionally altered for picking organic products, and real cutting procedure.

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