

Agrobot: IoT Enabled Crop-care

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Abstract

Agriculture serves as the foundation of global civilization, particularly in nations like India, where it accounts for roughly 70% of the GDP, underscoring its pivotal role in economic stability. Despite its significance, traditional agricultural practices have often overlooked critical elements such as disease identification and precise pesticide application, focusing primarily on conventional methods like harvesting and seedling techniques. To address these gaps and usher in a new era of efficiency and sustainability, there is a growing imperative for modernization, particularly in disease detection and precision agriculture, necessitating the integration of cutting-edge technologies. The emergence of advanced image processing technology represents a transformative breakthrough, exemplified by solutions like AGROBOT, which enable the precise detection of leaf diseases and targeted pesticide application, thus enhancing agricultural productivity while mitigating environmental concerns such as water contamination and soil degradation. By prioritizing disease management and precision agriculture, we can cultivate sustainable farming practices that not only ensure food security but also amplify overall agricultural output. Embracing technological innovations is essential to confront the evolving challenges facing the agricultural sector, from the need for increased efficiency to the imperative of minimizing environmental footprints and bolstering food production. Through the seamless integration of modern technology and pioneering solutions like Agrobot, we chart a course toward a future where agriculture is more resilient, sustainable, and equipped to meet the demands of a growing global population, ensuring food security for generations to come.

Keywords: Agriculture, modernization, disease detection, precision agriculture, bolstering food production

INTRODUCTION

The implementation of a free trade agreement (FTA) with the US could lead to farmers abandoning their profession due to the reduced crop prices. Many farmers are reluctant to engage in labor-intensive and potentially harmful chemical work. Robot technology presents a solution to this issue by assisting farmers in reducing their workload and saving time [2]. Many researches are ongoing in the field of

autonomous in agriculture. The project endeavors to tackle the myriad challenges facing Indian agriculture by prioritizing productivity enhancement, sustainability, and resilience. Leveraging state-of-the-art technologies and innovative methodologies, the initiative aims to optimize crop yields while minimizing the environmental impact associated with traditional farming practices. With a primary focus on early detection and management of plant diseases and pests, the project seeks to bolster crop health and resilience to ensure a consistent and reliable food supply for the nation. Additionally, by advocating for the prudent use of pesticides and promoting the adoption of eco-friendly farming techniques, the project aims to mitigate adverse environmental

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Received Date: May 20, 2024

Accepted Date: June 15, 2024

Published Date: June 18, 2024

Citation: Naveen Kumar V.M., K.V. Rahul, Gopika T.M., Simi Chandran, Sujith D.K. Agrobot: IoT Enabled Crop-care. Journal of Experimental & Applied Mechanics. 2024; 15(1): 38–45p.

impacts such as soil degradation and water pollution. Image processing technology emerges as a promising solution, offering automated image-based inspection, process control, and robotic guidance. This robot will spray pesticides based on the number of pests present on the plants and type of the pests present on the plants. This can be done only after the proper analysis of pest infestation. Therefore, there is a growing demand for efficient and accurate methods of automatic disease detection, particularly focusing on symptoms appearing on plant leaves. The primary objective of this research is to address the pressing challenges confronting Indian agriculture by focusing on enhancing productivity and sustainability. Through the application of cutting-edge technologies and innovative methodologies, the study aims to optimize crop yields while concurrently minimizing the environmental footprint associated with traditional farming practices. By emphasizing early detection and management of plant diseases and pests, the research seeks to bolster crop health and resilience, thereby ensuring a consistent and reliable food supply for the nation. Furthermore, by advocating for the judicious use of pesticides and promoting the adoption of eco-friendly farming techniques, the study endeavors to mitigate the adverse environmental impacts of agricultural activities, such as soil degradation and water pollution. Additionally, the research aims to extend beyond immediate productivity gains to encompass broader socio-economic benefits, including enhanced livelihood security for farmers and increased rural prosperity. The project's scope encompasses comprehensive literature reviews, experimental methodologies, technology assessment, and policy analysis, all aimed at advancing agricultural productivity, sustainability, and resilience in India. Collaboration with stakeholders and alignment with national sustainability objectives are essential aspects of developing holistic solutions to tackle the complex challenges faced by Indian agriculture.

LITERATURE SURVEY

Many researches are done in the field of autonomous in agriculture, some are following A versatile agricultural robot, known as the Agri-Robot, has been developed to perform various tasks including soil excavation, seed planting, harvesting, and irrigation.

Nitin Krishna V, Rangunath B, Kowshika Priya B, Sivaranjani M, Vasanthamani K proposed an idea "Smart Farm Assist Robot" in *International Journal of Engineering and Advanced Technology* (2020), it is to ensure sustainable power supply, the robot incorporates solar panels for battery recharging. Equipped with a front-mounted cutter, a robotic arm with metallic teeth for soil excavation, a seed storage funnel, an irrigation sprinkler, and a solar panel for battery recharging, the Agri-Robot is powered by an Arduino board ATMEGA 328P [1].

Another research has to be made in this sector is Innovative agricultural technologies are heralding a transformative era for Indian farming practices, that's done by Hari Mohan Rai, Deepak Gupta, Sandeep Mishra, Himanshu Sharma "Agri-Bot: IoT Based unmanned smart Vehicle for multiple agriculture operation", in 2021 International Conference on Simulation, Automation & Smart Manufacturing (SASM). The Agri-Bot, an autonomous smart agriculture robot, promises to revolutionize farming operations by executing tasks such as planting, plowing, fertilizing, and harvesting autonomously, without human intervention. Utilizing cutting-edge technologies like Arduino UNOs and NodeMCUs, the Agri-Bot incorporates sensors and components for precise distribution of seeds and fertilizers, offering increased efficiency in small farmlands while significantly reducing labor requirements [3].

Another pioneering concept is the Farming Robot which was proposed by Bagyaveereswaran V, Ankita Ghorui, R. Anitha "Automation of Agricultural Tasks with Robotics- Agrobot", 2019 Innovations in Power and Advanced Computing Technologies (i-PACT), which merges robotics and automation to streamline traditional farming activities. Outfitted with sensors like soil moisture sensors and camera sensors, this robot evaluates soil conditions, monitors crops, and performs tasks like plowing, seeding, and harvesting. Navigation is facilitated through Bluetooth, magnetometer, and GPS modules, aiming to automate agricultural processes and minimize manual labor, thereby bolstering productivity for farmers [4].

Addressing specific challenges in flower harvesting Bhaskar S, Pradeep Kumar M, Avinash M N& Harshini S B, proposed” Real Time Farmer Assistive Flower Harvesting Agricultural Robot”, 2021 6th International Conference for Convergence in Technology (I2CT), the AGO-ROBOT utilizes image recognition technology and neural network algorithms to identify healthy flowers, avoiding damaged ones. Equipped with integrated cameras and AI algorithms, this robot also detects harmful pests and insects, enabling timely spraying of pesticides and insecticides to ensure the safety and efficiency of flower harvesting processes [5].

Another project aimed to address this challenge by introducing automatic fertilizer spraying techniques to minimize manual labor. Through extensive experimentation and analysis, we encountered complexities in processing sample images. Our research focuses on monitoring crop health and treating diseases promptly. Leveraging IoT technology, which eliminates the need for manpower, we detect affected plant parts, such as leaves, and provide targeted remedies. Additionally, IoT enables immediate alerts to be sent to relevant personnel upon disease detection [6].

Another modern research was done by Smith A & Johnson B. (2020). “Advances in leaf disease detection using machine learning techniques” in Journal of Agricultural Science, this employs machine learning techniques for leaf disease detection, leveraging advancements in computer vision and pattern recognition algorithms. By analyzing digital images of plant leaves, these techniques enable automated identification of disease symptoms, facilitating early detection and precise management strategies [7].

Patel, S., Gupta, R., & Singh, M. (2019) proposed “Deep learning-based approach for automated detection of leaf diseases” in International Journal of Computer Applications, this paper presents a deep learning-based method for automated detection of leaf diseases, utilizing convolutional neural networks (CNNs) to analyze digital images of plant leaves. The study demonstrates the effectiveness of CNNs in accurately identifying disease symptoms, offering a promising approach for early disease detection and management in agriculture [8].

Kumar, V., Sharma, S., & Singh, P. (2018) done a work “Review on recent trends in image processing techniques for leaf disease detection”. International Journal of Computer Science and Information Technologies, this paper provides a comprehensive review of recent trends in image processing techniques for leaf disease detection. It discusses various approaches, including machine learning algorithms and digital image processing methods, highlighting their applications and effectiveness in detecting and diagnosing plant diseases [9].

Chen, Y., Li, X., & Wang, Z. (2017). “Leaf disease detection using convolutional neural networks”. Computers and Electronics in Agriculture, this study proposes a method for leaf disease detection based on convolutional neural networks (CNNs), leveraging the capabilities of deep learning in image analysis. The paper demonstrates the feasibility and accuracy of CNNs in identifying and classifying different types of leaf diseases, offering a promising solution for automated disease detection in agriculture [10].

Das, S., Mishra, S., & Mohanty, S. (2016). “Leaf disease detection using digital image processing techniques: A review.” International Journal of Computer Applications, 152(7). this review paper provides an overview of digital image processing techniques for leaf disease detection, summarizing various methods and algorithms used in the field. It discusses the advantages and limitations of different approaches, highlighting the importance of image processing in automated disease diagnosis and management in agriculture [11].

METHODOLOGIES

Our project enables the machine vision technology to provide the analyzing of image by using image processing method, guidance to the robot and other control of pesticide. The main challenge facing in the project is capturing the image of leaf in real time and comparing with the input images.

Components

Raspberry Pi 4 Model B: This is a single-board computer developed by the Raspberry Pi Foundation. It features a quad-core ARM Cortex-A72 processor, multiple USB ports, HDMI output, GPIO pins for interfacing with external devices, Wi-Fi, and Bluetooth connectivity. The Raspberry Pi serves as the central processing unit for your project, running the necessary software and algorithms for image processing and control.

Pi Cam: This is a camera module specifically designed for use with Raspberry Pi boards. It connects directly to the Raspberry Pi's camera port and allows for high-quality image and video capture. The Pi Cam is essential for capturing live images or videos of the target area, which can then be processed for various applications such as object detection or surveillance.

L293D Module: The L293D is a motor driver IC that allows you to control the direction and speed of DC motors. It provides bidirectional control for two motors, making it ideal for robotics and motor control applications. The module typically includes additional features such as built-in protection diodes and terminal blocks for easy connection to motors and power sources [6].

Electromechanical Relay: A relay is an electrically operated switch that allows you to control high-power devices using low-power signals. In your project, the relay can be used to control the operation of external devices such as lights, pumps, or other electrical appliances. The Raspberry Pi can trigger the relay using its GPIO pins, allowing for remote or automated control of these devices.

Motor Drive: This could refer to a motor driver circuit or module specifically designed for controlling DC motors. In conjunction with the L293D module, the motor drive circuitry provides the necessary voltage and current to drive the DC motors used in your project. It ensures precise control over motor speed and direction, enabling smooth operation of robotic systems or other motorized mechanisms.

OpenCV: OpenCV (Open-Source Computer Vision Library) is an open-source computer vision and machine learning software library. It provides a wide range of algorithms and tools for image processing, object detection, and machine vision tasks. In your project, OpenCV can be used for tasks such as image capture, image segmentation, feature extraction, and pattern recognition.

Pump: This is a device used for pesticide to the leaf or the to the plant. In our project, the pump could be controlled using the relay and motor driver circuitry to regulate the flow of pesticide based on certain conditions or triggers detected by the Raspberry Pi and OpenCV.

DC Chopper: A DC chopper, also known as a buck converter or step-down converter, is an electronic circuit that converts a higher DC voltage to a lower DC voltage. It works by rapidly switching the input voltage on and off to control the average output voltage. In your project, the DC chopper could be used to step down the voltage from a power source to a level suitable for powering the Raspberry Pi and other components in the system (Figure 1).

Image Processing

Image processing in real-time for leaf disease detection involves capturing live images of plant leaves using a webcam or similar device and analyzing them to identify potential diseases or abnormalities. This process typically begins with image segmentation, where the leaf area is isolated from the background to focus on relevant features. Techniques such as thresholding, edge detection, and contour extraction are commonly used for segmentation. Once the leaf area is segmented, pixel analysis is performed to examine the color, texture, and shape characteristics of the leaf. This analysis may involve calculating various statistical measures, such as mean color intensity or texture entropy, to quantify the visual properties of the leaf. Machine learning algorithms, such as convolutional neural networks (CNNs), can then be trained on annotated datasets to classify the leaf images into different disease

categories or determine if they are healthy. Real-time processing enables quick and automated detection of diseased leaves, allowing for timely intervention to prevent the spread of diseases and minimize crop losses. Additionally, the use of webcams or portable imaging devices makes this approach suitable for on-site monitoring in agricultural fields, providing farmers with actionable insights for effective disease management (Figures 2, 3).

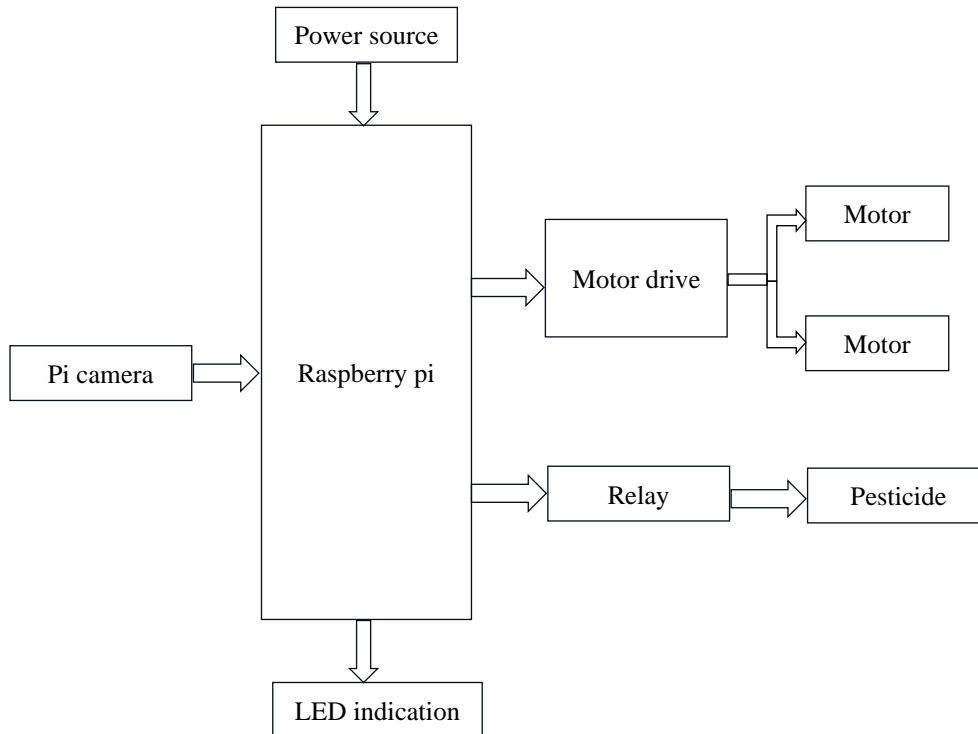


Figure 1. Block diagram of Raspberry Pi 4 Model B.

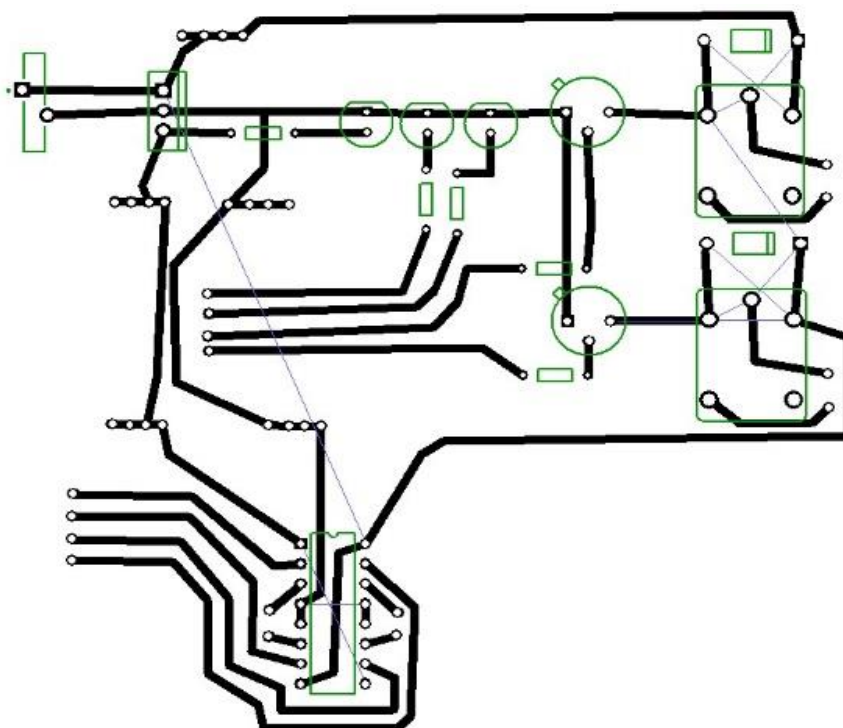


Figure 2. Detected image through image processing.

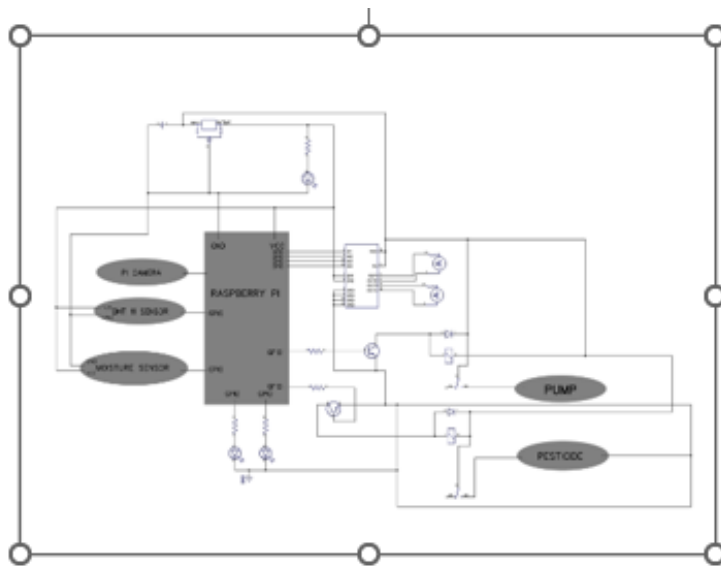


Figure 3. Detcted image through image processing.

Circuit Diagram

We provide a 12V DC supply to the circuit and it rechargeable by using a rechargeable module. The motor drive, water pump, and pesticide pumps are powered by 12V, while the Raspberry Pi, DHT11 sensors, and moisture sensors operate on 5V. The 12V supply is converted to 5V using a buck converter and supplied to the Raspberry Pi. A power LED indicates that power is supplied to the devices. The DHT11 sensor and moisture sensor are connected to the Raspberry Pi GPIO pins. We input the 16 and 8 pins into the GPIO pins, with the 1 and 9 pins serving as enablers, operating at 5V. The output GPIO pins are connected to the motor drive and pumps. Diodes are used to prevent the backflow of voltage. An electromagnetic relay is employed to control the pesticide and water, acting as a switch for these components. Data and power LEDs connected to the Raspberry Pi indicate data transmission and program execution. Additionally, by using DipTrace software, the circuit diagram can be seamlessly converted into a PCB (Printed Circuit Board) design, facilitating the transition from schematic representation to physical implementation (Figures 4, 5).

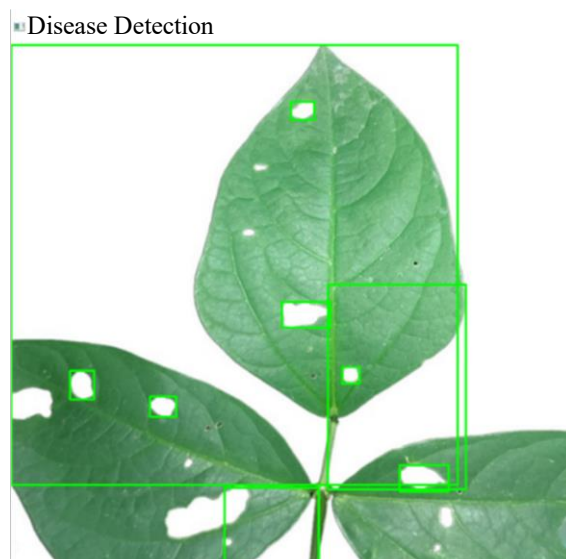


Figure 4. Circuit diagram in Diptrace software.


 Disease Detected



Figure 5. PCB (Printed Circuit Board) design.

CONCLUSIONS

In conclusion, the Agrobot iot based project represents a significant advancement in precision agriculture, harnessing innovative technologies like image processing, Raspberry Pi, and humidity sensors to revolutionize crop monitoring and management. Through data-driven decision-making, this project has the potential to enhance agricultural productivity, optimize resource allocation, and promote sustainable farming practices. The comprehensive approach and cutting-edge techniques of the Agrobot project are poised to transform the agricultural sector and contribute to a more efficient and resilient farming industry. Future work includes enhancing communication between the Raspberry Pi and farmers through Android devices and hardware implementation, focusing on more efficient methods for data exchange and interaction, and improving the overall user experience for farmers. Additionally, further research and development may explore integrating new technologies and sensors to enable better monitoring and control of agricultural systems, ensuring continued advancements in precision agriculture.

Acknowledgments

The authors would like to acknowledge department of Electrical and Electronics Engineering, College of Engineering Trikaripur for providing the facilities. The authors of this paper would further likely to acknowledge our guide Mr. Sujith D K Asst. Professor, EEE dept., College of Engineering Trikaripur who have helped in guiding and providing valuable suggestions in completing this part of the work.

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