IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SMART FARMING ROBOT FOR DETECTING PLANT DISEASES USING MACHINE LEARNING

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Abstract: Modern agriculture faces significant challenges in ensuring food security and sustainable crop production. Plant diseases are a major threat to crop yield and quality. To address this issue, our innovative solution to the pressing challenges in modern agriculture is a Smart Farming Robot incorporating advanced machine learning algorithms for early plant disease detection. This autonomous robot navigates fields, visually inspecting crops with a high-resolution camera and sensors. These capture plant health data processed by a machine learning model trained on a diverse dataset. With a sturdy chassis and advanced navigation, the robot efficiently moving through diverse terrains, gathering real-time data not only from images but also environmental sensors (temperature, humidity, soil moisture). A deep learning model identifies and classifies diseases based on this comprehensive dataset. This integrated approach enhances crop yield and quality, addressing crucial aspects of food security and sustainable agriculture.

Keywords: Smart Farming Robot, Plant Disease Detection, Convolutional Neural Network, Machine Learning, Deep Learning

I. INTRODUCTION

India is known for its farming. Many people here work on farms to grow food like rice, wheat, and fruits. India has different types of land and weather, so it can grow lots of different crops. Farmers use both old and new ways to grow food. One such advancement is the use of smart robots by farmers. These robots, equipped with sensors, cameras, and artificial intelligence, are revolutionizing farming practices by automating tasks and enhancing efficiency. M Arun et al [9] in 2018 has discovered a Smart Agriculture Robot using Arduino Board by using Sensors.

In today's farming world, making sure that we have enough food and can grow crops sustainably is a big challenge. One major problem is that plants can get sick, which can harm how much food we can produce. Plant diseases stem from various causes, including pathogens like fungi, bacteria, viruses, nematodes. Machine Learning algorithms can resolve the leaf detection issues by using algorithms. Jyothi Dinakar Bhosale et al. [2] has proposed Machine Learning-Based Algorithms for the Detection of Leaf Disease in Agriculture Crops implemented technologies ANN, SVM, KNN have achieved 95% accuracy.

Plant diseases pose a significant challenge to global food security, impacting crop yields and agricultural economies. Detecting these diseases early and accurately is crucial for mitigating their impact and ensuring the health and productivity of crops. To tackle this, our project has come up with something cool: the Smart Farming Robot which integrates both IOT and Machine Learning. This robot is like a smart helper on the farm, using really smart computer programs (called machine learning) to find plant diseases early. Smart robot is equipped with Machine learning and Deep learning algorithms, offer promising solutions for automating the detection process. Imagine it like a robot that can walk through fields and take pictures of plants with a special camera. This camera helps the robot see if the plants are healthy or if they're sick. Minah Jung et al [3] has proposed Construction of deep learning-based disease detection model in plants by implementing Convolutional Neural Network have achieved 97.09% accuracy.

What makes this robot super smart is its brain, which is a computer program that has learned a lot about different plants – both healthy ones and sick ones. It looks at the pictures the robot takes and also checks things like how warm it is, how wet the soil is, and other important stuff. All of this helps the robot figure out if a plant is sick. The cool part is that it does this in real-time. So, if the robot sees a plant that might be getting sick, it can tell the farmer right away. This means the farmer can take action quickly

to keep the plants healthy. Our goal with this Smart Farming Robot is to make farming better by using smart technology to find plant problems early, so we can grow more food and take care of the environment too.

II.Literature Survey

Vibhor Kumar Vishnoi et al. [1] in 2022 has proposed detecting diseases in apple plants by analyzing leaf images through Convolutional Neural Networks. Identifying diseases in apple plants involves analyzing leaf images using Convolutional Neural Networks, which enable automated and accurate detection with high efficiency have achieved 98% accuracy.

Jyoti Dinkar Bhosale et al. [2] in 2023 has proposed an Algorithms Based on Machine Learning for Detecting Leaf Diseases in Agricultural Crops. Implementing ML-based approaches to identify diseases affecting leaves in farming. Applying machine learning algorithms to detect diseases in crop foliage within agricultural settings have achieved 95% accuracy.

Minah Jung et al. [3] in 2023 has developed a disease detection model in plants based on deep learning techniques. The process involves constructing a model utilizing deep learning methods to detect diseases present in plants. By leveraging deep learning techniques, the model can effectively learn and adapt to different types of plant diseases, enhancing its ability to provide accurate detections have achieved 97% accuracy.

Tiago Domingues et al. [4] in 2022 has proposed a thorough survey on the application of machine learning for detecting and predicting crop diseases and pests. This survey delves into various methods and approaches employed within the agricultural domain to enhance disease and pest management strategies. It aims to provide a detailed overview of the role of machine learning in tackling agricultural challenges related to crop health.

Sunil S. Harakannanavar et al. [5] Utilizing computer vision and machine learning algorithms to detect diseases in plant leaves. This approach involves leveraging advanced technology to analyze leaf images and identify signs of diseases accurately. By combining computer vision with machine learning, it enables automated detection and diagnosis of plant health issues, aiding in timely interventions for crop protection have achieved 99.6% accuracy.

Arathi Nair et al. [6] has implemented IoT and machine learning for plant disease detection in smart farming. This integration enables the use of sensor data and advanced algorithms to enhance disease monitoring and management in agricultural settings.

Prachi Chauhan et al. [7] in 2021 has proposed a utilizing deep learning techniques to address plant diseases within the framework of smart agriculture. This approach integrates advanced algorithms to enhance disease detection and management strategies in agricultural settings. By leveraging deep learning capabilities, it aims to improve crop health monitoring and mitigate potential losses in smart farming systems have achieved 99% accuracy.

Yan Guo et al. [8] in 2020 has proposed a utilizing deep learning techniques to address plant diseases within the framework of smart agriculture. This approach integrates advanced algorithms to enhance disease detection and management strategies in agricultural settings. By leveraging deep learning capabilities, it aims to improve crop health monitoring and mitigate potential losses in smart farming systems have achieved 83.57% accuracy.

M. Arun et al. [9] in 2018 has designed a robotic system for smart agriculture applications. This technology aims to automate various tasks in farming operations, contributing to increased efficiency and productivity. The smart agriculture robot integrates advanced sensing and control mechanisms to optimize crop management processes.

Sharada P. Mohanty et al. [10] in 2016 has proposed a deep learning techniques to detect plant diseases through image analysis. This approach utilizes advanced algorithms to analyze visual data and identify signs of plant illnesses accurately. By harnessing deep learning, it enables efficient and automated detection of crop diseases, aiding in timely interventions for agricultural management have achieved 99% accuracy.

III.EXISTING SYSTEM

Several existing systems and prototypes for Smart Farming Robots designed to detect plant diseases using Machine Learning have been developed. These systems typically feature wheeled or tracked mobile platforms equipped with high-resolution cameras and sometimes environmental sensors for capturing images and collecting additional data. The software components commonly include Convolutional Neural Network (CNN) models trained on datasets containing images of healthy and diseased plants, along with image processing techniques like resizing and normalization. Vibhor Kumar Vishnoi et al. [1] in 2022 has proposed Detection of Apple Plant Diseases Using Leaf Images Through CNN by implementing Deep Learning Algorithm which is Convolutional Neural Network have achieved 98% accuracy. Disease databases are maintained for accurate classification, and communication modules transmit data to central servers or cloud platforms for analysis. Integration involves deploying trained models for real-time disease detection during field operations, and some systems provide remote user interfaces for monitoring robot activities. Challenges include power management, autonomy, and the need for validation through field trials to refine algorithms based on user feedback. For the latest developments, exploring recent literature and agricultural technology updates is recommended, as the field evolves rapidly.

Disadvantages:

- Multiple Algorithms
- Limited Datasets

IV.PROPOSED SYSTEM AND WORKING METHODOLOGY:

The proposed Smart Farming Robot for plant disease detection employs a wheeled or tracked mobile platform equipped with cameras and environmental sensors. The onboard computer, running a lightweight operating system, processes high-resolution images through a Convolutional Neural Network (CNN) model designed for plant disease classification, such as VGG16 or ResNet. The system includes modules for image acquisition, data preprocessing, and an inference mechanism for real-time disease detection. A comprehensive disease database enhances classification accuracy, and a communication module enables data transfer to a central server or farm management system. A user interface facilitates remote monitoring, while a feedback mechanism allows users to correct misclassifications. The integration of power management ensures optimal energy use, potentially incorporating charging mechanisms or solar panels for extended autonomy. The system undergoes thorough testing, including field tests, and is designed for easy maintenance and updates to adapt to evolving agricultural conditions.

A. Smart Framing Robot

A smart farming robot designed for plant detection using deep learning is equipped with a range of hardware components tailored for autonomous operation and data analysis. Mounted on a mobile platform, these robots feature an array of sensors including cameras, and environmental sensors. These sensors capture vital data about the crops and surroundings, facilitating plant detection and navigation tasks. The robot is powered by onboard processing units, typically CPUs or GPUs, for real-time data analysis, with storage capacity for logging captured images and sensor data. To ensure sustained operation, reliable power sources, such as rechargeable batteries or solar panels. The integrated hardware suite enables the robot to autonomously navigate fields, capture images, analyze plant health, and contribute to optimized agricultural practices.

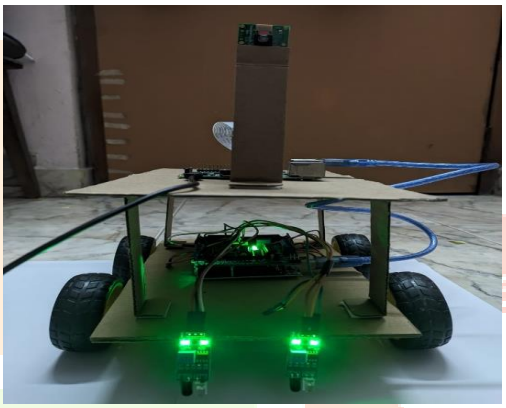


Fig.1.Smart Agriculture Robot

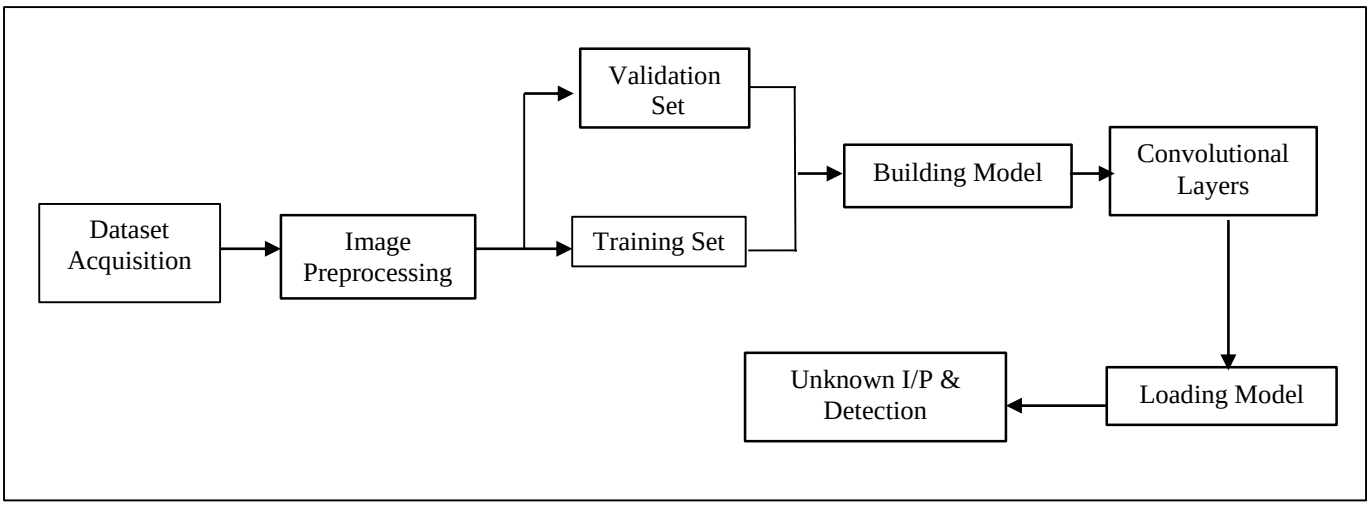
B. Convolutional Neural Network

Convolutional Neural Networks (CNNs) represent a ground breaking advancement in the field of artificial intelligence, particularly in the realm of computer vision. Originally inspired by the visual cortex of the human brain. The architecture of a CNN is composed of multiple layers, each with specific functions tailored towards feature extraction and classification. These layers typically include convolutional layers, pooling layers, and fully connected layers, arranged in a hierarchical manner to progressively learn and abstract features of increasing complexity.

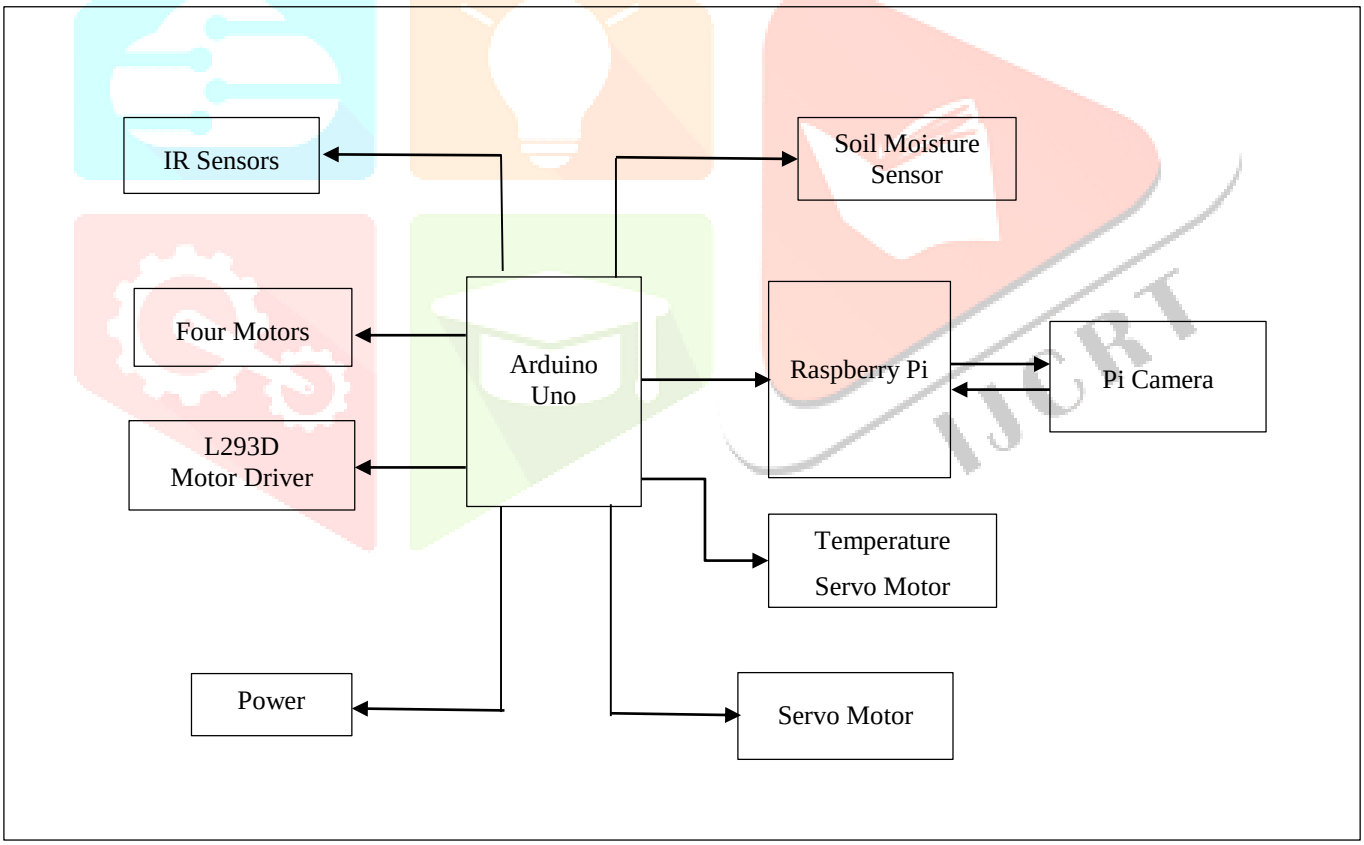
In a smart agriculture robot designed for plant disease detection, the VGG19 convolutional neural network (CNN) plays a pivotal role. With its ability to extract intricate features from images, VGG19 serves as a potent tool for discerning patterns indicative of various plant diseases.

V.BLOCK DIAGRAM FOR THE PROPOSED MODEL

1.Data Preprocessing and ML Model



2.Arduino Board integrated with Sensors



VI.RESULTS

Fig.2. Smart Robot

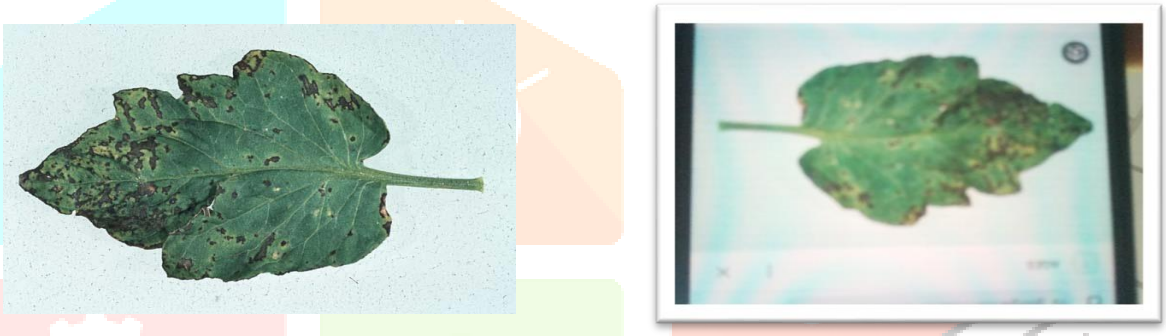


Fig.3. Disease Detection in Tomato leaf

Fig.4. Disease Detection in Bell Pepper leaf

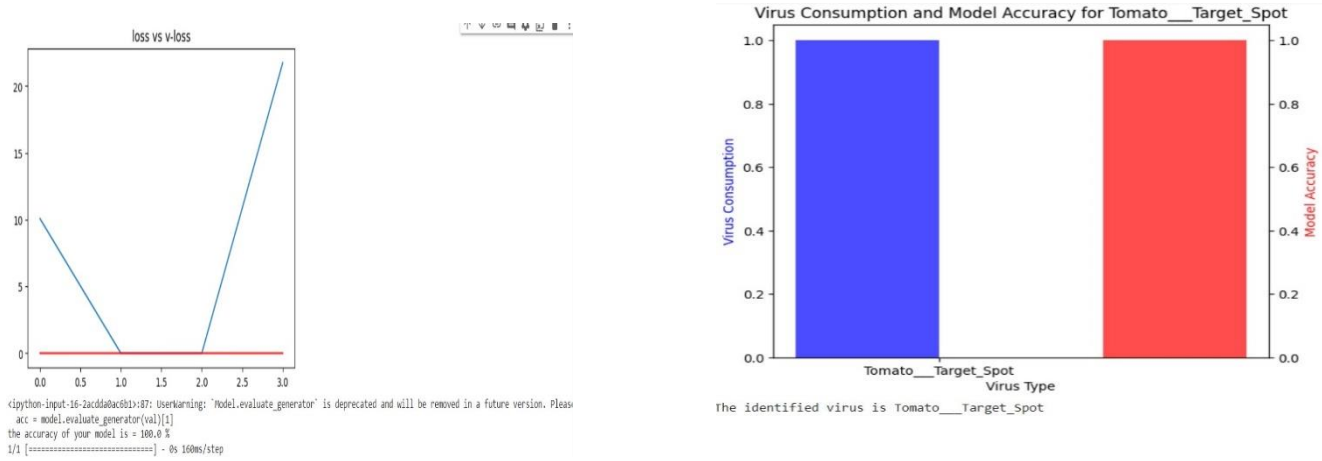


Fig.5.Analysing the Diseases using Machine Learning Model

VII.CONCLUSION:

In conclusion, the integration of smart farming robots equipped with machine learning algorithms presents a promising solution for early detection and management of plant diseases. By leveraging advanced technologies, such as computer vision and data analytics, these systems can accurately identify diseases, thereby optimizing crop yield, reducing resource usage, and promoting sustainable agricultural practices. Overall, the implementation of such innovative solutions signifies a significant step towards enhancing productivity and resilience in modern agriculture.

VIII.FUTURE SCOPE:

The future scope for smart farming robots in detecting plant diseases using machine learning is promising. Advancements will focus on refining algorithms for higher accuracy, enabling real-time monitoring and proactive management. Integration of multi-spectral imaging and autonomous navigation will enhance detection capabilities and operational efficiency. Customization to specific crops and regions, along with predictive analytics, will further optimize disease prevention strategies, contributing to sustainable agriculture and global food security.

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