PESTO-BOT

Charukesh P.N.[1]; Ashritha A. Shetty[2]; Lekhana Satheesha[3]; Ashmith[4]

[1,2,3,4]Acharya Institute of Technology

Publication Date: 2025/02/24

How to Cite: Charukesh P.N.; Ashritha A. Shetty; Lekhana Satheesha; Ashmith. (2025). PESTO-BOT. *International Journal of Innovative Science and Research Technology*, 10(2), 498-513. https://doi.org/10.5281/zenodo.14916995.

Volume 10, Issue 2, February – 2025 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

TABLE OF CONTENT

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

ABSTRACT

Agriculture is the backbone of our country. Digital technologies are being used to improve and increase the production of the crops. This proposes to use of Robot in the agricultural sector. The robot can be controlled autonomously. Farmers are reaching out to agricultural robot to help mitigate the problems of pest control and increase the yield of crops.

The aim of this project is to create an autonomous spraying robot that will decrease pest and minimize the usage of pesticides and decreases human health Impact, allowing farmers to be protected and labour intensity can be reduced. The bot will be trained for route planning, navigation systems, spraying mechanism and obstacle avoidance with multi-sensor module integration. First the robot detects the pest using thermal camera and the algorithm of Image processing is applied in which the images of the leaves affected by pests is captured by using a digital camera. The leaves with pest images are processed for getting a grey-coloured image and then using feature extraction, image of the pest is detected. Once the pest is confirmed the nozzle gets activated and it sprays pesticides only to the particular area where the pest is present.

The CAD model of the Bot is designed using FUSION 360. Belt drive mechanism is designed for the movement of the Bot. There is a robotic arm which consists of a sprayer and a tank is present to store the pesticides and there is a light pole which tell us the location of the bot.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

CHAPTER ONE
INTRODUCTION

A. Introduction

Pesticides are chemicals used to eradicate pests. Not only they are used for plant protection and livestock in agriculture, but they are also used in public areas to kill mosquitoes, cockroaches, and other pests. Approximately 95% of the pesticides produced are only used in agriculture for crop protection. Every country wants to increase crop production. To protect their crops from pests, farmers must use pesticides. Exposure to pesticides is increasing day by day, whether occupationally or environmentally. This has resulted in an increase in crop production, but it has numerous adverse effects on human health, animal health, and the environment [1].

Chili (Capsicum annuum L.) is one of the important commercial vegetable crops cultivated in different parts of the India, but majorly grown in Telangana, Andhra Pradesh and Karnataka for both green and red chilies. India is a major producer, exporter and consumer of chilies in the world and contributes about 42.60 % to the total world production with a production of 17.02 lakh tones (Horticulture Statics at Glance, 2018). It has immense export potential of different chilies meeting the needs of various markets around the world. The market outlay of India from exporting chili accounts for 4.84 lakh tones in 2019-20 with worth of nearly Rs.6211.70 crores but the average productivity is very low in comparison to that of other countries because insect pests and diseases are the major biotic constraints for chili production. About 25 to 26 insect and non-insect pests have been recorded infesting chili leaves and fruits, of which, thrips, is so far considered as the most serious and important pest. However, crinkling and curling of leaves and yield loss despite insecticidal sprays has been observed recently in Telangana, Andhra Pradesh and Karnataka by the farmers [2].

Fig 1: Chilly Plant Affected by the Thrips [11]

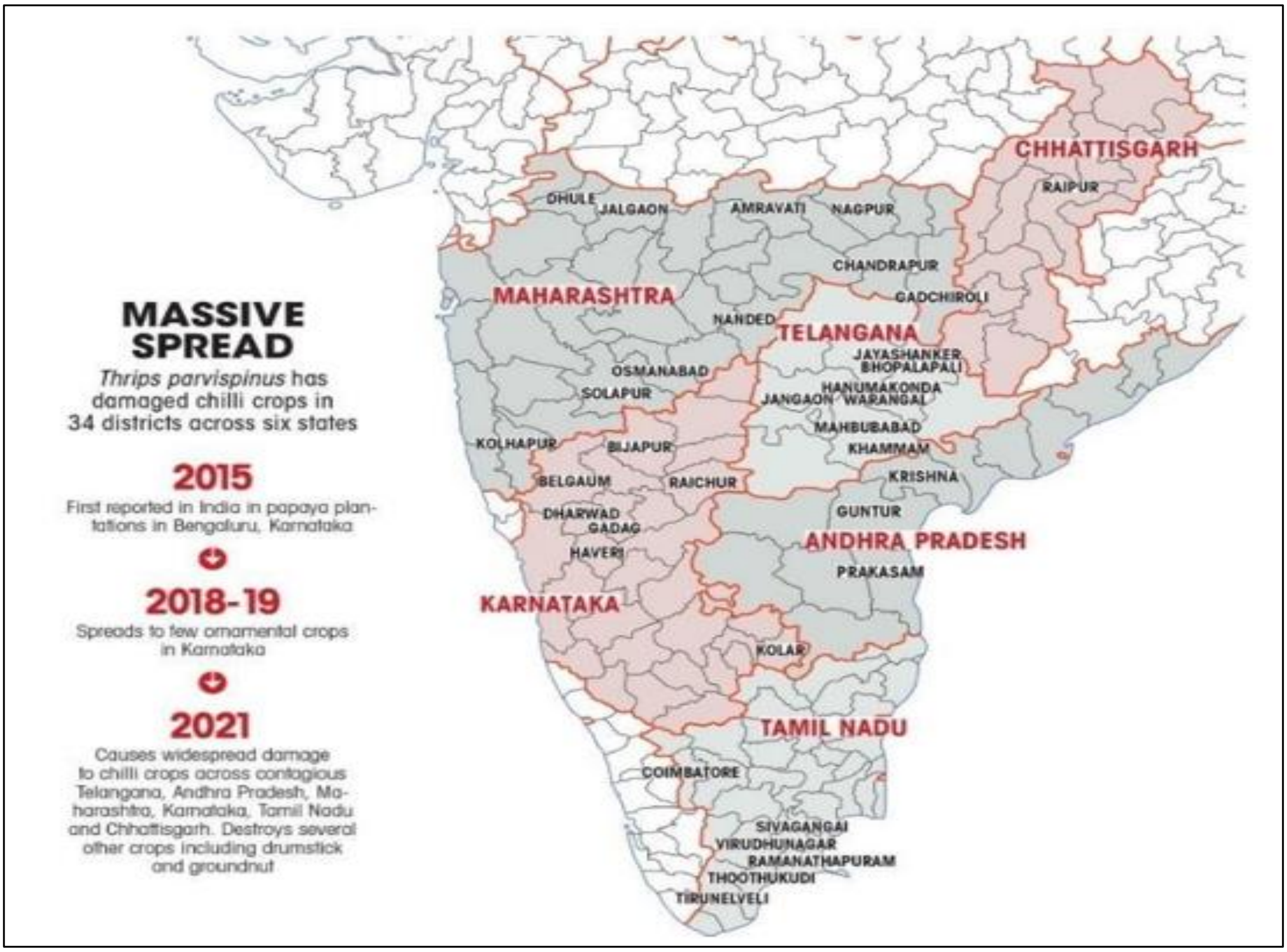

Fig 2: Massive Spread of Chili Pest in others States [Down to Earth - Monday 16 May 2022]

Fig 3: A Laborer Dries Chilies at a Farm in Lakshmipuram Village in Telangana's Hanumakonda District, Which Lost 51 Per Cent of its Chili Crops to a New Species of Thrips this Year

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

Fig 4: Skin Disease that are Caused to Farmers Due to Pesticide Usage [12]

B. Problem Statement

- Prolonged exposure to pesticides can have adverse effects on human health. Farmers and agricultural workers who handle and apply pesticides are at risk of acute poisoning and long-term health issues. Additionally, residues of pesticides can remain on crops even after harvest, leading to potential health hazards for consumers if consumed in excessive amounts.
- They can contaminate soil, water bodies, and air, leading to pollution and disruption of delicate ecosystems. Pesticides can harm beneficial organisms such as pollinators (bees, butterflies) and natural predators that help control pests, leading to imbalances in ecosystems and reduced biodiversity.
- Over time, pests can evolve and adapt to survive exposure to pesticides, rendering them less effective. This phenomenon necessitates the use of higher quantities or more potent pesticides, exacerbating the environmental and health concerns.
- Pesticides can degrade soil quality and fertility. They can kill beneficial soil microorganisms, disrupt nutrient cycles, and decrease soil biodiversity. These factors ultimately lead to reduced soil productivity, increased erosion, and long-term degradation of agricultural land.
- The farmers are spending huge amount on buying the pesticides and manual spraying machine which should be maintained regularly.

C. Problem with Existing Technology

Pesticide spraying robots often lack the precision required to effectively target specific areas or plants. This can lead to uneven distribution of pesticides, resulting in inadequate pest control and potential crop damage. They lack advanced sensing and perception capabilities. They may not be able to accurately detect and identify pests, which limits their ability to respond effectively and apply the appropriate pesticides.

Existing robots may not optimize the use of pesticides or other resources. They may spray excessive amounts of chemicals, leading to environmental concerns, increased costs, and potential harm to beneficial organisms and humans.

D. Objectives

- To Design a CAD model for Pesticide spraying Bot.
- To Develop an Integrated Intelligence System to detect pests using image processing.
- To Develop an Autonomous Pesticide Spraying Mechanism for Black Thrips.

Volume 10, Issue 2, February – 2025 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

CHAPTER TWO
LITRETURE SURVEY

The various research paper which we referred, and it is shown in the table below.

Table 1: Research Paper

SL. No	Title & Author	Problem Addressed	Methodology	Inference
1)	K. MURUGAN, B. J. SHANKAR, A. SUMANTH, C. V. SUDHARSHAN and G. V. REDDY, "Smart Automated Pesticide Spraying Bot,"	Robot is developed to spray the pesticides by its own and it is less harmful to the environment.	This bot will spray the pesticides over entire the crop with the help of mobile phones. This bot can be easily controllable. The bot sprinkles the pesticides covering all plants in the farm	This will use in pest control and disease prevention application forms. By using this bot, the time and work of the farmer will be reduced.
2)	Smarter Robotic Sprayer System for Precision Agriculture by André Rodrigues Baltazar, Filipe Neves dos Santos, António Paulo Moreira, António Valente and José Boaventura Cunha	This journal tells us that Precision spraying is a method used to reduce the losses during pesticides application, reducing chemical residues in the soil	They developed a smart and novel electric sprayer that can be assembled on a robot. The sprayer has a crop perception system that calculates the leaf density based on a support vector machine (SVM) classifier using image histograms (local binary pattern (LBP), vegetation index, average, and hue). This density can then be used as a reference value to feed a controller that determines the air flow, the water rate, and the water density of the sprayer. This perception system was developed and tested with a created dataset available to the scientific community and represents a significant contribution	The performance of the ISSLA approach in detecting leaf density was evaluated. The PRYSM sprayer performance was validated according to the size and dispersion of the water particles obtained
3)	AGRICULTURAL PESTICIDE SPRAYING ROBOT K. Sushma Priya*1, R. Praneetha Reddy*2, Y. Pradeep*3	The aim of this project is to create an intelligent spraying robot that will decrease pesticide use and human health damage, allowing farmers to be protected and labour intensity can be reduced.	The robot will have full route planning and navigation systems, as well as driving control, spraying mechanism and system construction and obstacle avoidance with multi-sensor module integration. The spray robot will be designed, including obstacle avoidance, spraying and sensor integration simulations and analyses.	This agriculture vehicle proves to be an effective and efficient machine which can be easily navigated and controlled. The robot can traverse a variety of terrains and soils the robot's control is simple, and farmers can easily operate this intelligent vehicle.
4)	Smart Phone Operated Multipurpose Agricultural Robot B S Balaji, Shiva kumara M C, Sunil Y S, Yamuna A. S, Shruthi M	The paper aims on the design, development and the fabrication of the robot which can dig the soil, leveler to close the mud and sprayer to spray water, these whole systems of the robot works with the Battery and the solar power.	The vehicle is controlled by Relay switch through IR sensor input. The language input allows a user to interact with the robot which is familiar to most of the people. The advantages of these robots are hands-free and fast data input operations.	In the field of agricultural autonomous vehicle, a concept is been developed to investigate if multiple small autonomous machines could be more efficient than traditional large tractors and human forces.
5)	AGRIBOT-A MULTIPURPOSE AGRICULTURAL	The main aim of this project, the	Provides manual management and keeps a track on the humidness with the assistance of humidness	These systems are more flexible than traditional systems. This system

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

	ROBOT by Shinde Shital Balaso, Bhoge shraddha Vijaykumar, Gaikawad Reshma Babasaheb, Bhosale mukesh shantaram, S.M.bhadhkumbhe	mechanism system is employed to develop the agricultural processes while not the employment of force. It provides manual management and keeps a track on the humidness with the assistance of humidness sensors.	sensors. The most element of our projected system is that the Advanced Virtual computer architecture (AVR) at mega small controller that supervises the whole method. For manual management the mechanism uses the wi- fi affiliation application as management device and helps within the navigation of the mechanism within the sector. Solar array is employed for power offer to the mechanism. This is often particularly necessary for the security and health of the employees	helps to reduce human efforts. Thus, it has made possible to automate the most significant working routines. Multipurpose autonomous agricultural robothas successfully implemented.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

CHAPTER THREE
METHODOLOGY

Developing an Automated solution to the given problem requires many components both mechanical and electrical, to be interfaced together for it to work. The design of the system, components used in this project and the block diagram of the proposed solution is show in this chapter.

A. Functional Block Diagram

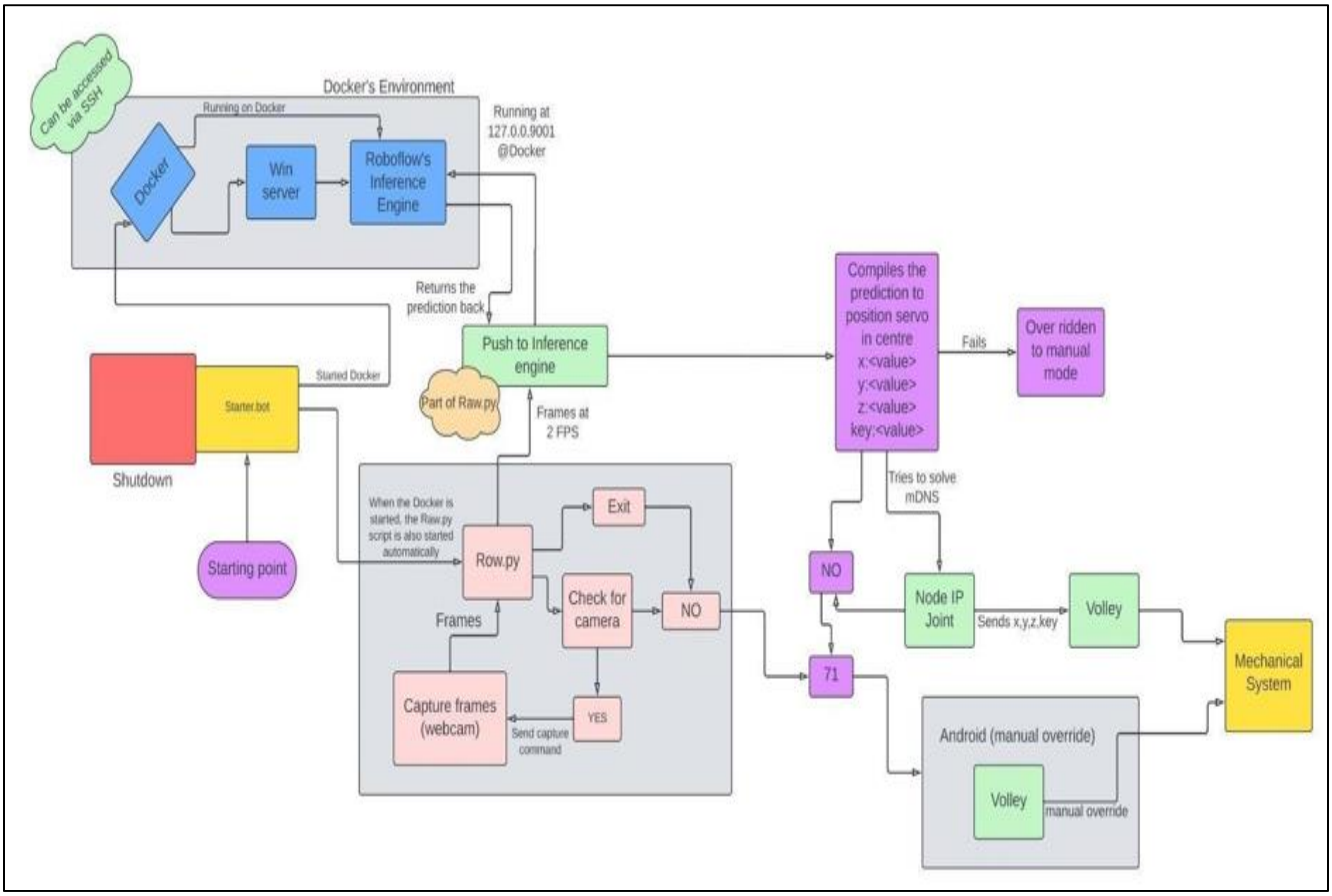

Fig 5: Working Block Diagram

B. Working

Double click on starter Bot, it will enable server 1 which is docker's environment, in which we have docker. It is a platform for developing, shipping, and running applications in containers., and has windows server and roboflow's inference engine. Containers are a lightweight, standalone, executable package that includes everything needed to run a piece of software, including the code, runtime, system tools, libraries, and settings. Windows Server is a group of operating systems developed by Microsoft designed to run on servers. It is the server counterpart of Microsoft's Windows client operating systems, such as Windows 10. Windows Server provides a variety of features and services tailored for enterprise-level computing needs.

An inference engine, in the context of machine learning and computer vision, is the component responsible for making predictions or inferences based on a trained model. It takes input data such as images and produces output predictions such as bounding boxes around objects or class labels. The inference engine will push the docker to run at a specific IP address. SSH stands for Secure Shell. It is a cryptographic network protocol that allows secure communication between two devices over an insecure network. SSH is commonly used for remote access to servers and devices, enabling users to log in to a remote system and execute commands as if they were directly interacting with the system locally. When the docker is started the Raw.py script is started automatically which will start the server 2. The Raw.py will check for the camera, where it has 2 conditions yes or no. If yes it will capture the frames, else it will send a command to the app where we will have the manual control of the robot. When the frames are captured, docker returns the predictions to the inference engine where these predictions are compiled and the predicted data will be sent to position the servos. If it fails then manual override is enabled. If yes, then it sends the data to the node, from there the x, y, z, key values are sent. Through Volley it will be sent to the mechanical systems to the movement of arm

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

and then the spraying mechanism is activated. Roboflow is a platform designed to simplify and streamline the process of training, deploying, and managing computer vision models. It provides a range of tools and features to assist developers and data scientists in building custom computer vision solutions without the need for extensive expertise in machine learning or computer vision algorithms. Volley is an open-source networking library for Android developed by Google. It provides developers with a simple and efficient way to manage network requests and responses in Android applications. Volley is designed to handle asynchronous network operations, such as fetching data from a web service or making HTTP requests, without blocking the main UI thread. Volley manages network requests by queuing them and prioritizing them based on their importance. This ensures that high-priority requests are processed first, while lower-priority requests are queued and processed later. Volley automatically handles retry logic for failed network requests, including transient errors such as network timeouts or connectivity issues. It uses an exponential backoff strategy to retry failed requests with increasing delays between retries.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

CHAPTER FOUR
OVERALL DESIGN OF PESTOBOT

This Chapter tell us the Overview of Mechanical and Electrical Design In the below figures we can see the different views of the rover with the robotic arm placed on it. It is designed in such a way that it can move easily on the rough terrain of the chilli plant and the robotic arm can reach the flowers of chilli plant and Spray Pesticides. The electrical Design Consists of the Various Components that is used in the bot.

A. Mechanical Design

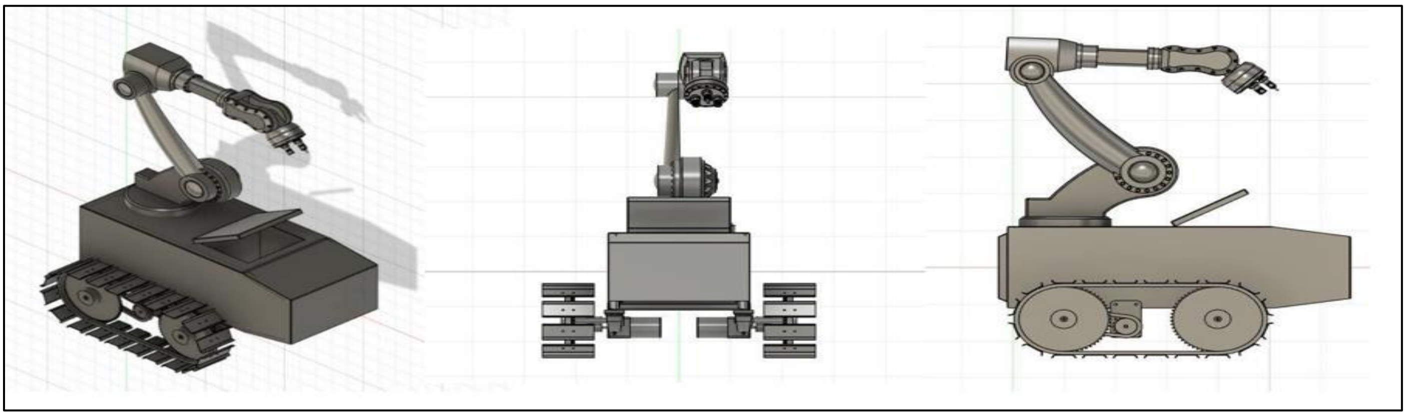

Fig 6(a): Home View Fig 6(b): Front View Fig 6(c): Side View

The designs were done on Auto Fusion 360 software by conducting field trails and mapping the field space to move the rover between the spacing of the plants. In the above figures we can see the different views of the rover with the robotic arm placed on it. The overall length of the rover is 62 cm in length and height of the rover is 20 cm with a width of 45cm. it is designed in such a way that it can move easily on the rough terrain of the chilli plant and the robotic arm can reach the flowers of chilli plant and can easily spray the pesticide on it. The front of the rover has an opening for the pesticide to be placed in it and will not have any leakage from any side. The backside of the rover will have all the electrical components connected and integrated with each other. The entire rover is customized for smooth running. The belt drive mechanism is a specially crafted chain mechanism between the two lengths of the driving and the driven metal disc and the plates on them placed will help the rover move easily in the clay soil while maintaining the equilibrium of the rover at all the times.

B. Electrical Design

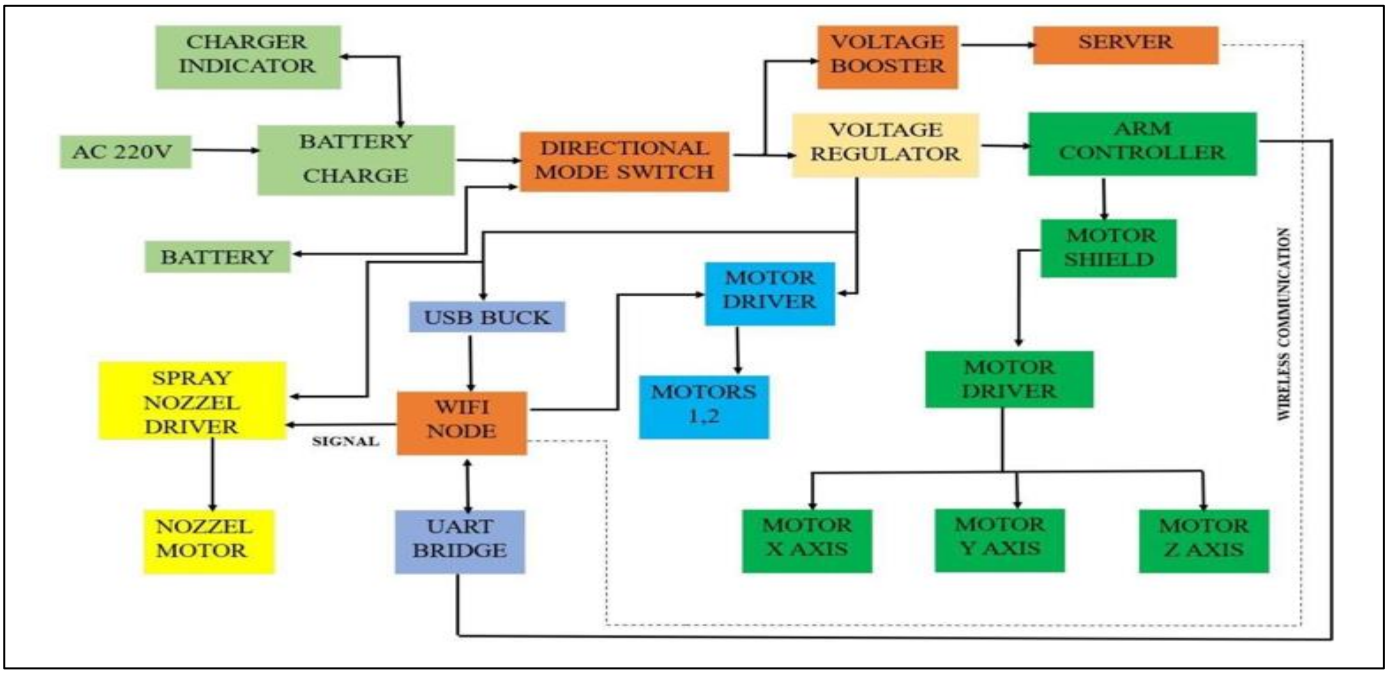

Fig 7: Electrical Design

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

Here we have 3 modes for running the agricultural robot. First, we have the charging mode when the switch is turned to forward mode it will charge when it is connected to external power AC source. The digital voltmeter ammeter will show the voltage reading and the amperes that the battery is using to charge and it will take 3 to 4 hours to complete to full charge. Second, we have the OFF mode where the bot will be in the idle position. Third we have the working mode where the power from the battery will be supplied to all the electronics of the robot. The power will go to the voltage booster there it will change the voltage to 19 volts and supply to the server which will handle the image processing and the detection of the pest which is black thrips and send the 3-dimensional coordinates to the ESP 32 for the movement of the robotic arm. Then from voltage regulator to the robotic arm where it will power all three motors in x, y and z axis for moment. From voltage regulator to the motor drivers for the moment of the motors 1 and 2 for moving the robot through belt drive mechanism. Finally, from voltage regulator to USB buck and WIFI node for wireless communication to the server and then to the spraying mechanism.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

CHAPTER FIVE
RESULTS

Through the literature survey and the visit of the farm site at the ICAR we have successful designed a CAD modelconsidering the parameters like atmospheric temperature, pressure, wind speed and other factors affecting on it. The CAD model designed is suited for all the terrain conditions and can work smoothly. We have successfully developed an integrated intelligent system for detecting black thrips using image processing. We have partially made the robot automatic in terms of detecting of the black thrips and sending the 3D coordinate to the system for the moment of robotic arm.

Fig 8: Pesto Bot Field Trials at Chilli Field

A. *CASE 1*

The robot is made on and initial checking and resource compilation will be done and the camera will be on, from the image of chill plant, the software will determine that it is healthy chili plant and will move forward to the next plant.

Fig 9: Healthy Leaf Detection

The above figure represents the healthy leaf where the software will give coordinates to the robotic arm and will continue to scan for every 5 seconds.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

B. Case 2

The robot is made on and initial checking and resource compilation will be done and the camera will be on, from the image of chill plant, the software will determines the pest Black thrips present on the chili plant and will spray pesticide only on that particular area.

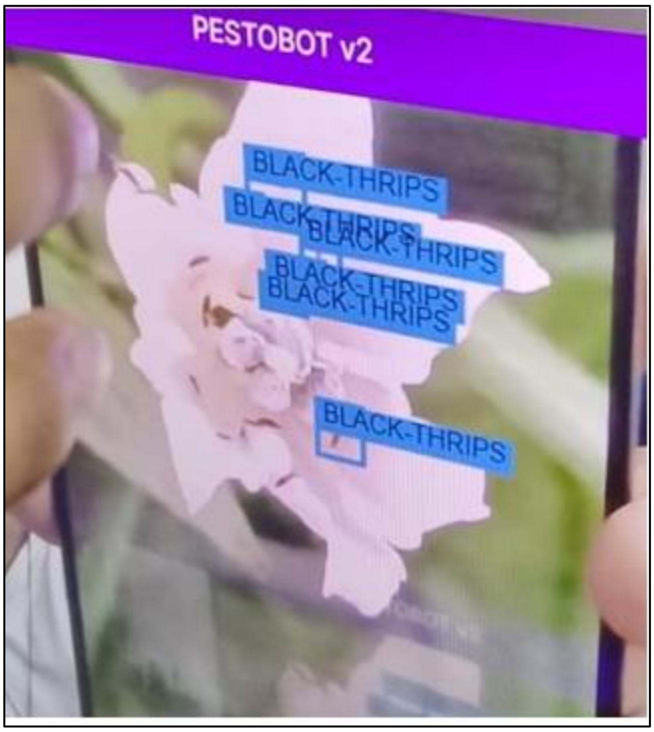

Fig 10: Black Thrips Detected

The above figures represent the infected leaf on chilli plant and the coordinates are sent to the robotic arm for the movement and the spraying mechanism is activated for spraying pesticide at the infected lea

C. Future Scope and Enhancements

- We further need to train the data for 100% accuracy, as of now it is only 70 to 80% accurate.
- We need to optimize the design of the prototype to turn it into product for commercial use.
- We need funding for using powerful components which can handle heavy loads very easily and easy to operate

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

CHAPTER FIVE
CONCLUSION

We conclude that the agricultural bot is designed and is ready to use in field to detect and identify the pest Black Thrips and spray pesticide on the particular area. All of this has been achieved through one year of hard work where at the first we have conducted a literature survey to choose the type of plant and the pest at which we are going to work. Then we conducted survey in ICAR – Bangalore where we have visited chilli plot measured the spacing between each plant and the space for a person to walk. After conducting all the survey, we have finally started working on the CAD model of the Robot. The CAD model comprises of all the hardware components which are simulated under various conditions like stress – strain analysis etc.

After completing the CAD model, we have completed the hardware setup of the robot with all the electrical components. The center of gravity is maintained in the robot. We have also written a program for the movement of robotic arm to the specified location. We have trained the model to detect Black thrips under various conditions. We have also created an App where the robot will be connected to the App wirelessly and the movement of the robot will be controlled through the app.

We have tested the robot for two conditions in first condition it detects healthy leaf and in the second condition it’s the black thrips and it sprays the pesticide to the particular area. We have also tested the robot tank capacity which has a max capacity of 6L.

Overall, we can tell that our prototype can work under rough terrain conditions and it will detect pest.

ISSN No:-2456-2165 https://doi.org/10.5281/zenodo.14916995

REFFERENCES

[1]. Anurag Singh Baghel, Arpit Bhardwaj, Wubshet Ibrahim Optimization of Pesticides Spray on Crops in Agriculture using Machine Learning", Computational Intelligence and Neuroscience, vol. 2022, Article ID 9408535, 10 pages, 2022. https://doi.org/10.1155/2022/9408535

[2]. N. R. PRASANNAKUMAR, Pest Management in Horticultural Ecosystems Status of the outbreak of Thrips Parvispinus (Karny) on chilli in Karnataka, Vol. 27, No.2 pp 286-290 (2021).

[3]. https://www.newindianexpress.com/states/telangana/2021/dec/06/invasive-insect-thrips-destroys-chilli-cropfarmers-hopes 2392254.

[4]. Chilli under attack: New thrips species destroys farms in 6 states https://www.downtoearth.org.in/news/agriculture/chilli-under-attack-new-thrips-species destroys-farms-in- 6- states-82811

[5]. Insect hits 9L acres of chilli crop in south India; experts point to use of pesticide: https://indianexpress.com/article/india/insect-hits-chilli-crop-south-india

[6]. K. Sushma Priya, R. Praneetha Reddy, Y. Pradeep AGRICULTURAL PESTICIDE SPRAYING ROBOT, International Research Journal of Modernisation in Engineering Technology and Science, Volume: 04/Issue:07/July-2022

[7]. Shinde Shital Balaso, Bhoge shraddha vijaykumar, Gaikawad Reshma Babasaheb, Bhosale mukesh shantaram, S.M.Bhadhkumbhe, AGRIBOT- A MULTIPURPOSE AGRICULTURAL ROBOT, 2020 IJCRT, Volume 8, Issue 4 April 2020.

[8]. Pavithra N , Veena S Murthy, An Image Processing algorithm for pest detection, Perspectives in Communication, Embedded-Systems and Signal-Processing (PiCES) ISSN: 2566-932X, Vol. 1, Issue 3, June 2017.

[9]. B S Balaji, Shivakumara M C, Sunil Y S, Yamuna A S, Shruthi M Smart Phone Operated Multipurpose Agricultural Robot, International Journal of Engineering Research & Technology (IJERT) Vol. 7 Issue 05, May-2018

[10]. Kavita Zole1, Sanghasevak Gedam2, Aditya Dawale3, Kiran Nikose4, Jayant Hande5,Agricultural Robot International Research Journal of Engineering and Technology (IRJET),Volume: 05 Issue: 02 Feb-2018.

[11]. Source - https://agritech.tnau.ac.in/crop_protection/Chilli%20thrips%20sym.png

[12]. https://encryptedtbno.gstatic.com/image?q=tbn:ANd9GcSTcQ9qOVLpRVc0hiX4MkfSMNdfRpszwzlo 3KAxl2Vqw&s

[13]. Syed Mutahir Mohiuddin, Agricultural Robotics and Its Scope in India,International Journal of Engineering Research & Technology (IJERT) Vol. 4 Issue 07, July-2