Weed Detection and Removal Bot

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Abstract

A major part of our economy is agriculture-dependent. Being agriculture-dependent, crop quality has a significant impact on our livelihood. In many cases the crop quality is compromised due soil degradation which is a direct result of weed growth and the herbicides used to destroy them. Other method to clear out weed is by directly uprooting and discarding them. These tasks if carried out manually are time consuming, costly and at the same time not efficient. This led us to develop a project which will be capable to do these tasks precisely and efficiently. The initial part of the project is to identify weed and study their characteristics using image processing, followed by creating a dataset containing images of weeds to be uprooted. Subsequently we will be then training the model with created dataset and rectifying it as per requirement. The last step to our project is integration of the trained model with microcontroller to obtain expected actuations. Ultimately, the testing of complete model along with the communication protocols used will be carried out.

Keywords *— (Weed, Detection, Gripper, Blade, Bot, YOLOv5)*

I. INTRODUCTION

Villagers are the backbone of our nation. Agriculture is born in villages which feed all of us. But due to some unwanted plants in the field, the production of the yield is decreasing day by day. Growth of weed surrounding the crop area is a common concern while having a plantation or a farm. Weeds are the unwanted plants that are growing around the crop which is absorbing most of the nutrients in the soil which makes the actual crop unhealthy. Weeds contest with the crop plant for air, water, sunlight and nutrients in the soil making them scarce for the main crop. It costs a lot of money and also consumes more time for removing weeds and controlling infected plants manually. Even though it is no guarantee for completion of work 100% as the human eye may skip some plants which may lead to the destruction of the plants. Also, they are not of use to humans. Thus, they affect the growth of the plant and their removal is necessary.

So, to tackle this problem we decided to make a robot that will detect the weed around the plant and accordingly will pluck it from its roots, firstly we will be training our model using the pictures of some specific weeds which we want to target in our project, and create a dataset of those pictures, then we will integrate these data set and algorithm into the microcontroller of our robot. Here our robot will move forward and if it will detect the weed which we have mentioned in our dataset it will hold it with the help of a gripper and additionally we have attached a cutting wheel so as to remove the soil around the weed so that uprooting the weed will become much easier.

The proposed eco-friendly approach improves
production leading to the benefit of farmers and then to the nation. Thus, leads to the enhancement of life-stock for villagers.

II. LITERATURE REVIEW

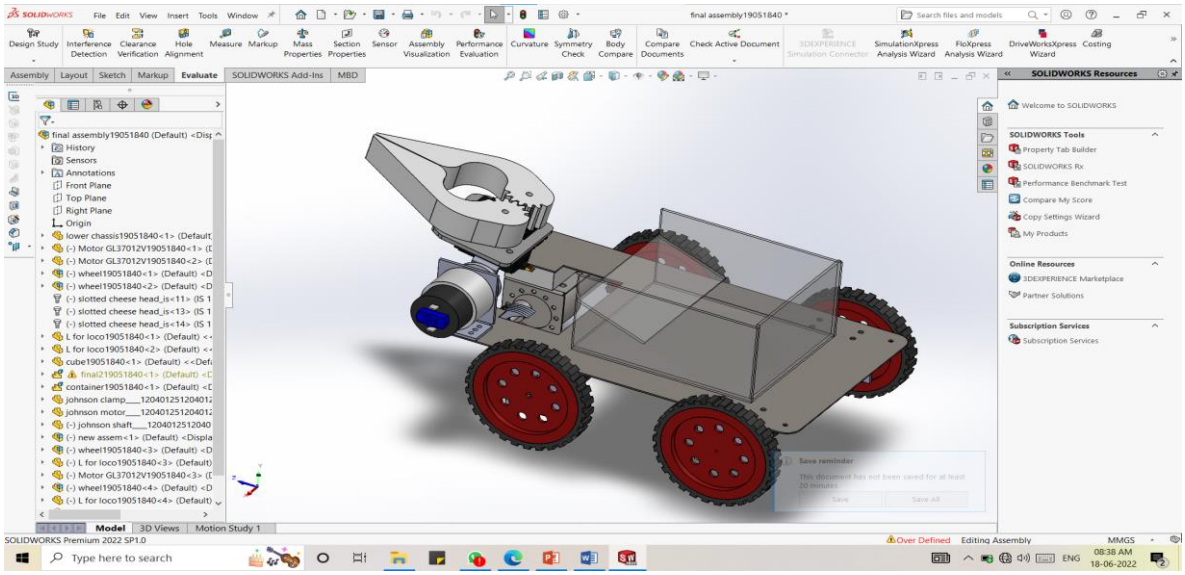
Gaurav Sethia et al proposed a method in which the image is captured by employing a raspberry pi camera. Image is passed to Rasberry Pi with the assistance of camera serial interface (CSI). The detected plant leaf is then identified as crop or weed,if identified as a weed, the delta robotic arm with a high speed rotating blade cuts the leaf. The major scope of improvement for this system was that the precision of the delta arm of the robot must be increased.

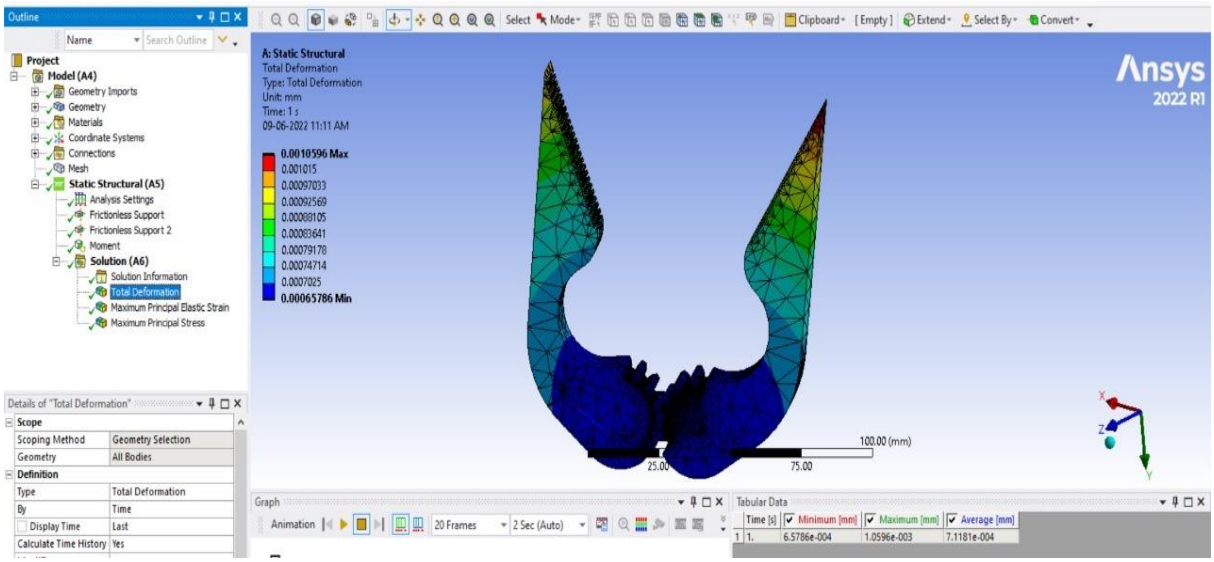
P. Sakthi et al. proposed a weed removal technique using image processing. It enables usage of herbicides i.e., spraying of herbicides only on weed. But the major drawback in this process is degradation of soil quality over the period of time

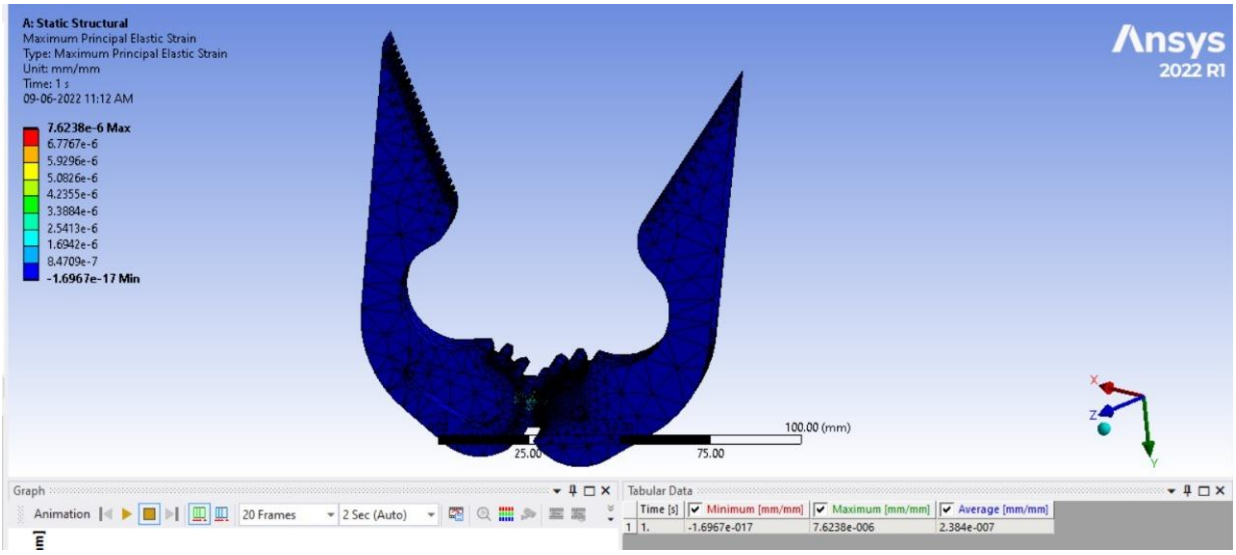
Rajyalakshmi Uppada et al proposed a system wherein there were two main features of the bot-detection of weed and plucking of detected weed using robotic arm, and detection of infected plant and sprinkling of fertilizer on the same. The main drawback of this system was that if the weed is strongly fixed in the ground, the robotic arm is unable to pluck it out and moreover the camera used was of low resolution so there was a high chance of error in initial detection of weed and infected plants.

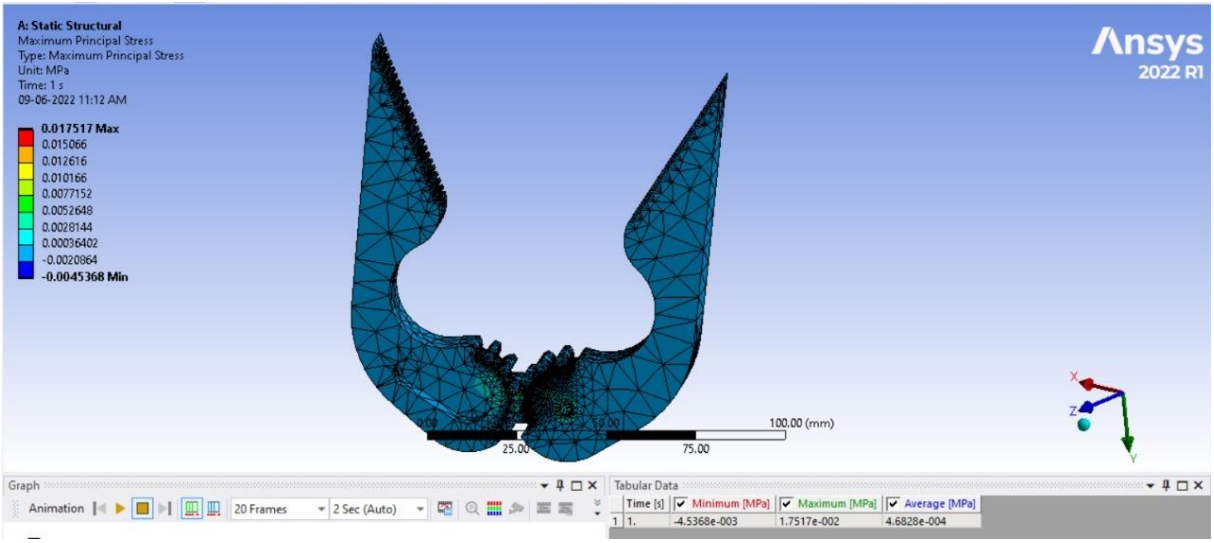
O Liu et al discussed different weed detection technologies and summarized that CNN deliver better results. In our project we have used YOLOv5 for real time detection.

III. CAD AND ANSYS SIMULATION







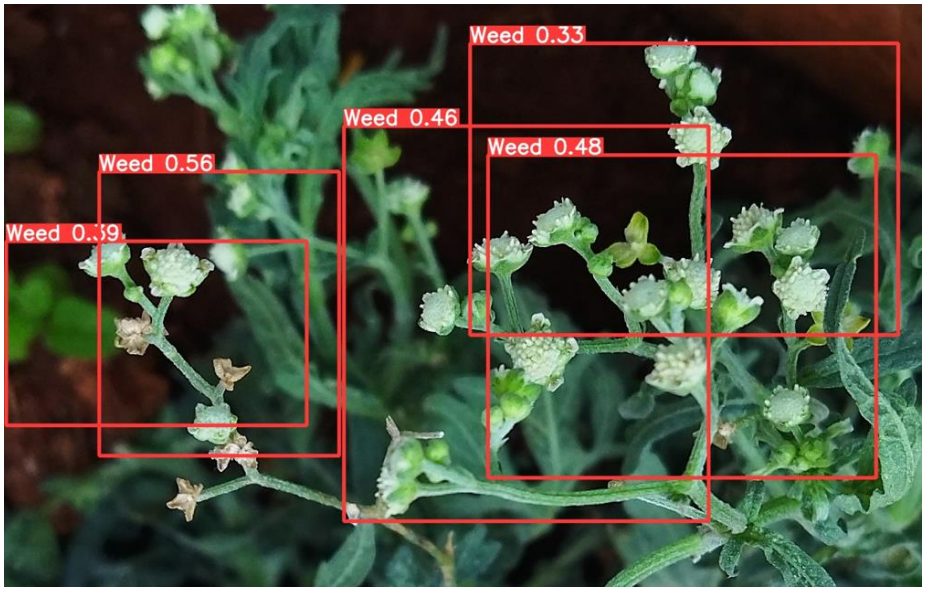


IV. YOLO V5 (TRAINING AND TESTING)

For detection of weed, we have used YOLO v5 model. YOLO is novel convolutional neural network which is primarily used for live object detection. It is pre-trained in COCO dataset. This model is developed by Ultralytics and is open-source hence used in this project. As this is open-source model, we have tried training our model on latest version of YOLO which at the time of building this project was YOLO v5. For training this dataset we have collected 144 images of our desired weed which was congress grass.

All the photos were taken from different angle as the live image which camera will be taking may have any angle. So, our model has training dataset that includes all probable viewing angles. Next part before uploading to the dataset was labelling the dataset. Labelling in our case was the feature which want our plant to be recognized with which in our case was the small white flowers. So, every feature was well labelled in before uploading to dataset and then our model was ready after processing the dataset. It gave very good results for such small dataset because of the no. of iterations performed while making, labelling and modelling of dataset. The results are as follows:

No weed detected
(Not congress grass)



Weed detected in uploaded image (Congress Grass)

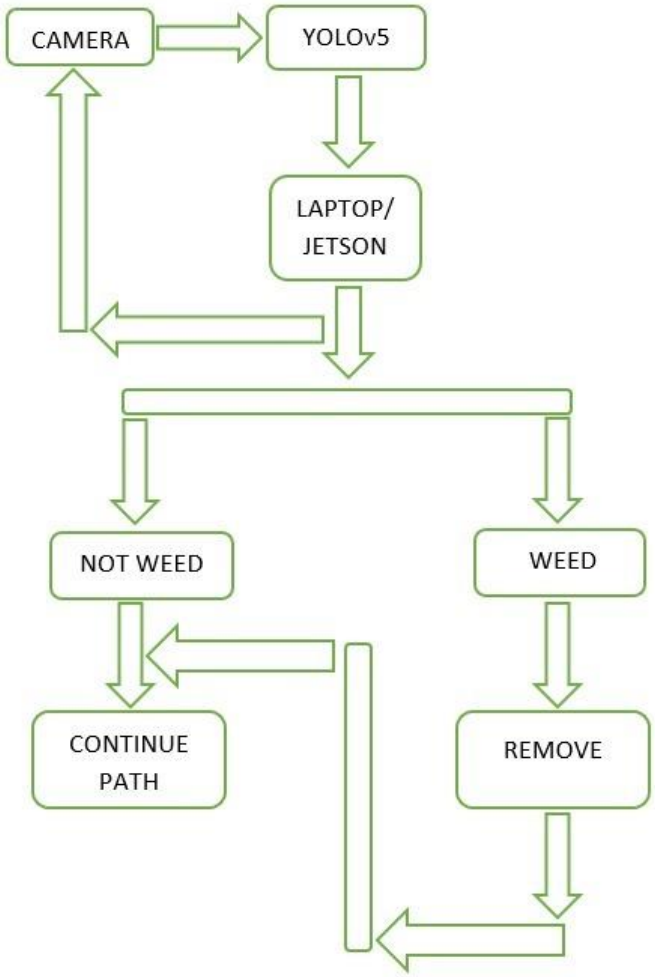
Result obtained from on field testing while integrated with robot. Maximum efficiency 72%.

V. METHODOLOGY/EXPERIMENTAL

The paper discusses about weed detection and removal robot using artificial intelligence techniques by YOLOv5. This system consists of a gripper and blade which is connected to Arduino Uno. Based on the YOLOv5 classification, the robot moves ahead, during its moment it captures the images of the crop which are present around and near the plant with the help of a camera. Real time images processing is carried out by YOLOv5. The images are compared with the pre-trained data set of the weed. Based on the accuracy rate it classifies the plant as either a healthy crop or weed.

If the plant is identified as weed then the serial data is sent to Arduino, to actuate the gripper for removing the weed, also the blade assists the gripper for easier weed removal.

When there is no detection of weed the robot move forward in the field.



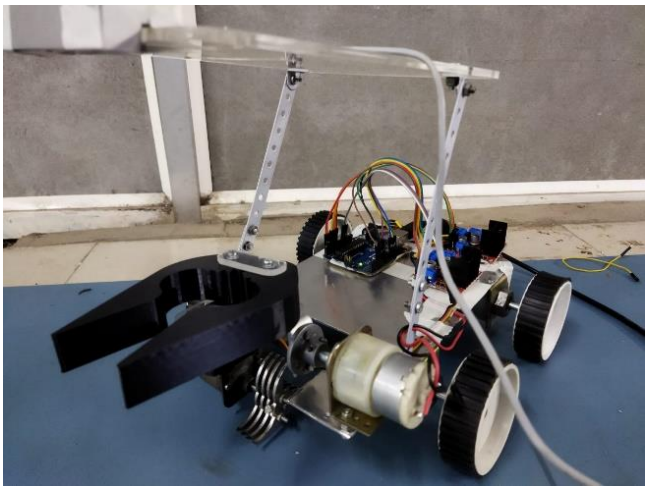
Materials/Components –
ELECTRONIC HARDWARE:
Jetson Nano 2GB Developer Kit, Portable camera module, DC Motor, Water pump, BO motor, 12V DC Battery, Motor Drivers, Microcontroller (Arduino Uno)

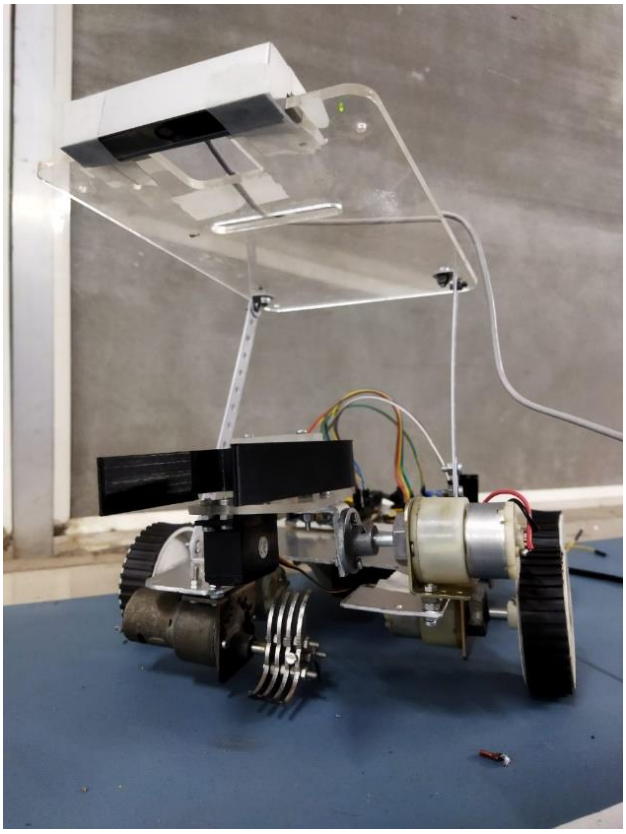
SOFTWARE REQUIREMENTS:
Python, Deep Learning, Dataset of weeds, Yolo
(ML Algorithm)

MECHANICAL REQUIREMENTS:
Wheels, MS sheet, acrylic sheet, Couplings, Motor clamps, PLA

VI. RESULTS AND DISCUSSIONS

We have conducted multiple trials and tested our robot, we found out that, our robot is working in right condition and is detecting the weed and picking it as desired.





VII. LIMITATIONS

i. If the blade gets stuck in soil, there is high chance that the bot can topple.
ii. The bot can damage the plant while its motion.

VIII. FUTURE SCOPE

i. The system can be upgraded to be efficient to add fertilizer to the crop only.
ii. It can be solar powered.
iii. It should cover large working area.
iv. We can control the bot remotely via mobile application.
v. It will collect data for future analysis.
vi. More and Different types of weed can be detected by adding large dataset.

IX. CONCLUSION

Detection of weed and its removal is very important as it can affect not only the single crop but the whole yield and subsequently the income which could have generated.

Using traditional method for the removal might sometime leave the weed completely unrooted or it can go unnoticed, also for removing the weed we need to invest a lot of money and time every time to remove weeds but with the help of our bot, a person with lack of knowledge about the weed can also remove the weed from his field, our bot is not only efficient but also time saving.

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We are very grateful to our team.

Anything test – level can be enough to understand without the support and guidance of our teachers and help of friends and we are thankful for the same.

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