DESIGN AND DEVELOPMENT OF AGRICULBOT

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Abstract.

Agriculture is the origin of human sustenance. Almost 42% of the total population of the world choose agriculture as an occupation and almost 60% of India's population also choose this as a major occupation. Agriculture is the process of cultivation of plants for providing necessary nutritious products for human livelihood. As per the recent analysis, we observe that farmers even now follow traditional methods for better production but with increasing population meeting, the demand is being very difficult. And farmers face enormous challenges such as plant diseases, weeds infestation, and pests. Here in our project, we are considering the weed as a major aspect of controlling we are finding out the best technique. In the olden days, weed detection was done by inspecting each corner of an agricultural field and was manually removed with bare hands. Later with the improvement in technology, people started using herbicides to take out the weeds which were causing drastic changes in the environment causing Green Revolution which was a major cause for effect in the environment. Later, few methods came to find the weeds without human intervention, but because of lack of accuracy, they were incapable of achieving for the public. So, weed control is important, as failure to adequately control weeds leads to reduced yields and product quality. Hence, weeds should be identified and classified properly so here we are implementing a few methods in our project to reduce the usage of herbicides and use the spraying technique only in areas where the weed is present and remove them permanently. The robot which is designed for agricultural needs is named Agricul-Bot such that without human intervention the weed is identified and does the necessary operations. To accomplish this project, we are using an image processing technique using python.

Keywords. Agriculture, Image Processing, Weed Detection, CNN Algorithm, Spraying, Cutter.Introduction

I. INTRODUCTION

Agriculture is a key element in the existence of human life. The rapid growth of the global population is putting up immense pressure on the agriculture sector for better quality and quantity of food production. As per the prediction that the global population would reach 9 billion by 2050, food production must be doubled with increasing demands, but agricultural lands face enormous challenges such as plant diseases, pests, and weed infestation.

This would reduce the quality and yield of food that are poisonous, and produce thorns that harm the crops. To reduce these challenges faced by agricultural lands, the management of the weed will make farmers spend billions of dollars without sufficient help, which results in less weed control and crop production. Thus, weed control is a major aspect that leads to reduced yield and quality. The main aim of Agricul-bot is to use robotic technologies within the field to detect the weed and manually spray only in that area. In the olden days, weed detection was done by employing some men who used to inspect every sector and remove them manually using their hands. Later with the advancement in technology they started using herbicides to get rid of the weeds. Later there came a few methods to detect the weeds automatically but due to lack of their accuracy, they didn't reach the public. So, they started using the image processing technique for this purpose which aim of our project. We will provide inputs of the field to an agricul-bot this will detect only the weeds and spray on them. To get the accurate weed image, we have to insert the good clearance picture as input. Taking a photograph may be done by attaching a camera to a tractor or taking them manually. Then we are going to apply the image processing technique using python for weed detection. The objective of this project is that weeds are the unwanted thing in agricultural lands which is consuming all the nutrients, water, land, and many more things that have to go for crops which results in less production of the required crop. The farmer often uses pesticides to remove weeds which is also effective but some pesticides may stick with the crop and may cause problems for humans

II. RELATED WORKS

The review of the proposed system is been addressed in this section.

[1]. Leaf Diagnostics, can be found using a variety of technological microscopic detection approaches and can be categorized into the analysis tool and application type. This is a highlight of paper issues and leaf diagnostic challenges. The growth of the world depends on the better quality and quantity of production of yield. Production can be improved by diagnosing leaf disease.

[2]. Autonomous robot for agriculture is to conduct various agricultural activities such as seed, herb, spray, fertilizers, and pesticides. Arctobot 2570 microcontroller is controlled by the Arduino Mega Port. The powerful Arduino mini system is used to control and monitor robot jobs. If a seed is planted at a suitable spacing and depth, it allows a sensory sequence to know the robot.

[3]. The IoT-based solar-powered acrylic paper uses three suppliers, design and development irrigation services, and automatic and remote agricultural surveillance. Solar power is harvested when irrigation is done. When implementing the irrigation project, it

moves in a predetermined path of a farm, and the soil moisture and moisture feel. Two major issues in modern agriculture are water shortages and high labor costs, these issues are agricultural desktop automation.

[4]. A robot is designed for agricultural purposes. The speed and accuracy of work are designed to reduce the workload of the farmers. The proposed system aims to design a multi-purpose autonomous agricultural robot vehicle that is controlled by IoT for sowing and spraying pesticides. These robots are used to reduce human intervention, ensuring higher yields and capabilities use resources.

[5]. The use of machines in precise agriculture has increased investment and research using robotics applications in mechanical design and job management. To carry out the agricultural activities in a better way, the check of the functionalities of the machinery is very important. It encourages agricultural robots.

[6]. In this paper, navigation problems with wheel motor robots (WMRs) are reviewed, WMR's navigation technique is extensively analyzed, and there are ways to solve problems such as robot navigation, spread, and route planning. The advantages and disadvantages of summarizing and existing methods. This document is a solution to the solution of WMRs in a complex and intricate purpose of agriculture.

[7]. The parallel sites can be useful in situations where the precise motion requires a particular place, in system configuration, low recession, high element, and accuracy. This article mainly focuses on a 4-PPPR robot handler with three General DOF and a circular DOF, in the ridge content of strawberries. A software simulation is implemented to prove that this movement can meet all the movement requirements by driving four operational movements allocated in the system.

[8]. The design of agricultural robots, which are inspired by agriculture, is designed. AGRIFA is an automobile driver and a farmer who continues to pursue automated agricultural work. It will replace farmers working in a dangerous and harmful environment. Intelligence design concept, process design, and control system design are described in this paper.

III. OBJECTIVE

Weed is an unwanted thing in agriculture. Weed uses the nutrients, water, land, and many more things that must have been used by the crops.

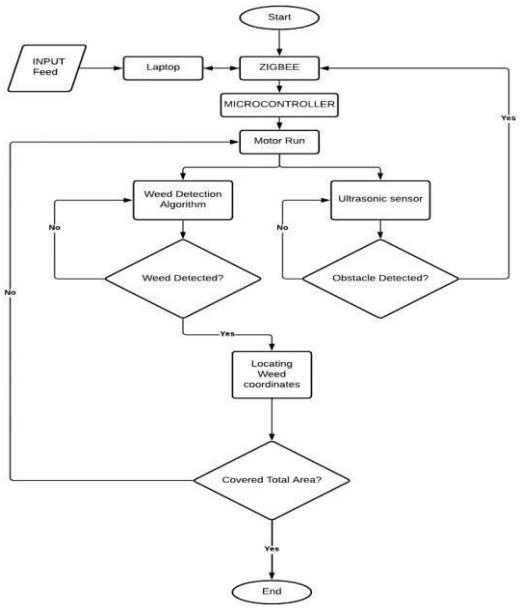
Which results in less production of the required crop. The farmer often uses pesticides to remove weeds but some pesticides may stick with the crop and may cause problems for the human. Hence these weeds should be identified and classified. So, categorizing the weed in the agricultural lands will be very helpful for better production of yield.

IV. PROPOSED FRAMEWORK

Fig 1: Flow Chart of Agricul-Bot

A connection is established between the robot and the laptop through the microcontroller with the help of ZIGBEE. Once we provide the input feed to the laptop, the robot starts running, and the software starts to identify the weed present in the input feed. If the weed is

detected, the robot slows down and the spraying mechanism is implemented by collecting



the coordinates of the weed. If the weed is not detected, then the robot continues to move. This process happens until the entire area is covered or until the input feed ends. Simultaneously the ultrasonic sensor mounted onto the robot will keep on monitoring the obstacles which come in its way and notify the user. The working of the Agricul-bot can be explained with the help of the block diagram shown below.

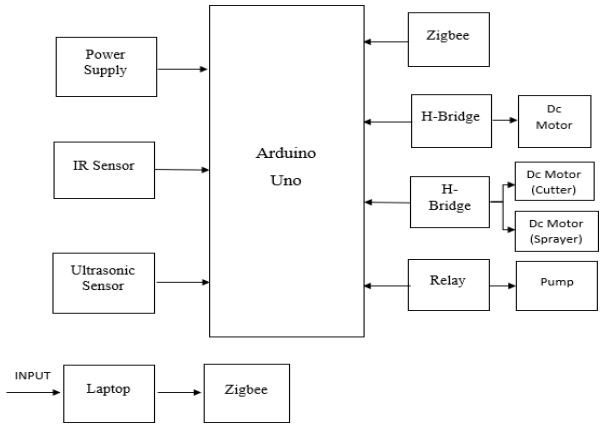


Fig 2: Block Diagram of Agricul-Bot

The working of Agricul-bot can be controlled using a microcontroller or an Arduino. Here we use the Arduino for controlling the functionalities of the robot. The power supply given

to the Arduino can be direct or can be given through a battery. The direct supply given to the Arduino is 230V AC, which needs to be converted to 12V DC. This conversion can be done using an adaptor that has an inbuilt transformer, rectifier, filter, regulator, and load. This is exhibited in Fig 3

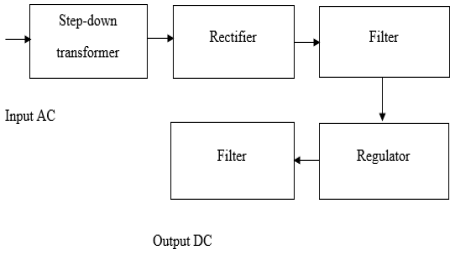


Fig 3: Block Diagram of Power Conversion

A transformer is used to decrease the output voltage. There are two types of transformers: Step- up transformer as well as Step- down transformer. Here we need to decrease the output voltage so, we use a step-down transformer. In a step-down transformer, primary windings are greater than secondary windings. The output of the transformer will be 12VAC. This 12V AC is given as input to the rectifier. The rectifier converts Alternating Current to Direct Current. There are two main types of rectifiers, they are Half-wave as well as Full-wave rectifiers. The full-wave rectifier is again divided into a Bridge rectifier and a Center-tapped rectifier. A bridge rectifier consists of 4 diodes whereas a center-tapped rectifier consists of 2 diodes in which one is used for the forward direction and the other for the reverse direction. The output of the rectifier is 12V DC. Even though we get 12V DC, there will be some sort of distortion or noise present in the signal. Hence to remove this noise we use filters. There are 3 types of filters, they are Low pass filter, High pass filter, and Bandpass filter. The output of this filter circuit will be a 12V DC signal free from noise. This noise-free 12V DC signal is sent to the Arduino for performing the required functionalities. Instead of this supply, we can directly connect a 12V battery. A moisture sensor is used to sense the water content of the soil. This moisture sensor works on the analog output equivalent, the moisture content in the soil is inversely proportional to the analog output equivalent. When the analog output equivalent is low it indicates that moisture content is high and when the analog output equivalent is high, it indicates that the moisture content is low. Depending on the moisture content, the pump is turned on or off. Relay is used as a switch to turn on or off the pumps used for water sprinkling and spraying of weedicide. This robot's movement and functionalities can be controlled either manually or automatically. Manual control is achieved by giving the required functionalities as commands to the robot as input through a cable wire connected to Arduino or through wireless communication like Zigbee. Automatic control is achieved when the robot is made to work all the functions one after the other by programming some amount of delay in between them.

I. IMPLEMENTATION

V.I. SOFTWARE DESIGN

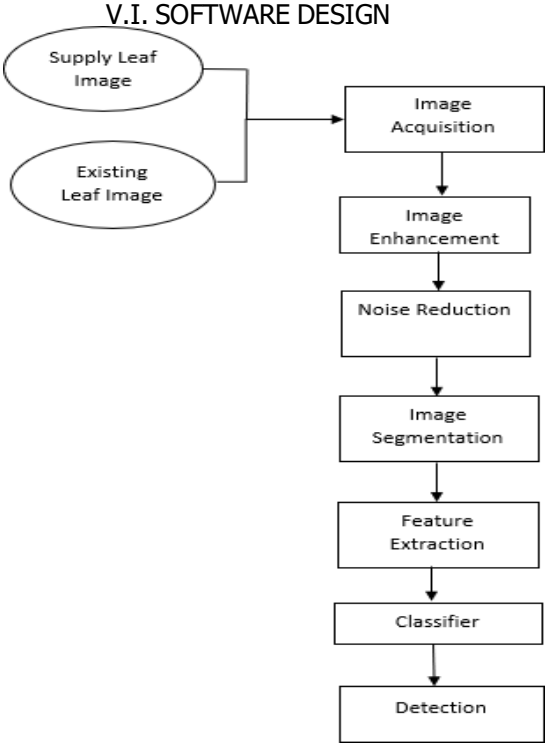


Fig 4: Software Flow

Image Acquisition Process: At first fresh crops and weeds are handled. The dataset comprising this fresh crop and weeds is known as the preparation dataset. When the preparation dataset is handled then the added or provided leaf picture is the test weed picture. Further picture investigation is accomplished for a progressively appropriate presentation; the picture improvement process is connected.

The Image Enhancement: This task is used to enhance the input image for the further process which helps to carry the process of image analysis for a more suitable display. The image enhancement method used in the project is the contrast stretching and slicing technique and further, many more techniques can be used.

Noise Reduction Process: The noise could be introduced amid the procedure of picture securing or the electronic transmission of the pictures. The noise reduction systems are utilized to evacuate the undesirable noise of the leaves' pictures. Further, the procedure is made basic and simpler by sectioning the noise-free leaves pictures.

Image Segmentation Process: In the picture, the segmentation process leaves pictures that are separated into sub-pictures or a set of pixels or small multiple segments. The elements of the subdivision of the picture rely upon the problem picture and segmentation is ceased when the desirable or region of interest of the picture gets separated, in this way the segmentation dimensions are taken into consideration.

Feature Extraction Process: Next the segmented images are given for feature extraction. This process helps to reduce the image data by mainly focusing on features of interest and removing other features. This is done by measuring particular features such as entropy of the weed, energy, mean, size and texture, etc.

Classifier Process: These extracted features from the weed images are used as input to a classifier, which classifies weed images. The classifier we are using here is the CNN classifier; this classifier is used only if we have two classes. So, here we are going to consider one class as the database of leaves images and the other as the input image data set.

Texture Feature Extraction: Gray Level Co-occurrence Matrix (GLCM) helps in analyzing the surface of the weed image. This characteristic is used for abstracting the texture of the weed detected. The conflict of the pixel with its neighbors is determined in the majority of the image and with a variation of the pixel to find the difference between the local pixel.

Histogram Equalization: To get better quality information from the image it is necessary to calculate the histogram equalization of the image. The process of changing the intensity value or adjusting the intensity value can be done using this process. This process is about intensity values transformation so that the particular histogram is approximately matched to the histogram of the output image. The histogram equalization function is histeq

V.II. HARDWARE DESIGN

The experimental setup of our project consists of a frame in which the battery is mounted and a solar panel is placed upon the frame. Also, the cuter blades are present in the front of the machine which is operated by a motor1. The power from the battery is transferred to the DC motor. Also, the frame consists of a wheel and which is used to guide the vehicle in the desired path as per the wish of the operator. The battery is charged by the solar panel continuously during the daytime. When the machine is switched on, the battery supplies power to the motor which operates the cutter blades. And also, the machine is provided with a tank that is connected to the sprayer and is used to spray the water or the fertilizer that is stored in the tank automatically from left to right. The main objective is to achieve more profit and make the manpower consumption level low in the Agricultural field. In the current situation, the agricultural sector is one of the main things to be developed and it's very important and useful to our mankind. Our idea is to save the time and energy wasted on repetitive farming tasks. Importing this machinery into the Agricultural sector is quite helpful. The working of the current model is based on the field Parameters. The design of this product can be used for various tasks such as spraying, sprinkling, and cutting. The solar panel consists of a Photovoltaic (PV) cell, that absorbs the sunlight to generate the power which is used to run the vehicle. The battery can also be recharged through regular electricity. The main objective of this design:

- ECO friendly (Because we are using solar power and charged battery for operation)
- Easy of construction
- More economical.
- Its works on the renewable energy source.
- It does not create air pollution & noise.

- Easy to handle.

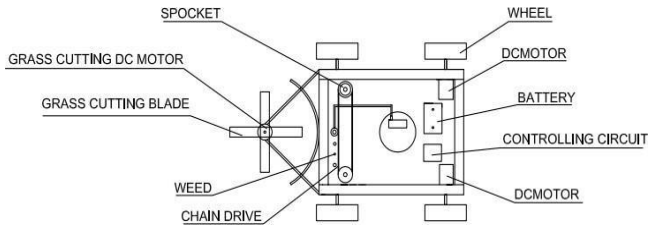


Fig 5: Experimental Setup of Agricul-Bot

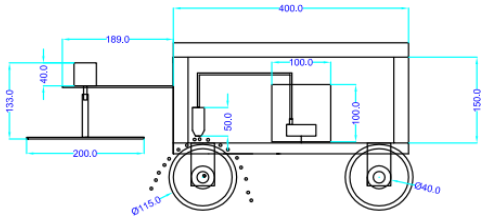


Fig 6: Design of Agricul-bot

Sl. No	COMPONENTS	QUANTITY	PRICE
1.	Solar Panel (32cells, 10W,12V)	1	1200
2.	Battery (1.3ah, 12V)	1	600
3.	DC Motor (20W, 12V)	6	2400
4.	Blades (3000rpm)	2	300
5.	Wheels (1.5inches,100mm)	4	900
6.	Storage Tank (2.5L)	1	100
7.	Relay (12V)	1	26
8.	Arduino AtMega-328p	1	975
9.	ZigBee 802.15.4	1	3000
10	HC-SR04	1	175
11	H Bridge L293D	2	135
12	Pump	1	500
13	Sprayer nozzle	1	300

14	Shield	1	500
15	Sprocket and chainset	1	1500
16	MS rods (framework)	--	3000

Table1: Price and Quantity of Components of Agricul-bot

VI. RESULTS AND DISCUSSION

The proposed work is trained by the excellence dataset and compared with the given test/input images. Hence, we define the method for gauging as follows:

PREDICTED

ACTUAL

	Class Crop	Class Weed	All Classes	Total Actual	Precision of each class= Correctly Predicted/ Total Predicted	Recall of each class= Correctly classified/ Total Predicted
Class Crop	0.86	0.03	0.74	1.63	0.86/1.01= 0.85	0.86/1.63=0.52
Class Weed	0.02	0.87	0.26	1.15	0.87/1=0.87	0.87/1.15=0.74
All Classes	0.13	0.10	0	0.23	0/1=0	0/0.23=0
Total Actual	1.01	1	1	Total=3.01	Average Precision=0.79	Average Recall= 0.75

Average Precision= (Actual of class crop * Precision of class crop) + (Actual of Class Weed * Precision of Class Weed) + (Actual of All Classes * Precision of All Classes)

$$\text{Average Precision} = \frac{(1.63*0.85)}{3.01} + \frac{(1.15*0.87)}{3.01} + \frac{(0.23*0)}{3.01} = 0.79$$

Average Recall= (Actual of class crop * Recall of class crop) + (Actual of Class Weed * Recall of Class Weed) + (Actual of All Classes * Recall of All Classes)

$$\text{Average Recall} = \frac{(1.01*0.52)}{3.01} + \frac{(1*0.74)}{3.01} + \frac{(1*0)}{3.01} = 0.75$$

$$\text{F1 curve} = \frac{2*(\text{Precision}*\text{Recall})}{(\text{Precision}+\text{Recall})} = \frac{2*(0.79*0.75)}{(0.79+0.75)} = 0.769$$

Table2: Experimental Calculations

The precision vs recall, F1 score, and confusion matrix results are given in the following figures as shown.

Fig 7: Precision vs Recall curve

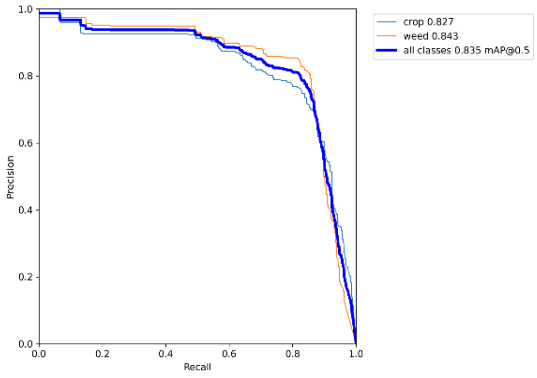
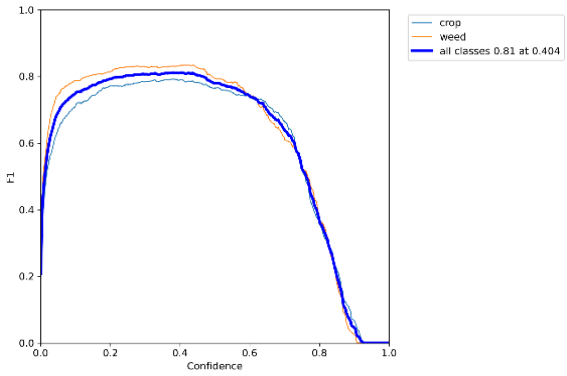


Fig 8: F1 score curve



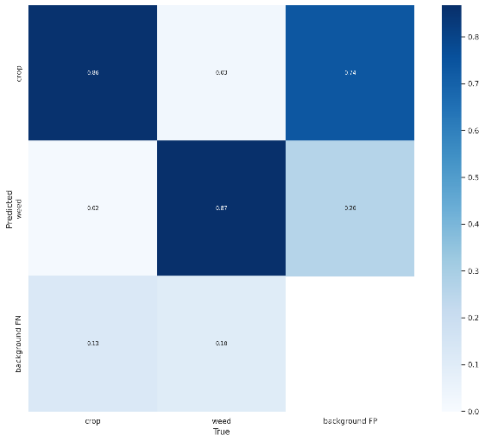


Fig 9: Confusion matrix

The following are labeled and predicted images are shown below

(a) Labeled images

(b)Predicted images

Fig 10: Truth and predicted images

A-frame is used as a base for connecting and assembling everything in the agricultural robot, it consists of six motors in which four gear motors and two motors for the sprayer and cutter. The robot encompasses the following functions:

1. Weed Detection
2. Spraying
3. Cutting

These functions are done using different modes. Programming for different modes is done using different loops and functions. Normally weeds, as well as healthy plant pictures, have dissimilar structures. Generally, a healthy plant will not have abrasion but weeds will have abrasion, thus the complex can acknowledge the design, in this way system recognizes the differences between healthy plants and weeds.

(a) Front View (b) Side View

Fig 11: Sprayer robot after assembly

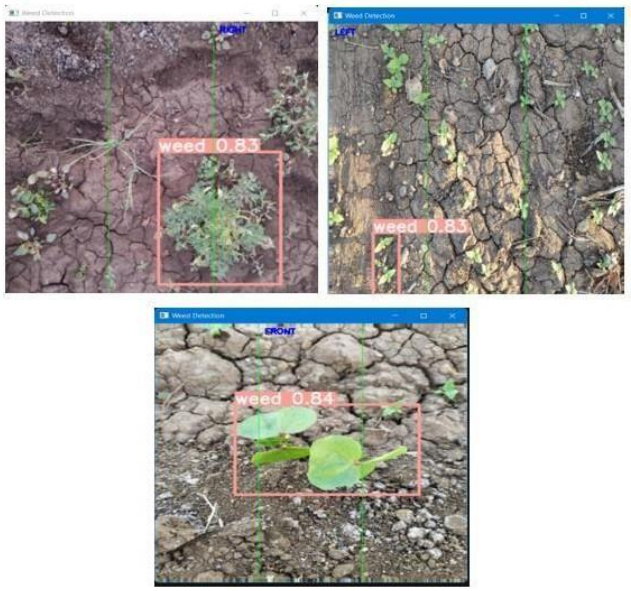


Fig 12: Simulation Results

VII. CONCLUSION

As agriculture has been chosen as the fundamental occupation, it is necessary to have an alternative method to carry out the agricultural activities. As to make the work of the farmers easier, an Agricul-bot with weed detection is built which performs all the agricultural activities such as spraying pesticides, cutting weeds, and also detect the weed present along with the crop. Using the weed and crop database when an image or video is given as input it can automatically classify weeds and the weed position is indicated to the robot. The main objective of this project is to build a robot that carries out the agricultural activities which are mentioned above and also to detect the weed in the fields which may further damage or infect the plants. Zigbee module is used for communication purposes and power supply for the manual working of the robot. This robot moves forward, left, and right during the activity. This robot is basically built for a small area purpose. In this project, image pattern classification is used to identify the weeds depending on texture and color feature extraction. The input which is given to the laptop can either be an image or video or a live feed image through the laptop camera which is processed and classified based on Convolution Neural Network and the results are indicated. The results of this project are to identify the weeds in the field depending on appropriate features. At first, weed images are collected and pre-processed. Next, from these pre-processed images features like color, shape, and texture are extracted. Then, these images are classified as weeds and crops by using CNN classifier. Depending on the type of input image, the detected weed is indicated using CNN classifier. Then the position of the detected weed present in the input image is sent to the robot through Zigbee which then decides to spray the weedicide or use the cutter which is operated based on the height of the weed.

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