International Journal of Scientific Research and Engineering Development-– Volume 6 Issue 6, Nov- Dec 2023

Available at www.ijsred.com

RESEARCH ARTICLE OPEN ACCESS

Deep Learning Based Laser Weeding Robot

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The weed detection system is very effective on crops, it requires hard work, time, and resources. Traditional weed management required herbicides and labor. Herbicides are harmful to nature. So we used computer vision and robotics for weed management. Using robotics and computer vision, we classify and eliminate the weeds.This research study proposes a novel These systems are a combination of object detection and robotic arm .It detect the weed autonomously, reducing the need for manual labor and herbicides. In this system, camera takes images of crops and weeds and it proceeds by Deep learning and eliminating is done by identifying weeds. These system evaluated on diff images of maize for detecting and eliminate weeds with an accuracy of over 90 percent. These systems reduce the labor cost and increases the accuracy of weed detection and production.

***Index Terms*—Deep-Learning, You Only Look Once Version Five(YOLOv5), Weed Detection, Single Shot Detection(SSD) Real-time detection.**

I. Introduction

Agriculture plays a vital role in the economy of India. But weed causes a 10 percent decrease in overall yield each year. So far you have used traditional weed removal technology and chemical-based weed removal technology. Weed can reduce 90 percent of production if they are not controlled. In traditional method it impact on production. For removing weeds in traditional weed removal technology we require labor for removing weeds. In chemical-based weed removal technology, a single pesticide does is spray over the entire field,it cover the all area of crops pesticides are harmful to our health it cause soil and water pollution. So we are creating a robust weed management system that is cost-effective, efficient, and environment friendly.

In this system, deep learning is used to detect weeds within and between crop rows. Weed detection and classification is done by deep learning. In deep learning, features are extracted from input data that are best for automatic classification and object detection.

In this system we used YOLO5(You Only Look Once Version 5)this algorithm are single stage object detection system also they genrate bounding boxes and class predictions. After only one image evolution. Another one-stage object detection model that has been used in literature is a single-shot multi-box detector residual network that is SSD-RESNET.[3]. Some limitation of existing system are there is some weeds and crops have extremely similar features like a size, color, etc.[3] Image segmentation is very difficult process due to nature of objects imaged where they often do not have very well defined boundaries in image. In limited information dificult to grnrate accurate boundry.[2]

II. Literature Survy

The Goal of that system to connect with farmers and farms and collect the images and gathered information about the farms

This section provides a review of machine learning techniques used for the weed detection system and classification system. For weed classification there are many cutting-edge deep learning models, such as CNN, RNN, and random forest regression have been proposed. For weed detection and image processing a system has been proposed. The convolutional neural network was used which shows 99 percent precision while classifying leaf species. The identification of plants can be improved with a Robust algorithm that can distinguish more speed of leaves regardless of color or form. Without damaging the crops.To identify weed locations in the field for precise killing. The model detected weeds with 97.50 percent precision under three conditions: Full cycle, multi-weather, and multi-angle. The object detection YOLO is the one-stage approach. . In the image, Wangetal was introduced as the first.[3]

YOLO version in 2015. Many improved versions of YOLO such as YOLOv1, YOLOv2, YOLOv3, YOLOv4, YOLOv5, YOLOv6, and YOLOv7 have been developed in recent years. There are different improvements in architecture from Yolov1 to Yolov7. Previous versions of YOLO have been studied for

application in weed detection. According to the study, YOLO5 performed significantly well. It consumed significantly fewer resources as compared to others making it suitable for real-time word detection. YOLOv5 achieves real-time performance for weed detection. In this study yolo5 is selected by comparing its performance with another object detection model SSD-RESNET. YOLO5 used for weed classifying and detecting [1]

III. Objective

A. Recognize Weeds

Deep learning algorithms can be trained to identify different types of weeds and distinguish them from desirable crops or plants.

B. Precision Weeding

By accurately identifying weeds, the robot can precisely target and eliminate them with a laser, minimizing damage to surrounding crops.

C. Reduce Herbicide Usage

Deep learning-based weeding robots can reduce the need for chemical herbicides, which is more environmentally friendly.

D. Increase Efficiency

Automation through deep learning allows the robot to work tirelessly and efficiently, covering large areas of farmland.

E. Improve Crop Yield

By removing competition from weeds, the robot can help increase the yield of the desired crops.

IV. Methodology

A. Data Acquisition

The goal was to connect with farms and collect the information about weeds and its environment

B. Data Preprocessing

Data processing is used for cleaning data. To obtain the best quality of data which is extracted from video, noisy, and blurry frames in data. Which is removed during data cleaning data cleaning improves the efficiency and accuracy of the model.

C. YOLOv5

YOLOv5 (you only look once version 5) algorithm detect real time object . YOLO 5 is known for its speed accuracy and object detection tasks. It mainly consists of two layers conv2d layer and BN+SiLU. Conv2d layer is a key component used for feature extraction and object detection. Commonly used in deep learning models for image processing. The second layer is BN+SiLU (batch normalization and sigmoid linear unit) Which improves the performance of deep learning neural networks batch normalization normalizes the activation of each layer and SiLU activation function then applies a nonlinearity to normalize the activation for better representation learning and improves model performance.

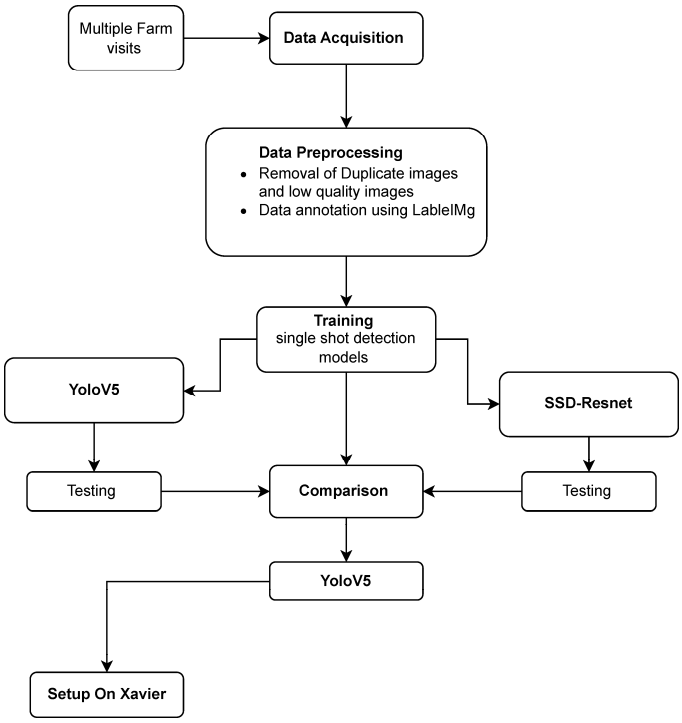

Fig. 1. Flowchart of weeding Robot.

D. SSD-ResNet

SSD (Single shot multi-box detector) it is a object detection algorithm that is designed to perform both object localization and classification in a signal forward pass of neural network SSD known for its efficiency and accuracy in real-time object detection tasks. It creates a bounding boxes with a specified size and predicts a confidence score of object category within the bounding boxes.

E. Comparison of models

In the SSD-ResNet model, performance slightly declined when objects are very small these models perform well for identifying large objects but their accuracy is compromised when objects are very small. YOLOv5 is excellent for detecting small objects it can detect a mixture of weeds and crops in the same field.The accuracy of YOLOv5 is mor than SSD because rate of weed detection in YOLO5 is 40 frames per second and in SSd 30 frames per second. YOlOv5 model is better for detecting weeds and crops and classifying also.

V. Apllications

A. Precision Agriculture

This technology is used for automate weed detection and removal also they increasing crop yield and reducing the need for herbicides.

B. Reduced Chemical Usage

The less use of herbicides and pesticides are environment friendly and cost effective.

C. Labor Savings

Autonomous laser weeding robots eliminate the need for manual weeding(tradistional weed removal system), reducing labor costs for removing labor.

D. Increased Efficiency

These systems help to enhancing the efficiancy of weed control in large scale.

Crop Health Monitoring Our system can also be used to monitor overall crop health and identify other issues such as disease or nutrient deficiencies.

ACKNOWLEDGMENT

We would like to thank you my guide, Professor Prof. A.P. Bangar ,and Prof.S.B.Bhosale for his continuous help and generous assistance. He giving us direction helping to find the solution, and outlining the requirements. His support and a few words of encouragement helped us to fight against all difficulties. We have furthermore thanked Dr. A. A. Khatri, HOD for encouraging us to go ahead and continuous guidance. We also want to thank all staff for all their assistance and guidance in preparing the report. We also extend Sincere thanks to all teachers of the Department of Computer Engineering for helping us in various aspects we are also thanks to my family members and my friends for their support.

CONCLUSION

Automatic weed detection systems are used in the agriculture industry. In this system, we used a computer vision technique and a machine learning algorithm. In this system, robots can accurately identify and remove of weeds without human interaction. These systems reduce the cost of labor. Also, they can reduce the use of herbicides and pesticides this system can save the soil pollution. We cannot use pesticides hence this system is environment friendly. These systems are used 24*7.their is challanges for find out the potential of robot these include improving the accuracy and reliability of the weed detection algorithm. Developing more advanced and effective weed removal techniques and addressing issues related to terrain and weather conditions. In this system we trained the model over the YOLOv5 algorithm we will compare to another YOLO version to acquire better accuracy.

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