



WEED DETECTION IN COTTON

Submitted by

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ABSTRACT

In this project, a weed identification framework for cotton plants is proposed using the cutting-edge machine learning algorithm YOLOv5. By precisely diagnosing weeds in real-time, the goal is to improve weed control in cotton fields. The method that was created makes use of a library of annotated photos that include several weed species that are frequently seen in cotton plantations. With the help of this dataset, which was used to train the YOLOv5 model, weeds may be located and identified with good recall and precision. The suggested framework offers an economical and effective method for weed identification in cotton plants, which can help with herbicide application optimization and minimize crop losses.

CHAPTER I INTRODUCTION

1.1 INTRODUCTION

Weed detection in cotton plants is crucial for efficient weed management and crop yield optimization. This paper proposes a machine learning-based approach using the YOLOv5 model for weed detection in cotton fields. The YOLOv5 model is a state-of-the-art object detection algorithm that achieves high accuracy and real-time performance. The developed weed detection system holds great potential for facilitating weed management practices in cotton farming. By automating the process of weed detection, farmers can efficiently target and remove weeds, minimizing the negative impact on cotton crop yield. The proposed approach offers a reliable and time-efficient solution for weed detection in cotton fields, contributing to sustainable agriculture and increased productivity.

1.2 PROBLEM STATEMENT

Weeds compete with cotton plants for resources, affecting the growth and yield of the crop. The manual process of identifying and removing weeds is time-consuming and labor-intensive. Therefore, there is a need for an automated weed detection system using machine learning to improve efficiency and productivity in cotton farming.

1.3 NEED FOR THE PROJECT

Weed detection in cotton plants using the YOLOv5 model offers a time-efficient and accurate solution for targeting and removing weeds, leading to improved crop yield and sustainable agriculture practices.

1.4 OVERVIEW OF PROJECT

The project focuses on developing an automated weed detection system for cotton plants using the YOLOv5 model. By training the model on annotated images of cotton plants and weeds, it can accurately identify and localize weeds in real-time, enabling efficient weed management and optimizing cotton crop yield.

1.5 SCOPE OF THE PROJECT

The scope of weed detection in cotton plants using the YOLOv5 model includes developing a robust and accurate system that can identify and localize weeds in real-time. This system can aid in automating weed management practices, optimizing crop yield, and contributing to sustainable agriculture in cotton farming.

1.6 ORGANIZATION OF THE REPORT

Chapter 1 deals with the introduction to weed detection and automating the same. Chapter 2 summarizes the literature survey. Chapter 3 and 4 deal with System Requirements and System Design respectively. Chapter 5 deals with the implementation of the project. Chapter 6 deals with the results and their analysis. Chapter 7 deals with the Application for the society. Chapter 8 concludes the project. Chapter 9 talks about the future works on the project.

CHAPTER 2 LITERATURE SURVEY

2.1 INTRODUCTION

Literature survey in a project report is a section which describes the various analyses and research made in the field of our interest and the results already published. It increases the learning scope in our research field and also in identifying landmark plays in our field helps. It helps in comparing our research with other related and relevant research and also helps in getting to know the limitations of other related works that were already published. It is used in finding solutions to overcome the limitations of existing works and also helps to discover methods which could be relevant to our work.

2.2 LITERATURE REVIEW

In [1], the agricultural sector in India was diminishing each day, which influenced the need for food. Many farmers in India had stopped involving in the agriculture field and started other businesses. This was due to a lack of labor and other natural factors. The author had proposed an essential survey of different methods for crop selection, sowing of crops, weed detection, monitoring of the system, thereby yielding a productive output. Also, the author had used various concepts from on the entire system using Image Processing, Machine Learning, Internet of Things, and Artificial Intelligence to build the entire system. The comparative research was conducted between the advanced framework and the present framework.

In [2], the primitive way to do away with weeds was to remove them manually. As time went by, the farmers started using herbicides to kill the weeds. The excessive usage of weedicides could cause severe health problems to the agricultural workers/farmers and could also contaminate the soil and the water. New methods had to be introduced to reduce the usage of weedicide. Even after the advancement in research, a lot of readily available solutions were

not being implemented at the grassroots level. Addressing the problem, a better solution was proposed by the author to minimize the usage of the herbicide by classifying the plant images into the weed and the crop for selective spraying of the herbicide. The first step towards it was to differentiate between the crops and the weed. Image Classification Technique was implemented using the Deep Learning function. A maximum efficiency of 96.3% was achieved with just 250 images of each plant in the dataset. The proposed model could easily be dumped in the Raspberry Pi, and the selective spraying could be performed with the help of an attached sprayer. This setup could be installed on a tractor or a drone for real-time implementation

In [3], the author had proposed a review on various agricultural practices and aspects that could be or were currently automated, using robotics, IoT, and Artificial Intelligence (AI) more prolifically. Alongside, the current and future perspectives were dealt with, covering major technology innovations focused around smart farming, precision agriculture, vertical farming, modern greenhouse practices, autonomous and robotic workforce, drones, and the 'connected farm.' Post Covid-19, the automation of the agricultural industry had become all the more relevant to the new norm set due to labor migration and shortage.

In [4], it was mentioned that in agriculture, weeds were unwanted as they competed with plants in absorbing essential elements such as nutrients, water, space, and other growth requirements. This negatively influenced the yield and quality of crops, which affected the farmers. According to a study by ICAR, farmers spent huge sums of money to manage weeds. Weeds were often ignored since their impact was not as visible as that of insects and diseases. However, weed growth could have a devastating effect on crop yield, sometimes resulting in losses of up to 70%. Timely weeding was necessary to obtain an increased yield. Among the various weed removal approaches, the use of weeder machines was commonly practiced. Recent advances in AI and automation technology presented opportunities for the agricultural field to benefit from these advancements. The author proposed the use of AI technology to assist farmers in the process of weed management. The author employed the YOLO v5 model, which was trained on a custom dataset of weeds, crops, and infected leaves, to monitor weed management. The YOLO v5 model facilitated the use of Multi-layer Neural Networks for the detection, recognition, and mapping of weeds during the initial growth stages of crops. This approach aimed to contribute to a more effective and sustainable weed management approach.

In [5], the author had mentioned that agriculture was the only way for most of the humans to survive in this world. Weed plant detection and classification were critical technical and economic issues in agriculture. Weeds created problems in the field as they extracted good nutrients required by other crops. To address this, manual weed detection had been carried out with specialized people. Later, as technology advanced, people began using herbicides to kill weeds. People were trying to detect weeds without human intervention, but they were unable to reach the public due to a lack of precision. The author focused on weed plant detection techniques that could be used to supplement physical detection methods. The author attempted to use the CNN technique called YOLOV3, which was an object detection technique that helped accurately identify weed crops. The goal was to counteract and provide a better solution for the existing problems in detecting weeds in crops.

2.3 SUMMARY

The projects proposed by the authors have mainly addressed challenges faced by the farmers in the agriculture field due to weeds. The main focus had been in automating the weed detection process using techniques like YOLOv5 of the CNN and other concepts of IoT, AI and Machine Learning and provide a better solution for the existing problems in detecting weeds in crops.

CHAPTER 3 SYSTEM REQUIREMENTS

3.1 INTRODUCTION

To be used efficiently, every computer software requires certain hardware components or other software resources to be present on a computer. These prerequisites are known as system requirements and are often used as a guideline as opposed to an absolute rule. The following chapter discusses the requirements needed for the project. It deals with hardware and software that are required for the implementation process.

3.2 HARDWARE REQUIREMENTS

| | |
|--------------|-------------------------------|
| Processor | : Intel Core i5 or above |
| Speed | : 2.4 GHz/ Enterprise Linux 5 |
| System Type | : 64 bit |
| Hard Disk | : 4 GB |
| Memory (RAM) | : 1 GB |

3.3 SOFTWARE REQUIREMENTS

| | | | |
|------------------|----------------------------|----------------------|-----------|
| Operating System | : Windows, Linux, MacOS | Programming Language | : Python3 |
| IDE | : Google Colab , tkinter , | | |

3.4 SUMMARY

This project requires high end specifications for faster execution. Thus, these are system requirements for the working of “WEED DETECTION IN COTTON”.

CHAPTER 4 SYSTEM DESIGN

4.1 INTRODUCTION

System design is the process of defining the architecture, modules, interfaces, and data for a system to satisfy specified requirements. It could be seen as the application of system theory to product development. This is the phase that bridges the gap between the problem domain and the existing system in a manageable way. This chapter deals with the system architecture of the project and involves the system design and the working of the algorithm.

4.2 PROCESS FLOW OF THE PROPOSED METHODOLOGY

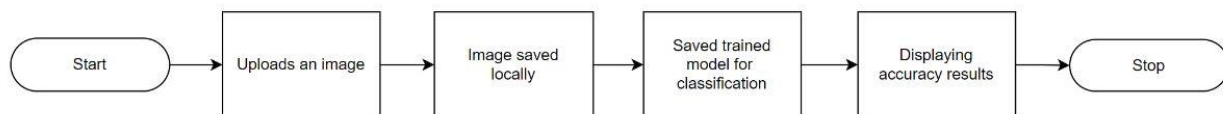


Fig 4.2.1 Process flow for weed detection using YOLOv5 model

There are seven steps involved in the weed detection in cotton plants. They are as follows:

Data Collection:

- Gather a large dataset of labeled images containing cotton plants and weed instances.
- Annotate the images to mark the bounding boxes around the cotton plants and weed areas.

Data Preprocessing:

- Resize and normalize the images to a consistent size.
- Split the dataset into training and validation sets.

Model Training:

- Initialize the YOLOv5 model architecture.
- Load the pre-processed dataset and configure data augmentation techniques (e.g., random scaling, flipping) to enhance model generalization.
- Train the model on the training set using techniques like transfer learning or fine-tuning.
- Adjust hyperparameters (e.g., epoch, batch size) to optimize model performance.

Model Evaluation:

- Assess the performance of the trained model on the validation set.
- Calculate evaluation metrics to measure the model's accuracy.
- Analyze the results and iterate on the model and data if necessary.

Model Deployment:

- Save the trained YOLOv5 model for future use.

- Set up appropriate interfaces to receive input images and provide weed detection results.

Weed Detection:

- Provide an input image containing cotton plants and weeds.
- Pre-process the image by resizing and normalizing it.
- Apply the saved YOLOv5 model to the pre-processed image to detect weeds.
- Extract the bounding box coordinates and weed class labels from the model's output.
- Overlay the bounding boxes on the original image to visualize the detected weeds.
- Perform post-processing techniques to remove redundant or overlapping bounding boxes.
- Calculate the area or density of weed coverage in the cotton field based on the detected weeds.
- Analyze the results to make informed decisions regarding weed control strategies.

4.3 SUMMARY

A system design or architecture is an important aspect in helping when a person implements the project. A good system has various partitions of work which are combined together to work as one. The “WEED DETECTION IN COTTON ” is implemented by three different modules which helps to detect the weeds in an accurate manner.

CHAPTER 5 IMPLEMENTATION

5.1 INTRODUCTION

In this chapter, three different modules of this project are clearly discussed here. First module deals with Collection and Preparation of data whereas the second module deals with Training of the model using dataset and the third module is concerned with performance analysis by calculating the accuracy . The further information of the modules are given below.

Module 1: Data Collection and Preparation is the process of collection of data required and splitting the dataset into training, testing and validation sets.

Module 2: Training of the model using the preprocessed dataset by setting various parameters like epoch and batch size.

Module 3: This module does the work of testing the model with the help of testing dataset and predicts the values and using those, the accuracy of the model is calculated.

5.2 DATA COLLECTION AND PREPARATION

Data Collection and Preparation is the process of collection of data required and splitting the dataset into training, testing and validation sets. In this process, the images are labelled using a software named labelling where a bounding box is specified in the image where the weed is present and a notepad file gets created which stores the details of the coordinates of the box. The steps involved in this process are :

Step 1: Import the necessary libraries

Step 2: Read the document having path for all the images

Step 3: Split the dataset into training and testing datasets using in-built function.

5.3 MODEL TRAINING

Training of the model using the preprocessed dataset by setting various parameters like epoch and batch size. For this project, a model is created using a CNN based technique known as YOLOv5. YOLO divides an image into a grid system, and each grid detects objects within itself. They can be used for real-time object detection based on the data streams. They require very few computational resources. YOLOv5 is based on the PyTorch framework. YOLOv5 uses .yaml file for configuration. YOLO v5 authors decided to go with the Leaky ReLU and Sigmoid activation function. In YOLO v5 the Leaky ReLU activation function is used in middle/hidden layers and the sigmoid activation function is used in the final detection layer. For optimization function in YOLO v5, we have two options : SGD and Adam. In YOLO v5, the default optimization function for training is SGD. However, you can change it to Adam by using the “--adam” command-line argument. The steps involved in training the YOLOv5 model using the labelled images is as follows:

Step 1: Import the necessary libraries

Step 2: Load the model to be trained

Step 3: Use the training dataset, train the model by setting parameters like epoch and batch size.

5.4 PERFORMANCE ANALYSIS

This module does the work of testing the model with the help of testing dataset and predicts the values and using those, the accuracy of the model is calculated.

Step 1: Import the necessary libraries.

Step 2: Define a variable and store the path of the directory where the images are stored.

Step 3: Specify the Bounding Box criteria. If the image passes the criteria, the weed will be detected.

Step 4: Test the model using the training dataset and show the output image plot
Step 5: Calculate the accuracy of the model

5.5 SUMMARY

The implementation of the algorithm is done using python. The implementation was carried out in Google-colab completely. The Google-colab is an open-source web application that allows you to create and share documents that contain live code, equations, visualizations and narrative text. Thus, the implementation phase of the project is clearly discussed in this chapter.

CHAPTER 6 RESULTS AND DISCUSSION

6.1 INTRODUCTION

Results are a representation of the outcomes of the implementation of the project. They help us in determining whether the project worked or not. They also help in finding out the mistakes and also help in rectifying them. Experiments have been done on healthcare dataset and the results were accurate enough as predicted.

6.2 DATA COLLECTION AND PREPARATION

The dataset is the collection of images of different types of weeds that are found commonly growing along with the cotton plant. For this project, 2,300 images were collected as samples. These images were separated into 1,615 training set of images, 344 validation set of images and 341 testing set of images. The training set of images were labelled using the labelling software where the bounding box in the image was specified. After that a notepad file will get created which stores the coordinated values for the bounding box specified in the format (class value x,y,width,height).

6.3 MODEL TRAINING

The model is then trained using the training dataset by specifying the epoch as 10 and the batch size as 160. After that the model was validated with validation set images by passing the images through the model. Here the images will be displayed along with the Bounding Box which with the confidence scores.

6.4 PERFORMANCE ANALYSIS

The model is then tested with the help of test datasets. These images were used to test whether the model can predict the presence of weeds in the image or not. Also the accuracy of the model is calculated by using functions like “--adam” which gives an idea about how images are detected by the model. For the particular model, the accuracy obtained was 70%.

6.5 SCREENSHOTS

Here, the result of the various privacy preservation techniques and their working process is displayed on the

screenshots.

TRAINING DATASET

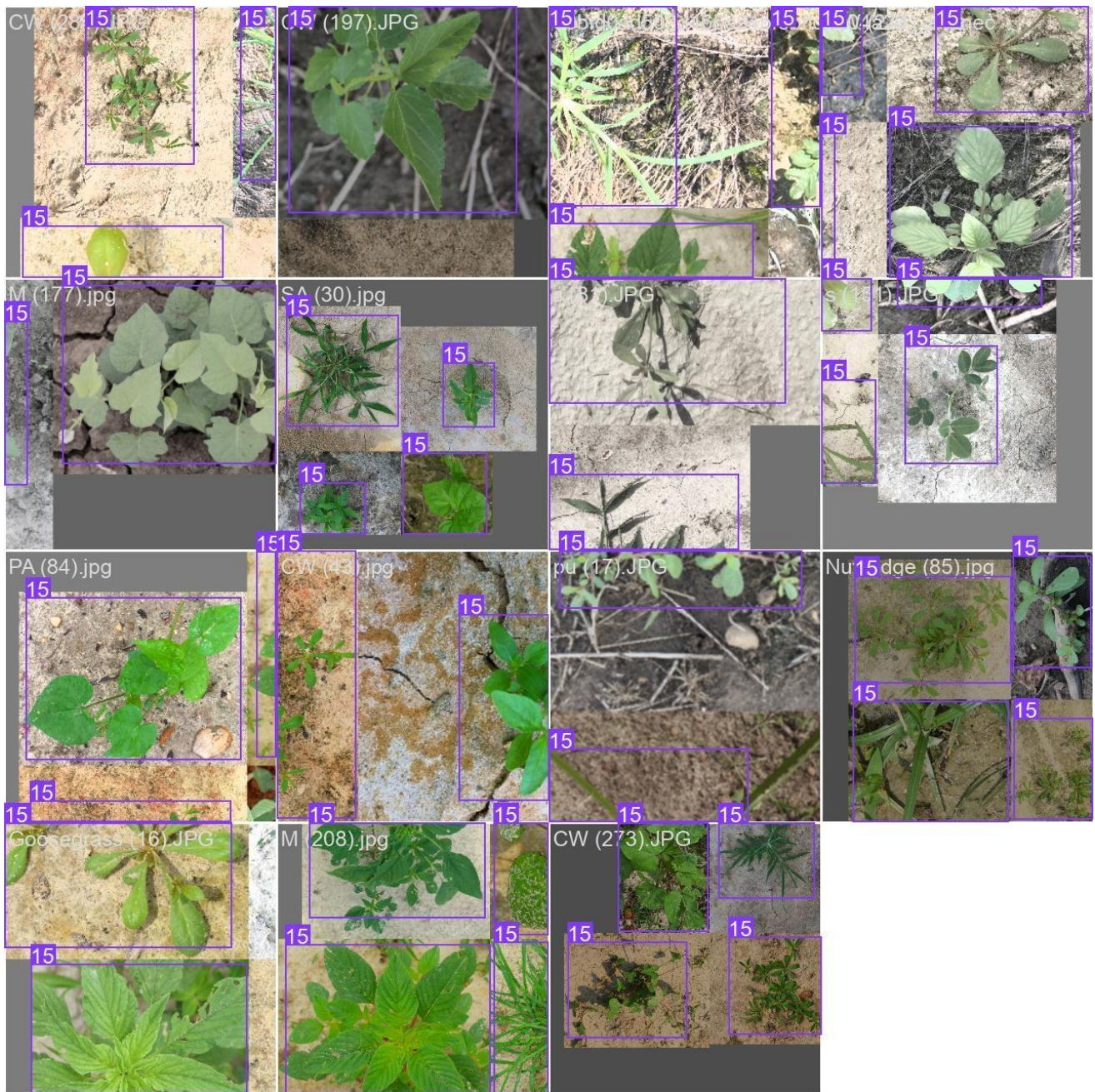


Fig 6.5.1 Training dataset images used to train the model which depicts the class value of the images labelled.

VALIDATION SET

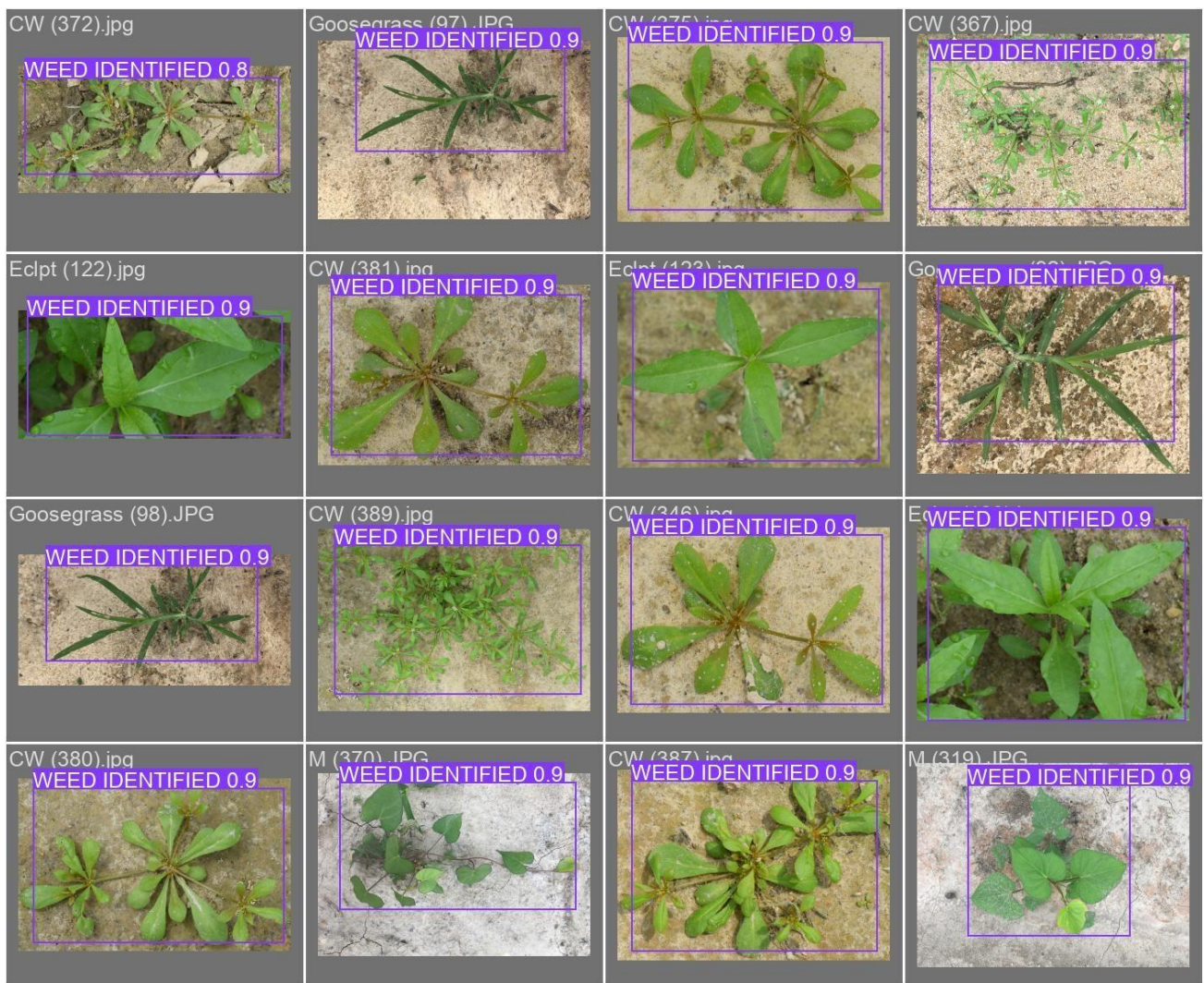


Fig 6.5.2 Validation Set images used to validate the performance of the model displaying the confidence score

TESTING SET



Fig 6.5.3 Testing set images used for assessing the prediction of the model.

WEED DETECTION

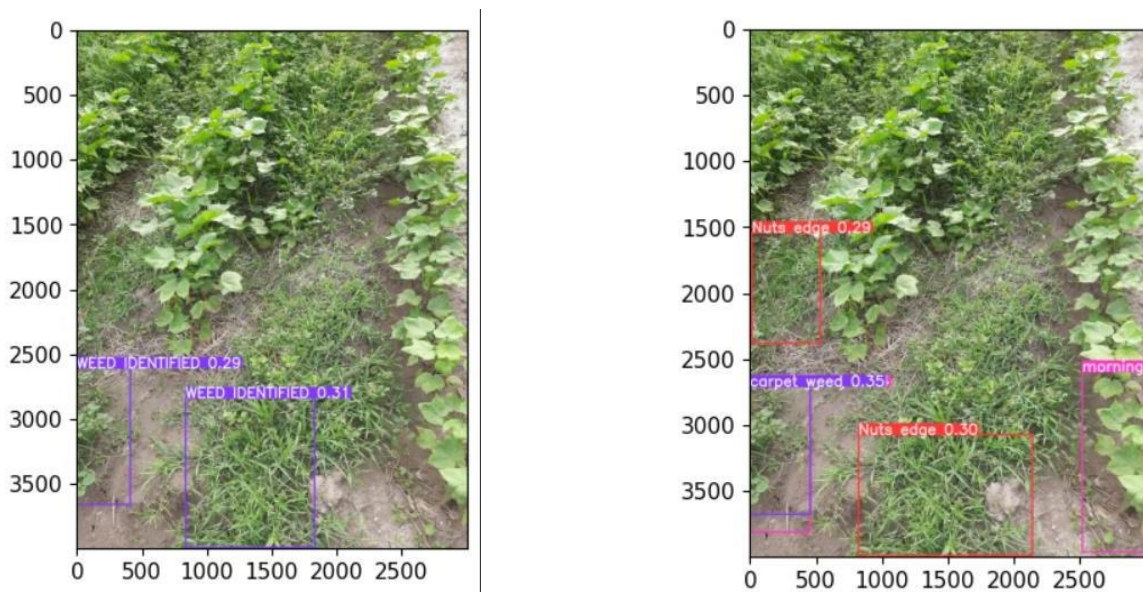


Fig 6.5.4 Bounding Box and confidence scores for the weeds identified
Images plotted which shows the height and width of the image on the x and y-axis respectively and the bounding box showing confidence score for the weed

CHAPTER 7

CORPORATE SOCIAL RESPONSIBILITY

The application of weed detection in cotton plants using the YOLOv5 model brings significant benefits to society. Firstly, it enables farmers to automate weed management practices, reducing labor-intensive tasks and increasing efficiency. This contributes to cost savings and promotes sustainable agriculture practices. Secondly, by accurately identifying and localizing weeds, the model helps farmers target specific areas for weed control, minimizing the use of herbicides and reducing environmental impact. Additionally, the improved crop yield resulting from effective weed management supports food security and economic stability. The application of this technology enhances agricultural productivity, promotes environmental sustainability, and ultimately benefits society by ensuring a stable and sufficient cotton supply while minimizing the negative effects of weed infestation.

CHAPTER 8 CONCLUSION

The weed detection system developed using the YOLOv5 model offers a promising solution for efficient weed management in cotton farming. By automating the process of weed identification and localization, the system helps farmers target and remove weeds more effectively, leading to improved crop yield and reduced reliance on manual labor. The YOLOv5 model demonstrates remarkable accuracy and real-time performance, making it a suitable choice for weed detection in cotton fields. Implementing this system in agricultural practices can contribute to sustainable farming by minimizing the negative impact of weeds on cotton plants, optimizing resource allocation, and promoting higher productivity in cotton cultivation.

CHAPTER 9

FUTURE WORK

There are some areas where additional focus is required. Firstly, expanding the dataset by including more diverse images of cotton fields and weeds can enhance the model's ability to generalize to different scenarios. Additionally, incorporating temporal information, such as the growth stages of cotton plants and weed dynamics over time, can provide a more comprehensive understanding of weed management needs. Furthermore, integrating the weed detection system with robotic platforms or autonomous vehicles can enable automated weed removal, further reducing manual labor and enhancing overall efficiency. Finally, exploring the possibility of multi-modal approaches, such as fusing visual data with other sensor inputs can potentially improve weed detection accuracy and robustness.

APPENDIX

CODE:

TRAINING

```
import torch

from matplotlib import pyplot as plt

from tqdm import tqdm

import numpy as np

import cv2

import utils

display = utils.notebook_init()

model=torch.hub.load('ultralytics/yolov5','yolov5s',force_reload=True)

!python train.py --img 320 --batch 15 --epoch 301 --data /content/yolov5/dataset.yaml --weights yolov5s.pt --
cache
```

TESTING

```
import torch

from matplotlib import pyplot as plt

from tqdm import tqdm

import numpy as np

import cv2

!git clone https://github.com/ultralytics/yolov5

%cd yolov5

%pip install -qr requirements.txt # install

cmodel=torch.hub.load('ultralytics/yolov5','custom','/content/cbest.pt',force_reload=True)

smodel=torch.hub.load('ultralytics/yolov5','custom','/content/sbest.pt', force_reload=True)
```



```

imlist = ["/content/T5.jpg", "/content/T13.jpg", "/content/T50.jpg", "/content/T51.jpg",
"/content/T74.jpg", "/content/T79.jpg", "/content/T91.jpg", "/content/T99.jpg", "/content/T100.jpg", "/content/T101.j
pg", "/content/T128.jpg"]

for i in imlist :

    result1=cmodel(i)

    result1.print()

    %matplotlib inline

    plt.imshow(np.squeeze(result1.render()))

    plt.show()

    result2=smodel(i)

    ans2 = str(result2)

    result2.print()

    %matplotlib inline

    plt.imshow(np.squeeze(result2.render()))

    plt.show()

    first_parenthesis_index = ans2.find('(')

    extracted_string = ans2[first_parenthesis_index :]

    comma_index = extracted_string.find(',')

    #y1 = ans2[first_parenthesis_index :]

    print(extracted_string)

    clean_string = extracted_string.strip "()")

    numbers = clean_string.split(",")

    try :

        numbers = [int(number.strip()) for number in numbers]

        for i in range(len(numbers)):

            #print(f"Index {i}: {numbers[i]}")

            print(numbers[i])

        x1 = numbers[0]

        y1 = numbers[1]

        width = numbers[2]

        height = numbers[3]

        x2 = x1+width

        y2 = y1+height

        cropped_image = result2.crop((x1, y1, x2, y2))

```

```
plt.imshow(cropped_image)
```

```
except :
```

```
    print()
```

```
    continue
```

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