SEMINAR REPORT

ON

REAL TIME WEED DETECTION IN PRECISION AGRICULTURE

BY
GAYATRI WALKE
T. Y. B.Tech. Computer Engineering,
Roll No -3474, Division - B

Year:- 2020-2021

SEMINAR GUIDE
Prof. Pooja Deshmukh

MKSSS's
Cummins College of Engineering for Women, Pune
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

CERTIFICATE

This is to certify that Ms Gayatri Walke has satisfactorily completed the seminar on
"REAL TIME WEED DETECTION IN PRECISION AGRICULTURE"
in the partial fulfillment of her term-work (Seminar) as a part of syllabus for T.Y.B.Tech. Computer Engineering for the Academic Year 2020-2021 as prescribed by MKSSS's Cummins College of Engineering for Women, Pune (An Autonomous Institute Affiliated to Savitribai Phule Pune University)

Prof. Pooja Deshmukh | **Dr. Mrs.S. M. Kelkar**

Seminar Guide | **HOD Computer**

Dr. Mrs. M. B. Khambete

Principal

MKSSS's
Cummins College of Engineering for Women, Pune
(An Autonomous Institute Affiliated to Savitribai Phule Pune University)

PLAGIARISM CERTIFICATE

This is to certify that Gayatri Walke has satisfactorily completed the seminar report on
“REAL TIME WEED DETECTION IN PRECISION AGRICULTURE”
and the data present in this report is found to be 93.14% plagiarism free.

This seminar report is towards the partial fulfillment of her term-work (Seminar) as a part of syllabus for T.Y.B.Tech. Computer Engineering for the Academic Year 2020-2021 as prescribed by MKSSS’s Cummins College of Engineering for Women, Pune (An Autonomous Institute Affiliated to Savitribai Phule Pune University)

Name of the Student and sign **Prof. Pooja Deshmukh**

Seminar Guide

ACKNOWLEDGEMENT

I would like to take this opportunity to express my sincere gratitude to everyone who was supported me throughout the course of this seminar on “Weed Detection in Precision Agriculture”. I am thankful for their most generous guidance and constructive advice during the completion of this work. I also express my sincere regards to Prof. Pooja Deshmukh for her unending support and guidance. I would also like to extend my gratitude to all those who have directly or indirectly guided me during the Research work due to which I came to know about so many new concepts and technologies.

Thank you,

Gayatri Walke

Abstract

To sustain the worldwide population with sufficient farm produce, new smart farming methods are necessary to increase or maintain the crop yield while minimizing the environmental impacts. Weed is one of the main reasons for getting less production, therefore, in automatic weed control techniques, accurate weed detection is an essential indispensable part of site-specific weed management. The conventional time-consuming manpower method of weeding is plucking manually spraying herbicides uniformly all over the field which contaminates crops and gives rise to many health-related issues. Therefore to address these disadvantages and reduce the number of herbicides used in agriculture, a new system has been proposed to perform the real-time identification of weeds in farm crops by using a deep learning method is a relevant step towards modern, sustainable agriculture. Many algorithms are developed to classify and autonomously destroy weeds from crops. Various color-based, learning based, and threshold-based techniques have been deployed in the past. To get best performance in some critical situations also, such as collecting images of different lighting conditions, identification of plant species, overlapping crops with weed, and designing an autonomous patch sprayer. This report studies algorithm that using image processing detects the weeds that are located in a specific area of the plantation. The results of this study suggest that the proposed algorithm for weed detection using low level features and thresholding classifier has a high performance and accuracy validated with sensitivity and specificity indices above 90%

KEY WORDS: smart farming, weed detection, weeding, weed management,
Computational vision, Image processing

Table of Contents

Appendix

LIST OF FIGURES

INTRODUCTION

What is the importance of agriculture?

Agriculture plays a critical role within the whole lifetime of a given economy. Agriculture is that the backbone of the financial system of a given country. Agriculture is that the most stay of India's economy. It accounts for more than 15% of the gross domestic product. It ensures food security for the country providing several raw materials for industries. Agricultural development is important to our national prosperity.

It is estimated that the planet population will reach around 9 billion by 2050 and to satisfy the food demand agricultural food production must be doubled. On the opposite hand, weeds alongside other problems and challenges are the most causes which are faced by agriculture.

What are weeds?

There are numerous definitions of a weed:

1. plant out of place and not intentionally sown
2. plant growing where it's not wanted
3. plant whose virtues haven't yet been discovered.
4. plants that are competitive, persistent, pernicious, and interfere negatively with human activities.

Many studies have been done to control weeds, which grow in the field and share everything needed by the main crop, as a result, the main crop losses target yield. This report compiles all of the above.

Many studies have been done to control weeds, which grow in the field and share everything needed by the main crop, as a result, main crop losses target yield. This report compiles all of the above.

Figure 1 Weeds in agriculture

WEED AND CROP COMPETITION

Weed competition and crop yield loss relation

Weeds are damaging in many ways. Primarily, they lessen crop yield by competing for water, light, soil nutrients, and space. Other problems associated with weeds in agriculture include:

1. Weeds fight with crops in the domain of space soil moisture, nutrients, and solar radiation.
2. Weeds should be removed at every step of the growth of any crop particularly at the initial stages to diminish overall production loss.
3. Weeds harm crops which include sharing of water, light, nutrients, and space, increased reduction costs, difficulty in harvesting, reduction of product quality, increased risk of pests and diseases, and drop in the commercial value of cultivated areas.
4. Weeds are the most challenging difficulty of farmers as these threaten their ability to produce good quality food cost-effectively.

Why managing weeds is difficult?

I. Manual weeding is hard and labour costing that’s why making it infeasible.

II. Mechanical weeding is comparably effective but could not remove intra-row weeds and seldom it could damage the main crop due to human error.

III. Herbicide usage is most common due to its huge efficiency in managing weeds. The use of herbicides in the complete agricultural field causes waste of herbicide and environmental pollution. Using half dosage in a low-density weed area can produce the same result as full dosage in a low-density weed area.

IV. Chemical weeding is at number one as a technique used against weeds that have detrimental effects on farmer health and second, uniformly sprayed using tractors and supporting setup which results in high cost of herbicide and undesired environmental pollution.

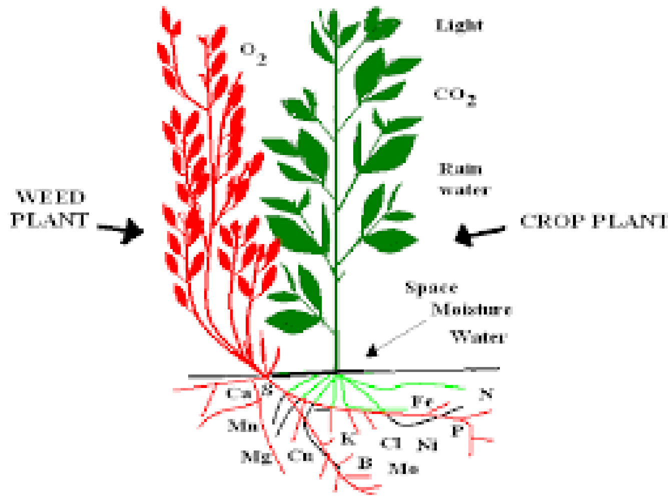


Figure 2 Weeds

The control of weeds is of vital importance in agriculture, these are unwanted by the farmer since they are causing several problems in the crop. Among its negative effects is the contamination of production, shelter of insects and diseases, facilitates the growth of other pests and increases irrigation costs.

The monitoring of these weeds allows us to detect the presence and/or abundance of weeds, gather information that allows decision-making during the campaign, provide data to build the record of the sites on which long-term actions can be designed term, detect the entry of invasive species, not yet present in the lot and provide bases for precision agriculture and specific site management of inputs.

PRECISION AGRICULTURE

What is precision agriculture?

Precision Agriculture has opened the doors so that technology can be incorporated into the farming processes and improve the effectiveness of production in the crops. This new concept has led to developed countries highly productive in agriculture, opting for the use of new tools to improve their technological management in the agricultural enterprise.

Precision Agriculture is one of the most important developments in the domain of agriculture in the last two decades, from the perspectives of resource and nutrient use, efficiency, and ecological impact. Precision Agriculture primarily attempts to manage—by measurement, analysis and appropriate action—both spatial and temporal variability of soil and crop parameters, with the objective of optimizing profitability, sustainability and protection of the environment.

Consequently, greater benefits are obtained such as the optimization of the use of inputs, determination of the availability of nutrients, organic matter, water, etc. on the land, reducing production costs and improving the quality of crops.

PA employs multiple traditional and emerging technologies such as

1. Automation & robotics;
2. Geographic Information Systems (GIS)
3. Global Positioning Systems (GPS)
4. Remote Sensing (RS)
5. Sensor Technologies
6. Wireless Sensor Networks and
7. Decision-support and
8. Modelling software.

Figure 3 Precision Agriculture

The idea of making an algorithm that by means of image processing detects the weeds that are located in a specific area of plantation then arises. This methodology is advantageous because it offers a technological tool for farmers throughout the process of sowing, growing and harvesting crops. In addition, it increases the performance of operational processes in crop management, reducing the time spent searching for weeds throughout a plot of land and focusing weed removal tasks on specific sites for effective control. In this way, agricultural practices are determined to replace the usual inputs based on average values, as in traditional agriculture, for a more precise agriculture, with localized management, which studies the changes in yield in an entire area.

PRECISION AGRICULTURE IN WEED DETECTION

To avoid pollution and to minimize herbicide loss, herbicide spray must be done using modern technology autonomously. The first step in this regard is to classify weed, crop, and soil separately and efficiently. Many image processing approaches have been attempted so far. There have been three major types of approaches to handle this classification between weeds and crops in the past.

1. Color Based classification
2. Threshold-based classification
3. Learning-based classification.

Color and threshold-based approaches suffer loss in accuracy when the light is too high or too low, learning-based approaches promise more precision on the other hand.
From learning-based approaches, two best approaches that stand out due to high accuracy are

1. support vector machines
2. deep learning

Figure 4 Smart farming

Deep learning has placed itself in the first position by delivering maximum accuracy compared to all other techniques. Color and threshold-based approaches suffer loss in accuracy when the light is too high or too low, learning-based approaches promise more precision on the other hand. But then it should be trained before with a huge dataset and is computationally expensive. The use of low-level characteristics such as the color of the plants and the area is an advantage given that the specific characteristics of the weeds as texture or shape are not relevant, providing versatility for the application of the algorithm in different crops of vegetables. This advantage is important, due to the great variety and types of weeds that exist in crops. A specific database of weeds is not necessary to be able to train the algorithm and identify weeds, as an automatic learning algorithm would do.

So we will look at an algorithm that using image processing detects the weeds that are located in a specific area of the plantation.

MATERIALS AND METHODOLOGY

The methodology of the report is achieving a baseline method for developing a real-time weed detection system through binary classification when vegetation is detected, that is, to separate soil and plants, then, to use a feature extraction for discriminating weed.

- The Green plant detection algorithm is implemented to get rid of soil from the image such image information is reduced.
- The algorithm focus only on vegetation, then, median filtering removes noise as “salt and pepper” with the advantage of preserving edges.
- The previous output is converted to binary; at now, small objects are removed so as to avoid outliers.
- After the pixels connected around their neighborhood are labeled, thus, all objects within the image are identified.
- Finally, the world calculation for every object is completed. With the resulting values obtained, we set a threshold to differentiate weed from the crop, such the tactic could also be a feature extraction criterion supported size.

Figure shows the flow chart like the method described above. The algorithm was performed using MATLAB R2015.

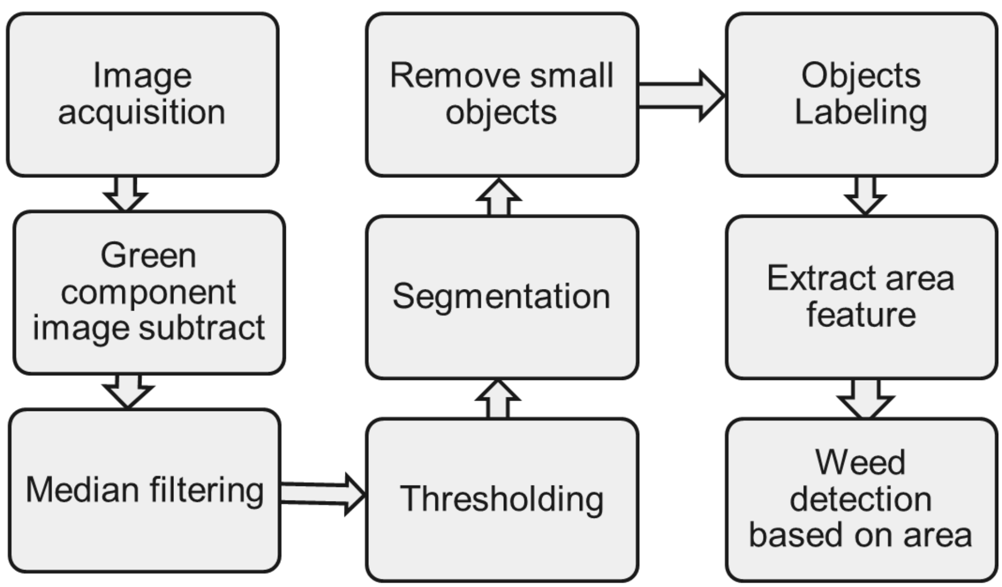


Figure 5 Vision Flowchart

1. Image acquisition

Figure 6 Input Image

A. The digital images captured in outdoor light conditions with perspective projection over crop.
B. The main idea of crop images acquisition is to avoid lighting and sharpness problems, therefore, color changes about vegetation are reduced.
C. The accuracy of the first step of the plant classification algorithm increases provided that green color over objects is kept.

2. Green plant detection algorithm

Figure 7 Image Subtracted

- Method for the segmentation of green plants and separation from the background is to use green component of RGB color model to get an image only with vegetation information.
- Previous studies have based their criteria for selection on an Index that stands out green component of source image; Excess Green Index and Normalized Difference Vegetation Index are some methods that use this approach, however, they are aimed to perform on different sunlight and background conditions.
- The module for the weed remover robot will have a camera obscura and lamps in order to maintain uniform illumination. Then, it results appropriate to subtract green component from the original image.

Method is one of the most practical ways of separating plants from soil:

- Source image is converted to grayscale intensity whereby the hue and saturation information is eliminated while retaining the luminance.
- All components in XY space corresponding to green value on image are subtracted from the corresponding element in grayscale array.

3. Median filtering

A. Median filtering is used for noise suppression in images subtracted, preserving edges whereby the relevant image information is conserved and tends to produce regions of constant or nearly constant intensity.

B. This filtering works using pixel values around 3-by-3 neighborhood mask. This window is moved over the points of an image, then, the value at the mask center is replaced with the calculation of the median from source image values within the window.

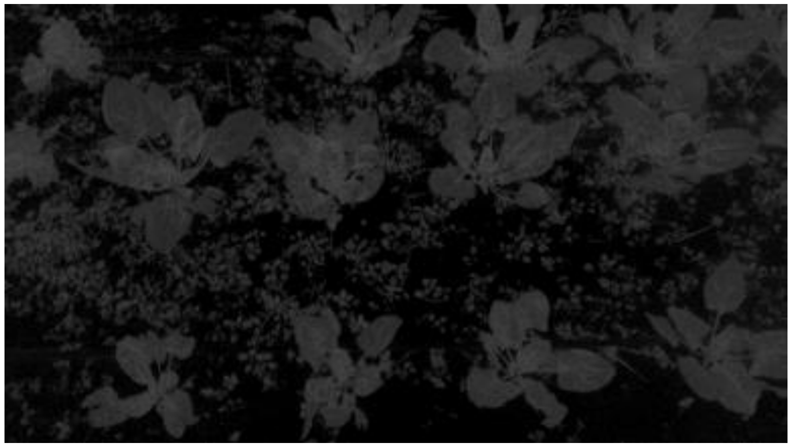


Figure 8 Median Filtering

4. Feature extraction

It is necessary to segment the objects of interest in order to locate plants, assigning a label to each pixel and highlighting the similarity of the features used for detection of plants.

In the present work, color and area serves as descriptors for a threshold classifier.

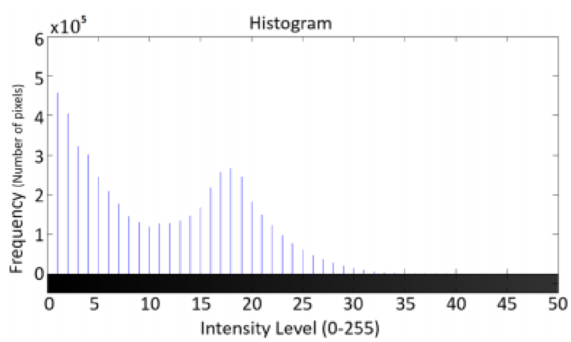


Figure 9 Image Histogram

Threshold segmentation Threshold segmentation method is appropriate because elements of interest have been highlighted above, having a clear difference of objects to be removed from the scene.

Segmentation is accomplished by

$$I_{bin}(x,y) = \left\{ \begin{array}{l} 0, I_{Median}(x,y) < t \\ 1, I_{Median}(x,y) \geq t \end{array} \right\}$$

Threshold

The selection of threshold may not be obvious for human eye just to see the image.

The Otsu method, estimates optimal threshold to segment through an exhaustive search of maximum variance between classes in gray levels.

The selection of an appropriate threshold is carried out with image histogram, taking the value of the valley formed by two peaks, corresponding to the light and dark areas

Then, the optimal value divides the two peaks.

5. Fill image holes

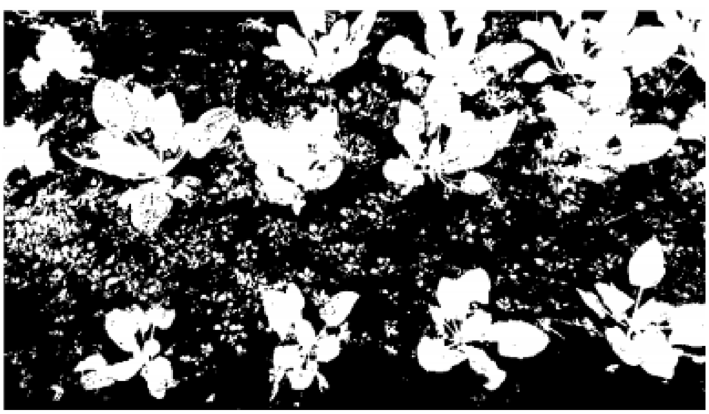


Figure 10 Threshold segmentation

Because of feature extraction based on area, it is appropriate to fill in the holes in the image. Thus, evaluation in the next step is enhanced since compact objects are obtained.

For this purpose, an algorithm based on morphological reconstruction is used.

This method uses 4 or 8 connected neighborhood pixels to evaluate the resulting image.

$$F_{mark}(x,y) = \begin{cases} 1 - I_{source}(x,y), & (x,y \text{ is on the border of } I_{source}) \\ 0, & \text{otherwise} \end{cases}$$

The algorithm calculates a marked image stemming from source image borders using

Figure 11 Images filled with holes

Afterwards, the method iterates until it reaches all image positions

$$H_k = (H_{k-1} \otimes B) \cap G$$

where B, a 3 x 3 matrix of ones, H0 =F and G = image to fill in the holes.

Then, Hk , is a binary image with holes filled in.

6. Labeling

- Labeling is identifying objects in the scene.
- Required is to label each element as a plant, getting a region description in order to extract features in the next step.

Therefore, an algorithm based on connected components is used. The region labeling stage evaluates each pixel with a 4 neighbor-connectivity, using a heuristic stated on pixel values according to predecessor labels at north and west position.

7. Classification based on area

- Extract area features from each element to discriminate weed and crop.
- The algorithm presented, defines an area counting the number of pixels in the object region then, the value is stored for all items.
- The elements are sorted according to the area values in descending order.
- When a difference with the next object evaluation is greater than 50%, the average of the previous elements is calculated. This value is the threshold for weed detection.

Figure 12 Weeds plant detected in spinach crop

ANALYSIS DONE

1. The algorithm of weed detection system was tested using photos taken perpendicularly to crop lines, avoiding illumination.
2. The images were labeled manually based on random behavior of weed and the expertise of crops manager, in order to compare and evaluate the performance of the proposed approach to weed detection.
3. The classes assigned to define the specificity and sensitivity are shown as follows:
    - True positive (TP): Number of plants detected as weed correctly.
    - True negative (TN): Number of plants detected as crop correctly.
    - False positive (FP): Number of crop plants detected as weed.
    - False negative (FN): Number of weed plants detected as crop.
4. Each image is accompanied with a table that indicates sensitivity and specificity to group information about correct weed detection.
5. Positive and negative values are calculated to highlight the percentage of true positive and true negative detections with respect to all classifications.

Figure 13 Weeds plant detected in spinach crop

6. The indices are calculated as follows:
    - Sensitivity = TP/(TP+FN)
    - Specificity = TN/(FP+TN)
    - Positive predictive value (PPV) = TP/(TP+FP)
    - Negative predictive value (NPV) = TN/(FN+TN)

7. The sensitivity values shown in this section are around 0.90, which indicate a good performance of the proposed algorithm for detecting plants as weed correctly.

8. The specificity values near to 1 represent the ability of the system to detect correctly plants as crop.
9. The positive predicted values are greater than 80 percent, whereby, most of the cases identified as weed are true positive.
10. The negative predicted values are near to 0.7, which means a 30 percent of false negatives obtained when weed size is greater than or near the crop size.

CONCLUSION AND FUTURE WORK

- This research has proposed a practical way to detect weeds by image processing based on the characteristic of the area of each object in an image.
- Research has been limited in that the size of the weed is smaller than that of the crop, high indices of sensitivity, specificity and positive predictive value have been achieved, contrary to the negative predictive value, which is lower than 50%.
- The proposed algorithm has the advantage of detecting weeds present between the plants in the crop lines. It also detects effectively as crop plants even those that are outside the crop lines, which is an objective difficult to achieve with other methods using computational vision .
- However, the algorithm loses effectiveness when the sizes of the weeds are similar to the sizes of the plants of the crop, since the characteristic that is taken as variable of classification is the size of the plants. This problem can be solved by adding another characteristic as a classification method.
- The use of low level characteristics such as the color of the plants and the area is an advantage given that the specific characteristics of the weeds as texture or shape are not relevant, providing versatility for the application of the algorithm in different crops of vegetables. This advantage is important, due to the great variety and types of weeds that exist in crops.
- A specific database of weeds is not necessary to be able to train the algorithm and identify weeds, as an automatic learning algorithm would do.
- It was concluded that the proposed algorithm using low level characteristics and a threshold based on the area, have an improvement field in the specificity indexes and NPV, but the results are good enough to use the algorithm in practical applications of precision agriculture.

APPENDIX

A Frequently Asked Questions

1. **Advantages of the report?**

   The use of low level characteristics such as the color of the plants and the area is an advantage given that the specific characteristics of the weeds as texture or shape are not relevant, providing versatility for the application of the algorithm in different crops of vegetables.

2. **Disadvantages of the report?**

   Color and threshold-based approaches suffers loss in accuracy when the light is too high or too low, learning-based approaches promise more precision on the other hand.

3. **What is the history of the field?**

   Understand the current and past weed pressure in a field, including the specific weed species and resistance issues. It's also important to understand the herbicide history of the field.

4. **What is the weed pressure in the region?**

   Consider not just weed pressure in the surrounding fields, but also throughout the local geography..

5. **How does the soil hold the herbicide?**

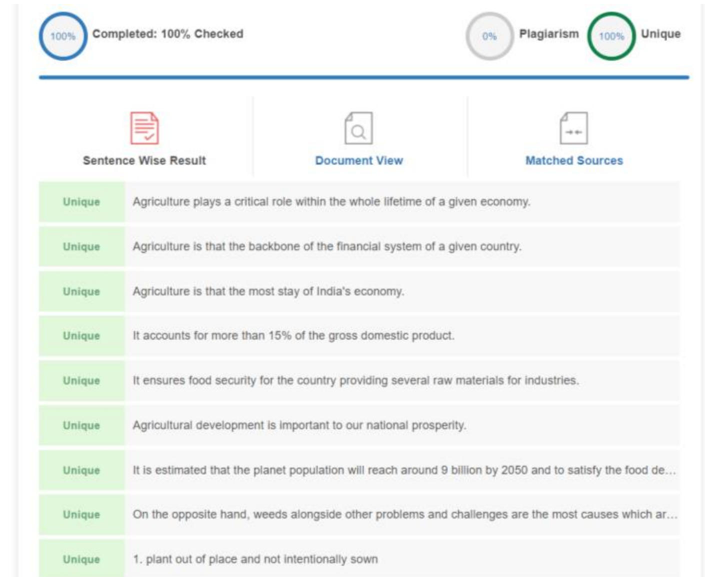
   Heartier soils can absorb and hold on to a herbicide for longer periods of time, whereas sandy soils and lighter soils are at risk of having the herbicide flushed away with rain.

6. **How do weed escapes affect season-long plan through harvest?**

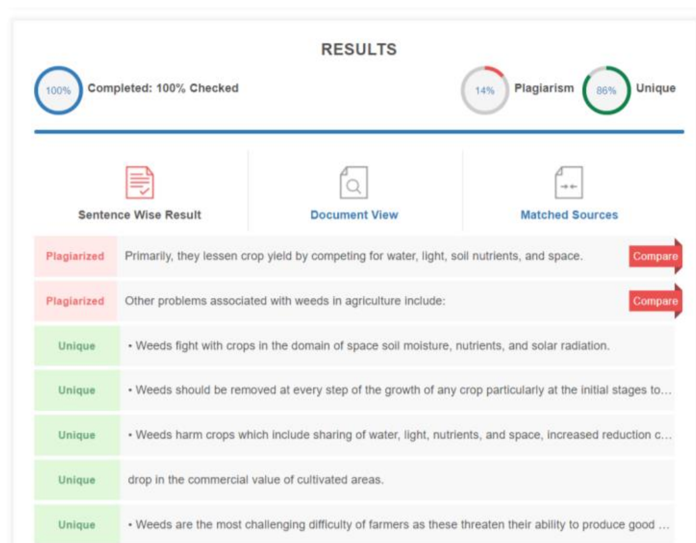
   Weed escapes compete with nutrients. If left in fields, they can chip away at crop potential.

B Plagiarism report.

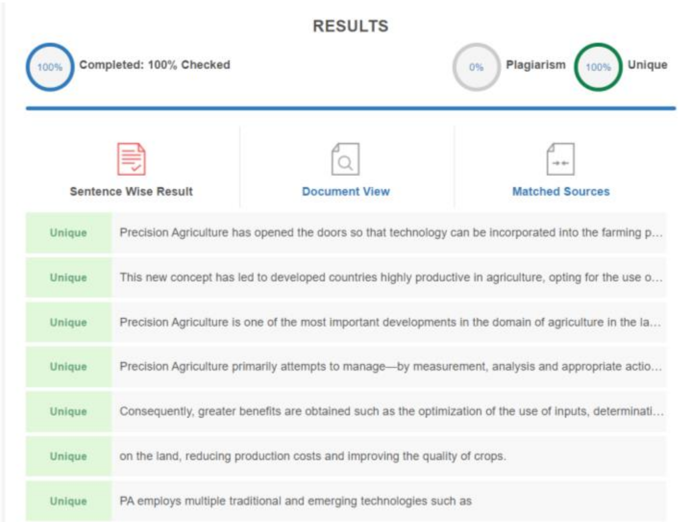
1. INTRODUCTION



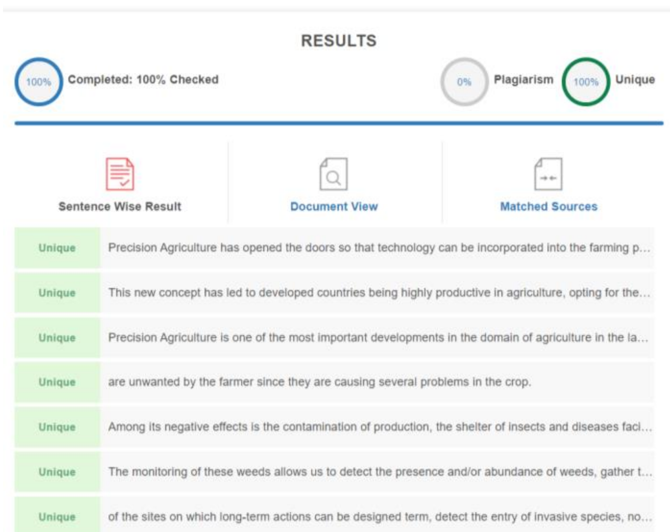
2. WEED AND CROP COMPETITION



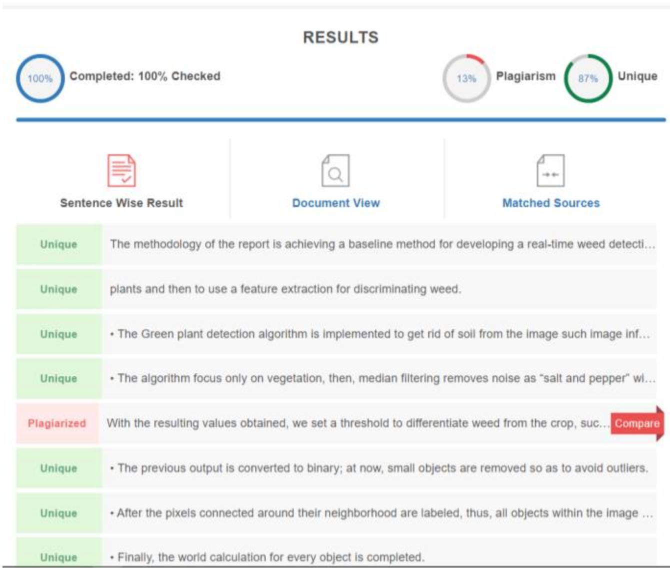
3. PRECISION AGRICULTURE



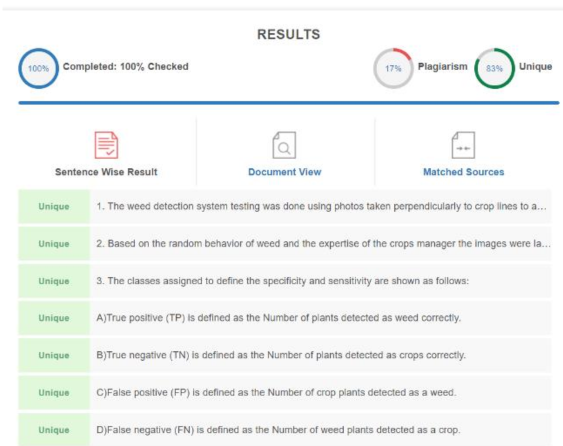
4. PRECISION AGRICULTURE IN WEED DETECTION



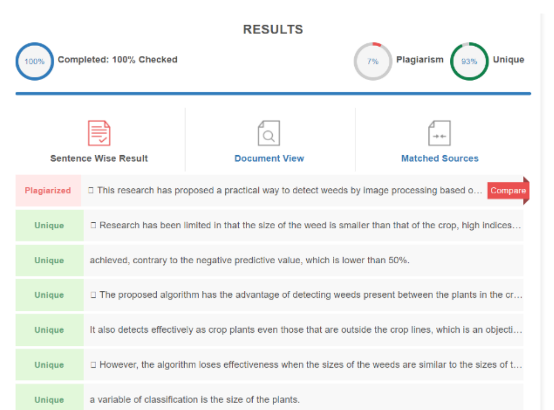
5. MATERIALS AND METHODOLOGY



6. RESULTS



7. CONCLUSION AND FUTURE WORK



REFERENCES

1. S. I. Moazzam, U. S. Khan, M. I. Tiwana, J. Iqbal, W. S. Qureshi and S. I. Shah, "A Review of Application of Deep Learning for Weeds and Crops Classification in Agriculture," 2019 International Conference on Robotics and Automation in Industry (ICRAI), 2019, pp. 1-6, doi: 10.1109/ICRAI47710.2019.8967350.
2. G. Gyarmati and T. Mizik, "The present and future of the precision agriculture," 2020 IEEE 15th International Conference of System of Systems Engineering (SoSE), 2020, pp. 593-596, doi: 10.1109/SoSE50414.2020.9130481.
3. S. Babu, "A software model for precision agriculture for small and marginal farmers," 2013 IEEE Global Humanitarian Technology Conference: South Asia Satellite (GHTC-SAS), 2013, pp. 352-355, doi: 10.1109/GHTC-SAS.2013.6629944.
4. A. J. Irías Tejeda and R. Castro Castro, "Algorithm of Weed Detection in Crops by Computational Vision," 2019 International Conference on Electronics, Communications and Computers (CONIELECOMP), 2019, pp. 124-128, doi: 10.1109/CONIELECOMP.2019.8673182. Crop Weed Identification System Based on Neutral Network.
5. F. Miao, S. Zheng and B. Tao, "Crop Weed Identification System Based on Convolutional Neural Network," 2019 IEEE 2nd International Conference on Electronic Information and Communication Technology (ICEICT), 2019, pp. 595-598, doi: 10.1109/ICEICT.2019.8846268.