Detection of Weeds by Using Machine Learning

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Abstract. The foundation of our nation is agriculture. India's economy is mostly based on agriculture. So many people dependent on the agriculture in the country. The people involved in agriculture is reduce as threats there increase. Weeds are the one of the main things which is affecting the crops in agriculture fields. In this research, we present a straight forward image processing technique that enables quick and easy weed detection by scrutinizing the input image. Photos of plants from various crop are taken with a digital camera, and the images are used to classify the affected region in the plants. Here we have used python-3.1 version and open CV. In this image processing deep convolutional neural network (CNN) architecture is developed to implement this classification with improved accuracy by increasing the deep layers as compared to the existing CNN. We will follow this method for the detection or recognition of the weeds in the crops. Where it will detect multiple types of weeds.

Keywords: Input images · python open CV · weed detection · convolution neural network (CNN) · Machine learning

1 Introduction

A weed detection system is a technology that uses machine learning algorithms to identify unwanted plants in an agricultural field. These systems can help farmers to reduce the use of herbicide and Weedicide, which can be harmful to the environment and human health. The detection system can provide information on the types of the weeds, which can be used to develop targeted weed control strategies. Weed detection systems are typically based on machine learning techniques. Such as artificial neural networks and deep learning. These algorithms are trained on large datasets of images of both crops and weeds, allowing them to learn the visual characteristics of different weed species and accurately distinguish them from crops.

Weeds are a major problem in agriculture reducing crop yields, increasing production costs, and impacting the quality of the crop. Traditional weed management practices, such as hand weeding or the use of herbicides, can be labor intensive and can result in significant environmental impacts. In recent years, the development of weed detection systems has provided an innovative and sustainable approach to weed management. Weed detection systems can also be used to support precision agriculture practices. By providing farmers with detailed information about the type of weeds.

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Weed detection systems can enable the development of more targeted and precise weed management strategies. This can help to optimize the use of resources such as water and fertilizer, and improve the overall sustainability of agriculture and horticulture practices. Weed detection system is a computer vision-based solution that automatically identifies and classifies weeds in agricultural fields. By using image analysis algorithms and machine learning techniques, the system can accurately distinguish between crops and weeds allowing farmers to take targeted actions to eliminate weed infestations. The system can help reduce herbicide usage, increase crop yields and save the famers time and resources.

Weed detection using machine learning is an emerging technology that has the potential to revolutionize agriculture. The system is designed to identify and locate weeds within a field, allowing farmers to take targeted action to remove them collect images of a field, process the images using machine learning algorithms, and then identify the weeds within the images. This process can be accomplished using a variety of techniques including object detection segmentation, and classification. To address this issue other additional strategies are being studied to find the weeds, we chose an image CNN technique the image, it is more like analyzing it to find the weeds.

2 Literature Survey

A literature survey for weed detection systems would involve reviewing existing research articles, conference proceedings, and patents related to the topic. Some potential areas of focus could include. R. Anirudh Reddy has investigated the use of the image processing for the weed detection system for the cotton field in the system. They have implemented the template matching concept of image processing. The patch image or the template image is two dimensionally convoluted and is matched in the main image. After processing weed locations are highlighted on the images and template image and input images are converted into gray scale for faster processing. Here they are using the hardware raspberry board which uses templet images for the reference images. After that they are using open CV for templet matching where this technique used to detect the object [1].

Faisal Ahmed et al. studied the separation of weeds from crops in digital photos using support vector machines (SVM) and Bayesian classifiers. The SVM classifier has been found to perform better than the Bayesian classifier. A weed detecting device powered by solar panels was created by Robert Bosch the machine has a camera installed at the base for continuous image capture, and wheels are also available for movement between crop rows. This is being researched in the context of moderately temperate climates in nations like Germany Other Eastern European nations have built a robot that can smash weeds as soon as they are discovered. While a mechanism is created in other Western nations to remove all the unneeded weeds [2].

There are weeds Herbicides are carefully applied to the weeds after being identified. For the purpose of weed detection they employed MATLAB and Support Vector Machine techniques respectively. The weed detecting system employed in [3].

The herbicides are sprayed on the weeds with the aid of pumps in accordance with the algorithm utilized by the weed detection system which use the Erosion and Dilation technique to detect weeds. However, herbicides have negative effects not just on the crop

but also on the people who eat the harvest. We therefore set out to create a technology that can detect weeds automatically and aid in their mechanical eradication [4].

"A Weed Detection System for Crops Based on a Deep Learning Network" by Liu et al. (2021). This paper presents a deep learning-based system for weed detection in crops using UAV imagery. The authors used a modified version of the Faster R-CNN model to detect and classify weeds in the images. The system achieved high accuracy in weed detection and was also able to provide a weed density map for precision weed control [5].

Several researches are done on the weed detection system which are based on image processing and support vector machines (SVM). But our system is based on the machine learning. Which uses CNN convolution neural network for identifying the weeds. The potential of machine learning techniques for weed detection in agriculture, and the various methods that can be used to achieve high accuracy in weed detection and classification. They also highlight the need for large diverse datasets for training and testing machine learning models.

3 Software Requirement

The software required to design the system we require python 3.4.1. Python is the one of easiest language to implement the code without error. For implementing packages of datasets with image processing we use open CV for implementing the different type of weeds. In open CV we need to install some libraries like Num.py, Matplotlib and some more. To build machine learning models, need to choose from frameworks as Keras and PyTorch. These frameworks offer a range of pre-built machine learning models and tools for data preprocessing, model training and deployment. A development environment is required to code and test the weed detection system. Integrated development environments Jupyter Notebook commonly used for developing machine learning models.

4 Proposed Work

The proposed system explains the weed detection system for this we are taking some of the different weed images as input images which are captured by the camera in the day time. For this we need to follow the step-by-step processes. We are implementing the deep learning concept for the system such as a convolutional neural network on the dataset to recognize the weed species (Fig. 1).

In this proposed system we are using some of weed images. We are using the different types of weeds such as blue grass, Chenopodium, Cirsium setosum, sedge are the images we have taken as input images. For this images we going to apply the techniques which are so in the block diagram.

4.1. Input image: the input images are typically images of a field or agricultural area where weeds may be present. These images are then processed by the machine learning algorithm to detect the presence of weeds (Fig. 2).

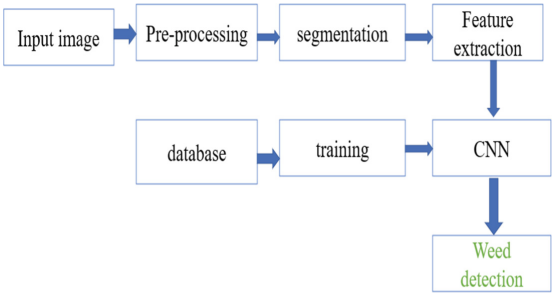

Fig. 1. Block Diagram

Fig. 2. Input images of weeds

4.2. Preprocessing: preprocessing is an essential step in a weed detection system that uses machine learning. Preprocessing of the input images can improve the accuracy of the detection system and enable the machine learning algorithm to analyze the images more effectively. Some common preprocessing techniques used in a weed detection system of machine learning include.

(a) Image resizing: This involves resizing the input images to a standardized size. This ensures that all images have the same dimensions and enables the machine learning algorithm to process the images more efficiently.

(b) Color balancing: Color balancing involves adjusting the color balance of the input images to account for lighting conditions and other environmental factors. This can improve the accuracy of the weed detection system and make it more robust to changes in lighting and weather conditions.

(c) Noise reduction: This involves removing any noise artifacts in the input images, such as sensor noise or image compression artifacts. This can improve the clarity and quality of the images and make them easier to analyze.

4.3. Segmentation: The goal of segmentation is to separate the weed plants from the background of the input images, which can help improve the accuracy of weed detection and classification.

There are several different approaches to segmentation that can be used in a weed detection system of machine learning, including:

(a) Thresholding: This involves setting a pixel intensity threshold that separates the weed plants from the background. Pixels above the threshold are considered part of the weed plant, while pixels below the threshold are considered part of the background.

(b) Edge detection: This involves identifying the edges of the weed plants in the input images, which can be used to separate the plants from the background. This can be done using techniques such as the Canny edge detector or the Sobel operator.

4.4. Feature extraction: extract features from images of crops, and then using these features to train a model that can classify whether a given patch of land contains weeds or not feature extraction techniques used in weed detection systems: Shape-based features: Weeds often have a distinctive shape, so shape-based features can be used to differentiate between the two. These features might include the size, aspect ratio, or eccentricity of the weed.

(a) Edge-based features: Weeds often have a distinct edge or boundary so edge-based features can be used to differentiate between the two. These features might include the edge sharpness of image edge density.

4.5. Training: Train the selected model using the training dataset. The model is trained by adjusting its parameters to minimize the error between the predicted output and the actual output.

(a) Data Collection: Collect a large and diverse dataset of images that include crops with and without weeds. These images should be captured from different angles and lighting conditions to ensure that the model can accurately detect weeds in different scenarios.

(b) Data Preparation: Preprocess the collected data by resizing, cropping, and normalizing the images. This is done to ensure that the input data has the same dimensions and pixel intensity.

(c) Range Labeling: Manually label the images with the correct classification, i.e., weed or no weed.

(d) Splitting Dataset: Divide the labeled dataset into training, validation, and testing sets. The training set is used to train the model, the validation set is used to tune the hyperparameters of the model, and the testing set is used to evaluate the final performance of the model.

4.6. Convolutional neural network (CNN):

CNNs will show high accuracy and performance in various image classification tasks and can be used to automatically learn discriminative features from images for weed detection.

(a) Model Architecture: Design the architecture of the CNN by defining the number and type of layers in the network. Typically, a CNN consists of convolutional layers, pooling layers, and fully connected layers. The convolutional layers are responsible for extracting features from the input image, the pooling layers reduce the spatial dimensions of the features, and the fully connected layers classify the

(b) Features Testing: Test the final CNN using the testing set. The performance of the CNN can be evaluated using metrics such as accuracy, precision, recall, and F1-score.

5 Implementation

The implementation of the detection of weeds is by applying the all above steps. The input images are taken First. For all this images are taken for preprocessing to improve accuracy and next is segmentation here the thresholding, edge detection will take place Training will Done for the data collection. This all will collect the images into the data set. Then we will go for CNN architecture as explained detail all the steps in the above block diagram (Fig. 3).

For implementing of the code, we need follow the steps in Fig. 4.

After completing the training of the images then we need to install the some libraries in open CV like Num.py, Matplotlib, import shuffle, import confusion matrix, import CV2, import tensor flow, completing the installation of libraries. Next step is to open the Jupiter note book and write the code for loading the data and training and testing.

Development environment: A development environment is required to code and test the weed detection system Integrated development environments Jupyter Notebook, commonly used for developing the machine learning models (Fig. 5).

(a) Confusion matrix: A confusion matrix is a table used to evaluate the performance of a machine learning model. It is also called an error matrix. A confusion matrix displays the number of true positives, true negatives, false positives, and false negatives produced by a classification algorithm.

This is useful for evaluating the performance of a model, as it can provide insights into which types of errors the model is making different metrics can be calculated from the confusion matrix, such as accuracy, precision, recall, and F1 score, among others.

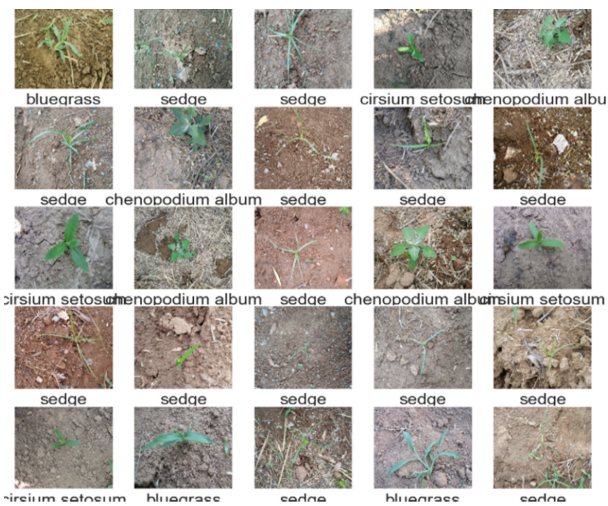

Fig. 3. Different datasets images

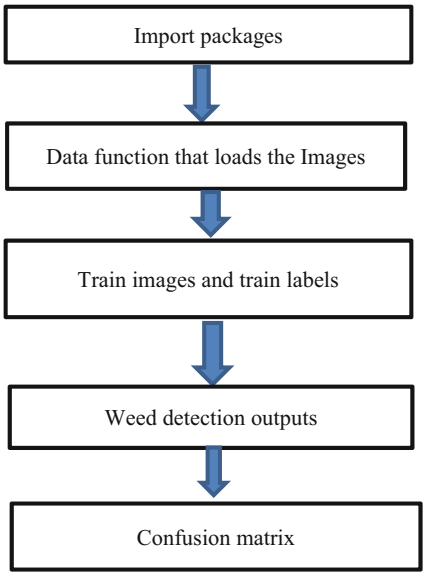

Fig. 4. Flow chart for the code

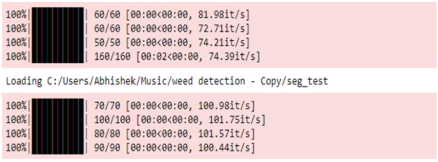

Fig. 5. Different test cases for training and testing

6 Results

See Figs. 6, 7, and 8.

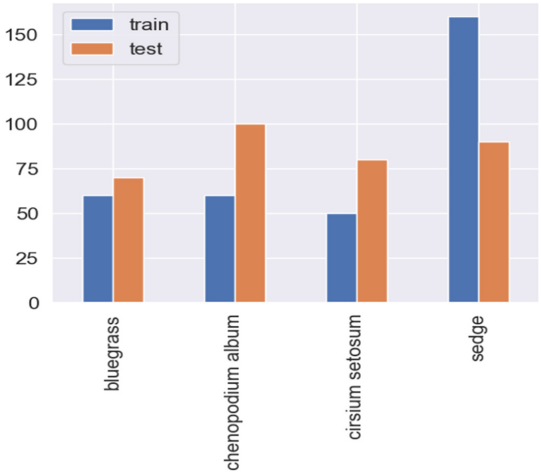

Fig. 6. Graphical Representation results of training and testing of various weeds

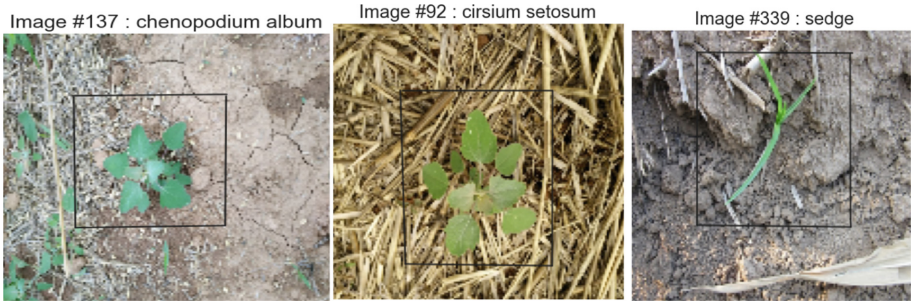

Fig. 7. The following figures shows the different weeds in the detection

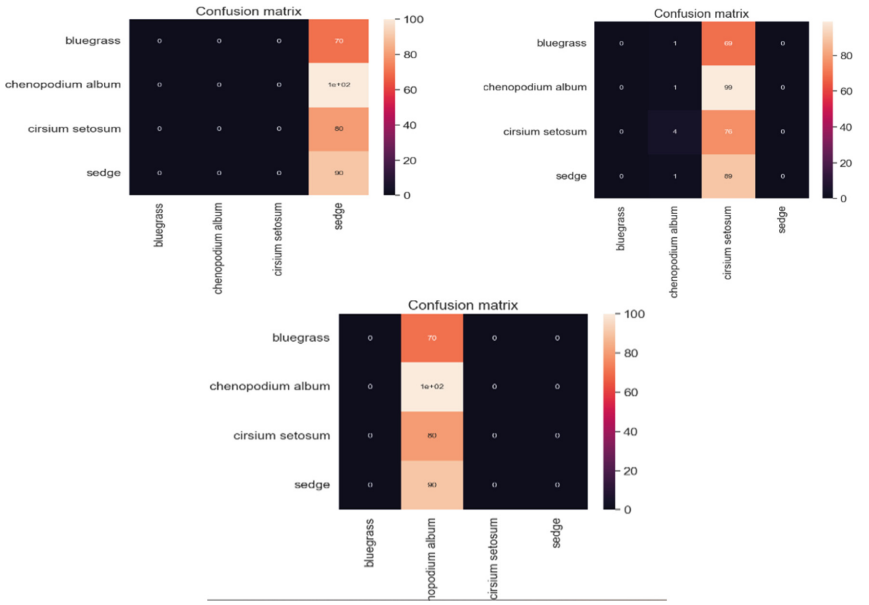

Fig. 8. Confusion matrix of various weeds

7 Conclusion

Thus, in our proposed system using the implementation of convolutional neural network (CNN) architecture by using machine learning techniques. We have implemented the detection of weeds. Collection of data set or data base which provide the objective of the detection of the weeds. Collecting the images and making the data base and training and the testing the images by open CV gives the clear outputs of the weeds in the crop field. We also researched on many other weed detection system with the study of many researches we have implemented the detection of weeds using machine learning. Many of the researches has worked on the only one type of the weeds in the crops. But we have implemented the different types of the weeds. With the help of Jupyter notebook which will give the exact outputs of the detection of weeds. Hence which will helpful for the farmers to take targeted actions to control weed infestations.

8 Future Scope

The future scope of weed detection systems using machine learning is promising. There are several areas where this technology can be improved and expanded to provide more effective and efficient weed management solutions in agriculture. Some of the future directions for weed detection systems are.

Multi-spectral imaging: Multi spectral imaging can provide more detailed and accurate information about the health and growth stage of crops and weeds. By integrating multi-spectral imaging with machine learning, it is possible to develop more accurate and efficient weed detection systems. Autonomous weed control: Autonomous weed control systems can automate the process of weed control, reducing the need for human intervention. By integrating weed detection systems with robotic systems, it is possible to develop autonomous weed control systems that can identify and remove weeds in real-time. Cloud-based weed management: Cloud-based weed management can enable farmers to access and analyze weed data from anywhere, at any time. By integrating weed detection systems with cloud-based software, it is possible to develop a comprehensive weed management system that can provide farmers with real-time information and insights.

Overall, the future scope of weed detection systems using machine learning is vast, and there is much potential for this technology to provide more efficient, sustainable, and effective weed management solutions in agriculture.

References

1. R. Anirudh Reddy, G. Laasya, "Design of a weed detection system for cotton field" Mat Journal of Image Processing and Artificial Intelligence, Volume 3 Issue 3 in 2017.
2. R. Aravind, M. Daman, B. S. Kariyappa, "Design and development of automatic weed detection and smart herbicide sprayer robot", Intelligent Computational Systems (RAICS), December 2015.
3. Faisal Ahmed, A.S.M. Hussain Bari, Emam Hussain, "Performance analysis of Support Vector Machine and Bayesian Classifier for Crop and Weed classification from digital Images", World Applied Sciences Journal, 2011.
4. H. Yalcin and S. Razavi, "Plant Classification using Convolutional Neural Networks", IEEE Fifth International Conference on AgroGeoinformatics, 2016.
5. "A Weed Detection System for Crops Based on a Deep Learning Network" by Liu et al. November (2021) Remote Sens. 2021, 13, 4486.