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DEEP LEARNING BASED WEED DETECTION IN AGRICULTURE

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Abstract: In the context of agriculture, a weed is any plant that grows where it is not wanted and competes with cultivated plants for nutrients, water, and sunlight. Weeds can pose significant challenges to crop cultivation by reducing yields, interfering with harvest operations, and increasing production costs. They can also harbor pests and diseases, further impacting crop health and productivity. Controlling weeds is an essential aspect of modern agriculture, and various strategies, including mechanical cultivation, chemical herbicides, crop rotation, and mulching, are employed to manage weed populations and minimize their impact on crop production.

Traditional methods of weed identification in agriculture, relying on visual inspection by farmers, are time-consuming and prone to errors due to the vast diversity of weed species. This project proposes an approach to weed identification utilizing deep learning and image processing techniques.

I. INTROUDCTION

Agriculture is one of the most important sectors that significantly contributes to the world's economy. However, weed infestation in crops has been a major challenge for farmers as it can lead to reduced crop yield and quality. Traditionally, farmers have used manual labour or chemical herbicides to remove weeds from crops. However, these methods are time-consuming, labor-intensive, and can be harmful to the environment. In recent years, machine learning-based approaches have gained popularity in the field of agriculture for weed detection and removal. In this project, we propose a machine learning-based weed detection system for agricultural images using deep learning and image processing techniques. The system employs convolutional neural networks (CNNs) for weed identification and utilizes image processing techniques such as image segmentation and feature extraction to improve the accuracy of weed detection. The proposed system is trained and evaluated using a dataset of agricultural images captured from different regions and under varying weather conditions. The project's ultimate goal is to develop an accurate, robust, and efficient weed detection system that can assist farmers in reducing herbicide use and improving crop yield.

Problem Statement

Farmers are finding it more and harder to recognize and control weeds in modern agriculture due to the variety of weed species. The efficiency of traditional techniques for visual weed identification is declining as new and unidentified plant species emerge. Farmers will have a very tough time properly implementing weed management strategies and minimizing losses in agricultural output as a result.

The challenge at hand is to develop a solution that uses deep learning and image processing methods to automate weed detection and improve the accuracy and efficacy of weed management in agricultural regions. The solution should be to create a machine learning model that can recognize and draw boundaries around vegetable leaves, allowing any plants that are outside of these boundaries to be rejected as potential weeds. By reducing the complexity and size of the training dataset required for weed detection, the technique aims to increase the efficacy and precision of weed identification, assisting farmers in making informed decisions about weed management tactics.To build a system which is energy efficient in distributed environment and also efficient in performance.

PRELIMINARY ANALYSIS & INFORMATION GATHERING

Before the advent of machine learning, farmers relied on traditional methods for weed detection. These methods include manual labour, where farmers physically remove weeds by hand, or mechanical methods like ploughing, tilling, or hoeing to uproot or bury weeds. These methods can be time-consuming, labor-intensive, and often require a large workforce.

Another traditional method for weed detection is visual inspection, where farmers visually examine their fields for weed growth. This method can be effective for small fields, but it can be difficult to detect weeds in larger fields or when the weeds are not easily distinguishable from the crop.

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Additionally, some farmers use chemical herbicides and pesticides to control weed growth. However, these methods can be harmful to the environment and can have adverse effects on crop yield and quality.
Overall, traditional methods for weed detection can be labor-intensive, time-consuming, and often require a large workforce. They may also have negative environmental impacts. Machine learning-based approaches offer a promising alternative that is more efficient, accurate, and eco-friendly.

II. LITERATURE SURVEY

1. **A survey of deep learning techniques for weed detection from images**
https://www.sciencedirect.com/science/article/abs/pii/S0168169921000855
By, A S M Mahmudul Hasan, Ferdous Sohel, Dean Diepeveen, Hamid Laga, Michael G.K. Jones
The background study of the article titled "A survey of deep learning techniques for weed detection from images" aimed to explore the challenges associated with weed detection in agriculture and the potential of deep learning techniques to address these challenges. The article highlighted the need for accurate weed detection in agriculture, as weeds can significantly reduce crop yield and quality, increase labor costs, and require the use of herbicides that can be harmful to the environment.

2. **Deep convolutional neural network models for weed detection in polyhouse grown bell peppers**
https://www.sciencedirect.com/science/article/pii/S2589721722000034
By,A Subeesh, S. Bhole, K. Singh, N.S. Chandel, Y.A. Rajwade, K.V.R. Rao, S.P. Kumar, D. Jat
The background of this study is that weed management is an important task in agricultural production, as weeds can reduce crop yield and quality. Manual weed control is labor-intensive and time-consuming, and herbicide use can have negative effects on the environment and human health. Therefore, automated weed detection and control systems are becoming increasingly important in agriculture.

3. **Early Weed Detection Using Image Processing and Machine Learning Techniques in an Australian Chilli Farm**
https://www.mdpi.com/2077-0472/11/5/387
By,Nahina Islam,Md Mamunur Rashid,Santoso Wibowo,Cheng-Yuan Xu,Ahsan Morshed,Saleh A. Wasimi ,Steven Moore and Sk Mostafizur Rahman
The background study of this paper highlights the increasing importance of early weed detection in agriculture to reduce the usage of herbicides and ensure sustainable farming practices. The paper notes that traditional methods of weed detection are often time-consuming and expensive, and may not be effective in detecting small weed seedlings. Hence, the authors propose a computer vision-based approach using image processing and machine learning techniques for early weed detection.

4. **WEED DETECTION USING DEEP LEARNING TECHNIQUES: A Review**
https://ijcrt.org/papers/IJCRT2203197.pdf
By,Hisana C H, Anoop K.Student, Assistant professorElectronics and communication EngineeringCollege Of Engineering Thalassery, Kerala, India
The paper titled "WEED DETECTION USING DEEP LEARNING TECHNIQUES: A Review" presents a comprehensive review of various deep learning techniques used for weed detection in agricultural fields. The background study discusses the increasing demand for food production due to the growing population, which has resulted in the adoption of various technological advancements in agriculture. However, weeds are a major threat to crop growth and yield. Traditional manual weed removal methods are time-consuming and labor-intensive, which has led to the development of automated weed detection and removal systems using image processing and machine learning techniques.

5. **Weed Identification Using Deep Learning and Image Processing in Vegetable Plantation**
https://www.researchgate.net/publication/348360155_Weed_Identification_Using_Deep_Learning_and_Image_Processing_in_Vegetable_Plantation
By,Xiaojun, JinJun ,CheYong, Chen
The background of this study is the issue of weed control in vegetable plantations. Weeds are a major problem in agricultural production as they compete with crops for nutrients, water, and light. Traditional methods of weed control involve the use of herbicides, which can be harmful to the environment and human health. The study proposes a system that uses deep learning and image processing techniques to identify and classify weeds in vegetable plantations.

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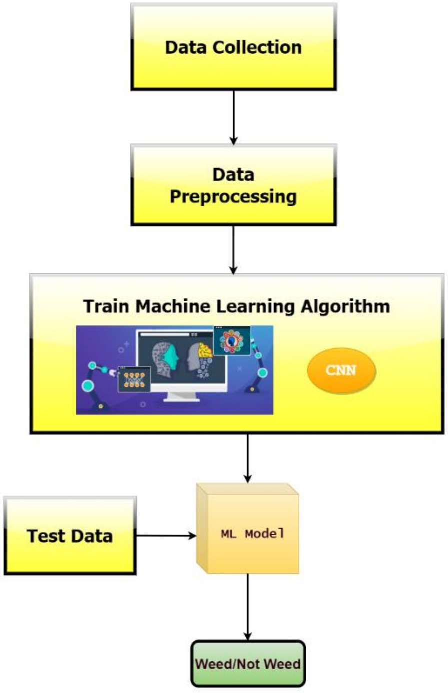
III METHODOLOGY



1. PROPOSED METHODOLOGY

The Proposed System utilizes deep learning algorithms, to detect weeds in the agricultural images and draw bounding boxes around them.

The project also employs image processing techniques to pre-process the images and extract features that can be used by the machine learning algorithms for weed detection. These techniques include image filtering, segmentation, and feature extraction.

The algorithm developed in this project has the potential to reduce the need for manual labour, improve the accuracy of weed detection, and reduce the use of harmful herbicides/pesticides. It can also potentially reduce the cost of weed detection, making it more accessible to small-scale farmers.

1. **Accurate Weed Detection:** Deep learning models can accurately detect and classify weeds, even in complex agricultural environments. They can identify the weeds based on their features, such as colour, texture, shape, and size.
2. **Faster and Cost-effective:** Deep learning-based weed detection can significantly reduce the time and cost of manual weed identification and herbicide application.
3. **Efficient Use of Herbicides:** Deep learning-based weed detection can help farmers use herbicides more efficiently by targeting specific areas where weeds are present, reducing the overall amount of herbicides required. It can also prevent over-spraying, which can damage crops and the environment..

CNN Algorithm

The CNN algorithm is used to achieve the same and cross validated. The Cross Validation is a technique for evaluating machine learning models by training on subsets of dataset and evaluating on complementary subsets of dataset. In this CNN model, k-fold cross-validation divides the dataset into k parts of equal size, one part is kept for validation and remaining parts are used for training.

CONVOLUTIONAL LAYER

It always comes first. It receives the image (a matrix of pixel values). Assume that the input matrix's reaction starts at the top left of the image. The software then chooses the smaller matrix there, which is referred to as a filter. The filter then generates convolution that moves over the input image. The filter's job is to multiply the original pixel values by its value. All of these multiplications are added together, yielding a single number. The filter moves because it only reads the image in the upper left corner. Additionally, one unit on the right performs a similar operation. A matrix is created after passing the filter through all points, however it is less than the input matrix. From a human standpoint, this operation is comparable to distinguishing visual boundaries and simple colors. However, in order to recognize the fish, the entire network is required. Several convolution layers will be blended with nonlinear and pooling layers in the network. The first layer to extract features from an input image is convolution. Small squares of input data are used in convolution. It's

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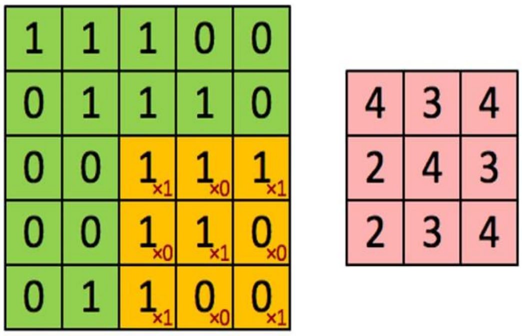
a mathematical procedure with two inputs: an image matrix and a filter or kernel.

- Dimension of an image matrix (h x w x d)
- A filter (fh x fw x d)
- Outputs a dimension (h-fh+1) x(w-fw+1) x1

Consider a 5 x 5 whose image pixel values are 0, 1 and filter matrix 3 x 3 as shown in below

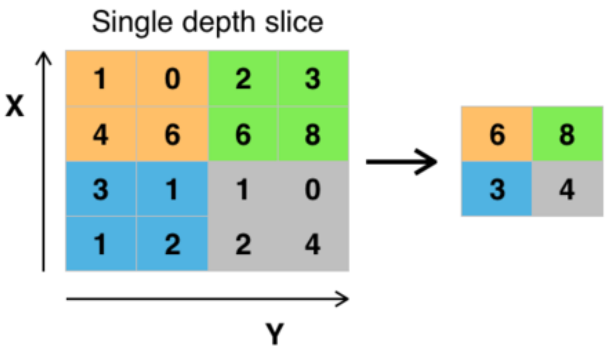
Convolution with a filter example

Then the convolution of 5 x 5 image matrix multiplies with 3 x 3 filter matrix which is called "Feature Map" as output shown in below

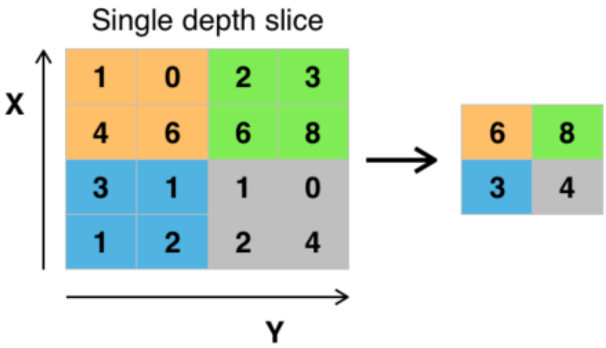


THE NON-LINEAR LAYER:

After each convolution process, it is adder. It features an activation function that provides a nonlinear property; without this trait, a network would be insufficiently intense and unable to simulate the response variable.



It moves in the same direction as the nonlinear layer. It works with the image's width and height, performing a down sampling procedure on them. As a result, the size of the image is lowered. This means that if some features were already recognized during the previous convolution operation, a detailed image is no longer required for further processing and is reduced into smaller images.



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FULLY CONNECTED LAYER:

It's primary to link an overall linked layer after completing the succession of convolution, non-linear, and pooling layers. This layer receives the convolution network's output data. When a completely connected, layer is attached to the network's end, it produces an N-dimensional vector, where Ni is the number of classes from which the model chooses the needed class.

CNN MODEL

- The TensorFlow framework and the OpenCV library were used to create this CNN model, which is widely utilized in real-time applications.
- This concept can also be used to create a full-fledged software that scans everyone entering a public meeting.

LAYERS IN CNN MODEL

1. Conv2D Layer
2. MaxPooling2D Layer
3. Flatten () Layer
4. Dropout Layer
5. Dense Layer

1. Convo2D Layer:

It has 100 filters and the activation function used is the 'ReLu'. The ReLu function stands for Rectified Linear Unit which will output the input directly if it is positive, otherwise it will output zero.

2. MaxPooling2D:

It is used with pool size or filter size of 2*2.

3. Flatten () Layer:

It is used to flatten all the layers into a single 1D layer.

4. Dropout Layer:

It is used to prevent the model from overfitting.

5. Dense Layer:

The activation function here is SoftMax which will output a vector with two probability distribution values.

IV.CONCLUSION

Deep learning-based weed identification employs deep neural networks to identify and classify plant species in pictures in order to enhance weed management in agriculture. Gathering a diverse collection of photographs of crops and weeds, pre-processing the images, selecting a suitable deep learning architecture, training the model, evaluating its performance, and proving its generalizability are the tasks at hand. Adopting deep learning-based weed detection has several advantages, including accurate weed detection, rapid and economical weed identification, efficient pesticide usage, higher agricultural yields, scalability, and environmental advantages.The project may be divided into stages such as data collection, pre-processing, model selection, training, evaluation, testing, and deployment. Overall, weed control in agriculture can be effectively and sustainably solved by deep learning-based weed detection, which lowers the demand for pesticides and supports sustainable agricultural practises.

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