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Smart Weed Detection Using Deep Learning Techniques

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ABSTRACT
Farmers now need to focus on enhancing agricultural production due to the rise in global population. Allocating the proper amounts of herbicide to the proper locations and times can help reduce the cost of pesticides and their negative effects on the environment (precision agriculture). Automatic weed detection is currently one of precision agriculture's most difficult problems. Nonetheless, because of their many similarities, weeds and crops are difficult to distinguish. Deep learning is the method of choice for weed detection. The training of the data sets is a key requirement for putting deep learning algorithms into practise. In order to detect marijuana in photos, the suggested system will use "deep learning algorithms and convolution neural networks" on supervised data. We are now deploying on sesame.

Keywords— Deep learning, CNN, tensor flow, dataset, Yolo algorithm.

I. INTRODUCTION

In India, agriculture is the main industry. Farmers grow a wide variety of products here in India. The following are the primary agricultural variables that impede crop growth:

A. Sediment hydration

Sediment is a substance that settles on the surface of the earth or at the bottom of a body of water. Sediment hydration is the process of adding water to sediment. This process may occur naturally as a result of exposure to rain or submersion in water, or it may occur artificially as a result of adding water on purpose during engineering or experimental procedures. In addition to affecting the sediment's capacity to store and transmit water and the biogeochemical cycling of contaminants and nutrients in the sediment and its surroundings, the addition of water can cause changes to the sediment's physical and chemical properties, such as increased porosity and altered chemical composition.

B. Inconsistent watering

Inconsistent watering is the process of giving plants water at random times or in varied amounts as opposed to consistently and regularly. This could be detrimental to plant growth and health, as they need a steady supply of water to survive.

C. Weeds are present

Unwanted plants, such as weeds, frequently sprout up on lawns, gardens, and agricultural fields, among other unwelcome locations. Desirable plants may experience decreased growth and productivity as a result of weed competition for resources like water, nutrients, and sunlight. Weeds can also be a pain and interfere with a landscape's aesthetic appeal.

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D. Pests are present

Pests are living things that can hurt or affect less humans, animals, or plants. They can harm crops, animals, pets, or human health and can take the form of insects, rodents, fungi, bacteria, viruses, or other species.There are several different approaches that can be taken to handle pests. These comprise mechanical, biological, cultural, and chemical techniques.

E. Foliage ailments

When a plant's leaves become discoloured, wilt, or develop spots, blisters, or lesions, these conditions are referred to as foliage illnesses. Many things, such as bacterial, viral, or fungal infections, insect or mite damage, nutrient excesses or deficiencies, environmental stresses including dryness, too much wetness, and chemical exposure, can result in these illnesses.

Weeds have an impact on crop growth to an extent of 20–25 percent, hence for our research, we are primarily focusing on weed detection. Weeding accounts for 30% of agricultural spending. When it comes to taking out the weeds by hand, it is a very ineffective chore. It's a labour-intensive task that takes a lot of time. Hence, in order to improve efficiency, we are utilising deep learning algorithms to identify weeds in farmlands. The only technique currently in use for weed detection is simple observation with the naked eye, which needs more manpower and expensive equipment, etc. Additionally, some machines are employed in the weed detection and herbicide application processes. Consequently, a change known as the "Green Revolution" began. Following this time, the use of lethal poisons as herbicides dramatically grew. By doing this, we succeeded in raising output, but we neglected the environmental harm, which calls into question whether we will continue to live on this lovely planet. As a result, we have implemented some strategies in this initiative to reduce the use of herbicides by only applying them where weeds are present.

Deep learning

Deep learning is based on the branch of machine learning that is a subset of artificial intelligence. Since neural networks imitate the human brain, deep learning will do. In deep learning, nothing is programmed explicitly. Basically, it is a machine learning class that makes use of numerous nonlinear processing units to perform the feature extraction as well as the transformation. The output from each preceding layer is taken as input by each of the successive layers. Deep learning models are capable enough to focus on the accurate features themselves by requiring a little guidance from the programmer and are very helpful in solving out the problem of dimensionality. Deep learning algorithms are used, especially when we have a huge no of inputs and outputs. Since deeplearning has been evolved by the machine learning, which itself is a subset of artificial intelligence and as the idea behind the artificial intelligence is to mimic the human behaviour, sesame is ‘the idea of deep learning to build such algorithm that can mimic the brain” .Deep learning is implemented with the help of Neural Networks, and the idea behind the motivation of Neural Network is the biological neurons, which is nothing but a brain cell. Deep

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learning, which is built on artificial neural networks, is a group of statistical machine learning techniques for learning feature hierarchies. So basically, deep learning is implemented by the help of deep networks, which are nothing but neural networks with multiple hidden layers.

Project Statement

Due to the existence of unwanted plants known as weeds, the growth of many crops in farmlands is hampered. Because these plants eat a lot of nutrients, crop development is slowed down as a result. Real-time image analysis can be used to identify undesirable plants, or weeds, in farmlands, saving labour and promoting the healthy development of crops. Weeds that are prevalent in farmlands have an impact on crop growth. They aggressively compete with crops for water, nutrients, and sunlight, which lowers crop yield and lowers crop quality. Weed detection is a challenging job because it takes extensive experience to identify it. If a human expert is used to make the forecast, a lot of human resources, time, and money must be invested. Disease detection will not be done correctly when there is a shortage of experts. Numerous mistakes can be made when identifying a sick plant. The dataset in the digital world is growing, the crop dataset is widely available, and the development of image techniques reveals that the existing models are not providing the results with sufficient precision, even if some models created using machine learning and image processing techniques do so. Therefore, a model that correctly identifies weeds and crops needs to be developed.

Objective

This project's primary goal is to distinguish weeds from products. Due to the existence of unwanted plants known as weeds, the growth of many crops in farmlands is hampered. Because these plants eat a lot of nutrients, crop development is slowed down as a result. Real-time image analysis can be used to identify undesirable plants, or weeds, in farmlands, saving labor and promoting the healthy development of crops. In farmlands, weeds have an impact on crop development because they aggressively compete for water, nutrients, and sunlight, reducing crop yield and lowering crop quality.

II. LITERATURE SURVEY

The creation of a computer vision-based system for weed detection in lawns is described in "Computer vision based approaches for detecting weeds in lawns" by Watchareeruetai et al. (2006). The authors state that automated solutions are required to increase efficiency and accuracy because present weed detection techniques are frequently labor- and time-intensive.The system's accuracy in identifying weeds was over 90% when the authors tested it on a set of pictures of lawns with various sorts of weeds[1].

Sandeep Kumar and Usha B. N.'s (2018) paper, "Convolution Neural Network based Weed Detection in Horticulture Plantation," details the creation of a weed identification system for horticultural plantations using convolutional neural networks (CNNs). The accuracy of the system's weed detection was over 95% when the authors tested it on a

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dataset of photos from various horticultural plantations. Also, they evaluated the effectiveness of their system in comparison to other cutting-edge weed detection systems, and discovered that it performed better than them in terms of accuracy and processing speed[2].

The creation of an unsupervised classification algorithm for early weed detection in row-crops using remote sensing data is described in "Unsupervised classification algorithm for early weed detection in row-crops by combining spatial and spectral information" by Louargant et al. (2018). The authors used a collection of high-resolution aerial photos of row crops to test their system, and they found that it detected weeds with an overall accuracy of 88.4%. They also tested the effectiveness of their algorithm against other cutting-edge weed recognition techniques and discovered that it performed better than them in terms of accuracy and computing efficiency[3].

Athani and Tejeshwar's (2017) "Support Vector Machine-Based Classification System of Maize Crop" describes a support vector machine (SVM)-based classification scheme for locating maize crops in satellite pictures. Using a dataset of satellite photos, the authors tested their categorization method, and their overall accuracy was 96%. Also, they evaluated how well their system performed in comparison to other cutting-edge crop categorization techniques and discovered that it was more accurate and computationally efficient[4].

A real-time image processing system for crop/weed discrimination in maize fields is described in "Real-time image processing for crop/weed discrimination in maize fields" by Burgos-Artizzu et al. (2011). The system classifies each pixel as either crop or weed by extracting information from the photos using a colour camera and an image processing algorithm. The scientists evaluated their method using a collection of photos collected in maize fields, and they were able to detect weeds with an overall accuracy of 94.6%[5].

An image processing method for weed detection in agricultural fields is presented in "Weed detection using image processing" by Paikekari et al. (2016). The accuracy of the authors' method for weed detection was 91.67% in a dataset of photos taken in a wheat field. They also evaluated the effectiveness of their technology in comparison to other cutting-edge weed detection techniques and discovered that it performed better in terms of accuracy.The study shows that image processing techniques may be used to detect weeds in agricultural settings, which can be a practical and affordable way to manage weeds[6].

An strategy based on computer vision is presented in "Weed density classification in rice crop using computer vision" by Ashraf and Khan (2020) for categorising weed density in rice crops. The accuracy of the authors' method for classifying weed density was 90.78% in a dataset of photographs obtained in rice fields. They also evaluated the effectiveness of their technology in comparison to other cutting-edge weed detection techniques and discovered that it performed better in terms of accuracy[7].

The use of ground-based machine vision and image processing techniques for weed

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identification is discussed in "A review on weed detection using ground-based machine vision and image processing techniques" by Wang, Zhang, and Wei (2019). The study by Wang, Zhang, and Wei offers a thorough analysis of the state of the art in research on weed detection utilising ground-based machine vision and image processing methods. The review emphasises how these technologies have the potential to enhance weed management and mitigate the drawbacks of conventional weed control tactics[8].

By Yu, Sharpe, Schumann, and Boyd (2019), "Deep learning for image-based weed detection in turfgrass" focuses on the use of deep learning algorithms for weed detection in turfgrass. The promise of deep learning algorithms for weed detection in turfgrass and other crops is generally highlighted in the article by Yu et al. The study offers insightful information about the potential of these algorithms for applications in precision agriculture[9].

Customized lightweight deep learning models were suggested by Razfar et al. (2022) for weed detection in soybean crops. The study made use of a dataset of more than 7,000 photos of soybean fields that included both weed and non-weed samples. The authors tested the accuracy, precision, recall, and F1-score of different models, including a proprietary deep neural network, MobileNetV2, and EfficientNet[10]

According to the results, the custom deep neural network outperformed MobileNetV2 and EfficientNet with F1-scores of 0.928 and 0.946, respectively, for the best overall performance. Also, the scientists compared their models to Support Vector Machine (SVM), a more established machine learning technique, and discovered that the deep learning models surpassed SVM in terms of accuracy and F1-score.

III. METHODOLOGY

Even the existing systems can be used for the weed detection there are limitations in the existing systems. There is lot of scope forth improvement of the performance of the system. To attain the better performance and to build the reliable system that can detect the plant weed based on the crop image provided, the proposed method is based on the Deeplearning.

A. Data Set And Pre-processing

This data set contains 1300 images of sesame crops and different type so fweedswith each image labels. Each image is a 512X512 colour image. Label for images are in YOLO format.

STEPS:

1. First, we must collect dataset for it. For that we must capture photo so weeds and sesame crops. we collected total 589 images.
2. After collection of photos, we must clean the dataset. This step is very important because if any bed photo Is remain edin dataset it causes worse effect in detection model after cleaning, we have 546 images.
3. Now time for image processing. Our photo size is 4000X3000 colour which is very large, and model will take very long time for training so we convert all images to 512X512X3 size.

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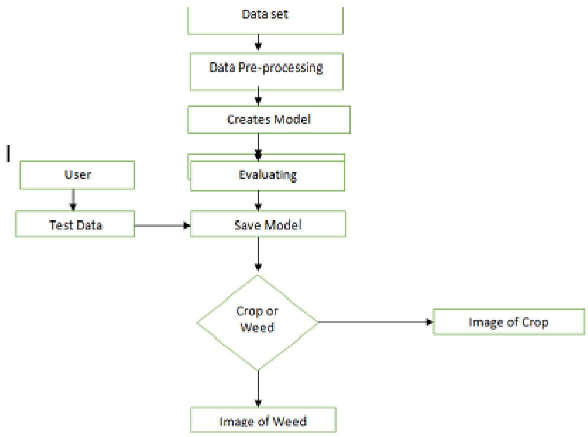
4. Now 546 images are not enough for training, so we have to convert 546 images into1300 images. We used Data Augmentation technique to increase dataset.

5. This step is very tedious, Manualla belling of image data!! In this step we have to drew bounding boxes on photos whether it we edor crop.



B. Algorithm

- Our approach to image recognition has changed fundamentally as a result of CNNs' ability to recognise patterns and understand them. They are thought to be the best architecture for image classification, retrieval, and detection tasks because of the high degree of accuracy in their outcomes.
- They serve a variety of functions in practical exams, producing high-quality results and successfully locating and identifying images of people, cars, birds, and other things. Due to this characteristic, they have become the preferred method for predictions using any image as an input. The capacity of CNNs to accomplish "spatial invariance," which denotes that they can learn to recognise and extract visual information from any location in the image, is a crucial quality. Since CNNs automatically learn features from the image/data and carry out extraction from images, manual extraction is not required. As a result, CNNs are an effective Deep Learning technique for producing precise findings.
- Lowering the spatial precision of the feature maps and achieving spatial invariance to input distortions and translations are the two objectives of the pooling layers, according to a study published in "Neural Computation". The pooling layer speeds up the process while also reducing memory utilisation and computational cost by reducing the number of parameters needed to analyse a picture.
- CNNs can be used for other types of data analysis and categorization problems, though they are most commonly used for image analysis. Since they cover important topics like face identification, video classification, street/traffic sign recognition, classification of galaxies, interpretation and diagnosis/analysis of medical images, among others, they can be used in a variety of sectors to generate accurate result

C.YOLO (You Look Only Once) Algorithm:

Popular real-time object recognition technology known as the YOLO (You Only

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Look Once) algorithm was created by Joseph Redmon, Ali Farhadi, and others. A convolutional neural network called YOLO can quickly and accurately identify items in a frame of an image or video. YOLO applies a single neural network to the entire image, dividing it into a grid of cells, and predicting bounding boxes and class probabilities for each cell. This differs from conventional object detection systems that use region proposal methods (such as the R-CNN family of algorithms). The method used in this case is called anchor-based object identification. The YOLO algorithm is ideal for real-time applications like autonomous vehicles, surveillance systems, and robotics due to its high speed and ability to identify multiple objects in a single pass.

YOLOV3:

In 2018, Joseph Redmon and Ali Farhadi unveiled the real-time object recognition algorithm known as YOLOv3 (You Only Look Once version 3). It is an improvement over YOLOv2 and has attained cutting-edge speed on several benchmark datasets. For the purpose of predicting bounding boxes and class probabilities for objects in an input picture, the YOLOv3 algorithm makes use of a deep convolutional neural network. It creates a grid of cells from the input image and predicts numerous bounding boxes and associated class probabilities for each cell. To increase the precision of bounding box forecasts, it also makes use of anchor boxes, which are pre-defined boxes with a variety of sizes and aspect ratios. The capability of YOLOv3 to recognise objects at various distances is one of its main characteristics.

The capacity of YOLOv3 to detect objects at various scales and resolutions is one of its key characteristics. It accomplishes this by combining features from various scales of the input picture using a feature pyramid network (FPN). This makes it possible for YOLOv3 to accurately identify both small and large objects.Additionally, YOLOv3 employs a method known as multi-scale prediction, which produces predictions at various scales of the input image. This contributes to increasing the precision of object detection. Skip connections, which help the network better locate objects, and the use of Darknet-53, a new backbone network that is deeper and more potent than the Darknet-19 network used in YOLOv2 are two additional enhancements in YOLOv3.Overall, the YOLOv3 object detection algorithm is very precise and effective, making it ideal for real-time apps. Numerous uses, such as robotics, security systems, and autonomous vehicles, have made use of it.

Training and Testing Algorithm

Input: providing an image of plants

Output: It classify the plant is crop or weed

Step1: start

Step2: prepare a database (weed or crop)

Step3: data pre-processing

Step4: Train Model

Step5: real images from dataset

Step6: pre-processing

Step7: test Model

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Step8: classifies the image is crop or weed. Clearly detects that image is crop or weed with the bounded box around it.

Step9: stop

IV. RESULTS

Fig 4.1: Output of weed.

In the figure4.1 we can clearly detect that a weed with the bounded box around it And it also shows the percentage onto pi.e,97% the plant belongs to the weed.

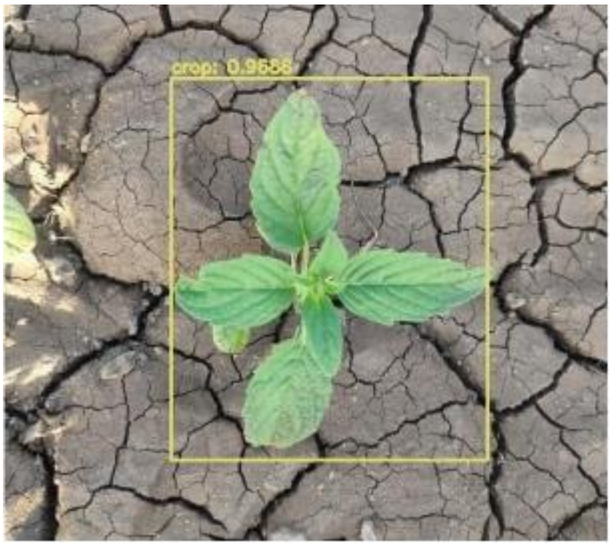

Fig 4.2: output of weed.

In the figure we can clearly observe that it is a crop with the bounded box around it And it also shows the percentage onto p i.e,96% the plant belongs to the crop.

In the above figures it is shown that weed is present in green bounded box and crop is present in yellow bounded box.

V. CONCLUSION

In this system, we have developed a method by which we can detect weed using deep learning techniques. We have used sesame crops data to detect the weeds. The model is implemented into2 classes, which contains both the crops and weeds. The model gives us the result whether the plant is weed or crop with bounded boxes around them, With this system we can detect the weeds from the sesame crop plants and helps to grow the crops without any loss of nutrients. The reason for developing this system is to identify and rescue weed affected area for more fertility of seeds. This process reduces the manpower and saves time where it can detect the weeds easily. It can be extended with more flexible features even to detect small weeds with the help of images.

VI. FUTURE SCOPE

In the future scope of this paper, we can increase the dataset by training different crops and weed samples. So that the system can recognize a very large set of crops and weeds. And also, we can implement the live detecting

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cameras so that the user can identify the weeds lively without taking the pictures of it. These features can be implemented for multiple applications on various platforms with user flexibility.

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