A Review on Machine Learning Architecture for Identifying Weeds in Various Crops

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***Abstract*— Food is a primary human necessity that is fulfilled through agriculture[1]. In India, agricultural management plays an important role in all types of cultivation. Machine learning and image processing are the latest technologies extremely imperative for farmers to maximize crop yield and for reducing farming losses by giving detailed information on the crop. Crop yield is a very important factor in agriculture; every farmer wants a better crop yield. Many diseases like virus bacteria fungus may be the main reason for low crop yield. Weed is also a reason for low crop yield and poor crop quality. Such diseases and weeds can be identified and prevented through crop and weed disease detection techniques. "Machine learning and image processing methods can be used for disease and weed identification"[2]. As part of this review, we focused on a complete investigation of current challenges and methods of image processing and machine learning for crop weed detection system.**

Keywords— Machine learning; classification; weed; image processing; precision Agriculture

I. INTRODUCTION

Food, a basic human requirement, is provided through agriculture, which is regarded as a significant contributor to the global economy. It is a significant source of employment in the majority of the countries [1]. Large countries like India continue to use the former agricultural method. Farmers are hesitant to use cutting-edge technologies when not familiar with. To get information and process artificial intelligence, machine learning can be used. Many other technologies can also be used to serve that purpose like internet of things (IoTs), deep learning. These technologies help farmers to increase production, improve crop quality and finally improve farmers' bottom line. Precision agriculture is regarded as the most important for improving the overall quality of crops and crop yield.

The following steps are followed by farmers while operating:-

1) The crop selection.
2) Preparation of land or soil.
3) Sowing of seed.
4) Adding fertilization.
5) Irrigation.
6) Weed protection and removal.
7) Harvesting.
8) Storage.

In line with the above steps, agricultural activities are divided into the following main sub-parts. Fig.1 shows the major steps of agricultural activities.

Precision farming is a cutting-edge technology that provides new methods for enhancing agricultural production. Farmers can collect data and information using precision agriculture and select the best decision for increasing agricultural land production.

Precision farming can be used for many applications like selecting pests for plants, detecting weeds, producing crops, and detecting plant diseases, etc. A farmer uses pesticides to control diseases and weed to increase crop yield.

Diseases and weeds in crops create a problem of low output and economic losses for farmers and the agricultural sector. For this reason, the identification of diseases and weeds is necessary. The identification of diseases and weeds in the crop are essential for the success of the agriculture system.

Using the naked eye, a farmer recognizes the weeds in the field. Observations on agricultural land require continuous surveillance. However, the process is more critical and takes longer in large operations. Sometimes it is not the most accurate. In some countries such as India, farmers are assisted by experts in detecting diseases or weeds, which take longer time and make the process more costly. The following sections of this document provide the basic steps for the crop and weed detection system and an

investigation of image processing and machine learning classification methods.

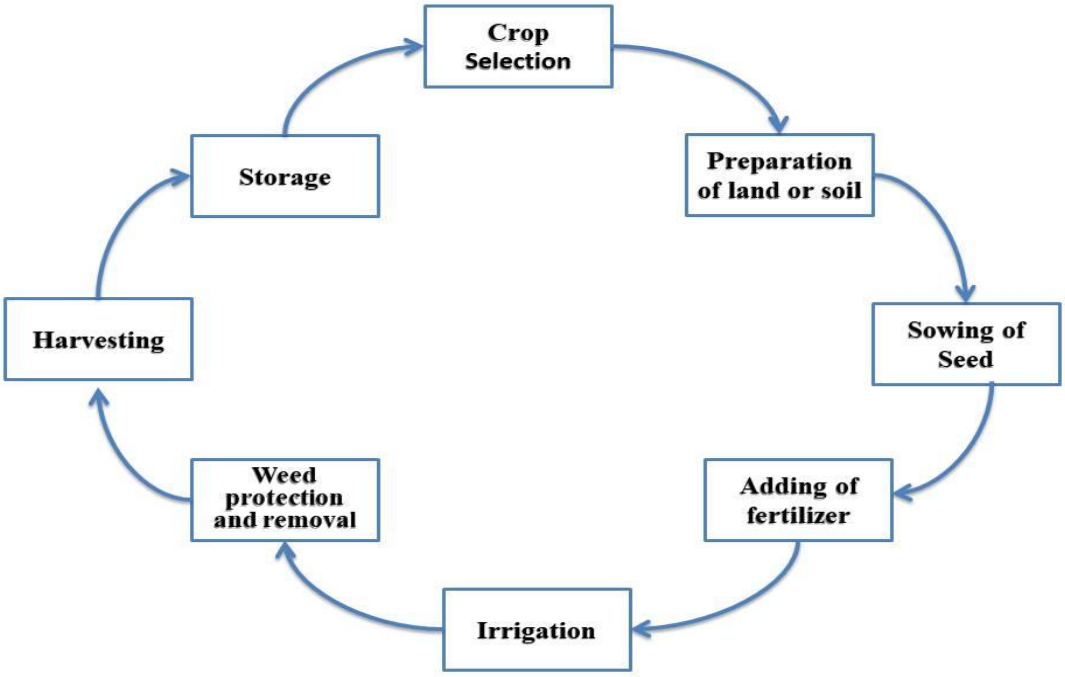

Fig. 1: The general steps taken for agriculture activities

II. Crop and Weed Detection System (WDS).

In the WDS, image processing techniques follow the general steps shown in Fig. 2.

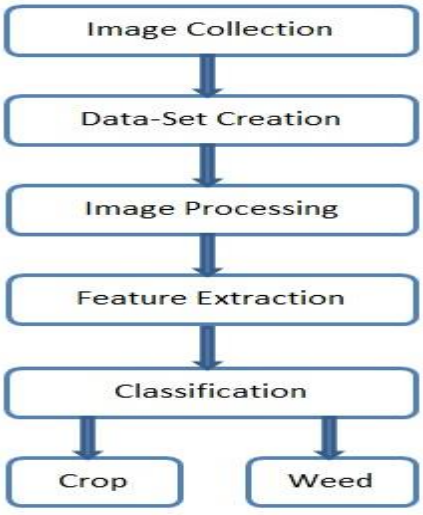

Fig. 2: Work-flow of weed detection system

1) Image Collection/Acquisition: The very first step in crop disease or weed detection system is image capture/acquisition. High-quality crop images can be acquired by means of digital cameras, drones or scanners[2]. Now a day UAVs (Unmanned Ariel Vehicle) and UGVs (Unmanned Ground Vehicle) are used to take images of farmland. Fig. 3 shows the image of UAV [21].

Fig. 3: The Image of UAV (Unmanned Ariel vehicle) [21]

2) Dataset Creation: Dataset can be created for images captured by drones, UGV or UAV.

3) Processing of the Image: Captured images to be used in the preprocessing step to extract some image features important for further steps, i.e. Segmentation. The segmentation process let you split the crop image into different segments. It is to be used for separating the diseased zone in the leaf, stem or root of a crop plant from the background. Segmentation is also used to partition the images into non weed and weed area.

4) Extraction of Features: Extraction of shape, color and texture features of the disease/weed portion of the plant is to be done to improve the quality of the images.

5) Classification: In this step, different machine learning methods are used for classification to discover the various areas in plants. A classification technique can also be used to classify the weed and non-weed portion the images.

II. The Literature Review.

Literature survey has been done for classification techniques in machine learning to detect Weed in various crops. This section contains the survey of the machine learning techniques for weed detection. Some of the machine learning methods used to achieve detection of disease/weed are SVM, ANN, KNN and CNN.

- *Overview based on Machine Learning for WDS (Weed Detection System)*

After, selecting the features and extraction the one most important step is to select the classification algorithm that classify the weed and crop accurately. Generally machine learning algorithms are of two types supervised and unsupervised learning. Unsupervised learning uses the data that is not labeled and find out the patterns that presents the information in a new way.

Clustering is the kind of the noteworthy job of unsupervised learning [3]. "The cluster is a group of similar data that have similar characteristics or properties without the labeling process beforehand. In the weed detection system unsupervised learning can be used for preprocessing and post processing "[4].

The k means clustering technique is used for preprocessing; it is an unsupervised learning method to form different features. Changes have been done in the random initialization of data of weights of traditional parameters of CNN [5]. This process achieved higher weed detection accuracy of 92.89%.

"For post processing DBSCAN algorithm is used with noise to separate the false positive points for weed "[6].

k-means algorithm suggested for image filtration and soil separation of plants [7]. In literature, it is found that "the k means clustering method necessarily required the count of clusters, which is unrealistic for a weed discriminating scenario in a place wherever there is no proof of nearly required groups" [4]. In some situation, clustering approaches that do not require a finite number of clusters are more achievable. [8].

Supervised learning is a type of training mechanism which utilizes a labeled sample of data [9]. The task of supervised learning is divided into two parts. Part 1 has a model that is formed by one of the methods with labeled training data. Part 2 has the trained model that is applied to non-specific data and predicts the most appropriate labeling for test data [3].

Weeds and crops are labels in Weed Detection System. SVM-support vector machine, ANN-artificial neural Networks are the major learning algorithm agreements supervised learning. Both ANN and SVM were used for the detection of weeds in precision farming. A kernel function is used in SVM algorithm for mapping the samples into a higher dimensional space. "For performing training and testing tasks a kernel called RBF-radial basis function is used by SVM. SVM, ANN classifiers have been widely used in WDS. The author compared the performance of SVM and ANN for four different type of weed in the field of sugar beet. shape features were used by both SVM and ANN, The classification result for weed detection by SVM and ANN were 95% and 92.92% respectively" [10].

SVM is used for the identification of weeds from crop maize fields [11]. Authors used two different CNN-Convolution neural networks to quickly and accurately detect crops and weeds[12]. RGB and INR-near infrared images of crop and weeds were used for classification. The system provided the best mean average precision 96.8 % and 91.3 % respectively for the pixel wise crop weed detection.

A GoogleNet architecture was used for weed detection. Authers trained and verified a fully CNN model [13]. The trained model obtained the result as precision of 86.6%. Conventional CNN uses random data to initialize the parameters of the network, due to which errors may occur from layer-wise transmission.

SVM is Used to detect weed from images and achieved 97.3% accuracy [14]. "Two types of algorithms is used for classifying images in terms of weed density. The

first one was the method GLCM with a combination of SVM to achieve a precision of 73%. The second method was based on a random forest classifier to achieve a precision of 86%" [15]. The Authors compared these two techniques and perform the implementation with the images that are collected from a real rice field.[16] Shows the development of a technique for the detection of ten types of weeds, including corn plants and certain species. The accuracy achieved by the system was 90%. The Authors Proposed weed detection from crops by using image processing[17]. MATLAB is used for Image processing to detect the weed. The algorithm performs weed detection by loading the image from a source, color segmentation, and edge detection.

Authors Developed weed detection technique by using machine vision[18]. Weeds in the farm field can be detected by its properties such as Shape, Size, features, Texture and Spectral Reflectance. They demonstrated weed detection by its Size features. After the image capturing excessive green algorithm is used to remove soil and other auxiliary objects from the plant image. By using median filtering, image noise removal done in this method. A labeling algorithm was used then size features were extracted like area, perimeter, and longest chord.

An Author Come up with a new framework for weed identification. "They developed a new VGG Beet CNN model based on the generic VGG16 (visual graphics) CNN model with 11 convolutional layers. A sugar beet dataset was used in this approach. The system obtained 86.3% accuracy on NGB composite image data" [19].

Authors Calculates the rate at which weeds grow in the rabi crop field. The weeds were collected at three different locations in MP(Madhya Pradesh) India with ten rabi cultures[20]. The training and testing ratio was 80%:20%. For training, both NetB7 and V4 architectures were used, giving an accuracy of 97% and 94% respectively.

IV. Challenges and Problem Identification

Traditional machine learning techniques provides very favorable classification accuracy with ideal image capturing conditions. But for real field applications the work becomes extremely challenging. At the later growth stage of plants, crops and weeds can overlap. At the same time, crops and weeds are indistinguishable. Often crop leaves are damaged or occluded by undesired objects like clay, stones, etc. The diverse conditions of light in the outdoor environment lead to another problem in the weed detection system. The reason for the failure of the classification technique may be the different colors of leaves, noise levels, the shadow of plants, contrast, saturation, reflection, and brightness of the image.

V. Conclusion

In this review we have provided a short summary of the current weed detection system using machine learning and image processing technique. To separate weeds and crops from the picture, various colour patterns and classification methods were used and good performance has been achieved. In weed detection systems sometimes crops and weeds have similar characteristics that lead to difficulty in crop weed discrimination. The final classification can be done by using machine learning-based algorithms. The study found that for accurate crop and weed detection image processing with machine learning is a very promising tool.

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