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WEED DETECTION USING IMAGE PROCESSING AND MACHINE LEARNING

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Abstract— In recent years, breakthroughs in deep learning, computer vision, and machine learning techniques have potential to transform and modernize how the crops are grown, cared and even predict yield. One of the problems every farmer encountersis invasive weeds that can kill or hinder the growth of crops by stealing water, nutrients, and sunlight from the plants. Another problem farmers face is predicting yield of crops. This is important for farmers to try to allocate resources, while maintain a low cost and maximize profits. With recent advancement in computer vision, predicting yield can potentially be done with a cost effective method using state of the art algorithms. In this thesis, I will apply new methods to solve problems that farmers have been facing for hundreds of years. A methodology willbe developed to collect data for weed detection along with a pipeline to processthe images. The data will be used to train state of the art object detection models such as YOLO, Faster R-CNN, and SSD Mobile. In order to find an optimal modelfor real time detection of weeds, I will develop a data collection methodology for prediction of crop yield. This work presents a machine vision system for weed detection in vegetable crops using outdoor images, avoiding lighting and sharpness problems during acquisition step. This development will be a module for a weed removal mobile robot with camera for lighting controlled conditions. The purpose of this paper is to develop a useful algorithm to discriminate weed, using image filtering to extract color and area features, then, a process to label each object in the scene is implemented, finally, a classification based on area is proposed, including sensitivity, specificity, positive and negative predicted values in order to evaluate algorithm performance.

I. INTRODUCTION

In computer science most problems can be solved by inputting a set of rules to the computer to execute and solves the problem. However, machine learning is a sub-field that focuses on finding the rules that solve the problem without implicitly or explicitly specifying the rules. These rules are learn from a set of data points to make predictions or perform decision making .With recent increase in data availability and computer performance, machine learning can be found in everyday life. Machine learning is used in smart phones, self driving cars, consumer electronics, home appliances, manufacturing, and many other applications. Within machine learning there exist two main types of algorithms: supervised learning and unsupervised learning. Supervised learning is much larger than unsupervised learning. The main idea behind supervised learning is to map and input to and output. The rules to map the input and output are learned. For example, given a set of input x and an output y, the pairs of data points would be use to learn rules. Within supervised learning problems are divided into two categories; classification and regression. A classification problem has the goal to predict a discrete value that is mapped to a category .In order to maximize the yield, timely removal of weeds is necessary as the weeds kill or hinder the growth of crops by stealing water, nutrients, and sunlight. Farmers use herbicides to get rid of the weeds or manually remove them. However, the use of herbicides increases the cost of production and exposes humans to dangerous chemicals. Moreover, herbicides can remain active in the environment for long periods of time, potentially causing soil and water contamination, adversely effecting non-target organisms, and affecting the health of human beings .Manually removing the weeds is very labor intensive, is inefficient, and increases the cost of production. Lastly, another main problem is predicting yield as early as possible. There are many variables when considering yield prediction, including weather, temperature, pest, and many others. With finite land available, being able to predict crop yield allows us to understand food security, and predict if we will have enough food for the future. Yield prediction would allow farmers to manage crops base on yield prediction, which would allow them to.

Precision Agriculture

Precision agriculture (PA) is an information-based and production-based farming system that has the goal of optimum productivity and profitability, sustainability and protection of the land resource by minimizing the production costs . The goal of precision agriculture can be simplify as maximizing output (i.e. crop yield) while minimizing input (i.e. fertilizer, pesticide, herbicide etc) in the processes of growing a crop. Advances in PA are important in order to develop sustainable agriculture practices. As the world population increases, the production of agriculture should increase while maintaining a low cost.

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I.Image Segmentation

The process of image segmentation is partitioning the images taken from the field into set of different segments. These image segments are known as pixels. Segmentation makes the image easy to analyze. The lines and curves which are typically called as Objects and boundaries respectively are represented through image segmentation by assigning each and every pixel. These pixels share certain visual characteristics. The set of pixels in the output represents the entire image of the weed. The Image segmentation process will provide good quality output result. Segmentation Process involves many pre processing procedures. The pre processing step has undergone the process of De-Noising and Image Enhancement [6]. The De-Noising process is provided with a non linear filter called Rank Filter. They able to identify the weed by the data which we provided earlier as Shape, Edge, Boundary, Object etc.

A. Methods for weed detection using image processing as follows:
Image Acquisition: Images of weed are taken from online dataset or from crop field using high resolution camera for more accuracy in RGB format. Each obtained image is stored in respective size and in jpg format.

Pre-processing: Obtained images are affected by the various factors such as noise, lighting variations, poor resolution of an image and unwanted background.

In pre-processing some tools are used for RGB to Gray scale conversion, Gray scale images to binary image filtering techniques are used to remove the noise and unwanted objects from background.

Feature Extraction: After pre-processing, features are extracted for detecting the weed. Feature extraction is process of defining a set of features, for the efficient representation of the information for analysis and classification . Different types of features are texture features such as entropy, energy, contrast etc., size shape and color based features are to extract the features.

Classification: Classification techniques are used to classify the weed. Feature vectors are passed as input to the classifiers. In classification classifiers are trained, validated and tested using images of different weed. Some classifiers are artificial neural network, probabilistic neural network genetic algorithm and edge based classifier etc.

B. Yield Prediction
As machine learning grew in popularity so did the number of applications across many disciplines. One particular application is crop yield prediction. Yield prediction refers to predicting the yield of crops or fields of crops. The predictions can be made using a RGB camera or a multi-spectral camera to collect the data. The prediction can take into consideration the weather if it's done in a larger scale. Recently, deep learning models have been use in crop yield prediction, You et al, use deep learning techniques such as CNN and LSTM to predict soybean yield in the United states based on images taken before harvest. The images were multi spectral imagery collected from satellites.

II. METHODOLOGY

The models take in images and notations that were previously processed. SSD and Faster R-CNN are open and available through the Tensorflows object detection library. [1] The models are available with multiple pre-trained weights and different architectures. However, the more parameters the model contains the slower the detections are able to processed. These models support GPU training. YOLO is available through the YOLO library.[21] There are several YOLO architectures available. In this paper, YOLOv3 is used to train on the images collected. YOLO also supports GPU training which is essential for our purpose.

All the models contain a configuration file. The file needs to be edited for training configuration. Some of the parameters in the configuration file, include input folder for images, input folder for annotations, output folder for images, learning rate, number of classes, batch size, batch normalization, and architectural changes such as size of anchors in the models, and pre-train weights. After choosing the parameters in the configure file, the model is trained using the data set created. The data set created is then split into two sets, training and testing. The training should stop when loss function no longer converges and starts to idle in a certain value.

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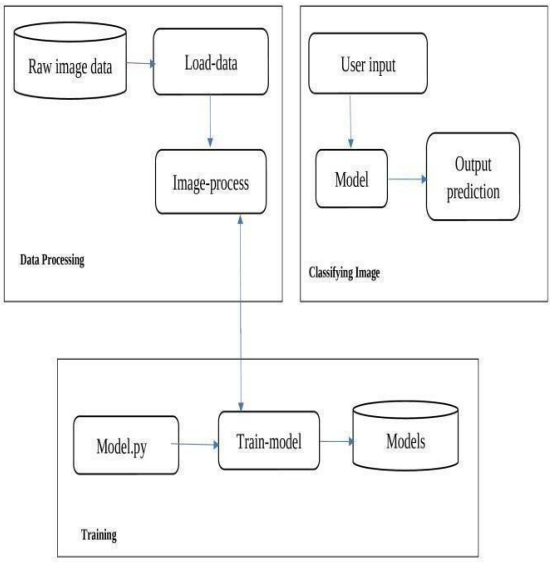

Figure 1:Design and creation process

III. CONCLUSIONS

A method for detecting that combines image processing and machine learning. We can identify and distinguish weeds from agricultural plants using this method. The goal of this research is to identify weeds and repurpose land that has been contaminated by a high concentration of chemicals. We can manage less spraying by detecting weeds, which helps to preserve the environment as well as money.

As a result, we may deduce that the image collection mechanism was developed to attain better speed and accuracy in order to satisfy the needs of weed detection in broad-acre cropping areas. The proposed method, which is based on the CNN algorithm, must be tested on weeds in various places and has proved to be highly successful in weed detection. In the future, more hybrid models combining deep learning and traditional image processing are predicted.

FUTURE WORK

Here, some possible future projects based on this thesis are proposed. A deeper research on the topic of this thesis can be done by considering the creation of the neural network from scratch, instead of using transfer learning on an existing network. By creating the network architecture there can be more control over its learning process. Another possible topic to research based on this thesis is the implementation of a weed detector taking into account a bigger number of crop and weed types, not only spinach, cleavers and dandelions. Finally, the implementation of an automatic Farm Bot weed removal based on deep learning detection would be an interesting topic to consider, given that the current weed removal system of Farm Bot cannot detect weeds located near a crop. There is still much more work to be done to improve the models and develop models that can be use daily. First, we now understand the type of angles that objected detection needs in order to detect weeds accuracy. Second, we learned that small weeds are hard to detect so we can improve the models by taking high resolution images and breaking them into smaller images. Another solution is to take images closer for small weeds so they appear larger in the image

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