Crop and Weed Classification Using Deep Learning

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Abstract: Information technology is prominent in precision agriculture and also support the agronomist in agro business. Usually, weeds grow along with the crops and reduces the yield of that crop. Herbicides are used to remove the weeds. Without the identification of the type of the weed, the herbicide may damage the crop too. It is necessary to identify and classify the weeds from the farms in order to control them. Deep learning-based computer vision technique, Conv Net or CNN is used to analyse images. This paper proposed a CNN based deep learning model to identify the weeds and crops from the farm field. Based on the predictions the type of herbicide will be suggested to the farmers.

Keywords: Conv Net, Deep Learning, Weed Classification, Precision Agriculture, Herbicides

1. Introduction

Deep Learning is a part of Artificial Intelligence which is strong-growing research pitch. Object identification is one of the protruding applications of deep learning which uses computer vision. The images and videos are analysed using computer vision technologies and useful information is gathered without human involvement. The undesirable plants growing along with the crops are called weeds. The weed management is imperative task in farming. Automatic weed identification [1] is done with the help of the computer vision techniques and enhances the precision agriculture. Manual weed control is time consuming and also the herbicides affect the crops too. It is necessary to identify the weed automatically to reduce the usage of agrochemicals for weeds.

This research proposed a weed classification mechanism using deep learning which classifies weed and crop. The proposed method analyses images of crop field and discriminated crop and weeds. CNN [2] is a deep leaning method used in the proposed system. CNN is distinct neural network used for especially image processing and classification problems. It is having a grid like structure. Convolution layers are the basic units of CNN and in each layer consists of one or more filters named as kernels. Each filter is a matrix process the image pixel using the same size filter. The output feature map is the product of input pixel matrix with the kernel. Also, the convolution is an affine function. This type of layering method is used for weed classification and once the weeds are identified, they are removed using exact treatment required. Figure 1 depicts the general structure of CNN.

This paper is organized as follows: Section 2 presents the related research in the literature, proposed the method used for the implementation is discusses in Section 3, Section 4 is having results and Section 5 Concludes the paper with future enhancement.

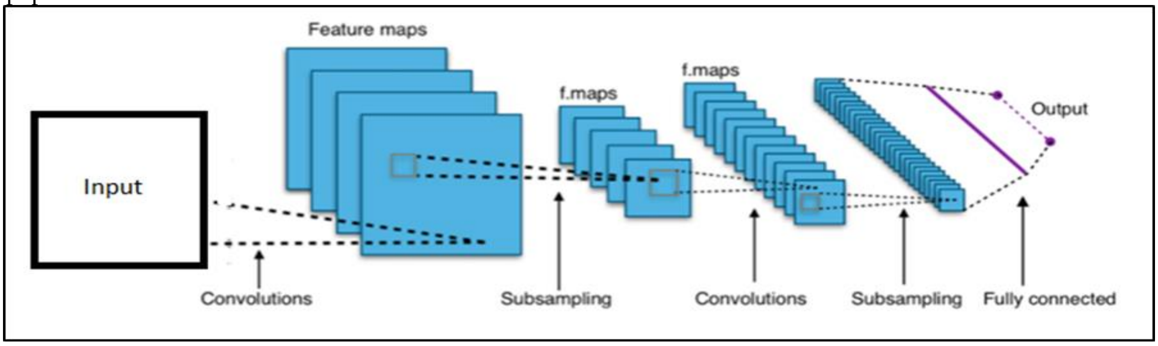

Figure 1. Convolutional Neural Network

2. Literature Survey

There are different techniques are proposed in the literature to get the weed details from the farm fields. This section presents the weed management techniques which are related to the proposed method. Haud et al. have proposed a weed classification system without the usage of segmentation concept [1]. Instead of using segmentation, the random forest and Markov methods are used to find the overlapping between crop and weed. The carrot crop field images were used for evaluation and testing. Background is removed from the input image to get the plants portion of the image. Image tiling and feature extraction were the other steps before classification. The classification accuracy is 93.8 % [1][2]

Abbas Khan et al. have implemented [3] Encoder-Decoder based architecture for weed classification. The deep learning is used for the weed location precisely. The proposed method in [3] is executed using publicly available datasets. Many smaller cascaded networks are used for training. For the convolution layer, the ReLU activation function is used and the sigmoid function is used in the output layer.Dice coefficient is used as loss function in [3]. Weed identification using graph convolutional network (GCN) is proposed by Honghua et al. in [4] to increase the crop yields. GCN-ResNet-101 is used to evaluate five different datasets and proved to be better. The proposed method in [4] is used for different class of crops identification as well as weed identification.

Potena et al. have proposed automatic crop yield detection system using unmanned ground vehicle (UGV). A lighter CNN and a deeper CNN is used for classification of crop and weed. The proposed method in [5] is a three-step process. During the first step, the vegetation index for each pixel is calculated. In the second step pixel wise classification is calculated using cNet CNN. The third step Blob-Wise is used to speed-up the classification process. The performance of the unsupervised dataset summarization is evaluated using MaP. Two set of data were used for testing. Weed are removed from the farm field either mechanically or spraying. The spraying needs some specific information such as type of weed and the corresponding herbicide for the identified weed. Lottes et al. have proposed a robot-based method for weed classification [6]. Convolutional network is used for differentiating the crop and weed. Both stem and plant decoders are used in CNN. The crop identification accuracy is increased in [6] when compared to the other methods in the literature.

Radhika et al. have proposed the classification of paddy and weed using colour features in [7]. Texture, colour and shape features are used to classify the weed and crop. The authors have prepared a dataset of 300 images using digital camera with sunlight conditions.Speeded-up Robust Features (SURF) is the technique used for colour feature extraction. LSSVM, K-NN and Random Forest classifiers are used to identify the weed from the paddy field with an accuracy of 86% [7]. Lottes et al. have implemented an Unmanned aerial vehicle (UAV) with camera to identify weed from sugar beets crop field. The images received from UAV are pre-processed to stabilize the intensity values [8]. The classification of crop and weed is performed with the help of the random forest algorithm. PHANTOM-dataset is used for the evaluation of the proposed method and the performance parameters such as ROC, precision and recall are calculated.

3. Proposed System

The main objective of the proposed system is used to detect weeds from other crops like wheat, maize and sugar beet using a deep learning approach. The Convolutional Neural Network is used to classify the different types of weeds and crops with an aim to achieve improved classification accuracy.

3.1 Dataset

The dataset used for training and testing for weed classification uses the plant seedlings classification dataset available publicly in Kaggle [9]. The dataset contains images of f approximately 960 unique plants belonging to 12 species at several growth stages and it comprises of annotated RGB images with a physical resolution of roughly 10 pixels per mm. The training dataset contains about 4750 images (85%) and the testing dataset contains about 795 images (15%).

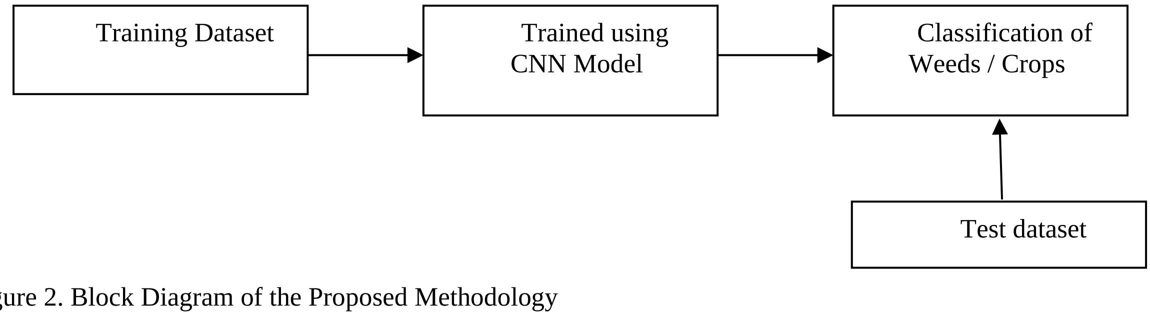

Figure 2. Block Diagram of the Proposed Methodology

4. Methodology

The Convolution Neural Network is a multilayer and special type of feed-forward neural networks (FFNN) which is used for identify, classify or to extract features from images with reduced training time. The CNN is mainly used in image classification applications across various domains including agriculture, industry automation etc., The CNN is trained to recognize different types of weeds from other crops like maize, wheat and sugar beet plants. The VGGNet16 is used to train the plant classification seedlings dataset. The training accuracy and validation accuracy are considered as performance metrics for assessing model efficiency. The block diagram of the proposed method is shown in figure 2.

The Convolutional layer is used extract features based on the filters in the image and the most widely used activation function in CNN, ReLU (Rectified Linear Unit) is used in the hidden layer and softmax at fully connected layer. The activation function ReLU is given by the equation (1),

$$f(x) = \max(x, 0) \quad (1)$$

Where f(x) = x, when x>0, otherwise f(x)=0.

SoftMax activation is used to output the different categories based on the probability distribution of the given data and it is given by the equation (2)

$$f(x_i) = \frac{e^{x_i}}{\sum_{j=0}^{k} e^{x_j}} \quad (2)$$

CNN model used for the analysis of the proposed system is shown in figure 3.

5. Results and Discussion

The experiment was carried out using the Google Colaboratory and the training and validation accuracy is calculated for plant seedling classification dataset. The training and the testing ratio are 80:20. The results shows that the validation accuracy of 89% is obtained and it reveals that it has better accuracy than AlexNet.

6. Conclusion

Classifying crops and weeds in any crop field is an application of precision farming. The proposed research classifies weeds and crops using deep learning algorithm, namely, CNN. The publicly available Plant Seedling Classification dataset of Kaggle is used for the evaluation of the proposed algorithm. The proposed CNN algorithm is simple and obtained an accuracy of 89%. This research is computationally less exhaustive. During the future research, transfer learning will be applied in order to improve the accuracy. Various types of weeds and real time data from UAV can be used in future work.

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 148, 148, 32)	896
conv2d_1 (Conv2D)	(None, 146, 146, 32)	9248
max_pooling2d (MaxPooling2D)	(None, 73, 73, 32)	0
dropout (Dropout)	(None, 73, 73, 32)	0
conv2d_2 (Conv2D)	(None, 71, 71, 64)	18496
conv2d_3 (Conv2D)	(None, 69, 69, 64)	36928
max_pooling2d_1 (MaxPooling2	(None, 34, 34, 64)	0
dropout_1 (Dropout)	(None, 34, 34, 64)	0
conv2d_4 (Conv2D)	(None, 32, 32, 128)	73856
conv2d_5 (Conv2D)	(None, 30, 30, 128)	147584
max_pooling2d_2 (MaxPooling2	(None, 15, 15, 128)	0
dropout_2 (Dropout)	(None, 15, 15, 128)	0
flatten (Flatten)	(None, 28800)	0
dense (Dense)	(None, 256)	7373056
dropout_3 (Dropout)	(None, 256)	0
dense_1 (Dense)	(None, 12)	3084

Total params: 7,663,148
Trainable params: 7,663,148
Non-trainable params: 0

Figure 3. Model analysis of the Proposed System

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