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Computer Vision for Ethiopian Agricultural Crop Pest Identification

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Abstract

Crop pest is an organism that creates damage on to the agriculture by feeding crops. The research focuses on four major types of crop pest which occurs on teff, wheat, sorghum, barley and maize these are Black tef beetles, Ageda korkur, Degeza and Yesinde Kish Kish. The aim of this paper is identification of the four types of agricultural crop pest using a computer vision technique. The image of crop pest were taken from Amhara regions of Ethiopia i.e. Adiet, Dejen, Gonder, Debremarkos (places where images were taken). In this paper, artificial neural network (ANN), a hybrid of self organizing map (SOM) with Radial basis function (RBF) and a hybrid of support vector machine (SVM) with Radial basis function (RBF) are used, and also we used Otsu and Kmeans segmentation techniques. Finally we selected Kmeans techniques for segmenting crop pest. In general, the overall result showed that using kmeans segmentation in RBF and SVM perform better than using otsu method in the other algorithm and the recognition performance of the combination of RBF (Radial basis function) and SVM (support vector machine) is 93.33%.

Keywords: *SOM, RBF, SVM, ANN, computer vision.*

1. Introduction

Ethiopia is a country of large bio-diversity and agricultural complexity. As in many developing countries, agriculture plays a key role in Ethiopia's economy. It provides employment for more than 80% of the population and contributes to nearly 50% of gross domestic product. The major crops produced include cereals, legumes, oil seeds, roots and tubers, vegetables, fruit crops, coffee, spices and cotton. About 95% of food production in Ethiopia comes from the peasant sector, where production technologies are primarily traditional. Land is prepared for planting by oxen drawing a local plough (the maresha in Amharic language) or by manually operated hand tools. Sowing is done by broadcasting and weeding is dependent upon labor intensive practices. The use of irrigation, improved seed and other external inputs such as pesticides is minimal [1].

The most commonly produced cereal in Ethiopia is teff (Eragrostis abyssinica), which is used to make the Ethiopian unleavened bread called injera. Corn and barley are the next most important grains, with an annual gross production of at least one million tons each. Sorghum, wheat, millet, peas, beans, lentils, and oilseeds are produced in substantial quantities; sugarcane and cotton are also grown. Tef (Eragrostis tef) is the most important cereal crop in the country as it is used to prepare "injera", the basic diet for the majority of the population. Ethiopia is the only country where tef is grown on a large scale for human consumption. In few other countries which grow teff it is used for hay production or as a green fodder. Also the other cereals can be used, often mixed with teff, to prepare injera, but they are regarded to be of less quality. As in all tropical countries, insect pests are major problems in Ethiopia, often causing considerable crop loss. A correct identification of a pest is the first step which leads to effective control or management of the pest [1, 2].

2. Literature Review

Different scholars gave a suggesting to detect the plant leaves diseases using a variety of approach and various implementation ways as described here. Ganesh Bhadane and et al, in this research paper the authors focus on the identification of crop pest using machine vision

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techniques. In this research paper the techniques of machine vision are extensively applied to agricultural science, and it has great perspective especially in the plant protection field, which ultimately leads to crops management. The main goal of this research is early detection of bioagressors. Zhang Faquan and et al, in this research paper the authors focuses on identification of crop pest using back propagation neural network. In this research paper an automatic identification system of agricultural pests based on machine vision, image processing and pattern identification was presented. The recognition rate was up to 85.7%. Murali Krishnan and et al, in this research paper the authors focuses on detection of Mono cropped Plantations pest based on K-means clustering. In this paper the authors presented an algorithm for easily identifying the pest infected areas of these crops. Gaurav Kandalkarand et al, in this research paper the authors focus on Plant pest identification and detection of chickpea crop using back propagation neural network. M Manoja and et al, in this research paper the authors present early detection of pests using SVM. Sonal P Patil and et al, in this research paper the authors focus on Plant pest identification and detection of chickpea crop using back propagation neural network and cotton Leaf Spot Disease Using Support Vector Machine. Prakash M Mainkar, Shreekant Ghorpade, in this research, the authors provide software based on imaging techniques to automatically detect and classify plant leaf diseases. Similarly the authors include image processing techniques starting from image acquisition to classification i.e. Image pre-processing, segmentation, features extraction and classification based on neural network. Q Yao and et al, in this research the authors focuses on detecting rice disease early and accurately, they presented an application of image processing techniques and Support Vector Machine (SVM) for detecting rice diseases. Rice disease spots were segmented and their shape and texture features were extracted. In this paper, the SVM method was employed to classify rice bacterial leaf blight, rice sheath blight and rice blast. The results showed that SVM could effectively detect and classify these disease spots to an accuracy of 97.2%.

3. Statement of the Problem

Agriculture disease identification is a major challenge especially in crop. Therefore suitable actions have to be taken to control diseases on agricultural products while reducing the use of pest sides. In Ethiopia agricultural crop i.e. teff, wheat, sorghum, barley and maize there are four major types of crop pest namely Black tef beetles, Ageda korkur, Degeza and Yesinde Kish Kish. These four types of crop pest reduce both the quality and quantity of crop so diagnosing and recognition of Ethiopian agricultural crop pest is very important in order to maximize the quality and quantity of the agricultural crop.

4. Materials and Tools

For acquiring images of agricultural crop pest we used Panasonic HDC-SD60 handy camera. When video were recorded, the camera was fixed on a stand which reduces the movement of hand and capturing uniform images of agricultural crop pest. The video were taken at resolution of 1280×1024 pixels at 10 frames per second. And finally reduce 360 X 360 pixels because this is the standard images that can be used in image processing.

5. Implementation Tool

For image processing of Ethiopian agricultural crop pest recognition MATLAB 2015Ra on windows platform is used because MATLAB 2015Ra is capable of computer vision and it is the state of the art tool for image processing and machine learning. Therefore, for the purpose of displaying, editing, processing and analyzing and recognizing agricultural crop pest recognition MATLAB tool were used.

6. Design of Pest Recognition

The first stage in crop pest recognition is input video of crop pest. The second step for Ethiopian agricultural crop pest recognition is that converting to image in order to apply per-processing for the acquired image. pre-processing of image, commonly used for removing low frequency background noise, normalize the intensity of the individual particles on a given image, removing reflection and masking portion of image this is because noises cause inaccuracy in identification of crop pest. We used adaptive median filtering methods for reducing noises which appear on crop pest image. In feature extraction stage, the features of crop pest are extracted to feed into the classifiers. The feature should be measurable, highly sensitive, highly correlative, high specificity, high probability of true positive and negative response. The final step is recognition or classification stage. A classifier classifies the given datasets into their corresponding class. In order to train the classifiers, a set of training of coffee plant diseases image was required, and the class label where it belongs to, 900 crop pest image were taken from Amhara regions of Ethiopia i.e. Adiet, Dejen, Gonder, Debremarkos.(places where images were taken).

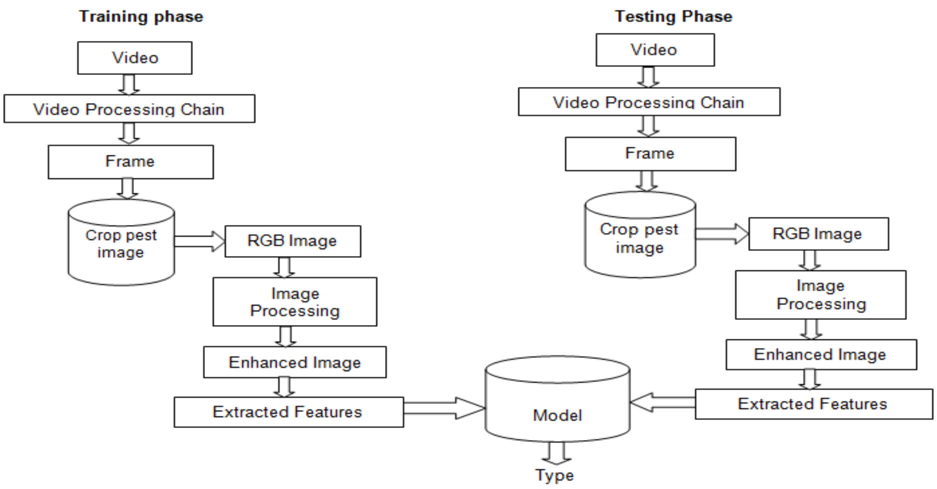

Figure 1. Crop Pest Recognition Framework

In machine learning and pattern recognition two fundamental phases training and testing phases are used. In the training phase, data is repeatedly given to the classifier, in order to obtain a trained model. In testing phase, the data are given to the trained model but the data are new and which are not given before these help us to know the performance of the trained model. Therefore, we need to design the model of classifier by dividing the total data set into training and testing data set. From the total of crop pest image 70% was used for training and the other remaining 30% are used for testing data. As shown in Figure 1. The first step of crop pest recognition is taking the video as an input. Once we recorded the video, on the recorded video we apply video processing chain in order to get frames once we get a frame we apply image processing techniques, the second step in the recognition is that pre-processing of image, as we describe in the previous section, pre-processing image commonly used reducing low frequency background noise, normalize the intensity of the individual particle image, removing reflection and masking portion of image. In our case we used adaptive median filtering method for reducing noises. The third step in our research i.e. Ethiopian crop pest recognition is segmenting image. There are different techniques of image segmentation, but there is no one single technique that is appropriate to all image processing applications. Therefore in our research we used Otsu and Kmeans techniques for comparison finally we selected Kmeans techniques for segmenting crop pest

In feature extraction stage, the features of crop pest are extracted to feed into the classifiers. The feature should be measurable, highly sensitive, highly correlative, high specificity, high probability of true positive and negative response. The purpose of feature extraction is to reduce the original data set by measuring properties, or features, that distinguish between the four types of coffee crop pest. In our case we have three groups of features these are texture, morphological and Color features. In crop pest have different color variation of each type and color analysis computed by taking HSV values. The feature set that were extracted from crop pest image produces very big matrices, in order to reduce the size of matrices PCA (principal component analysis) is applied finally GA(Genetic Algorithm) is used for feature selection. The final step of crop pest recognition is the classification stage. Depending upon the extracted features of crop pest it classifies according to the predefined class.

7. Experiment &Results

Table 1. Result of Classifiers Using Kmeans Segmentation

	ANN					RBF+SVM					RBF+SOM			
	BTB	AK	DG	YKK		BTB	AK	DG	YKK		BTB	AK	DG	YKK
BTB	47	4	5	11	BTB	65	1	0	1	BTB	54	3	2	8
AK	9	44	6	8	AK	3	61	1	2	AK	5	57	2	3
DG	11	5	46	6	DG	2	2	63	1	DG	7	4	53	4
YKK	12	2	8	46	YKK	2	2	1	63	YKK	5	3	2	58
	Total	270				Total	270			Total	270			
	correct	183				correct	252			correct	222			
	not correct	87				not correct	18			not correct	48			
	%	67.8				%	93.33			%	82.2			

Key	
Black tef beetles	BTB
Ageda korkur	AK
Degeza	DG
Yesindie Kish Kish	YKK

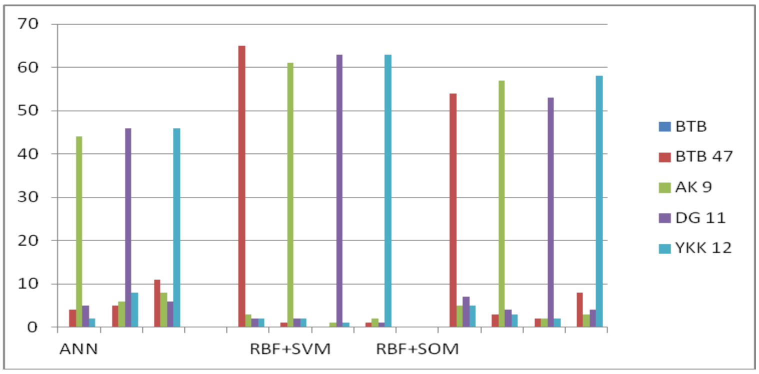

Figure 2. Performance of Classifiers using Kmeans Segmentation.

We have designed experimental scenarios to test the recognition performance by taking the extracted features of crop pest. We have got 25 features which are extracted from a given crop pest image these are 8 texture and 10 color features and 7 morphological features. The performances of recognition were tested by SVM (Support vector machine), ANN (Artificial neural network), Naïve, a hybrid of SVM and RBF (Radial basis function and Support vector machine) and a hybrid of RBF and SOM (Radial basis function and Self organizing map). In order to train the classifiers, a set of crop pest image was given to the model in addition to the class label, 3,251 crop pest image were collected from the regions of Ethiopia i.e. Debre Markos, Gonder and Dejen. From four types of crop pest i.e. black tef beetles, ageda korkur, Degeza and Yesinde Kish Kish. From the total of 900 data sets, 630 were used for model training and 270 were used for performance testing. In our research, there were four output classes, because the crop pest types were four. The representing features of training were normalized with mean 0 and variance 1 this helps the model to converge. We carried out experiments to test the performance of our model. We used SVM (Support vector machine), ANN (Artificial neural network), Naïve, a hybrid of SVM and RBF (Radial basis function and Support vector machine) and a hybrid of RBF and SOM (Radial basis function and Self organizing map) for identifying the four type of predefined class and we compared the classifiers by applying otsu and kmeans segmentation techniques. In this experimentation, each group of features is tested i.e. the four morphological features, together were used as input to the classifier. There were also four output classes that correspond to the four predefined crop pest type. As mentioned before, 70% of the data set was used for learning and 30% was used as testing data set. The classification result of ANN classifiers classifier using the selected morphological feature was 73.6%. For color features by computing HIS (Hue saturation and Intensity) the numbers of input features were 8 and also similar to all, there were four output classes. The classification result of ANN using color feature was 81.7%. The result of ANN classification using texture feature was 71.2%. Using all combined features in this scenario, the classification input features were 25 corresponding to the 8 morphological features, 7 color features and 10 texture features and there are also four output classes. In this scenario the classification performance of ANN by applying otsu segmentation method was79.2% and using kmeans segmentation method the performance of ANN classifier was 86.2%. Similarly we conduct experiment for the other algorithms.

Table 2. Result of Classifiers Using Otsu Segmentation

	ANN					RBF+SVM					RBF+SOM			
	BTB	AK	DG	YKK		BTB	AK	DG	YKK		BTB	AK	DG	YKK
BTB	39	7	9	12	BTB	56	7	0	4	BTB	49	7	2	9
AK	10	41	6	10	AK	7	52	3	5	AK	7	53	2	5
DG	11	5	46	6	DG	9	4	51	4	DG	7	4	53	4
YKK	12	2	8	46	YKK	2	2	1	63	YKK	5	3	2	58
	Total	270				Total	270			Total	270			
	correct	172				correct	222			correct	213			
	not correct	98				not correct	48			not correct	57			
	%	63.7				%	82.22			%	78.9			

Key	
Black tef beetles	BTB
Ageda korkur	AK
Degeza	DG
Yesindie Kish Kish	YKK

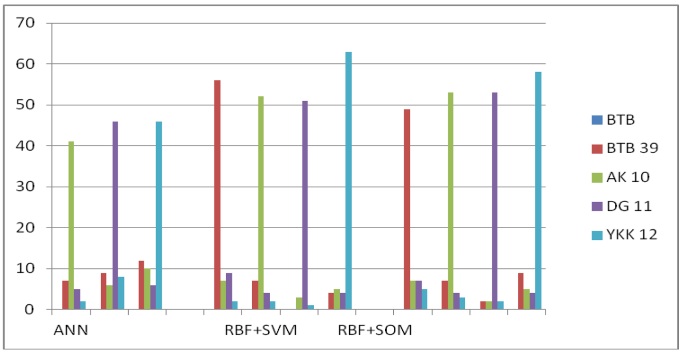

Figure 3. Performance of Classifiers Using Otsu Segmentation

As we have presented in the above, the experiments were conducted under three scenarios by using feature sets of morphology, texture and color separately, and finally combining the three feature sets. Then, the experiment results were compared the performance of ANN Combination of RBF and SVM and combination of RBF and SOM. In general, the overall result showed that color features have more discriminating power than morphology and texture features and the classification performance of combination of RBF and SVM using otsu segmentation method was 83.3% but when we applied kmeans segmentation in combination of

RBF and SVM the classification performance is 89.8% and this is better than ANN and a combination of RBF and SOM and also Kmeans segmentation is better than otsu method.

8. Conclusion

In this research paper we have evaluated three types of classifiers (ANN, RBF+SVM and RBF+SOM) for Ethiopian agricultural crop pest recognition. In line with this, in our Experimental simulation the combination of RBF and SVM has a better performance than the other classifier and also take minimal time of recognition for the given crop pest. But when we see the training time of the combination of RBF and SOM, it takes longer time in training. On the other way when we use Otsu segmentation method the performance of recognition declined for the three types of classifiers. Whenever we apply Kmeans techniques for segmentation the performance increased so in this research paper we have selected Kmeans segmentation techniques for segmenting crop pest image and a combination of RBF and SVM for classification of crop pest.

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