Maize Disease Identification: Computer vision approach

Abrham Debasu [1], Yibeltal Maru[2]
[1]Computing Faculty, Bahir Dar Institute of Technology, Bahir Dar University, , Bahir Dar, Ethiopia, Email: abrham.debasu@bdu.edu.et
[2]ICT Directorate Director, Bahir Dar University, , Bahir Dar, Ethiopia, Email: yibeltal.maru@bdu.edu.et

***Abstract*— Ethiopia is the fifth largest producer of maize in Africa and smallholder farmers make up 94 % of the crop production. The research focus on identification Maize Lethal Necrosis Disease, Gray Leaf Spot Disease and Maize streak virus for maize diseases using a mobile vision approach. In this research, the total of 3 groups of maize diseases with statistical, texture and color features are considered. The neural network consists of 21 inputs feature vectors and 3 neurons in its output layer to identify the diseases. 94.2% accuracy is achieved when back-propagation neural network (BPNN) is used.**

Keywords—BPNN, mobile vision, computer vision, image processing, Maize diseases.

I. INTRODUCTION

Ethiopia is a country of huge 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 holdings range between 0.5 and 3 ha or less, depending on the geographical region of the country1. Land is prepared for planting by oxen drawing a local plough (the maresha) or by manually operated hand tools. Sowing is done by broadcasting and weeding is dependent upon labour intensive practices. The use of irrigation, improved seed and other external inputs such as pesticides is minimal.(Amdissa Teshome, 2006).

Ethiopia's crop agriculture is complex, involving substantial variation in crops grown across the country's different regions and agroecologies. Smallholders account for 96 percent of total area cultivated and generate the key share of total production for the main crops. The core crop season is the Meher season, with harvests between September and February. Five major cereals (teff, wheat, maize, sorghum,and barley) are the core of Ethiopia's agriculture and food economy, accounting for about three-quarters of total area cultivated and 29 percent of agricultural GDP in 2005/06 14 percent of total GDP (Harold Macauley,2010).

There are three major maize diseases in Ethiopian agriculture these are:

A. Gray Leaf Spot Disease

The gray leaf spot disease is a type of fungal disease that decreases the yield of maize. This disease is caused by C.Zeina (Jennifer M. Rees & Tamra A. Jackson, 2008). The following characterize gray leaf spot disease

- Small tan/Yellow spots
- Pale brown or grey Leaves
- Dark greyish /brown lesions

B. Maize streak virus (MSV)

The maize streak virus (MSV) disease is transmitted by Cicadulina mbila or leaf hopper. The leaf hoppers have sucking mouth parts that enable them to penetrate the pant leaves. On this disease the symptoms begin within a week after infection that consists of round, scattered spots in the leaves (Darrin (P. Martin and Edward P. Rybicki, 2011).

C. Maize Lethal Necrosis Disease

This disease is caused by Sugarcane Mosaic Virus(SCMV). The diseases were first observed in September 2011 (Adams, I.P, 2017). The diseases shows various symptoms which includes

- Yellow and white edge leaves
- Dying leaf edge and etc.

Fig. 1. Gray Leaf Spot Disease, Maize streak virus and Maize Lethal Necrosis Disease maize diseases type

Along with the technologies invented in the past few decades, smartphones have gained large market shares among various user sectors due to their usefulness, ease-of-use, and affordability. The number of new smartphone users continues to grow. It is estimated that, by 2016, the number of users will be more than 2 billion people worldwide (Suporn Pongnumkul, 2015). According to Ethiopian Telecom there are 53 billion mobile users in Ethiopia and from these quarters of them used mobile data and internet which means the number of smart phones in Ethiopia also increased. Therefore the implementation of computer and mobile vision in the sector of agriculture will have a vital significance.

In the literature, different techniques (reviewed in Section II) have been proposed related with maize diseases identification. However, as per our knowledge, no research has yet been done in combination of computer vision and mobile vision to identify maize diseases.

Beside this, even thought maize diseases identification is applicable in agricultural area there no system tested in areas of mobile vision in Ethiopia.
The main contribution of this paper is that:

- ✓ Finding the more discriminate feature vectors of maize diseases type. Because when we directly apply the feature vectors of the work that have been done for the other countries the classifier performance is not adequate.
- ✓ Combining mobile vision with computer vision so as to identify easily the diseases type.
- ✓ Designing an automatic mobile based maize diseases identification.
- ✓ Most of the literature focused on detection of diseases on maize which means that detection of the presence of the diseases but they haven't seen recognition among different diseases. In this paper, we have shown that the recognition of the three types of maize diseases.

II. Related Work

Different researchers have been conducted their researches to find an automated means of identifying maize diseases. Regarding to this, related works have performed to identify the diseases. These are discussed as follow.

(Song Kai, 2011), in their work entitled as "Maize Disease Image Recognition of Corn Based on BP Networks" presented the texture characteristics of corn diseases, it uses YCbCr color space technology to segment disease spot, and uses the co-occurrence matrix spatial gray level layer to extract disease spot texture feature, and uses BP neural network to class the maize disease. Then, they found out that 98% success rate in their experiment. But this paper covers only computer vision and the authors didn't touch the mobile vision part.

(Srdjan Sladojevic, 2016), conducted a study on convolutional neural networks (CNNs) and they developed model that able to recognize 13 different types of plant diseases out of healthy leaves, a deep learning framework developed by Berkley Vision and Learning Centre, was used to perform the deep CNN training. On their experiment they achieved 96.3%.

(Ganesh Bhadane, 2013), conducted a study on early disease detection in agriculture field. In their work they developed a software prototype system for pest detection on the infected images of different leaves. Images of the infected leaf are captured by digital camera and processed using image processing techniques. They presented promising result and proposed several improvements in both material and methods can be carried out to reach the requirements of an Integrated Pest Management system.

(Liying Cao, 2011), they studied Machine vision technology in order to identify the rapid diagnosis and identification of maize diseases. In their work, the authors stated Laboratory tests showed that the uses of machine vision technology, disease recognition model for the disease sample collection process to identify, analyze findings and to get the real practical applications, consistent with the conclusions, to meet the agricultural production practical application. They developed vision technology for the diagnosis of diseases of corn provides a quick, inexpensive, non-destructive testing of possible means.

(Jagadeesh D.Pujari, 2015), on this paper the authors presented a study on the image processing techniques used to identify and classify fungal disease symptoms affected on different agriculture/horticulture crops. In their work they studied that plant health monitoring is still carried out by humans due to the

visual nature of the plant monitoring task, computer vision techniques seem to be well adapted. The goal of the study was to detect, to identify, and to accurately quantify the first symptoms of diseases that are caused by bacteria, fungi, virus, nematodes and focus has been done on the early detection of fungal disease based on the symptoms.

(Deshmukh, 2016), in their work they stated that plants play an important role in the biological field. In this paper the authors developed an Android application that gives users or farmers the capability to identify the plant leaf diseases based on the photographs of plant leaves taken from an android application.

(Shitala Prasad, 2016) , in this paper the author declared that the process of detecting plant disease by human naked-eye is difficult and very expensive practice, particularly in developing countries like India. They studied and develop a fast-reliable automated mobile vision system for such tasks, In this paper, they used a mobile client–server architecture for leaf disease detection and Gabor wavelet transform (GWT) and gray level co-occurrence matrix (GLCM) are considered. In their work, the result is sent back to the users screen via an SMS (short messaging service) with an accuracy rate of 93%.

(Deore Nikita, 2016), the authors in their work stated that the agricultural plants need to monitor for control and management of plant disease yield plant harvesting. In this paper they used mobile phones for real time monitoring of plant disease for proper diagnosis and treatment. In their work, a central server is placed at the pathological laboratory for sharing of the data collected by the mobile phones. A K-means clustering algorithm is considered in their work. In this paper the author showed that k-means segmentation has better than the other segmentation techniques.

III. Materials and Tools

To collect the data set Smartphone with 8 mega pixel and IP camera is used to capture the image directly, and both video and offline images are included in order to have a good data set form all perspective. The data contains noises because they were captured in uncontrolled environments. Having such types of data set, it was very helpful to identify the maize disease. Because if the model is trained in such a way that noisy patterns, the model become capable of identifying diseases in noisy environment. The total of 3 groups of maize diseases and each having 200 images are considered for this study. Once the data set collected, pre-processing and noise filtering steps are performed to achieve the goal of the study through MATLAB.

IV. Maize Disease Identification

In maize disease Identification system consists of two basic parts: computer vision and mobile vision. The images were captured in different areas of Ethiopia. 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 (K.-L. Du and M. N. S. Swamy, 2017). 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.

Back-Propagation Artificial neural network was used for classification and characterization of images in to different classes.

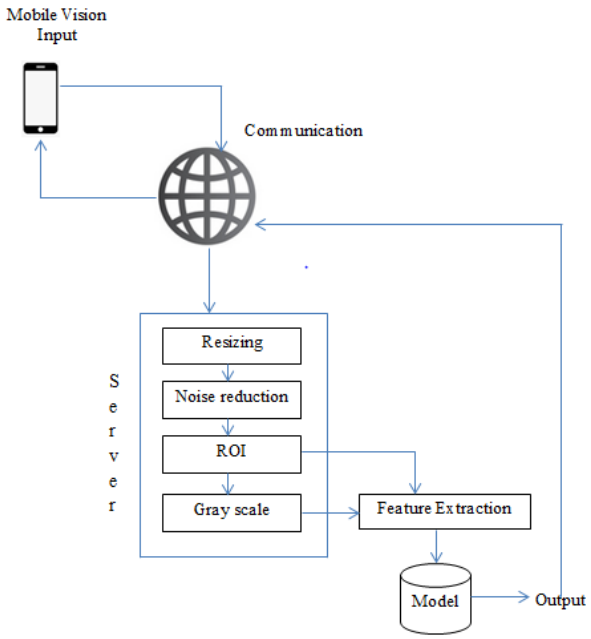

Fig. 2. Maize diseases identification Model

As shown in figure 2, the first step of maize diseases identification is taking the image or video as an input using mobile. To capture the image WIFI or ADHOC network is needed to transfer the captured image to the computer. Once the input is taken, pre-processing is applied , the second step in the

identification is that pre-processing of image, 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 this research adaptive median filtering method is used for reducing noises. The third step 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 (Er. Anjna and Er.Rajandeep Kaur, 2017). Therefore in this research K-means is used for segmenting image.

In feature extraction stage, the features 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 (Abrham, 2016). The purpose of feature extraction is to reduce the original data set by measuring properties, or features, that distinguish between the three types of maize diseases. In research three groups of features are considered these are texture, statistical and Color features. Color variation of each type and color analysis computed by taking HSV values. The final step is the identification stage. Depending upon the training sets it classifies according to the predefined class.

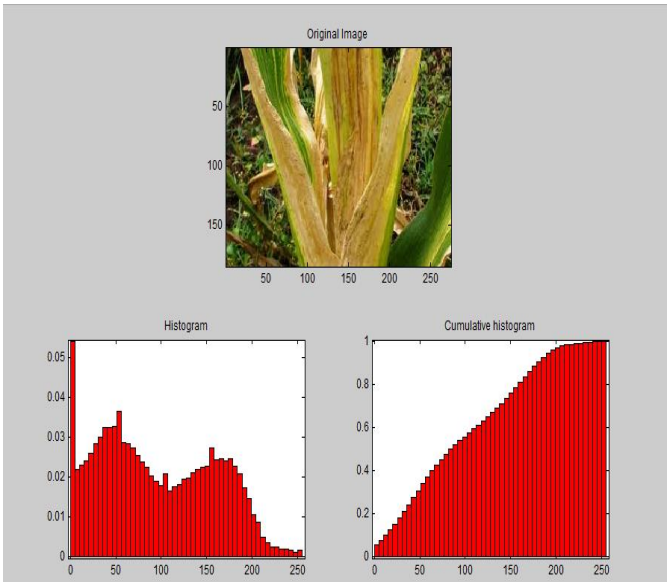

Fig. 3. preprocessed image

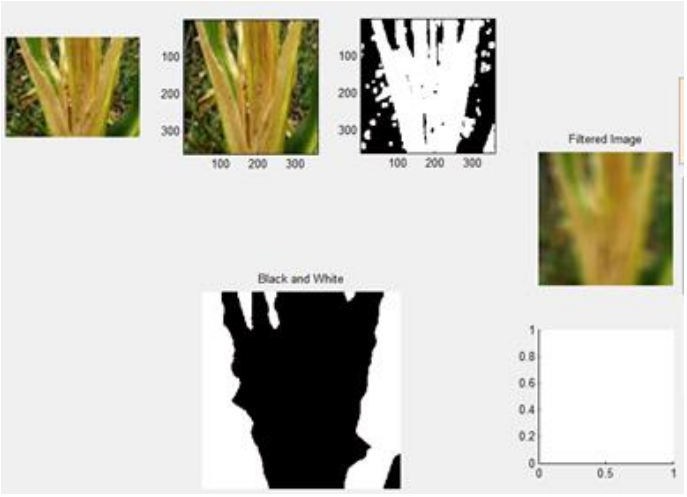

Fig. 4. Segmented image

V. EXPERIMENTS AND RESULTS

A. Back-propagation artificial neural network

The word network in the term 'artificial neural network' refers to the inter–connections between the neurons in the different layers of each system. An example system has three layers. The first layer has input neurons, which send data via synapses to the second layer of neurons, and then via more synapses to the third layer of output neurons. More complex systems will have more layers of neurons with some having increased layers of input neurons and output neurons. The synapses store parameters called "weights" that manipulate the data in the calculations. (Snehal S.Dahikar and Dr.Sandeep V.Rode, 2014)

In this paper, the neural network needs 21 inputs of the combined feature vectors of statistical, color and texture and 3 neurons in its output layer to classify the maize diseases. The hidden layer has 20 neurons .This number was picked by trial and error methods, if the network has trouble of learning capabilities, and then neurons can be added to this layer. There is a significant change when we increase the number of hidden layers neurons until 20 but there is no change when the number of hidden layer neurons increases above 20. Each value from the input layer is duplicated and sent to all of the hidden nodes.

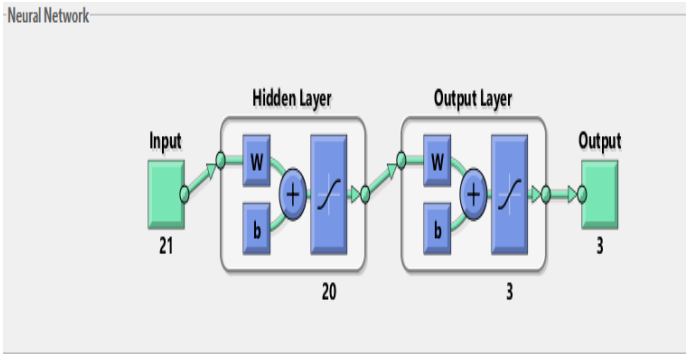

Fig. 5. BPNN Model

B. Experiments and Results

In this experiment, 21 features (6 texture, 5 color features and 10 statistical features) are considered and these features are used to classify different maize diseases. We have conducted an experiment for finding the more distinguishing feature vector among Texture, statistical and color features. From the experiment, statistical features have less power to classify to their corresponding class because mostly it consists of similar features so that accuracy of classifiers is very low. After conducting this experiment the more representing feature vectors are selected. In pattern classification, there are two phases called training and testing. For training the classifier needs input features with their class labels. In this research, ANN (Artificial neural network) is considered for this study. In order to train the classifiers, a set of maize diseases image was given to the model in addition to the class label, 600 images are collected from the regions of Ethiopia. The representing features of training were normalized with mean 0 and variance 1 this helps the model to converge. To this end, for 600 image data 21 features are extracted from each image and labeled with 3 classes where it belongs to. 70%, total data is used to build the Model. In this phase, data is repeatedly presented to the classifier.

In testing phase, the trained system (Maize diseases identification system) is challenged to new data that has never seen during training phase. The training has been done with random picked hidden neurons. In this research 1, 5, 10, 15 20, 25 and 30 hidden neurons are used. As shown in the experiment, the performance of the Model increases as the hidden neurons increase from 1 up to 20. But after the performance registered with 20, 25 and 30 are similar. Therefore, the authors have used 20 hidden neurons that has been registered maximum performance. In this research experiments are conducted under four scenarios by using feature sets of statistical, texture and color separately, and finally combining the three feature sets. The overall result showed that statistical and color features have more representing power than texture features and the classification performance of ANN is 94.2 %.

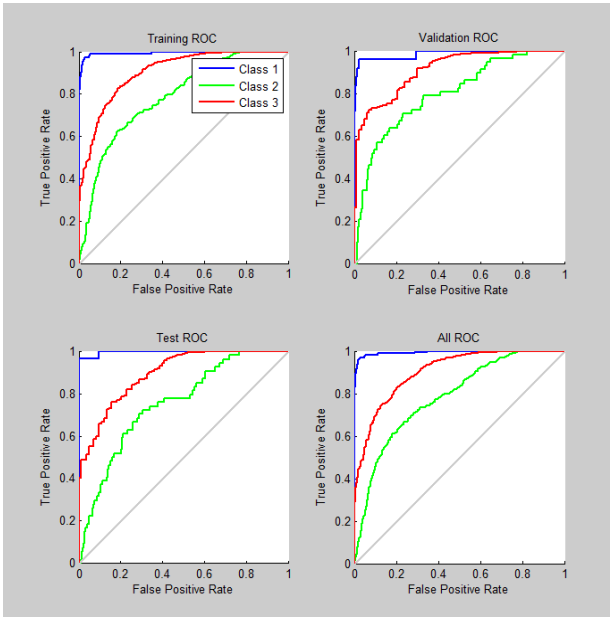

Fig. 6. BPNN Model Resilt

VI. A Conclusions

The aim of the research paper is to identify the three types maize diseases using a mobile vision approach. In this paper, BPNN are used and the accuracy of the system are presented, and the results of BPNN were discussed and promising results were obtained.

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