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Maize Leaf Diseases Recognition and Classification Based on Imaging and Machine Learning Techniques

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Abstract: Ethiopia is one of the developing countries in the world, and its economy depends on both agriculture and industry. From agriculture products, maize crop is one of the most important for both human beings and animals in Ethiopia. It has a great share and nutritive value; very vulnerable to different types of diseases. There are more than 72 maize diseases reported in Ethiopia caused by (fungi, bacteria, nematode and viruses). Among this diseases maize leaf blight, maize common rust, and maize leaf spot are common diseases that attack maize leaf. There are different traditional mechanisms to recognize and classify maize leaf diseases by chemical analysis or visual observation. The traditional mechanisms to recognize maize leaf diseases had their own draw backs, such as expensiveness, inconsistent, prone to error, take more time; require professional staff, specialized instruments, inefficient etc. Therefore, that motivated to develop maize leaf diseases recognition and classification model using imaging and machine learning techniques to support experts. In view of this, digital image analysis techniques based on texture, colour and morphology features were developed to recognize and classify maize leaf diseases and healthy leaf. Sample of maize leaf disease images were taken from Ethiopia country maize farming area. Totally 800 images were acquired for training and testing, 200 images from each class. For the recognition and classification analysis, 7 textures, 6 colours and 9 morphological features, totally 22 features are extracted from each image. To build the recognition and classification model, K-nearest Neighbour and Artificial Neural Network classification techniques were used. To evaluate the recognition and classification accuracy, form the total data set of 800 images, 80% were used for training and the remaining 20% was for testing the model. Based on the experimental results using combined texture, colour and morphology features, the Artificial Neural Network classifier was performing better than K-nearest Neighbour Classifier. The Artificial Neural Network classifiers algorithm with combined features accuracy for each four classes (Common rust, leaf blight, healthy leaf and leaf spot) are 92.5%, 100%, 90% and 95.0% respectively, and the overall performance was 94.4%. As a conclusion, there was satisfactory result to recognize and classify maize leaf diseases.

Keywords: Artificial neural network; Feature extracte; K-nearest neighbour; Maize disease

I. INTRODUCTION

Ethiopia has a decentralized federal system of government comprising nine regional states and two administrative cities. Ethiopia is one of the developing countries in the world, and its economy depends on both agriculture and industry [1]. Agriculture is the backbone of the Ethiopian economy, with more than 85% of the population gains their livelihood directly or indirectly from agricultural production including livestock and 45% of Gross Domestic Product (GDP) of the country gain from agriculture products. In Ethiopia, agricultural research started with the establishment of the Ambo and Jimma Colleges of Agriculture in 1947 and the Imperial College of Agriculture and Mechanical arts (today's Alemaya University) in 1953 [2]. There are many agricultural products found in Ethiopia, some are Coffee, Maize, Teff, Wheat, Malt-Barley and Tea. Maize is the single most important cereal, accounting for 17% of the per capita calorie intake, followed by sorghum 14% and teff 11[3,4]. Maize is one of the most important cereal crops used in the human diet in large parts of the world and it is an important food component for livestock. It is not only an important human nutrient, but also a basic element of animals' feed and raw material for manufacture of many industrial products. It is an important food grain crop in Ethiopia and is produced throughout the country under diverse

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environments [5]. Even though, maize has a great share and nutritive value, and it is very susceptible to different plant diseases. There are about 72 maize diseases reported in Ethiopia caused by fungi, bacteria, nematode and viruses [6.7]. However, diseases such as turcicum leaf blight (TLB), common leaf rust(CLR), gray leaf spot (GLS) are still important constraints in all maize growing regions in Ethiopia that cover 80-95% of maize leaf diseases. Maize streak virus (MSV) and the newly emerging disease named maize lethal necrosis (MLN) both are also currently getting greater attention due to their level of damages. Due to these maize leaf diseases, the product of maize is highly affected in both the quality and quantity of the result [7]. Currently, Computer technologies used to improve agricultural productivity and others in a number of ways. Machine learning techniques is one of the computer technologies to recognize plant diseases, sorting and grading of agricultural products, biotechnology, medical diagnosis, industrial automation, biometrics, remote sensing and improve agricultural products [8]. Digital image process and image analysis's technology based on the advances in microelectronics and computers have many applications in agriculture and it circumvents the problem that is associated with photograph [9,10].

II. RELATED WORK

Song K et al. used maize disease image recognition of corn leaf based on image processing and back propagation neural network, which is to study diseases of image processing and uses YCbCr color space and YCbCr Spatial colour model for image segmentation for segment diseases spot and matrix spatial gray level layer to extract features. The authors have taken a total of 10 pictures of corn leaf blight, sheath blight, southern leaf blight and 0 degrees, 45 degrees, 90 degrees and 135 degrees of matrix to each of them respectively. The author's extracted five types of texture futures (energy, entropy, moment of inertia, related and local stationary) using matrix spatial gray level layer used to basic information to recognize and classify maize leaf diseases. Back propagation neural network used to recognize and classify the above maize leaf diseases based on texture features [11-16].

Samanta D and Ghosh A used Histogram Approach on maize leaf to identify damage part of the leaf. In this thesis, the researcher focused on Turcicum Leaf Blight that identify the damage part of the leaf that follows the following steps, Capture Image, Image Preprocessing, Segmentation, Pick value of histogram and Disease grading. The authors used K-means clustering to separate the necessary part of image from other background part. Then drown histogram to grading the diseases of a binary image pixel and calculate the change of the pick value. The result from the preliminary study indicated that the proposed strategy is effective to assess disease intensity by the plant pathologist more precisely [13].

Pujari JD and Yakkundimath R, et al. recognize and classified three Cereals plants, which are Wheat, maize and jowar leaf diseases using Support Vector Machine (SVM) and Artificial Neural Network (ANN) based recognition and classification of visual symptoms affected by fungal disease. The authors collected four types of maize leaf diseases leaf blight, leaf spot, powdery mildew, smut and normal. To recognize and classify fungal diseases symptoms the authors followed the following steps: collect 750 JPG format images both fungal affected and normal. Then preprocess image (shade correction, removing artifacts, formatting. Formatting deals with storage representation and setting the attributes of the image), segmented using k-means segmentation technique, Color and texture features are extracted from affected regions and then used as inputs to SVM and ANN classifiers. For feature extraction from leaf image, the researchers used Color Co-occurrence Matrix (CCM) algorithm and, MATLAB tool is used for program interface. Based on this experimental result SVM and ANN average result, 83.83% and 77.75% classification accuracy was achieved respectively. From this result the authors conclude that SVM algorithm is more accurate than ANN to recognize and classify cereals fungal diseases [12]. Different neural network architectures can be used for classification and classify disease symptoms affected on fruits, vegetables, commercial crops were future research recommended by researchers.

Fuzzy least square vector machine (FLSVM) algorithm had been applied to recognize maize diseases. Lu C and Gao S, et al. proposed a new approach to recognize the maize diseases, based on fuzzy least square vector machine (FLSVM) algorithm. To segment the spot diseases from maize leaf used, YCbCr colour space technology (a luminance component and two colours component signals) and used the co-occurrence matrix spatial gray level layer to extract disease spots texture feature, and, use FLSVM to classify the maize disease. According to the researchers, the general step to recognize maize diseases spot, segment the acquires image used YCbCr colour model, and extract appropriate features for training and testing maize spot leaf diseases. The researcher taken total 12 pictures of corn leaf blight, sheath blight and southern leaf blight and calculate 0 degrees, 45 degrees, 90 degrees and 135 degrees of the matrix to

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each leaf diseases. Five texture features which extract as the input, and take hidden layer obtained with 10 nodes, starting Fuzzy Least Square support vector machine training. The experimental results achieved precision around 98%, for recognition and classification [9].

According to Zhang ZY and He XY et al. recognizing and classify five types of maize crop leaf diseases using image processing techniques and machine learning algorithms. They captured 100 images of the maize disease leaves from 5 kinds of maize disease; each kind of disease has 20 images used for experimentation for both training and testing purpose. The preprocessed images are cropped and normalized (in scale and orientation) and resized to 32 × 32 pixels by histogram equilibrium with 255 gray levels per pixel and with the white background. But, the authors didn't mention the five types of maize diseases. To recognize and classify maize leaf diseases the authors followed the following steps: collect different types of diseases maize leaf images and health images from different farming area using appropriate camera, segmented the images, features (color features, shape features and 5 texture features) were extracted and finally recognized and classified using k-nearest neighbour classifier to produce the class labels on the test data. This disease recognition experiment procedure is repeated 50 times. The classification rate is above 90%. The researcher concludes that to identify leaf image diseases shape and texture features are more dominate because the colour varies from plant leaves vary at the beginning, tiny, dark brown to black spots at later time, they have the phenomena of withered leaf, black or part leaf deletion, etc.). Increasing the training samples and extract the effective features from maize leaf colour, leaf shape and leaf texture are recommended for further research [17].

Zhang ZY and He XY, et al. proposed to recognize and classify four types of (Exserohilum turcicum, brown spot, gray spot, curvularia lunata and round spot) maize leaf diseases that occurred in china farm area. The researchers followed the following steps to recognize and identify the above maize leaf diseases. A series of maize diseases images (JPG format) are collected by digital camera under the sunlight condition and converted in to BMP format to acquire information. And segment the image using some thresholding value. The image is converted from RGB model to HSI one, and then mean and standard deviation of three components are extracted. Totally they extracted 20 features form the above maize leaf diseases to recognize and classify the diseases using GA-SVM algorithm. The researcher used RBF kernel function, SVM and GA-SVM to recognize and classify the above maize leaf diseases. The experimental results achieved precision between 69.63% and 90.09% for SVM and between 88.72% and 92.59 for GA-SVM for each of the above maize leaf disease [17]. Even though there are many attempts made to facilitate the recognition, classification and grading of crops, in Ethiopia, only few attempts were made to develop prediction model for coffee plant diseases recognition and classification and flower disease detection. Most of the plant diseases, recognition and classification researches are done outside Ethiopia; local maize cereals diseases dataset, new paradigms should be researched and even accuracy of existing algorithms need to be verified and optimized. To the best of the researcher's knowledge, still there is no any attempt in the area of Ethiopian major maize leaf diseases dataset. This initiates the current study to construct a recognition and classification model for Ethiopian maize crop leaf diseases dataset using imaging and machine learning techniques so as to facilitated and improve major maize leaf diseases recognition and early control.

III. STATEMENT OF THE PROBLEM

In agriculture plant diseases recognition and classification is a major challenge. Currently, recognition and classification of plant diseases is an important research topic as it may prove benefits in monitoring large fields of crops and detect the symptoms of diseases as soon as they appear on plant leaves. The classification and recognition of crop diseases are the major technical and economic importance in the agricultural industry [14,15]. Maize leaf diseases diagnosis is very essential in earlier stage in order to cure and control them. There are different traditional mechanisms to recognize and classify maize leaf diseases with human operator, chemicals etc. However, the traditional mechanisms to recognize maize leaf diseases have their own draw backs, such as expensiveness, prone to error, takes time, inconsistent, require expertise in the plant diseases, specialized instruments and inefficient [14]. Currently, in Ethiopia the farm area experts used the following techniques to recognize and classify maize leaf diseases, naked eye observation by farm area experts, chemicals and when necessary laboratory experiments, which are outside the country, can use. Such techniques have their own problems. Some of these are:

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- Lack of chemical on the right time and place
- Lack of laboratory material
- It takes time to detect the diseases
- Lack of farm area experts to identify the diseases by eyes observation

To this end, this study attempts to explore and answer the following research questions

Q1. What are the common diseases that attack maize leaf crop in Ethiopia?

Q2. Which image pre-processing techniques are effective for feature extraction from maize leaf images?

Q3. Which features are effective for maize leaf disease recognition?

Q5. What is the performance of the model for Maize leaf diseases detection and classification?

IV. IMPLEMENTATION PROCEDURE AND TOOLS

To implement the proposed method, K-nearest neighbour (KNN) and artificial neural network (ANN) classifier algorithms have been employed and MATLAB programming is used for image pre-processing, feature extraction and to build the prototype [3]. For displaying, editing, processing, analysing, and recognizing maize leaf diseases recognition, MATLAB tool is used. The following tools and materials were used for this research; Sample spot infected maize plant leaves diseases and healthy leaf, mobile phone camera, Computer and MATLAB software Version R2014a.

V. DESIGN OF MAZE LEAF DISEASES RECOGNITION MODEL

This research work was concerned with designing maize leaf diseases image recognition and classification model. First, the digital images were acquired from the environment using a digital mobile phone camera. Then image pre-processing techniques were applied to the acquired images to extract useful features that are necessary for further analysis [6,12]. In order to extract necessary information from leaf image, we have applied an image processing technique like image enhancement, segmentation, gray scale conversion, binary conversion and filtering. Then, features like texture, colour and morphology that have best suited to represent an image were extracted from each image. Finally, k-nearest neighbour (KNN) and artificial neural network (ANN classification algorithm were used to recognize and classify an image in to its class of disease. The recognition and classification of maize leaf diseases have a series of steps that was required. The details of these steps are showed in Figure 1.

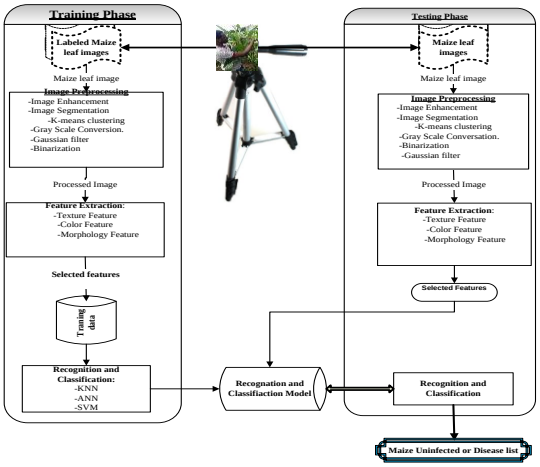

Figure 1: Architecture of the proposed model to recognize maize leaf diseases.

There is no ready-made dataset for this type of research in Ethiopia; so we have prepared our own dataset for training, and testing data. To do this, healthy and unhealthy maize leaves have been collected Ethiopia maize growing farming area. The collected maize leaves are certified by the farming area experts. All sampled maize leaf images are the

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products of 2016/2017 production year. The details quantities and images of sample healthy maize leaves and unhealthy maize leaves have used in our experimentation are 200 maize leaf images from each class and totally 800 images captured using Simon Cs Techno (16 MP) mobile phone camera. We have used three varieties of distance i.e., 130 mm, 150 mm and 160 mm form the maize leaf image. Finally, we get better image on the distance of 160 mm from the maize leaf. Some sample maize leaf image (Figure 2).

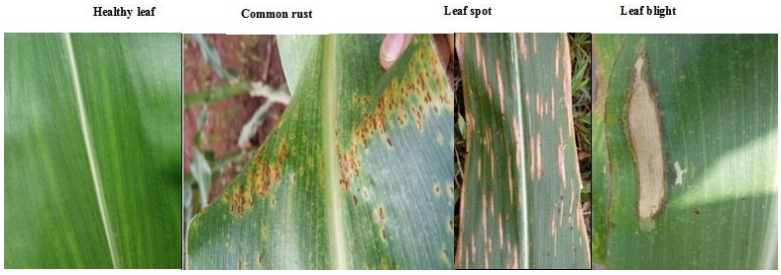

Figure 2: Sample maize leaf images.

After acquisition of maize leaf images, the researchers apply different pre-processing techniques used to get appropriate features from image. These are enhancement, noise removal, segmentation, colour transformation and binarization. For this study k-means clustering techniques was used. Because it is simple and appropriate for plant diseases spot identify. After image pre-processing complete, extract appropriate features that used for maize leaf diseases recognition and classification. For this research used texture, colour and morphology features were extracted. 22 total features extracted from each maize leaf image. These are 7 texture features, 6 colour features and 9 morphology features. To extract the above features, we used the following three feature extraction techniques which are implemented in MATLAB as a function, graycoprops (), rgb (:, :, C) and regionprops() for texture, colour and morphology features function respectively.

5.1 Data Set Partitioning

In order to train and test maize leaf diseases recognition and classification model the data set divide into two parts. These are training data (80% from total dataset) and testing data (20% from total dataset). Hence, from the total of 800 data sets, 640 were used for training and 160 were used for testing. The dataset splitting technique is done using 5 cross validation technique which is to avoid problems, like over fitting during training.

5.2 Building Model

In order to build the model, we have used the following classification algorithms such as k-Nearest Neighbours (KNN) and Artificial Neural Network (ANN). The model of maize leaf disease recognition and classification are shown below in Figure 3.

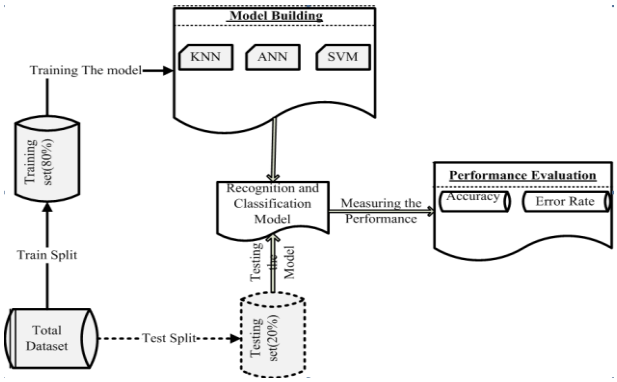

Figure 3: General approach model for maize leaf diseases classification.

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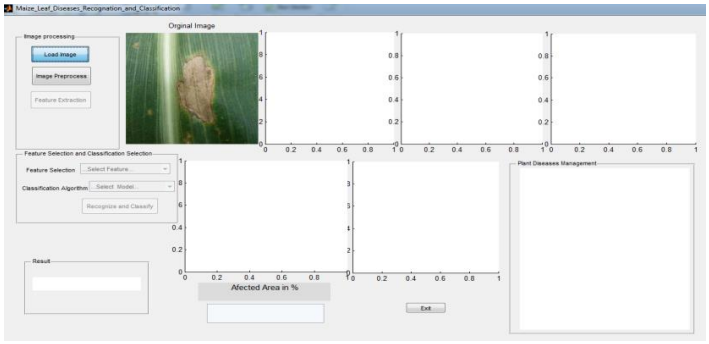
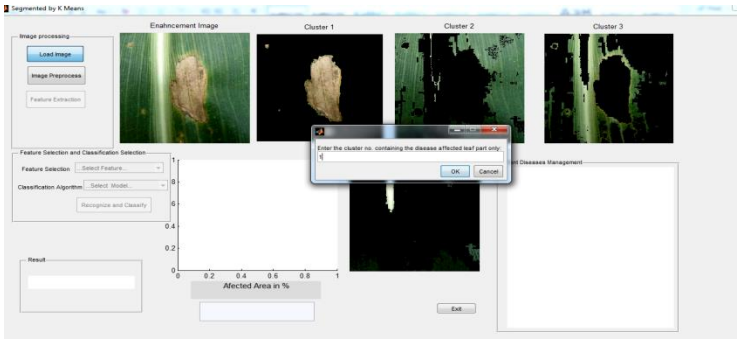
To describe the above general maize leaf diseases recognition and classification model, there was the collection of datasets from different Ethiopia farming area and divide total dataset into training and testing using percentage split where 80% is taken as training dataset and the remaining 20% as the test set. Based on the features extracted from the maize leaf image, two supervised machine learning algorithms (KNN and ANN) were used for training and constructing the recognition and classification model for three maize leaf diseases including healthy maize leaf. In this study work, texture, Color and morphological features, and their combination were used for training and testing purpose. And finally measure the performance of testing model.

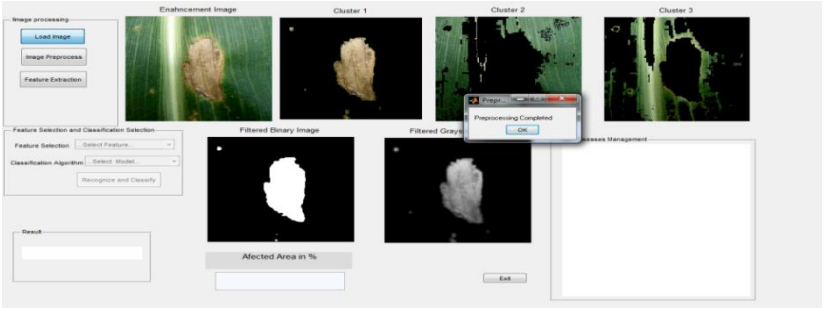
VI. MAIZE LEAF DISEASES RECOGNITION MODEL PROTOTYPE



a)



b)



c)

Figure 4: Maize leaf diseases recognition and classification prototype.

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As shown in the above Figure 4, the acquired maize leaf disease image was converted to enhanced image, and the segment enhanced image using k-means clustering. After selecting appropriate cluster image, extract colour features from selected clustered image. After select clustered image convert into gray scale image and extract texture features from gray scale image. Finally noise removal using Gaussian filters from gray scale image and convert into binary image. Then extract morphology features from binary image.

VII. EXPERIMENTAL RESULTS

In this experiment, we conducted each recognition and classification using texture, colour and morphology features and also used the combination of features. In our research experiment used the following classification algorithms; KNN and ANN used to classify the maize leaf diseases and select the best performing methods. In this research experiment first extracted 7 texture features, 6 colour features and 9 morphology features from each maize leaf diseases. And we have computed the entire possible features set by combining each of the three features. And finally using the above classification algorithms recognize and classifies maize leaf diseases.

7.1 K-Nearest Neighbour Classification (KNN)

In KNN for training data, the input data was the feature of maize leaf diseases and the classes were the maize leaf diseases with healthy leaf image. The class of the test data, which contain only the input variables, is determined by comparing the distance of the unknown tuple to k-nearest neighbours of that references model. There are 640 training data set, from this the square root of the training data get around 25. We consider Euclidean distance as the distance metric parameters value of k is 25. The experiment was conducted under the six conditions. Based on this, the accuracy of each feature and combined features set showed in Table 1.

Extracted Feature	Correctly Recognize	Incorrectly Recognize	Accuracy (%)
Texture	100	60	62.5%
Color	120	40	75%
Morphology	127	33	79.38%
Texture and Color	100	60	62.50
Texture and Morphology	132	28	82.5%
Texture + Color + Morphology	132	28	82.50%

Table 1: The performance of KNN test model for the selected feature sets.

From the above Table 1 experimental result, we have observed that, the combination feature sets both texture and morphology features relatively better results in KNN classifier maize leaf diseases than other feature set within an accuracy of 82.50%. From this result, we conclude that relatively the combined features in KNN classifier maize leaf diseases give better discrimination result than individual maize leaf diseases features. The best result listed during experimentation showed using confusion matrix as shown below in Table 2.

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Actual Class\Predicted class	Common Rust	Leaf Bright	Healthy Leaf	Leaf Spot	Accuracy (%)	
					Correctly	Incorrectly
Common Rust	38	2	0	0	95.00%	5.00%
Leaf Bright	1	27	9	3	67.50%	32.50%
Healthy Leaf	0	7	32	1	80.00%	20.00%
Leaf Spot	2	2	1	35	87.50%	12.50%
Accuracy (%) Correctly	92.68%	71.05%	96.97%	89.74%	82.50%	
Accuracy (%) Incorrectly	7.32%	28.95%	3.03%	10.26%	17.50%	

Table 2: Confusion matrix maize leaf diseases recognition and classification using KNN with a combination features.

From this experiment result we observed as none of them maize leaf diseases and healthy maize leaf were perfectly classified, but common rusts were more accurate recognize and classified as compare to other.

7.2 Artificial Neural Network Classifier (ANN)

In this recognition and classification, we used the following parameters with each value. 2 Number of hidden layer, 10 Number of neuron in hidden layer, Feed-forward with back propagation network type, Sigmoid activation function, Multilayer perceptron algorithms, 1 initial biases and initial weight.

Extracted Feature	Correctly Recognize	Incorrectly Recognize	Accuracy (%)
Texture	144	16	90%
Color	124	36	77.5%
Morphology	144	16	90%
Texture and color	148	12	92.5%
Texture and Morphology	149	11	93.1%
Color and Morphology	147	13	91.9%
Texture + Color + Morphology	151	9	94.4%

Table 3: The performance of ANN model for the selected feature sets.

From the above Table 3 experimental results, we have observed that, the combination feature sets of color, texture and morphology features relatively better results than other feature set within an accuracy of 94.4%. The best result listed during experimentation showed using confusion matrix as shown below in Table 4.

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Actual Class\Predicted class	Common Rust	Leaf Bright	Healthy Leaf	Leaf Spot	Accuracy (%)	
					Correctly	Incorrectly
Common Rust	237	1	1	1	92.50%	7.50%
Leaf Bright	0	4	0	0	100.00%	0.00%
Healthy Leaf	4	0	36	1	90.00%	10.00%
Leaf Spot	1	0	1	38	95.00%	5.00%
Accuracy (%) Correctly	88.10%	97.60%	94.70%	97.40%	94.40%	
Accuracy (%) Incorrectly	11.90%	2.40%	5.30%	2.60%	5.60%	

Table 4: Confusion matrix maize leaf diseases recognition and classification using ANN with a combination features.

From this experiment, we understand ANN classifier algorithm, relatively more accurate than KNN classifier algorithms.

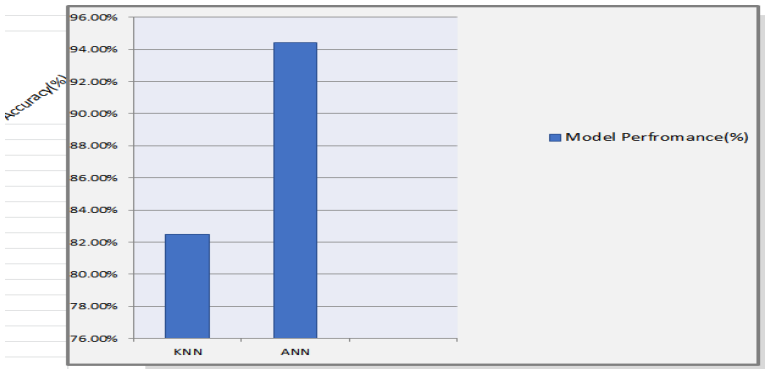

Figure 5: Overall model performance.

From Figure 5, we understand ANN classifier is more accurate than KNN classifiers during maize leaf diseases recognition and classification model.

VIII. DISCUSSION

In this study, two classification algorithms and 22 total features used. During the combination of three features (texture, color and morphology) and three classification algorithms (KNN and ANN) accuracy are 82.50% and 94.40% achieved respectively. From the above experiment result, using the combination of three features (texture, color and morphology) with artificial neural network (ANN) classification algorithm get best result during maize leaf diseases recognition and classification. During training and testing the model accuracy varies iteratively, while we select the accuracy mostly occur. The classification accuracy confusion or error in developing the model can be occurred. The reduction of accuracy result may be based on quality of the camera, the image acquisition environment, segmentation error and noise removal techniques may affect the result of the model. Furthermore, the recognition error is occurred due to morphological and color similarities (similarities occurred due to weather condition, soil type and fertilizer usage) between the input maize leaf diseases image and its recognition and classification result. And also, the main challenges that reduce the performance of maize leaf diseases recognition and classification is the similarity of maize leaf blight and leaf spot disease shape and color. And some maize leaf attack by more than one disease, due to this the confusion occur that cluster separate one diseases with other diseases. Therefore, the above factors have investigated which, the potential causes for the misclassification of some maize leaf diseases.

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IX. CONCLUSION

Maize crop is one of the major food sources for both humans and animals in Ethiopia as well as in the world. There are more than 72 diseases reported in Ethiopia that attack maize crop, for instance leaf spot, common rust and northern leaf blight diseases etc. To control the maize crop diseases at early stage, the farming area experts try to identify the maize diseases using visual observation, chemicals or other laboratory experiments. But this procedure of recognizing maize leaf diseases may take time and expensive, particularly when assessing large farming area. And also, it is difficult to get highly-skilled expertise in the farming area that recognizes maize diseases by visual observations. The development of maize leaf disease recognition and classification model using imaging and machine learning classification algorithms assists to recognize the diseases more effectively and help early control. This research is an experimental research in the sense, there is a data preparation for both training and testing to construct the model. Images of healthy as well as maize leaves disease (Common rust, leaf blight, leaf spot) were captured from Ethiopia country farming area. Then, we applied image pre-processing, segmentation and feature extraction techniques. After we extracted texture, color and morphology features for each of this class, we built the recognition and classification model using KNN, and ANN respectively. The best classification accuracy was obtained using artificial neural network (ANN) when texture, color and morphology features were used together. The overall performance was 94.4%. As a conclusion, this result was satisfactory to maize leaf diseases recognition and classification. The main, problem of misclassification of some maize leaf diseases and healthy maize leaf were due to the segmentation technique error from the samples of similar color and shape, and also due to noise removal techniques. And sometimes a single maize leaf image attacked by more than one disease, due to this, there may be the confusion of segmenting the diseased spot.

X. RECOMMENDATIONS/SUGGESTIONS

Based on the investigation and findings of this study, the following recommendations are forwarded for future and further research works:

- This study considered only some maize leaf diseases that are potentially harmful. As a result, future work should be considering and recognize other maize leaf diseases such as maize strike virus, maize lethal necrosis and maize stem diseases.
- This study is a computer based model, as future work it is recommended to extend to mobile based application.
- We recommend using other optimal feature selection techniques.
- It is recommended to use ensemble/boasting algorithms.

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XII. REFERENCES.

1. A Techane, Ethiopia's Agriculture Sector Policy and Investment Framework (PIF). Planning and programming Directorate of MOA 2010; 1-38.
2. S. Arivazhagan, RN Shebiah, et al. Detection of unhealthy region of plant leaves and classification of plant leaf diseases using texture features. Agric Eng Int: CIGR Journal 2013; 15: 1-7.
3. AA Mark, Engineering Programming in MATLAB: A Primer. Institute for Systems Research University of Maryland 2000.
4. B Efrem, Agricultural Research and Development in Ethiopia. International Conference on African Development Archives Ethiopia 2007; 1-127.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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5. M Demeke, Analysis of incentives and disincentives for maize in Ethiopia. Monitoring African Food and Agricultural Policies project (MAFAP) 2012; 1-36.
6. D Vinita, P Jyotika, Review of Image Processing Techniques for Automatic Detection of Tumor in Human Liver. International Journal of Computer Science and Mobile Computing 2014; 3: 371-378.
7. K Charles, Maize streak virus : A review of pathogen occurrence, biology and management options for smallholder farmers. African Journal of Agriculture Research 2014; 9: 2736-2742.
8. A Kidist Abera, Growth, productivity, and nitrogen use efficiency of maize as influenced by rate and time of nitrogen fertilizer application in haramaya district, eastern ethiopia Thesis, Haramaya University, Ethiopia 2013.
9. L Cunlou, G Shangbing, et al. Maize Disease Recognition via Fuzzy Least Square Support Vector Machine. Journal of Information and Computing Science 2013; 8: 316-320.
10. K Muthukannan, P. Latha, et al. Classification of Diseased Plant Leaves Using Neural Network Algorithms. ARPN Journal of Engineering and Applied Sciences 2015; 10: 1-7.
11. PD Jagadeesh, Y Rajesh, et al. Classification of Fungal Disease Symptoms affected on Cereals using Color Texture Features. International Journal of Signal Processing, Image Processing and Pattern Recognition 2013; 6: 321-330.
12. P Jagadeesh, R Yakkundimath, et al. SVM and ANN Based Classification of Plant Diseases Using Feature Reduction Technique. International Journal of Interactive Multimedia and Artificial Intelligence 2016; 3: 6-14.
13. S Debabrata, G Arya, Histogram Approach for Detection of Maize Leaf Damage. International Journal of Computer Science and Telecommunications 2012; 3: 26-28.
14. DB Sanjay, KP Nitin, Agricultural plant Leaf Disease Detection Using Image Processing. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering 2013; 2: 599-602.
15. Y. Sanjana, S Ashwath, et al. Plant Disease Detection Using Image Processing Techniques. International Journal of Innovative Research in Science, Engineering and Technology 2015; 4: 295-301.
16. K Song, Z liu, et al. A Research of maize disease image recognition of Corn Based on BP Networks. Measuring Technology and Mechatronics Automation China 2011: 246-249.
17. Z Zhiyong, H Xiaoyang, et al. Image recognition of maize leaf disease based on GA-SVM. Chemical Engineering Transactions 2015; 46:199-204.