International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-5, March 2020

Detection and Recognition of Paddy Plant Leaf Diseases using Machine Learning Technique

Nargis Parven, Muhammad Rashiduzzaman, Nasrin Sultana, Md. Touhidur Rahman, Md. Ismail Jabiullah

Abstract*: Rice is one of the important food crops and the most staple food for half of the world population. Farmers are often faces several obstacles in paddy production because of various paddy leaf diseases. As a result, rice production is extensively reduced. For finding the paddy plant leaf diseases, there are many techniques are available in the computer vision-based area. Now, it is the main concern to fast and accurate recognition of paddy plant diseases in the initial stage. For this reason, we proposed a better approach for early paddy plant leaf disease detection by using simple image processing and machine learning techniques. There are four types of paddy leaf diseases are highlighted in this paper; which are Brown Spot, Sheath Blight, Blast Disease and Narrow Brown Spot. To do this, at first the required normal and diseased paddy plant leaf images are captured directly from different paddy fields. The unnecessary background of the leaves images are eliminated by using mask in the pre-processing section. Then output is fed into the segmentation part where K-means clustering is used to separate the normal portion and diseased portion of the leaf images. Finally, the mentioned diseases are classified using Support Vector Machine (SVM) algorithm. The accuracy of the system is 94%. This technique can be also applied anywhere in the agriculture industry for plant leaf diseases detection.

Keywords: Paddy Plant, Leaf Disease Detection, Image Processing, Machine Learning, Support Vector Machine (SVM), K-Means Clustering.

I. INTRODUCTION

Most of the countries of the world, especially South Asian countries, a large number of peoples are totally depend on agriculture, which is also the main earning source of these people. Bangladesh is one of them, which is economically depended on agriculture. About eighty percent peoples of this country are directly involved with agriculture. In the agricultural industry, farmers are often fight with various diseases for crops production. Leaf diseases of paddy plant are mainly responsible for extensively reduced the paddy production. It's significant impact on the economy of the country along with the loss of the farmers.

Normally the symptoms of the paddy plant diseases are appears on the paddy leaves. Paddy plant can be affected by several types of diseases like Blast Disease, Brown Spot, Sheath Blight, Uninfected Bacteria Leaf, Narrow Brown Spot and Infected Bacteria Leaf Disease etc. From the various types of leaf diseases, in this paper we discussed and recognized four types of diseases, which are Brown Spot, Blast Disease, Narrow Brown Spot and Sheath Blight Spot. Brown Spot caused by fungus disease and the main symptoms of this disease are leaf become discoloration on the whole surface brownish and circle. Darkness green borders with white to grey-green wound or paddy leaves spots are the symptoms of Blast Disease. Narrow Brown Spot disease symptoms are light to dark brown straight line or growth parallel. Sheath Blight Spots affected usually above the water level sheaths, internode, upper leaves, and panicle.

II. EXISTING WORKS

We are already read, reviewed and analyzed more than hundred papers related to our proposed work, some of these are closest to our research; which are summarized as follows:

A study conducted by S. Phadikar, J. Sil, and A. K. Das proposed an automatic system for classify the brown spot and blast diseases of paddy plant leaf. In their research, they used Bayes and SVM Classifier to classify the diseases [1].

A study conducted by Vimal K Shrivastava, Monoj K Pradhan, Sonajharia Minz, Mahesh, and P. Thakur from KIIT, Bhubaneswar, aims to early detection and classification of paddy plant leaf diseases. In their research, they used pre-trained Deep Convolutional Neural Network (CNN) for feature extraction and Support Vector Machine (SVM) for classification [2].

A study conducted by K. Jagan Mohan, M. Balasubramanian and S. Palanivel from Annamalai, University, Annamalainagar, aims to identify and classify various paddy plant diseases using image processing technique. In their research, they used Scale Invariant

Feature Transform (SIFT) for disease recognition and used K-Nearest Neighbor (K-NN) and Support Vector Machine for classification [3].

Revised Manuscript Received on March 30, 2020.
* Correspondence Author
Nargis Parven*, pursuing M.Sc. in Computer Science and Engineering at Daffodil International University, Dhaka, Bangladesh. Email: nargis21nishan@gmail.com
Muhammad Rashiduzzaman, Research Associate, Department of Computer Science and Engineering, Daffodil International University, Dhaka, Bangladesh. Email: rashid.shimul@gmail.com
Nasrin Sultana, pursuing M.Sc. in Computer Science and Engineering at Daffodil International University, Dhaka, Bangladesh. Email: tonnydiu@gmail.com
Md. Touhidur Rahman, Assistant Programmer, Department of Computer Science and Engineering, University of Dhaka, Dhaka, Bangladesh. Email: touhidjpi@gmail.com
Md. Ismail Jabiullah, Professor, Department of Computer Science and Engineering, Daffodil International University, Dhaka, Bangladesh. Email: drismail.cse@diu.edu.bd

A study conducted by S. Ramesh and D. Vydeki from VIT University, Chennai, India aims to recognition and classification paddy plant diseases to protect farmer's crops as well as paddy plant. In their research, they used Deep Neural Network with Jaya Optimizing Algorithm to identify diseases, which are Blast Disease, Bacterial Blight, Sheath Rot and Brown Spot [4].

A study conducted by Jagadeesh D. Pujari, Rajesh Yakkundimath and Abdulmunaf S.Byadgi from India aims to identify and classify fungal diseases of different agricultural or horticultural products in primary stage. In their research, they used image processing strategies to detect fungal diseases symptoms in various agricultural products [5].

A research conducted by Dr. Neha Mangla, Priyanka B Rajand, Soumya G Hegde and Pooja R from Atria Institute of Technology, Bengaluru, Karnataka, India proposed an idea to detect and control various plant diseases in agriculture sector. In their research, they used some image processing strategies to detect and classify paddy plant leaf diseases [6].

A research conducted by Mohd Adzhar Abdul Kahar, Sofianita Mutalib and Shuzlina Abdul-Rahman from Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, 40450, Shah Alam, Malaysia aims to recognition and classification of paddy plant diseases in early stage and recommendation for control these diseases to protect farmer's paddy plant. In their research, they used neuro-fuzzy expert system for recognition and ANN for classification diseases. They mainly work with three common paddy diseases, which are Blast Disease, Bacterial Blight, and Sheath Blight [7].

This research conducted by Mosbah El Sghair, Raka Jovanovic and Milan Tuba proposed a method for detect leaf diseases of plant automatically. In their research algorithm includes median filter, threshold and several color model for segmentation [8].

III. METHODOLOGY

The methodology of the proposed system is composed with five main part, which are Image Acquisition, Image Pre-processing, Image Segmentation, Feature Extraction and Classification. The overview of the proposed methodology is shown in Fig. 1.

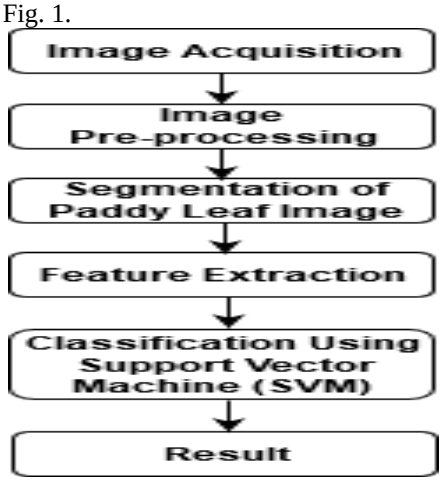

Fig. 1.Block Diagram of the Proposed System

A. Image Acquisition

For our research, we have needed a large number of high quality images of different kinds of paddy leaves of different ages of paddy plant. For this reason, we captured more than ten thousands images of various paddy leaves directly from different sources. We also collected the diseases name in several agriculture universities including Bangladesh Agriculture University, Mymensingh, Sher-E-Bangla Agriculture University, Dhaka and some other agricultural institutions. We also meet with some agriculture expertise for discussion of paddy plant diseases and solution of these diseases and some sample images are shown in Fig. 2.

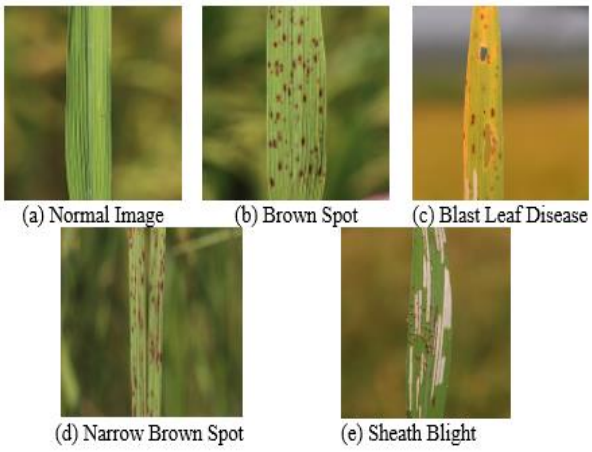

Fig. 2.Sample Images of Normal and Disease Paddy Leaf

B. Image Pre-Processing

Image pre-processing is the mandatory part for image segmentation and feature extraction. In this section, we resized the selected images into 256*256 pixels for various perspectives including memory space, display and image transmission. Another major task is removing the unnecessary background of image. Then, the captured RGB images are transformed into HSV model. Saturation Value (S Value) is calculated for process from the HSV color model because of its whiteness. Then picked threshold value 85 after few trials depends on this value the image is transformed into a binary image, which is connected with the genuine captured image that is initially in RGB model to construct a shadow or mask. The process removed the unnecessary background of the image by imposing '0' as the value of pixel, where black color is indicated by '0' in the RGB (Red-Green-Blue) color model. After removing the background of the image it shows only diseased portion of the leaf image that presented in Fig. 3.

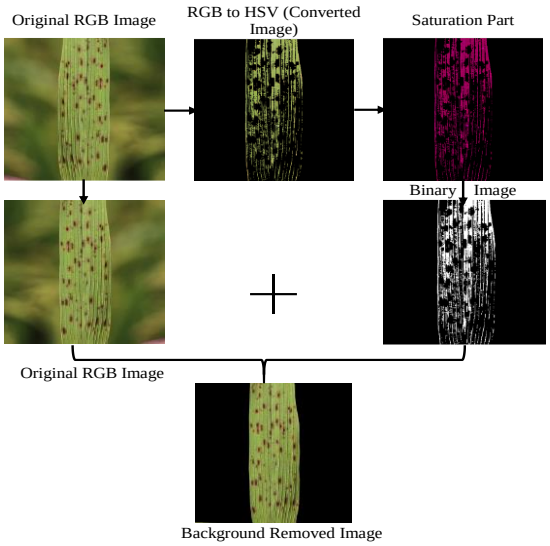

Fig. 3.Pre-processing Steps for Background Elimination

C. Image Segmentation

In image segmentation, digital images are partitioned into multiple segments. Here uses K-Means Clustering for image segmentation. For image segmentation various techniques are used for segmented image such as Threshold, Otsu technique etc. But K-means clustering is better way to separate normal portion and diseases portion. This is the way to separate group of objects. For the K-means clustering at first RGB images has been converted into binary image and then make centroid matrix. Then input images are converted from RGB (Red-Green-Blue) to HSV (Hue, Saturation Value) Color space. After K-mean clustering, features would be extracted but there was a need to select one cluster out of 'n' clusters obtained. In this proposed system we have selected three clusters. After segmentation Figure shown in Fig. 4.

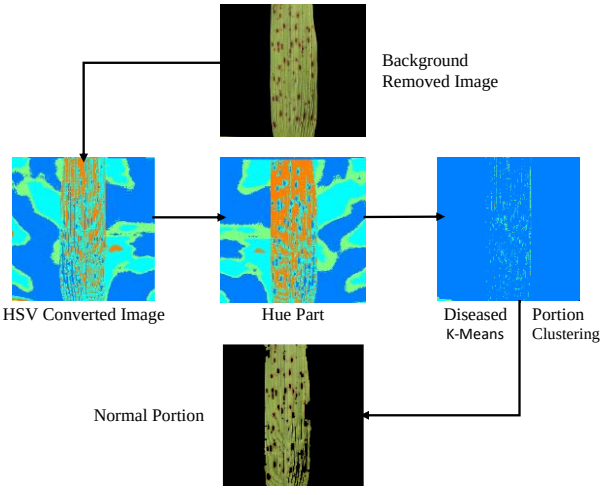

Fig. 4.Clustered Image from the Hue Part

D. Feature Extraction

Feature Extraction is a key role of the whole system. It's a method of capturing visual content of image for indexing. In this research, features has been extracted using Gray-Level Co-occurrence Matrix (GLCM). GLCM worked with texture analysis, pattern recognition and feature frames. It is a statistical method of examining texture. It provides the sum of square element. Higher series texture think about three or more pixel. This feature are extracted from diseased portion using color feature and texture feature where color and texture plays a significant role in image processing for separate features. The calculations of texture, feature use the object of GLCM for the quantity of the variations in redundancy value at the pixel of interest. GLCM calculate a formula of contrast, homogeneity, correlation and energy.

E. Classification

At first trained image using SVM technique, which is also used for classification. Here diseases are classified using support vector machine and detected 4 types of diseases, which are brown spot, blast disease, sheath blight and narrow brown spot of paddy leaf.

For classification of the paddy plant leaf diseases Support Vector Machine (SVM) is used in this research. It is a supervised learning algorithm which worked with labeled data. This technique is mostly used for image classification part. In this algorithm, each data item separate in n-dimensional space. SVM supervised method that sort into two classes. Classification performed by finding decision surface. SVM is a binary classifier which take decision boundary decision surface/hyper-plane between two classes. Hyper-plane can be assigned to different classes on either side of falling data points. Using the training vectors, the SVM optimizer will find the decision surface which will maximize the margin of separation between the two classes [3]. This process shows in Fig. 5.

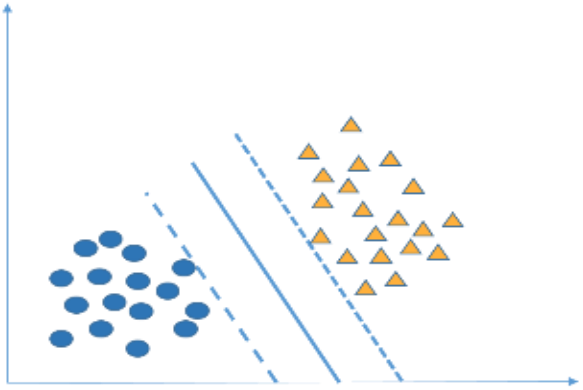

Fig. 5.SVM in Linearly Separable Conditions

The algorithm of diseases classification using SVM is below here step by step:

Step 1: At first, Load the sample images from data-set.
Step 2: Then generate data using two column matrix with sepal width and sepal length measurement for 150 irises.
Step 3: After that make a new column vector for separating data and non-data.
Step 4: Then randomly select training and test sets.
Step 5: At last, using linear kernel function for trained data and plot the ordered data.

F. Implementation

The proposed system for paddy plant leaf disease detection has been implemented using "MATLAB R18a" programming language for its simplicity and better interactive capability.

We developed the proposed system through pre-processing, segmentation, feature extraction, classification and identification of leaf disease, where every steps plays an important role. We are try to develop the system more user friendly in an efficient manner, which is shown in Fig. 6.

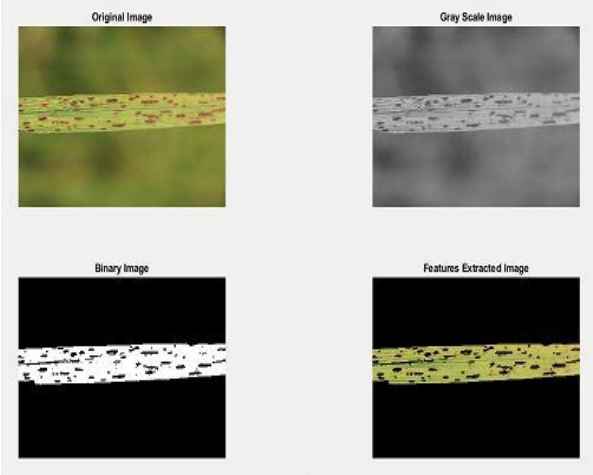

Fig. 6.Frontend Interface of the Proposed System

This system easily operates the minimum educated persons, because this system gives a visual content-based frontend interface for the users where they are easily selected the affected area and gets the name of the disease and do some necessary action in due time, which is increase the paddy productions.

IV. RESULT ANALYSIS

In this proposed system, effort to analyze four diseases of paddy plant leaf. In this system, using SVM for classification where in conventional system 1, 2 and 3 using different method for classify diseases and get different accuracy. Conventional system 1 used SVM and Bayes for classification and achieved 79.5% and 68.1% for Bayes' and SVM respectively. Conventional system 2 used CNN for classification and achieved 91.37% accuracy. In conventional system 3 used K-NN and SVM for classification and achieved 86.66% and 90.14% for SVM and K-NN. But our proposed system performed better accuracy compared to others conventional system and its accuracy is 94%.

Table- I: Comparative Accuracy of Paddy Leaf Diseases Classification

System	Identified Diseases				Applied Technique	Average Accuracy Rate (%)
Conventional System-1 [1]	Normal Leaf 92%	Brown Spot 96.4%	Blast Image 84%	Sheath Blight 82%	Bayes' and SVM	79.5% and 68.1%
Conventional System-2 [2]	Rice Blast 89.45%	Bacterial Leaf Blight 90.39%	Sheath Blight 91.37%	Healthy Leaf 88%	CNN	91.37%
Conventional System-3 [3]	Brown Spot 88%	Leaf Blast 89%	Bacterial Blight 90%	Uninfected Leaf Disease 93%	SVM and K-NN	86.66% and 90.14%
Proposed System	Brown Spot 94%	Sheath Blight 95%	Narrow Brown Spot 93%	Blast Image 96%	SVM	94%

V. CONCLUSION

To increase the paddy production in the agricultural sector, we proposed and developed a system for paddy plant leaf diseases in the initial stage. For this reason, required normal and diseased paddy leaf images for this research has been captured directly from different paddy fields of rural areas of Bangladesh by taking the permissions of these field's owners. The main aim of this research are quick and perfect detection of various paddy leaf diseases in the primary stage. To develop this system at first unnecessary background of captured images are eliminated using mask, then output is fed into segmentation part and separate the group of object for feature extraction. After that extracted the color and calculated texture features for disease portion using color feature and texture feature then create trained data-set and classified this feature using SVM and finally identify the diseases. Our developed system was tested several times, which detected four types of paddy plant leaf diseases. The system provide better solution to detect leaf diseases. The developed system were also compared with several conventional systems and found better accuracy, which is 94%. Farmers are also benefited from this system by detecting the paddy plant leaf diseases. This paper will also helpful for the new researcher, who wants to study on image processing and machine learning techniques for leaf disease detection in agricultural sector.

REFERENCES

1. S. Phadikar, J. Sil, and A. K. Das, "Classification of Rice Leaf Diseases Based on Morphological Changes," International Journal of Information and Electronics Engineering vol. 2, no. 3, pp. 460-463, 2012.
2. Vimal K. Shrivastava, Monoj K. Pradhan, Sonajharia Minz, Mahesh P. Thakur. "Rice Plant Disease Classification Using Transfer Learning Of Deep Convolution Neural Network." (2019).
3. K. Jagan Mohan, M. Balasubramanian, S. Palanivel, "Detection and Recognition of Diseases from Paddy Plant Leaf Images." (2016).
4. S. Ramesh and D. Vydeki, Recognition and classification of paddy leaf diseases using Optimized Deep Neural network with Jaya algorithm, Information Processing in Agriculture.
5. Jagadeesh D. Pujari, Rajesh Yakkundimath, Abdulmunaf S. Byadgi, Image Processing Based Detection of Fungal Diseases in Plants, Procedia Computer Science, Volume 46, 2015, Pages 1802-1808, ISSN 1877-0509.
6. Mangla, Neha and Raj, Priyanka and Hegde, Soumya. (2019). Paddy Leaf Disease Detection Using Image Processing and Machine Learning. 7. 2321-5526. 10.17148/IJIREEICE.2019.7220.
7. Kahar, Mohd Adzhar Abdul et al. "Early Detection and Classification of Paddy Diseases with Neural Networks and Fuzzy Logic." (2015).
8. J. Mosbah El Sghair, Raka Jovanovic, Milan Tuba. (2017) An Algorithm for Plant Diseases Detection Based on Color Features. International Journal of Agricultural Science, 2, 1-6.

AUTHORS PROFILE

Nargis Parven, received her Bachelor of Science degree in Computer Science and Engineering from Daffodil International University, Dhaka, Bangladesh, in 2018. Currently she is studying Master of Science and Engineering in Computer Science and Engineering at Daffodil International University. Her research interests are includes Image Processing, Machine Learning, Deep Learning, Artificial Intelligence, Network Security, Wireless Network, Information Security, and Big Data.

Muhammad Rashiduzzaman, received the Master of Science degree in Computer Science and Engineering from Daffodil International University, Dhaka, Banglsadesh, in 2020. He completed his Bachelor of Science in Computer Science and Engineering from Faculty of Science and Information Technology (FSIT) at Daffodil International University, in 2018. His research interests are includes Cryptography, Cyber Security, Network Security, Information Security, Satellite Network, Cryptocurrency, Steganography, Wireless Network, Mobile Network, Internet of Things (IoT), Artificial Intelligence, Machine Learning, Deep Learning, Image Processing, Software Security, Neural Networks and Big Data.

Nasrin Sultana, received her Bachelor of Science degree in Computer Science and Engineering from Daffodil International University, Dhaka, Bangladesh in 2018 and currently she is pursuing her Master of Science in Computer Science and Engineering at the same University. Her programming skill is very good and she is a dedicated person in her works. Her research interests include Computer Vision, Image Processing, Artificial Intelligence, Machine Learning, Deep Learning, Network Security and Information Security.

Md. Touhidur Rahman, received his BSc and MSc degrees from the Department of Computer Science & Engineering at Daffodil International University, Dhaka, Bangladesh in 2018 and 2019, respectively. He is currently working as an Assistant Programmer at the University of Dhaka, Dhaka, Bangladesh. He has already published one conference paper and one journal paper. His research interests includes Computer vision, Image processing and Human-computer Interaction, Artificial Intelligence, Machine Learning, Deep Learning.

Md. Ismail Jabiullah, received Ph.D. degree in Computer Science and Engineering from the University of Dhaka, Bangladesh. His Ph.D. topic was in Cryptography and Network Security. He is currently a Professor in the Computer Science and Engineering Department at the Daffodil International University, Dhaka, Bangladesh. He has published 39 research articles in reputed journals and more than 78 research papers in the International Conferences. He authored more than 26 books. His research interests include Network Security, Information Security, Cryptography, Cyber Security, Cryptocurrency, Steganography, Wireless Network, Mobile Network, Artificial Intelligence, Machine Language, Deep Learning, Software Security, Satellite Network, Image Processing, Software Testing and Neural Networks. He serves as a reviewer for various reputed journals and conferences annually.