PADDY DISEASE ANALYSIS USING IMAGE PROCESSING TECHNIQUE

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ABSTRACT

Paddy is a monocotyledonous angiosperm and it belongs to Oryza. It contains more than 20 species, yet just two species are alluded to as development. In this proposed work different data set is considered with kNN classifier, in this experimentation, the features extracted from red component is used for training and the features extracted from green component is consider for testing which has given a success rate of 87%.In agricultural field recognition of healthy or diseased plant was the major constrain. The control period was habitually missed because the traditional approaches are taking long time to analyse. Because an expert has to visit agricultural field repeatedly, it may take more time to analyse, and it may be burden to the farmer. The Proposed system we analyze the paddy disease .

Keyword: Paddy Disease, KNN Clasifier,Feature Extraction.

I.INTRODUCTION

PADDY DISEASE:

Leaf Blast (Pyricularia grisae)

Leaf blast (LB) caused by Pyricularia grisae , a fungal pathogen. A blackish, rhombus-shaped, brown spot with a white colored central patches will appears at the leaves of the sick plan. Leaf blast is difficult to control because it's ability to forms pathogen strains quickly .

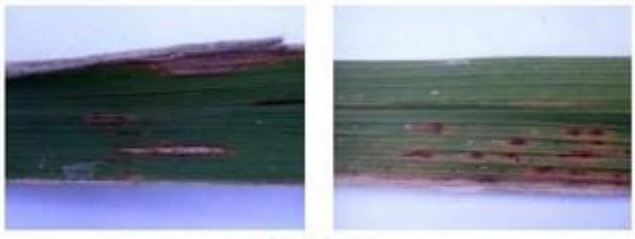


Fig 1.4.1 leaf blast

Brown Spot (Helminthosporium oryzae)

Brown spot (BS) caused by the fungus Helminthosporium oryzae. This disease can cause death in young rice plants and reduces grain quality. Leaves of the rice plants affected by this disease will have an oval shaped or round shaped brown colored patches about the size of sesame seeds .

Fig 1.4.2 Brown spot

Bacterial Leaf Blight (Xanthomonas campestris)

Fig 1.4.3 bacterial leaf

Bacterial leaf blight (BLB) is a disease caused by the bacterium Xanthomonas campestris. This disease is widespread and lowering the yield to 36%. HBD disease produces two characteristic symptoms: the crackle and blight. Crackle is a symptom that occurs in old plants <30 days. Leaves becomes grayish, folded, and rolled. In severe circumstances, the entire leaf curl, wilt, and die. Symptoms begin with a speckling of gray (yellow) on the edge of the leaf. During its development, the symptoms will be expanded, forming blight, and finally dried leaves .

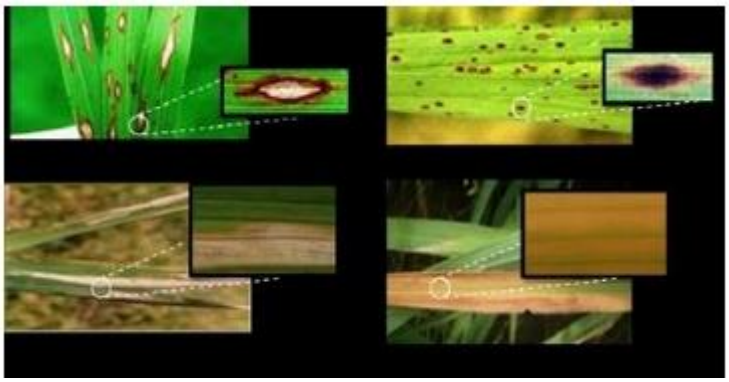
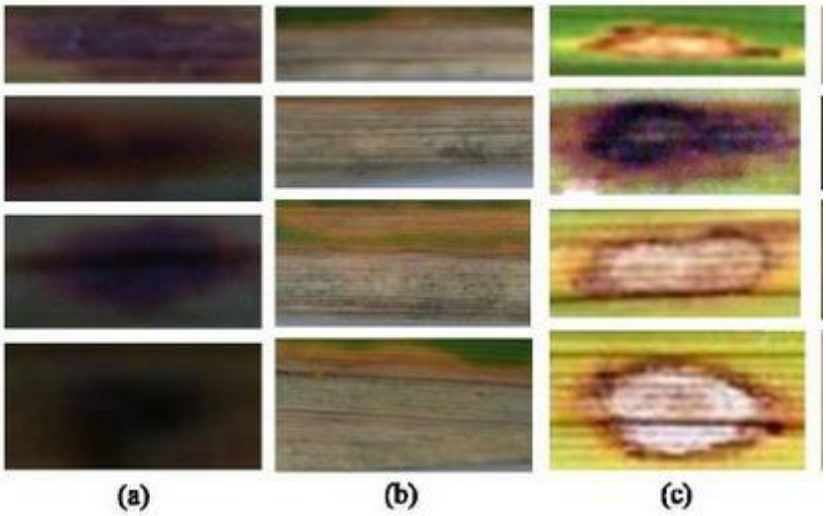


Fig 1.4.4 paddy disease

Tungro (TG) is one of the important diseases in rice. It is very destructive. It caused by tungro bacilliform virus (RTBV). Depends on the phase of the infected plants, tungro can cause 5-70% yield loss. The younger the plants is, he loss caused by tungro will be greater. Tungro attacks prominent symptom is discoloration of leaves and stunted plant growth. Diseased plant leaf color varies from slightly yellow to orange. The typical symptoms are determined by the level of resistance of varieties, environmental conditions, and the growth stage when the plants infected . From above description, we already seen the general characteristic of each disease. In practice, diagnosing a disease visually involves more than one lesion characteristic i.e. the location of the symptoms, the spots or lesions shape, the size of the spots or lesions, and the color of the spots or lesions . In this research, we only focused on descripting the color texture of the disease lesions. This, however, does not mean that color texture is enough to differentiate the diseases. Some diseases may have a similar color and can only be differentiate by using the shape. The most obvious example of this kind of disease are brown spot .

No	Pest	Area of Attack (ha)
1	Rice Stem Borers	57,875
2	Brown Planthopper	11,351
3	Rats	54,300
4	Tungro	4,994
5	Leaf Blast	31,383
6	Bacterial leaf blight	43,719



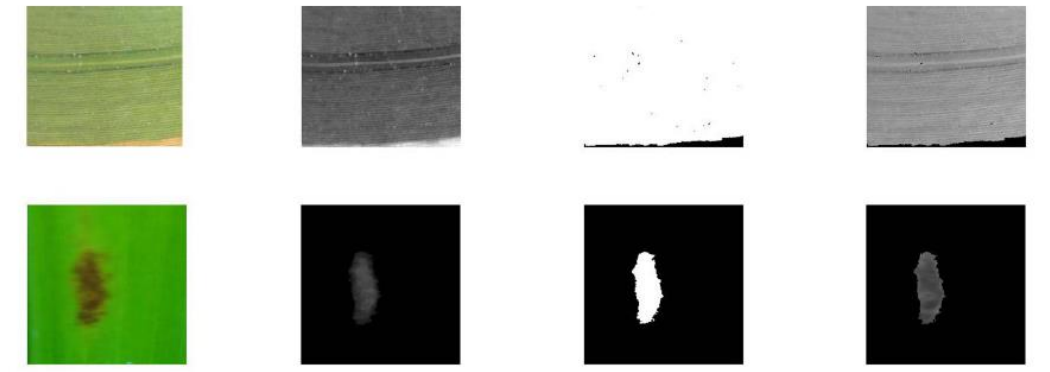
2 .LITERATURE REVIEW

2.1 IDENTIFICATION OF HEALTHY AND DISEASED PADDY LEAVES USING Knn CLASSIFIER

AUTHOR: Shreekanth K N

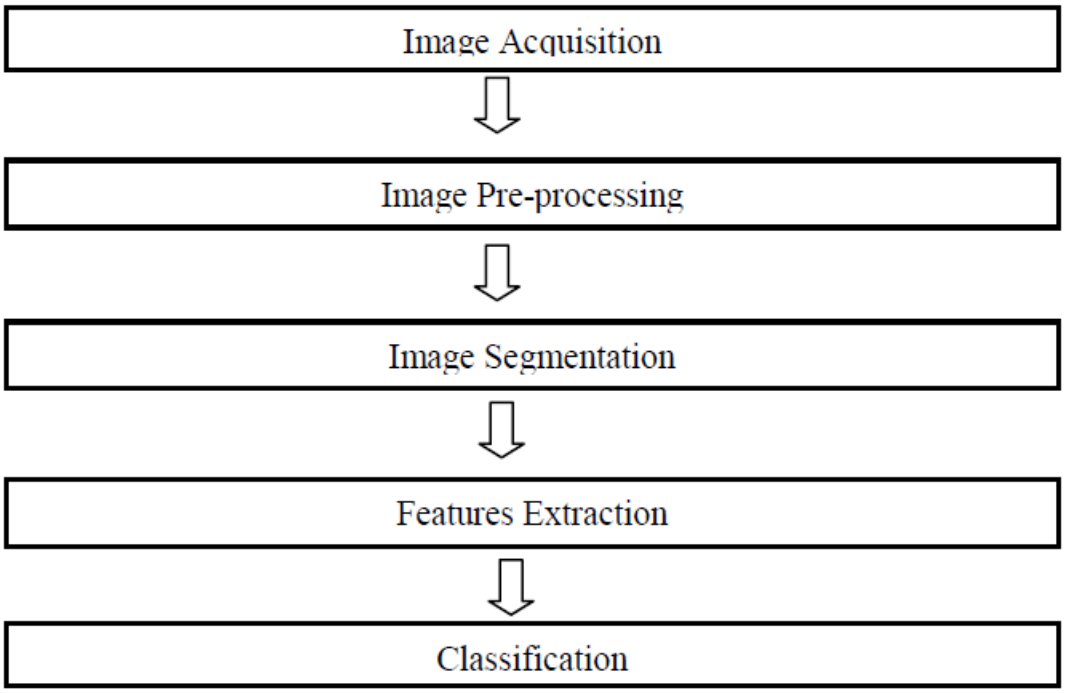
Rice is a monocotyledonous angiosperm and it belongs to Oryza. It contains more than 20 species, yet just two species are alluded to as development ie Oryzasativa and Oryzaglaberrima developed in south-east Asia and West African nations. Basically rice was developed in the tropical locale of Asia, and from the past record rice is from 5000 years BC, and there after reached out to calm areas . Rice is a fundamental staple nutrition food in Asia. In an Asian country rice is the major leading food which is grown all over the world ie 90%. Three billion Asian people were intake caloric in the ratio of 35 – 60% . Plant development was suggestively decreased with compared to un-inoculated plants and inoculated plants. Blast disease indications of Rice are also produced in inoculated plants . Rice Brown Spot is the evolving disease in low fertility and marginal areas which causes substantial yield loss . Initially brown spot lesions and blast diseased lesions are difficult to distinguish. Blast lesions turn to diamond or spindle shape after maturity .Rice (Oryzasativa) blast, instigated by Magnaporthegrisea, which is one of the most harmful agent of rice. Many studies have been conducted to resist mechanisms of rice to the blast fungus and thus several antifungal substances have been isolated from rice leaves . In particular, seven parasites Curvularialunata, Magnaportheoryzae,Fusariummoniliforme, Helminthosporiumoryzae, Nigrosporaoryzae, Aspergillusniger and Alternariaalternata were disconnected from influenced leaves and seeds contaminated leaves of five rice assortments viz., IRRI-8, IRRI-6, KS-282, DR-82, and Shua. N. Oryzae is disconnected just from IRRI-8 and IRRI-6 rice assortments. Among these growths, M. Oryzae was, for the most part, disengaged both from leaves and seeds of the rice assortments considered. M. Oryzae was detected with maximum frequency from seeds and leaves of IRRI-6 .Brown Spot diseases is one of the most significant diseases in rice, Brown spot is caused by the fungus Bipolarisoryzae (earlier identified as Helminthosporiumoryzae)can affect all plant parts of the paddy which will affect the quality of grain and yield losses. Brown spot symptoms primarily

appear as small circular to oval spots on the leaves. Yield loss, shape, size, and color these depend on and and these are estimated based on environmental conditions and rice variety, 16 to 40% of yield loss observed in Florida. Large spots have a light grey centre enclosed by a dark to reddish-brown margin or reddish-brown while small spots are dark brown to reddish brown. Elder spots may have a bright yellow halo surrounding the lesion. Spots on the hulls and leaf sheath are similar to those on the leaves. Diseases are most important causes for quality and quantity reduction in agricultural products. Plant diseases also can harm and wreck the agricultural fields. The tungro is the most important rice virus disease; it is transmitting through green leaf hopper and it is the one of most destructive diseases of rice at the early stage of the tungro. Disease symptoms are absent and symptoms appear only in the later stages . Rice plants infected with tungro symptoms including stunting growth which leads to yellow to orange discoloration and reduced tillering. Leaves may discolour and shows irregular shaped dark-brown blotches. The younger leaves how striping or mottling along with intervernalchlorosis.Bacterial blight is one of the most devastating diseases of rice worldwide and is found both in tropical and temperate regions .



Original Image Smoothened Image Binary Image Segmented Gray Image

The disease is accountable for a loss of 20-30% in different countries. In India losses in yield varied from 6-60% in different states depending upon stage and severity of infection and type of cultivars . Leaf blight is one of the most common syndrome, it begins like water-soaked stripes on the leaf blades. Then stripes enlarged in area and become yellow to white and enclosed entire leaf blade. Water-soaked margins are small circular lesions, they appear in severe infections, and infected plants produce poor quality of grain. Bacterial leaf blight is produced by Xanthomonasoryzaepv.oryzae. It is Gram-negative, non-spore forming rod .Bacterial Brown Stripe also known as bacterial stripe occurs in nurseries and also distributed widely in rice growing countries .The symptoms of this disease in seedling stage are inhibition of germination occurring brown stripes interveinally or margins of leaf sheath is curving and abnormal elongation of mesocotyl. Manifestations were covered after the contaminated seedlings were transplanted to paddy fields. The regular event of the illness was seen where rice plants were submerged by overflowed water . Bacterial dark colored stripe is caused by Pseudomonas syringaepv. panici. is a Gram-negative, non-spore-shaping, non-embodied pole .



2.2 Paddy Diseases Identification with Texture Analysis using Fractal Descriptors Based on Fourier Spectrum

AUTHOR: Auzi Asfarian, Yeni Herdiyeni

The efforts to increasing the quantity and quality of rice production are obstructed by the paddy disease. This research attempted to identify the four major paddy diseases in Indonesia (leaf blast, brown spot, bacterial leaf blight, and tungro) using fractal descriptors to analyze the texture of the lesions. The lesion images were extracted manually. The descriptors of 'S' component of each lesion images then used in classification process using probabilistic neural networks. These techniques achieved at least 83.00% accuracy when identifying the diseases. This method has a potential to be used as one of the feature if it combined with other features, especially when two diseases with relatively same color involved.

The efforts to increase the quantity and quality of rice production to satisfy the increasing needs of rice in Indonesia experienced several obstacles, one of which is the attack of the diseases on paddy fields. Indonesian Directorate General of Food Crops stated that during the period of October 2011 to March 2012, 80,096 hectares of paddy fields exposed to attach by three major paddy diseases in Indonesia: tungro, leaf blast, and leaf blight. To control these diseases and to minimize the impacts of the attacks, the diseases must be identified quickly. Unfortunately, experts who are able to identify the diseases are often unavailable in some region . Computer vision is a potential solution to tackles this problem. One way to identify the diseases in plants is by observing the physical changes (diseases spots or lesions) caused by chemical changes in the sick plants . The images of these spots can be processed and used to recognize the diseases quickly, easily, and inexpensively . This method also nondestructive and the results are consistent. This

method involves the extraction the features of the said disease lesion. The common paddy lesion features are the texture, the color, the position, or the size of spots or lesions . Some research combined more than one of these features. For example, used the texture, color, and shape to recognize blast, sheath blight, and brown spot, the three major rice diseases in Sri Lanka, with 70% accuracy. used a color features (e.g. boundary color and spot color) to recognize blast, brown spot, and narrow brown spot diseases and achieved 87.5% accuracy. proposed a new technique to analyze the texture using fractal descriptors based on image Fourier spectrum. When tested to four different datasets (Brodatz, USPTex, OuTex, and plant leaves), this method is more accurate and faster than any other fractal descriptor estimation techniques. This research attempted to identify the four major paddy diseases in Indonesia using fractal descriptors proposed by and assess the performance of said method. The four diseases are leaf blast.

II.PROBLEM DESCRIPTION

EXISTING SYSTEM

In agriculture sector where farmers and agribusinesses have to make innumerable decisions every day and intricate complexities involves the various factors influencing them. An essential issue for agricultural planning intention is the accurate yield estimation for the numerous crops involved in the planning. Data mining techniques are necessary approach for accomplishing practical and effective solutions for this problem. Agriculture has been an obvious target for big data. Environmental conditions, variability in soil, input levels, combinations and commodity prices have made it all the more relevant for farmers to use information and get help to make critical farming decisions.

The texture features used in this work are, LBP, Haar Wavelets, GLCM and Gabor features. The attributes used in these texture features are explained in the subsequent sections. Results obtained from each texture feature set and best discriminative subset of features from HSI and YCbCr color models are selected empirically based on combination of features. The below mentioned algorithm discuss about proposed methodology which covers segmentation, feature extraction and classification.

Algorithm

1. Transform a RGB arecanut image to HSI and YCbCr color model.
2. Extract Saturation component from HSI for segmentation of arecanut from background.
3. Threshold based segmentation is used based on Global image threshold using Otsu method.
4. The color components extracted from HSI and YCbCr are Hue, Saturation, Intensity, Yellow, Chromatic Blue and Chromatic red.
5. Enumerate all these color components. Segmented image is multiplied with color component in iteration.
6. From each color component Haar Wavelets, GLCM, Gabor texture features are extracted.

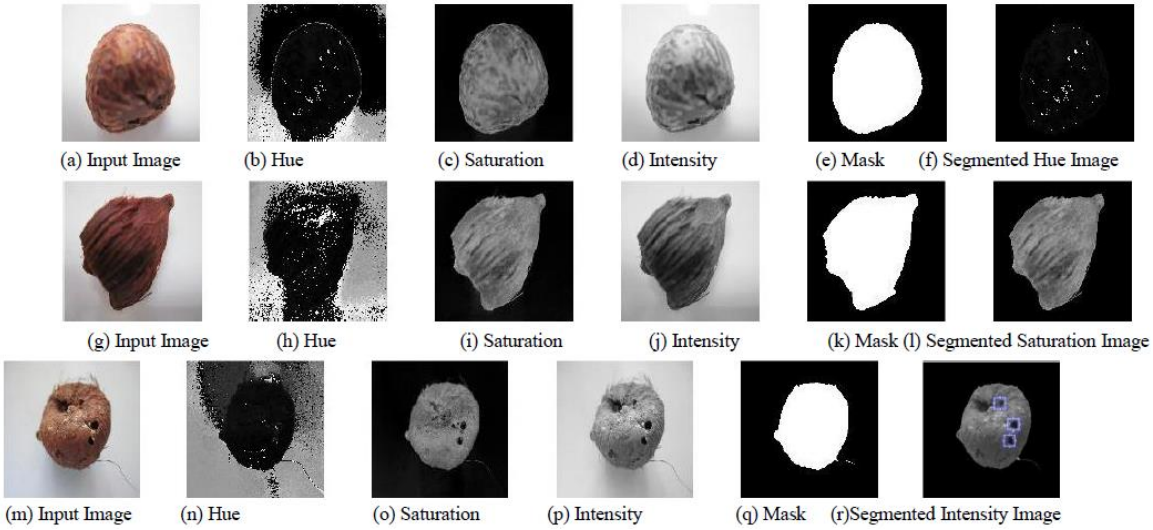


Fig 3.1 feature extraction

Wavelets Features used in this work

Mean Value of approximation, horizontal, vertical and diagonal energy	$\frac{1}{mn}\sum_{i=1}^{m}\sum_{j=1}^{n}x_{ij}$
Mean of Decomposition Vector	$\frac{1}{n}\sum_{i=1}^{n}x_i$
Variance of Decomposition Vector	$\frac{1}{n}\sum_{i=1}^{n}(x_i-\mu)^2$
Entropy of Decomposition Vector	$-\sum_{i=1}^{n}p(x_i)\log_2 p(x_i)$

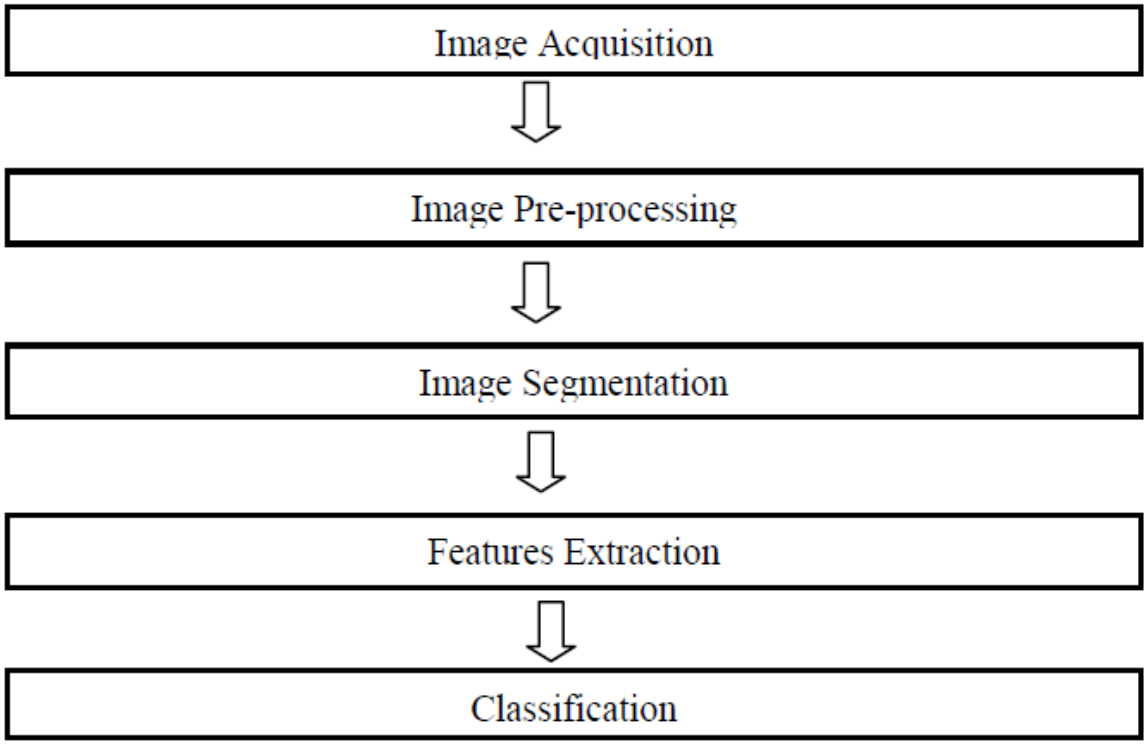


Fig 3.1.2 Architecture

A. Image acquisition:

Sampled Images are captured using sony digital camera with 18.1 megapixels in day light because clear view of leaf object is required for analysis. Sample diseased and healthy paddy leaves are shown in figure 2.

B. Image Pre-processing:

Pre-processing is the preliminary step before segmentation and feature extraction. In this proposed work images are resized to 255 X 255 to improve the accuracy of an algorithm. Individual RGB components are extracted for image smoothening. Here the G and B components are interpolated with scalar values and the resultant value is subtracted with R component and multiplied with a value shown in equation (2). Images are smoothened and then enhanced. In resultant image the healthy part and diseased part can be easily identified because the diseased part appears darker compared to other part of the leaf using equation (2). Same type of other calculation for R, G, B components are conducted .

$$SIM = 2 X (R – (0.75 X G – 0.25 X B)) \quad (2)$$

C. Image segmentation:

In image analysis and pattern recognition segmentation is the major task, partitioning of an image into groups of pixels based on similarity measurement is known as segmentation. It helps in the feature extraction

from the segmented image based on the interested area or based on the objective which is considered for the experiment . Pre- processing of images is significant task. In proposed methodology image smoothening were carried out using equation (2). For resultant images segmentation are carried out by using global thresholding method of Otsu segmentation. Experimental segmented images .

Normalized Block Size	*Sample data set*	*Accuracy*
255 X 255	Gray images	77.71%
	Similarity difference of Gray with Red component	70.48%
	Similarity difference of Gray with Green component	75.30%
	Similarity difference of Gray with Blue component	78.91%
	Red component	79.57%
	Green component	79.51%
	Blue component	76.50%
32 X 32	Gray images	84.93%

D. Feature extraction:

The local binary pattern texture feature information extraction was proposed by Ojala et al.,.Based on theory, texture has locally two corresponding parts like a pattern and its strength with the goal of texture

Image Acquisition

Image Pre-processing

Image Segmentation

Features Extraction

classification and then it is extended to face detection, face recognition, face expression recognition, disease identification etc.

The advantages of LBP are it is invariance to monotonic gray-scale modifications, convenient multi-scale extension and minimum computational. Traditional and statistical structural methods are well designed in LBP. In an input image each processing pixel is matched with its eight neighbors and ones whose intensities exceed the processing pixels are marked as 1, else as 0, in resultant a circular point features consisting of only binary bits were measured. Naturally the feature ring is considered as row vector, and binomial weight

assigned to each bit. Row vector is transformed to decimal for further work. Local Binary Pattern using circular neighbourhoods and linearly incorporating the pixel values allows the choice of any radius, R, and number of pixel in the neighbourhood, P, to form an operator, which can model large scale structure.Basic LBP is noise sensitive, because the threshold value is the processing pixel, so average of pixels including processing pixel that encompass by an LBP operator as a threshold. The mathematical model for LBP is shown in equation (3)

Where gc is the average gray value of the pixels and gp is the intensity value of pixels in eight neighborhood.

$$d(GRAY, R) = GRAY(x, y) - R(x, y)$$
$$d(GRAY, G) = GRAY(x, y) - G(x, y)$$
$$d(GRAY, B) = GRAY(x, y) - B(x, y)$$

Where GRAY – Gray component,
R – Red component,
G – Green component,
B – Blue component.

3.2 PROPOSED SYSTEM:

Classification algorithm in R mining

DATA MINING IS A TECHNIQUE USED IN VARIOUS DOMAINS TO GIVE MEANING TO THE AVAILABLE DATA CLASSIFICATION IS A DATA MINING (MACHINE LEARNING) TECHNIQUE USED TO PREDICT GROUP MEMBERSHIP FOR DATA INSTANCES. IN THIS PAPER, WE PRESENT THE BASIC CLASSIFICATION TECHNIQUES. SEVERAL MAJOR KINDS OF CLASSIFICATION METHOD INCLUDING DECISION TREE, BAYESIAN NETWORKS, K-NEAREST NEIGHBOUR CLASSIFIER, NEURAL NETWORK, SUPPORT VECTOR MACHINE. THE GOAL OF THIS PAPER IS TO PROVIDE A REVIEW OF DIFFERENT CLASSIFICATION TECHNIQUES IN DATA MINING. KEYWORDS— DATA MINING, CLASSIFICATION, SUPPER VECTOR MACHINE (SVM), K-NEAREST NEIGHBOUR (KNN), DECISION TREE.

3.2.1 K-NEAREST NEIGHBORS ALGORITHM

Known as: Ibk algorithm, Nearest neighbors classifier, K-NN

I. IN PATTERN RECOGNITION, THE K-NEAREST NEIGHBORS ALGORITHM (OR K-NN FOR SHORT) IS A NON-PARAMETRIC METHOD USED FOR CLASSIFICATION AND REGRESSION. IN BOTH CASES, THE INPUT CONSISTS OF

THE K CLOSEST TRAINING EXAMPLES IN THE FEATURE SPACE. THE OUTPUT DEPENDS ON WHETHER K-NN IS USED FOR CLASSIFICATION OR REGRESSION: K-NN IS A TYPE OF INSTANCE-BASED LEARNING, OR LAZY LEARNING, WHERE THE FUNCTION IS ONLY APPROXIMATED LOCALLY AND ALL COMPUTATION IS DEFERRED UNTIL CLASSIFICATION. THE K-NN ALGORITHM IS AMONG THE SIMPLEST OF ALL MACHINE LEARNING ALGORITHMS.

3.3 PROPOSED TOOL

INTRODUCTION TO R

R is a language and environment for statistical computing and graphics. It is a GNU project which is similar to the S language and environment which was developed at Bell Laboratories (formerly AT&T, now Lucent Technologies) by John Chambers and colleagues. R can be considered as a different implementation of S. There are some important differences, but much code written for S runs unaltered under R.

R provides a wide variety of statistical (linear and nonlinear modelling, classical statistical tests, time-series analysis, classification, clustering, …) and graphical techniques, and is highly extensible. The S language is often the vehicle of choice for research in statistical methodology, and R provides an Open Source route to participation in that activity.

One of R's strengths is the ease with which well-designed publication-quality plots can be produced, including mathematical symbols and formulae where needed. Great care has been taken over the defaults for the minor design choices in graphics, but the user retains full control.

R is available as Free Software under the terms of the Free Software Foundation's GNU General Public License in source code form. It compiles and runs on a wide variety of UNIX platforms and similar systems (including FreeBSD and Linux), Windows and MacOS.

The R environment

R is an integrated suite of software facilities for data manipulation, calculation and graphical display. It includes an effective data handling and storage facility,

a suite of operators for calculations on arrays, in particular matrices,

a large, coherent, integrated collection of intermediate tools for data analysis,

graphical facilities for data analysis and display either on-screen or on hardcopy, and

a well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities.

The term “environment” is intended to characterize it as a fully planned and coherent system, rather than an incremental accretion of very specific and inflexible tools, as is frequently the case with other data analysis software.

R, like S, is designed around a true computer language, and it allows users to add additional functionality by defining new functions. Much of the system is itself written in the R dialect of S, which makes it easy for users to follow the algorithmic choices made. For computationally-intensive tasks, C, C++ and Fortran code can be linked and called at run time. Advanced users can write C code to manipulate R objects directly.

Many users think of R as a statistics system. We prefer to think of it of an environment within which statistical techniques are implemented. R can be extended (easily) via packages. There are about eight packages supplied with the R distribution and many more are available through the CRAN family of Internet sites covering a very wide range of modern statistics.

IV.EXPERIMENTAL RESULT

R has its own LaTeX-like documentation format, which is used to supply comprehensive documentation, both on-line in a number of formats and in hardcopy.

```
summary(paddy)
  Crop year          Long-grain    Medium-grain
 Length:68          Min.   :41.60   Length:68
 Class :character   1st Qu.:60.63   Class :character
 Mode  :character   Median :68.87   Mode  :character
                    Mean   :65.39
                    3rd Qu.:73.18
                    Max.   :79.52
                    NA's   :14
  Short-grain      Total production   Temperature
 Min.   : 0.4725   Length:68          Length:68
 1st Qu.: 1.3138   Class :character   Class :character
 Median : 1.9162   Mode  :character   Mode  :character
 Mean   : 4.2678
 3rd Qu.: 8.1673
 Max.   :11.9000
 NA's   :14
 Environment          Disease          Crop year__1
 Length:68          Length:68          Length:68
```

```
 Class :character   Class :character   Class :character
 Mode  :character   Mode  :character   Mode  :character



 United States     Arkansas      California
 Min.   :3411   Min.   :3500   Min.   :4325
 1st Qu.:4548   1st Qu.:4530   1st Qu.:5658
 Median :5555   Median :5300   Median :7380
 Mean   :5578   Mean   :5492   Mean   :7018
 3rd Qu.:6647   3rd Qu.:6545   3rd Qu.:8225
 Max.   :7694   Max.   :7560   Max.   :8890
 NA's   :9      NA's   :9      NA's   :9
    india              banglore        kerala
 Length:68          Min.   :2950   Min.   :3300
 Class :character   1st Qu.:4275   1st Qu.:4373
 Mode  :character   Median :5400   Median :5100
                    Mean   :5371   Mean   :5242
                    3rd Qu.:6650   3rd Qu.:6265
                    Max.   :7420   Max.   :7770
                    NA's   :9      NA's   :9
       up
 Min.   :2900
 1st Qu.:4580
 Median :5600
 Mean   :5631
 3rd Qu.:6770
 Max.   :8370
 NA's   :9
```

Knn algorithm:

Step1:

```
str(paddy)
Classes ‘tbl_df’, ‘tbl’ and 'data.frame':    68 obs. of  16 variables:
 $ Crop year       : chr  NA NA "1965" "1966" ...
 $ Long-grain      : num  NA NA 43 41.6 48.5 46.8 49 49.3 NA 52.6 ...
 $ Medium-grain    : chr  "- - - - - - - - - - - - - - - - - - - - - - - - Perce
nt - - - - - - - - - - - - - - - - - - - - -" NA "45.6" "46.5" ...
 $ Short-grain     : num  NA NA 11.4 11.9 9.2 11.1 10.7 10.3 NA 10.2 ...
 $ Total production: chr  "1,000 cwt" NA "76281" "85020" ...
 $ Temperature     : chr  NA NA "23.5° to 35°" "23.5° to 35°" ...
 $ Environment     : chr  NA NA "warm" "warm" ...
 $ Disease         : chr  NA NA "Bacterial leaf blight" "Bacterial leaf
blight" ...
 $ Crop year__1    : chr  NA NA NA "1960" ...
 $ United States   : num  NA NA NA 3423 3411 ...
 $ Arkansas        : num  NA NA NA 3525 3500 ...
```

```
 $ California      : num  NA NA NA 4775 4800 ...
 $ india           : chr  NA "- - - - - - - - - - - - - - - - - - - - - - - - - -
- - - - - -  - - - - Pounds per acre - - - - - - - - - - - - - - - - "|
__truncated__ NA "2850" ...
 $ banglore        : num  NA NA NA 2950 3300 3200 3900 3800 3700 4300 ..
.
 $ kerala          : num  NA NA NA 3400 3300 4200 4200 4300 4500 4400 ..
.
 $ up              : num  NA NA NA 3075 2900 ...
```

CONCLUSION

In this thesisclassification of healthy and diseased paddy leaves is identified using kNN classifier with DBSCAN features. There are three types of diseases called viral, bacterial and fungal. In this paper, we have considered only identification of healthy and diseased leaf. classify the accuracy level.

REFERENCE:

[1] Ansari, M. M., & Sridhar, R. (2012). Iron nutrition and virulence in Xanthomonasoryzaepv. oryzae. Indian Phytopathology.

[2] Aryal L, Bhattarai. G, SubediA Subedi .M , Subedi .M &Sah. G.K. (2016, April-June) Response of Rice Varieties to Brown Spot Disease of Rice at Paklihawa, Rupandehi, Global Journal of Biology, Agriculture and Health Sciences, ISSN: 2319-5584, G.J.B.A.H.S., Vol.5(2) pp: 50-54.

[3] Caglayan, A., Guclu, O., & Can, A. B. (2013, September). A plant recognition approach using shape and color features in leaf images. In International Conference on Image Analysis and Processing (pp. 161-170). Springer, Berlin, Heidelberg.

[4] Datnoff, L. E., &Lentini, R. S. (1994). Brown spot in Florida rice.

[5] Daud, S. M., Jozani, H. J., & Arab, F. (2013). A review on predicting outbreak of tungro disease in rice fields based on epidemiological and biophysical factors. International Journal of Innovation, Management and Technology, 4(4), 447.

[6] Gnanamanickam, S. S. 2009. Major diseases of rice, in Biological Control of Rice Diseases, Springer publications, ch. 2, pp. 32-34.

[7] Guyer, D., Tuttle, A., Rouse, S., Volrath, S., Johnson, M., Potter, S., ...& Ward, E. (1998). Activation of latent

transgenes in Arabidopsis using a hybrid transcription factor. Genetics, 149(2), 633-639.

[8] Hibino, H. (1996). Biology and epidemiology of rice viruses. Annual review of phytopathology, 34(1), 249-274.

[9] Hibino, H., Roechan, M., &Sudarisman, S. (1978). Association of two types of virus particles with penyakithabang (tungro disease) of rice in Indonesia. Phytopathology, 68(10), 1412-1416.

[10] Jamal-u-ddinHajano, M. A., Pathan, Q. A., &Mubeen, A. L. (2011). Rice blast-mycoflora, symptomatology and pathogenicity. International Journal for Agro Veterinary and Medical Sciences, 5(1), 53-63.