Rice Disease Detection by using techniques of machine learning, Image processing and AI: A Systematic Literature Review

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Abstract

Introduction: Rice plant diseases can cause damages and yield losses. To reduce the productivity losses, farmers need to observe and decide suitable treatments for the diseases recognized from the abnormal characteristics appeared in their farms. Traditionally, farmers identify potential diseases from their experiences or by consulting other experts. However, this approach has certain disadvantages due to varying knowledge, and at times unreliable experience and perception of different farmers. Externalization of knowledge from existing reliable sources and utilization of multiple farmer's observations can overcome such problems. Thus, to study these kind of diseases many experts provide different solutions by using the techniques of machine learning, Image Processing, as well as Neuro computing Therefore, this review aims to examine the research studies that deal with the issue of rice disease and to determine the characteristics of these disease to be identified to overcome this..

Methodology: In last 20 years many researchers have worked in the rice disease detection by applying different techniques of machine learning and image processing and published their work in a well-known journal. Although most of researchers worked on this field to get the best output. In this view as per our best knowledge there is no comprehensive systematic literature review (SLR) has enumerate the primary studies on rice disease detection over past 20 years. Though we applied preferable knowledge from well-known databases, and we don't find any result in regard to provide secondary study on the topic of rice disease detection. Consequently, the current study aims to present SLR of academic article on rice disease detection published from 2000 to 2020. Thus we intend to maximize the discussion based on different aspects, namely detection of rice disease in leaves of rice plant, suggest proper solution for blast disease by using different techniques of images Processing and Machine Learning, Different Semantic-Based Framework for Rice Plant Disease Management, Different datasets that are not explicitly mentioned in most of articles, Image processing techniques to automate the process to rice disease techniques.

Results: To achieve our objectives ,542 primary studies from 5 well known databases were systematically selected after applying searching criteria on well-defined keywords. After removing duplicate articles and apply screening on remaining 228 articles based on their title and abstract, we sort 31 articles for study. This review clarifies 3 types of rice disease,3 types of machine learning techniques as SVM, frameworks, Image Processing techniques of RGB coloring to find spot on rice plant Furthermore, this review determined bag of words; bag of phrase and bag of concepts features thereby showing improved classification results .SVM-based ,SPS-based , Image classification-based ,k-means classification approaches were commonly adopted to classify the rice diseases. To determined accuracy of these classification approaches we used precision, Confusion matrix.

Conclusion: Finally open research issues and challenges are presented for future scholars who are interested in rice disease detection .This SLR absolutely will be beneficial resources for researchers, agriculture experts as well as for formers who are engaged in the field of agriculture studies and related to rice crop diseases.

Keywords: rice disease detection, Image Processing, Machine Learning, Artificial Intelligence, Image Classification.

1. Introduction

Agriculture is the main source of income in different countries of the world. Generally, Rice has been the important source of food consumption in different countries of world. Particularly, almost 90% of rice is consumed in Asia in term of food consumption. So, there is need of increase in productivity of rice in Asia but the productivity of rice is infected by the various rice plant disease.

Moreover, different types of Rice Disease are Rice Blast, Bacterial Blight, Brown spot, Sheath Blight, Sheath Rot (Devi, Hemalatha et al. 2017). Rice plant disease cause great loss and damages. Generally, Due to rice blast disease, 60 million people are affected in 85 countries worldwide (Devi, Hemalatha et al. 2017). Particularly, In Asia 10 to 15% of production is destroyed because of rice diseases (Daniya and Vigneshwari 2019). To reduce the loss, there should be proper method to detect the rice plant disease earlier. If the rice plant disease detects earlier then the loss will be minimum. The steps concerned in classification and detection of rice plant diseases are discussed as follows:

(i) image acquisition

(ii) image pre-processing

(iii) image segmentation

(iv) feature extraction

(v) selection of features

(vi) classification (Ghyar and Birajdar 2018).

This Systematic Literature Review (SLR) reviews the different techniques of machine learning and image processing to identify the rice plant disease such as Probabilistic Neural Network (PNN), Genetic Algorithms (GA), k-Nearest Neighbor Classifier (KNN) and Support Vector Machine (SVM) (Daniya and Vigneshwari 2019). We have collected article of rice plant disease from 5 different database published from 2000 to 2020. We got total 450 articles. After removing duplicates, we got 228 articles. After abstract screening we got 80 articles. After full text screening we got 21 articles. After reference screening we got 15 articles and after quality assessment we got 11 articles which we have review in this SLR. Structure to be followed as REDF, here “R” consists for Rice Disease and “E” includes Early Stage and “D” stands for Detection and the “F” focuses on for farmers.

This SLR aims to provide the authenticated algorithm and image processing/machine learning techniques for early stage rice disease detection for farmers, researchers, and Agricultural experts and their characteristics to overcome the rice disease. In the agricultural world, many well known researchers have proposed authenticated rice disease detection studies. The need of this Systematic Literature Review (SLR) is that as per our best knowledge there is no SLR present on this topic so our Systematic Literature Review (SLR) will help the researcher to review all the published articles in one place.

The SLR is organized as follow, Section I gives the Systematic Literature Review (SLR) introduction of authenticated studies proposed by agricultural expert and researcher, Section II gives the methodology in which we apply the selection criteria and quality assessment to proposed this

Systematic Literature Review (SLR), Section III present the review of all the articles which we included on the basis of our selection criteria, Section IV present the discussion on the included quality articles, Section V present the future research direction for the upcoming researchers, agricultural experts and professionals. Section VI summarize the whole study and present the conclusion of Systematic Literature Review (SLR). In image analyzing the symptoms is an essential part for feature extraction and classification. However, some of the challenges are still lacking to predict the disease. To meet those challenges, the proposed algorithm focuses on a specific problem to predict the disease from early symptoms. Bacterial Leaf Blight and Brown Spot are a major bacterial and fungal disease respectively in rice (Oryza sativa) crops, it causes yield loss and reduce the grains quality(Archana and Sahayadhas 2018)

2. Methodology

2.1 Research Design

This study is comprised of two parts. In first part, we describe a summary of findings whatever we get through our collected studies for the sake of getting good understanding of that particular aspects (Ana, Loreto et al. 2020) and to enable for the identification of gaps in pervious given studies. This way of study assists us to reflect, explore, review, and analyze the synthesis of the information on that particular topic, for the sake of exploring the current state of knowledge, suggest some precautions for implementation for finding the limitations and gaps that will be helpful for the researchers in future. As such, this strategy is useful for the identifications of studies that enable us scientific evidence on early rice disease detection using multiple algorithms and techniques of Image processing and machine learning (Cheng and Ying 2004).

Another part of this study consists of searching the different studies who have much contributed in detecting the disease of rice at early stage. The motive of this study is providing the knowledge, usages and implementation of that algorithm and techniques which are related to our topic.

The purpose of this design is to clarify the use automated techniques and algorithm to improve the rice production by early identification of rice disease and proposed well known solutions to overcome these harmful diseases. Initially, we set our inclusion/exclusion criteria, our keywords, research questions and databases based on our objectives. The searching of the articles was performed with respect to our stated inclusion/exclusion criteria. The studies that were comprises in inclusion criteria were gathered, reviewed, and grouped in a categorical form.

2.2 Research Question

The research question was as follows: How many authenticated algorithm and techniques are available for early stage rice disease detection for farmers, researchers, and Agricultural experts and what are their characteristics? How to propose well known solutions to increase the rice production? Evaluation of studies for the rice disease detection by using image processing and machine learning. Structure to be followed as REDF, here “R” consists for Rice Disease and “E” includes Early Stage and “D” stands for Detection and the “F” focuses on for farmers.

2.3 Criteria for Selection of articles

2.3.1 Inclusion Criteria

The selection of the studies was conducted by four different intelligent researchers separately, and the inclusion criteria is given below:

Types of studies: Agricultural (Rice) disease trials using image processing and machine learning techniques.

Inclusion survey-based articles for rice disease detection.

Types of participants: Farmers, researchers, and agricultural experts.

Types of Techniques are Image Segmentation, Image Classification, Computer Vision, Neural Networks *Table 6*

2.3.2 Exclusion Criteria

No access to full text document.

Duplicates results in Databases.

Techniques for agricultural disease detection other than rice.

IOT based techniques for rice disease detection

2.4 Search Strategy

The selection of studies was conducted from February till April 2020 through a well-known and authenticated database. Thus, various search keywords are formulated to retrieve related literature from five reliable and high-quality academic databases, namely, Web of Science (WoS), Scopus, IEEE Xplore, PubMed and Google Scholar. Four well known authors (Naseer Ahmed, Saad Ishaq, Asra Aijaz, Mashooque Ali) gathered the list of several keywords to find out the relevant literature on "Rice Disease Detection by using techniques of machine learning, Image processing and AI: A Systematic Literature Review" from the selected databases. Many studies had premium access on different databases so, we contact with their authors to get the full access of studies. *Table 1* shows the keywords list that are used to extract data from well-known databases. Selection of keywords depends on the strategy of AND and OR operators to form a relevant search query. Each keyword within the group is paired using OR operator, whereas groups are paired using AND operator *Table 1* to perform the search queries. *Table 1* shows that the query was applied on the article Title, abstract and keywords to determine the relevant journals and conference articles from 5 selected academic databases published in English from 2000 to 2019.

2.5 Search Results

After the selection of the keywords once the search queries were applied to all selected databases, extracted the articles, and gathered in one place. After applying extraction strategy, we get 452 Total conference and journal articles from selected databases. These articles were extracted and stored in the citation manager Software (EndNote X7). These 452 articles contain duplicates as well but by the assistance of EndNote software we apply duplicate removal filter to remove duplicates. Once we apply removal filter, we exclude 224 articles.

2.6 Screening and selection Criteria

Once we apply removal filter, we get 228 articles and removed 224 articles. Now we want to apply screening strategy upon the included articles (Title and Abstract) that we retrieve on our study selection criteria. *Table 2* shows that the selection of articles on the bases of title, abstract, and keywords. After screening we get only 11 articles out of 31 and excluded the remaining articles. Three basics reasons we used for the exclusion of 20 articles. First, the aim of the majority of the excluded articles was that it does not contain any relevant information. There domain is not satisfied the our domain that we mainly focused on image processing and machine learning techniques but those contains some other AI based techniques.

Second, few studies were unrelated to automation. Thirdly a few retrieved studies, focused on medical image classification but not on medical text classification.

Table 1

Keywords Selection criteria

Group 1 – Keywords related to the Rice disease detection using Machine learning.	Machine learning, disease classification, automatic disease identification, disease analysis, classification prediction
Group 2 – Keywords related to the Rice Disease detection using image processing.	Image classification, automatic spot classification, image analysis, image categorization, Image processing.
Group 3 – Languages	English
Group 4 – Publication years	February 2000 to February 2020
Group 5 – Document types	Journal and Conference Articles
Final Search Query	(Member 1) AND (Member 2) AND (Member 3)

Table 2

Search Results

Database	Initial Search	After Duplicate Removal	After Abstract Screening	After Full-Text Screening	After Reference Scanning	After Quality Assessment
IEEE Explorer	135					
PUBMED	70					
Scopus	92	228	80	21	15	11
web of science	16					
google scholar	139					
Total	452					

3. Discussion

This portion prescribes the proposed work after lots of research for the rice disease early identification and detection. This paper presents a survey of 11 papers of rice disease detection including criteria such as image dataset, no. of diseases, Preprocessing Segmentation, Edge Detection, Feature Extraction, Image Background, and Color Space *Table 3*.In our proposed and suggested work, we intend to detected the rice diseases in a very early stage for the sake of better production, improve growth rate and increase per capita income of the country.

By the assistance of well-known and authenticated databases we get the several articles and come to know about number of strategies of rice disease detection using Image processing and Machine learning. We pay a deep and a thorough study of previous work in this domain and get to know about the lackness, deficiency, gaps and loo poles in this work and then proposed a well-known solution for detecting early rice disease detection. The dataset used in this study are divided into two sets: training data having 100 images and testing data with 45 images for a total of 145 images for each class *Table 4*

Image Samples.

3.1 Machine Learning Operations Applied for Rice Disease Identification

This portion prescribes the survey of machine learning techniques used in classification and identification of rice plant diseases. The survey data contains following parameters for detecting diseases:**(types of classifier, parameters for classification, input to classifier, and accuracy of classifier)** *Table 4*. *In* machine learning we used Support Vector Machine (SVM) as a classifier for identifying the

rice disease. Researchers used different classifiers as per their requirement. Generally, authors use a support vector machine for classification of any type of diseases.

3.1.1 Support Vector Machine (SVM)

Support vector machine mostly used for multiple dimensional data. Support vector machine is strong enough in cases of data that has some distorted and disintegrated data. We need to create some production rules in this method. For example, if color and shape features of trained dataset image is match with the test image then test image that it must be sure that the specific data lies under that specific disease category. Input to the classifier is generally image features which is extracted from the diseased portion, some time we take image from whole or some time we take any specific portion that has been infected (Shah, Prajapati et al. 2016)

3.1.2 Image Processing Operations Applied for Rice Disease Identification

This portion prescribes the image processing techniques used in various works on rice disease detection.

We use following notations:

Rice Blast(RB), Sheath Blight (SB), Brown Spot(BS),Bacterial Leaf Blight (BLB), Sheath Rot(SR), Narrow Brown spot (NBS), Red (R), Green (G), Blue (B), Hue (H), Saturation(S), Value (V), RGB (Red, Green, Blue), HSV (Hue, saturation, Value), HIS (Hue, Saturation, Intensity)(Pugoy and Mariano 2011) *Table 5*. Generally, to identify the disease from a leaf, two tasks are required. First image processing task and second machine learning task. At each step of image processing task, different techniques are applicable. Through study of different literatures, we came to know that no dataset for this problem is available freely. We used to capture images for their experiments from rice fields. Some of the authors used some standard database such as IRRI (International Rice Research Institute) for the sake of getting sample images (Shah, Prajapati et al. 2016)

3.2 Image Processing Techniques

3.2.1 Image Acquisition

The images of the plant leaf are captured through the camera. This image is in RGB (Red, Green and Blue) form. Color transformation structure for the RGB leaf image is created, and then, a device-independent color space transformation for the color transformation structure is applied.

We have collected samples of rice plants, both normal and having diseases, from a village. We used a Digital SLR camera with 12.3 effective megapixels. We captured images of the leaves on white background, under direct sunlight. We have prepared total 145 images in our database containing 30 images of healthy leaves, 46 images of bacterial leaf and 25 images of brown spots.

3.2.2 Image Pre-processing

Pre-processing is a common name for operations with images at the lowest level of abstraction both input and output are intensity images. These iconic images are of the same kind as the original data captured by the sensor, with an intensity image usually represented by a matrix of image function values (brightness's). The aim of pre-processing is an improvement of the image data that suppresses unwilling distortions or enhances some image features important for further Processing.

We resize and crop the images into a dimension of 897x3081 pixels to reduce the memory requirement and computational power. The separation algorithm was performed using the histogram profile extraction to remove the probable background in the received images. We empirically explored four techniques to remove background from the leaf image:

(1) apply mask generated based on original image

(2) apply mask generated based on Hue component values of the image in HSV color space

(3) apply mask generated based on Value component values of the image in HSV color space

(4) apply mask generated based on Saturation component values of the image in HSV color space

The received images included rice bushes, stems, and green leaves and mud (green and gray colors). So we converted the RGB image into HSV color model. The original image was first split into three components: red, green, and blue, and then the rice plant was removed from the background of the image. After that, we create a mask such that the mask removes and makes all the background pixel values to zeroes, which represents black color, in an RGB color space image. The background removed image contains only leaf portion, including disease spots.

3.2.3 Image Segmentation

It is the process of partitioning an image into multiple different regions (or segments). The goal is to change the representation of the image into an easier and a more meaningful image.

We use K-means clustering for image segmentation. Three clusters are expected from a leaf image: (1) background, (2) diseased portion, and (3) green portion. We applied three image segmentation techniques to extract diseased portion from the leaf image:

(1) LAB color space based k-means clustering, (2) Segmentation technique, and (3) HSV color space-based k-means clustering.

We use K-means clustering on the Hue component of the HSV image in our proposed work. For some images, normal K-means algorithm could not produce desired clusters, i.e., three segments. To produce accurate segments, we feed the centroid value of each desired cluster, which we find based on histogram analysis of Hue values of leaf portion. We use thresholding to remove the unnecessary green

portion present in the diseased cluster, obtained as a result of K-means clustering.

3.2.4 Feature Extraction

In the feature extraction step, the task is to describe the regions based on chosen representation, e.g. a region may be represented by its boundary and its boundary is described by its properties (features) such as color, texture, etc...There are two types of representations, an external representation and internal representation. An external representation is chosen when the primary focus is on shape characteristics. An internal representation is selected when the primary focus is on regional properties such as color and texture. Sometimes the data is used directly to obtain the descriptors such as in determining the texture of a region, the aim of description is to quantify a representation of an object. This implies, one can compute results based on their properties such length, width, area and so on.

Features have a crucial role in differentiating one disease from another. We intend to use color features such as mean and standard deviation. We also plan to use texture features such as we are empirically exploring the number of diseased spots and the number of pixels of disease portion falling under 4(red,green,blue,gray) predefined color ranges, which we decide based on manual color analysis of all the types of diseases that we want to classify. At present, we have extracted around 50 features from a few images, and we are validating our implementation, done in MATLAB, of feature extraction step.

3.2.5 Classification

We will use a Support vector machine for the classification Support vector machine is supervised learning approach. It classifies the training data based on the classes given as training class labels. In this research, with the improvement of KNN algorithm by K-means, a new, quick and accurate method for diagnosis of rice disease was developed using image processing. The results of this study showed that the dynamic range of gray surfaces should be increased to determine the damaged parts of the rice leaf(Shah, Prajapati et al. 2016, Jayanthi, Archana et al. 2019) *Table 6*

Moreover, the Lab color space enabled us to separate the colors in the image using the K-means clustering algorithm, identify the diseased locations and the spots that have changed color on the rice leaf. The K- means method is one of the data mining techniques used in machine vision. Clustering is an uncontrolled learning method that does not rely on predefined categories or specific features as objectives, and places instances with the same amount of data together in one group.

The trees used are the number of times a node is split until the desired count of trees are achieved and will then operate as an ensemble trained using the feature vector to make its prediction, where in this case 10-100 trees are considered. The optimal number of trees was determined according to recognition results of the models (Kang, Ma et al. 2018).

This is probably because of its 145 distinct shape and color as compared to the other classes. Both classifiers have shown that the models improved its discriminating capacity when identifying diseases thus, increasing the accuracy of the classifiers.

While an automated intelligent system like one used in Japan will bring higher yield output, we also need to consider the Indonesian farmer's capability to adopt new technologies. Considering the current technology used new technologies require new training and maintenance. It can be learned that certain factors played an important role in the rice yield gap, those are insufficient water (38%), use of fertilizer (22%), harvest date (21%) and weeding (19%) (Archana and Sahayadhas 2018).

As discussed in materials and methods, the solution is composed of four phases. In the first phase, the input image of different infected rice leaf is selected from the dataset folder. Under natural light condition it must be enhance the contrast of image so that it will produce the contrast image and again it will convert into a grayscale image. Next, color transformation drawn by RGB to HSV image format to analysis image segmentation. Those colors were extracted by color models HSV (Hue, Saturation and value). Hue component is used for further analysis from the color space transformation. Then, the disease spot region is extracted by image segmentation. K-means clustering can be used for the image segmentation method shown. So, k-means clustering method used to partition the collection of objects into k groups. The algorithm starts by calculating the mean values through each cluster and compute the distance of each cluster to the corresponding mean. Finally assign the point to nearest cluster. The result of various clustering segmentation which presents different cluster using k-means algorithm in image segmentation. The proposed method shows full automatic and good efficiency (Daniya and Vigneshwari 2019)

Table 3
criteria for rice disease detection

Criteria For Detection The Rice Disease
Image dataset
Disease Identification
Preprocessing Segmentation
Edge Detection
Feature Extraction
Image Background
Color Space

Table 4
Image Samples

Sample of Images
Total images we gathered are almost 145
Training datasets = 100 images

Testing datasets = 45 images

Table 5
leaf disease Identification

Leaf Diseases	**No: of images**
Rice Blast(RB)	20
Sheath Blight (SB)	29
Brown Spot(BS)	14
Bacterial Leaf Blight (BLB)	32
Sheath Rot(SR)	40

Narrow Brown spot (NBS)	10

Table 6
Image Processing Techniques

	Image Processing
Techniques Image Acquisition	
(Rice plant images captured using digital camera) Image Pre-processing	
(Images are preprocessed to suppress undesired distortions)	Image Segmentation
(Partitioning of rice plants in group who	
have similar features)	

Feature Extraction

(Image feature such as color,shape ,texture)

Classification

4. Review on Rice Disease Detection

This portion of this study reviews the selected studies related to our topic from 4 different aspects: Types of different Rice diseases, Machine Learning Methods used by different researchers, image processing approaches, The best performance Model/method.

4.1 Types of different Rice Diseases

Bakanae disease is a seed-borne rice disease, or "foolish seedling'. The disease occurs most often with the use of infected plants (Chung, Huang et al. 2016). Rice is an important, staple food consumed throughout the world. Rice development is threatened by Bakanae disease, which is caused primarily by the Fusarium fujikuroi fungus. Bakanae disease causes sterility, which results in a major loss of grain production (Chung, Huang et al. 2016).

F. fujikuroi-infected plants demonstrate morphological and color abnormalities. These abnormalities include elongation, stunting, a large angle between leaf and stem, and yellowish-green leaves (Chung, Huang et al. 2016).

We briefly define any disease on the leaf. More data can be found at (Shah, Prajapati et al. 2016, Ghyar and Birajdar 2018) on all types of rice plant diseases.

1) Leaf blast: The symptoms of this disease are dark spot to oval spot, with narrow reddish-brown margins and the center of gray or white (Shah, Prajapati et al. 2016, Ghyar and Birajdar 2018).

2) Brown spot: This disease occurs on rice plant leaves. The disease's signs are in round to oval form with dark brown lesions (Shah, Prajapati et al. 2016, Ghyar and Birajdar 2018).

3) Sheath blight: Sheath blight occurs on both the leaves and stems. The signs are oval, white or straw colored areas with reddish brown streaks in the center (Shah, Prajapati et al. 2016, Ghyar and Birajdar 2018).

4) Leaf scald: Narrow reddish-brown broad bands are the symptoms. There are often lesions on the edges of the leaf, with yellow or golden borders (Shah, Prajapati et al. 2016, Ghyar and Birajdar 2018).

5) Bacterial leaf blight: the signs include elongated lesions on the tip of the leaf, the lesions are several inches long and the bacteria (Shah, Prajapati et al. 2016, Ghyar and Birajdar 2018) turn into yellow from green.

4.2 Review of Machine Learning and image processing Methods used by different researchers

Machine vision incorporates image analysis and the techniques of machine learning to provide automatic inspection. Since machine vision techniques are simple, non-destructive, and objective, various techniques for grading the level of leaf spot diseases have been implemented (Chung, Huang et al. 2016).

The researchers' main goal is to build classifiers for machine learning to differentiate safe and infected seedlings(Chung, Huang et al. 2016).

This system 's effectiveness depends on how reliable the system is System performs both machine and image processing required Operations learn to learn (Shah, Prajapati et al. 2016).

Support Vector Machine (SVM) is an overseen machine learning process Algorithm based on the notion of planes for decision where Hyperplane can be used to define linearly separable groups (Liundi, Darma et al. 2019).

Gabor filter is commonly used for image processing of images Analysis, edge detection, extraction functionality and much more (Liundi, Darma et al. 2019).

Machine learning model for the prediction of PPIs between rice and rice blast is developed. The results of machine learning verified that the database is only rice and rice blast sensitive. The latest research work can be a valuable tool for the plant community to describe the relationship between the host and pathogen Rice with M.grisea (Karan, Mahapatra et al. 2019)

SVM is the Supervised Machine Learning algorithm used for prediction tasks (Karan, Mahapatra et al.

2019).

In machine learning, pattern recognition and in image processing, feature extraction techniques are applied to get features that will be useful in classifying and recognition of images (Jayanthi, Archana et al. 2019)

On digital image Processing techniques, used to improve the Image. GLCM and SURF functions are used Extraction: Extraction. For segmentation the edge detection and FCM are used. ANN is used for ranking (Jayanthi, Archana et al. 2019)

(SVM) is a nonprobabilistic supervised powerful binary classifier used in machine learning and pattern classification tasks (Ghyar and Birajdar 2018).

Key Technique	Description	Limitations
Segmentation	To spot the infected leaf part of the rice plant images, a region identification methodology centered on Fermi energy was recommended. NGLDM (Neighboring gray-leveled dependence matrix) centered textural features were extorted to categorize the various diseases of rice plants.	Segmentation accuracy is low
Feature Extraction	Symptoms were characterized using features like, color and shape of the infected part of the rice plant and the extorted feature was utilized for recognizing the diseases.	The risk factors in the recognized diseases were not found
Classification	A methodology to recognize the utmost occurring disease in rice plant say, Rice Leaf blast (RLB) utilizing SVM classifier was propounded.	Segmentation process was not ameliorated. Employed the conventional framework for segmentation.

An image processing algorithm using FCM based clustering has been developed to identify the diseases in rice plant. Disease detection at the right time can increase the crop production (Devi, Hemalatha et al. 2017).

Table 1: Basic image processing steps in the detection of rice plant diseases (Daniya and Vigneshwari 2019).

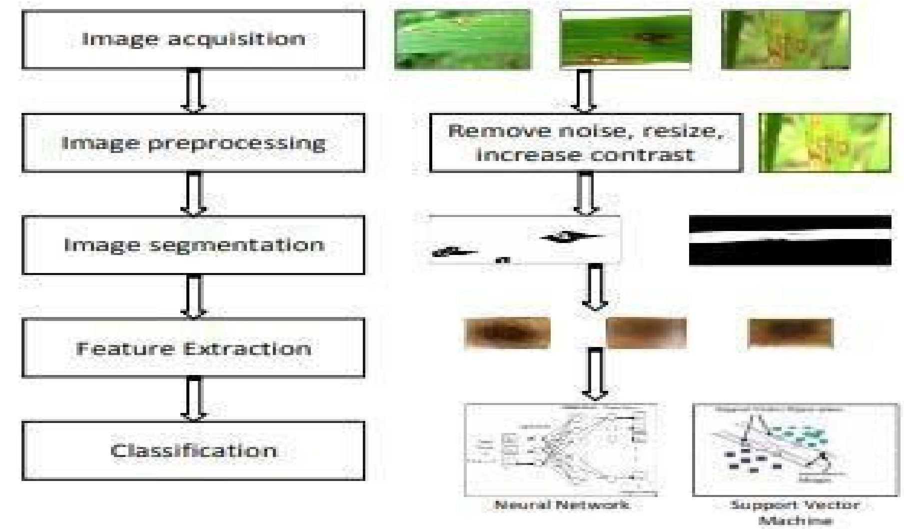

Fig. 1. General Approach of Plant Disease Identification from the Images

4.3 The best Performance Method

In this emerging world, everyone tries to touch the sky in the field of technology. In research side many researchers have worked and proposed the best algorithms and techniques. In this this review, we have reviewed all these machine learning and image processing techniques and suggest the best method for detecting the rice disease in *Figure 1*

4.3.1 Image acquisition

Nevertheless, an image archive is available at IRRI (International Rice Research Institute) specifically for rice disease pictures but it is not accessible freely. We must therefore prepare our own image database which requires image acquisition from live farm. In this process, images are captured from the farm using a digital camera so that digital image processing operations can be applied directly in digital form with numerical values (Bera, Das et al. 2019).

4.3.2 Image preprocessing

To get better results in further steps, image preprocessing is required because on the plant dust, dewdrops, insect excrements may be present; these items are called image noise (Chung, Huang et al. 2016). In addition, captured images can result in distortion of some water drops and shadow effects, which could create segmentation problems and feature extraction stages (Chung, Huang et al. 2016).

4.3.3 Image segmentation

Segmentation of images can play a critical and important role in the The prevention of plant diseases. Segmenting the image means dividing Image of different regions or objects. Primary goal Segmentation is the analysis of the image data so that one can extract Its useful data features. There are two ways of carrying Picture segmentation: 1) discontinuity-based, and (2) Keeping in mind parallels (Chung, Huang et al. 2016).

4.3.4 Feature extraction

The image analysis feature extraction component focuses on identifying inherent characteristics or characteristics of objects present within an image. You can use these features to describe the object. In general, characteristics are derived from the following three categories: color, form, and texture. The color is an essential feature, because it can distinguish between one illness and another (Chung, Huang et al. 2016).

4.3.5 Classification

Classification maps data into groups or classes unique to it. Classification is usually called as a supervised learning method Classification is a two-step process: the classifier model that describes predefined class set is generated first. This step is called as the learning process (Training stage), in which the classification algorithm develops the classifier with their unique class labels by "learning from" the data. In the second step the model is used for classification which is created in the first step. In other words, test data is used to measure the performance of the model being trained by measuring how well it is doing on the test data.

5. Future Research Direction

Several research gaps were identified from our review. This section highlights various future research directions, in which more effort is required to improve the performance of detecting rice disease. These research directions are presented as follow:

(1) *Quality image:* In the articles we studied, we saw that the researchers use mobile phone camera or digital camera to click the picture of effected plant (Abu Bakar, Abdullah et al. 2018) which have low quality. Whereas we think that the researchers must use quality images in order to diagnose the disease properly.

(2) Quality Datasets: In the articles we studied, the researchers didn't tell about the dataset they use. We think the future researcher must use the quality dataset and should mention in the article.

(3) Language-barrier: As we know that 90% of rice consumed and produced in Asia. So, there will be more problem in Asia than the rest of the world regarding the rice disease. English is not the language of Asian people. So, the Asian researcher should research in their native language such as Urdu, Hindi, Bengali etc. in order to maximize the benefit of research to local public.

(4) Introduced New Method: In Future, there should be a new proposed method to the extract pigment through feature analysis and to differentiate the type of diseases from image classification.

(5) General System: We have seen in the articles that no such system was made that will detect all the disease of rice so, the future research should be on creating a one general system which can detect all the rice disease.

(6) *Deep learning:* We have not reviewed any study related to deep learning to detect rice disease, so the future researcher should include deep learning articles to review.

(7) *Accuracy:* The researcher should research on how to develop the system which give the accurate result. We have seen the system in the articles which give 80% to 90% accurate result but the researcher should develop the system which give 100% accurate result.

Conclusion

According to Collins and Fauser "The strengths of the systematic review include the narrow focus of the question, the comprehensive search for evidence, the criterion-based selection of relevant evidence, the rigorous appraisal of validity, the objective or quantitative summary, and the evidence-based inferences

" **(Collins and Fauser 2004)**.In this Systematic literature review that are co-related to the associated protocols and guidelines that were supposed as a way of supporting the design of unbiased, consistent, clear reviews of primary articles that are extracted and selected after applying all the protocols data extraction and selection defined in *Table 2* and proposed in inclusion and exclusion criteria. This extensive study provide a critical analysis of rice disease detection by collecting major research attempt to help out researchers and experts that are related to this field, However we use to acquiring an updated awareness for the existing related solution proposed in this area of domain. Research papers on rice disease detection published in 5 different kind of well-known academic databases from 2000 to 2020. After applying articles selection protocol 12 articles were rigorously selected that are reviewed and analyze in critical way. The selected primary articles were reviewed by following the perspective proposed in Table 8. In most of selected primary studies authors does not explicitly defined the datasets that were used in their published work. There are different perceptions from different authors for detection of rice disease. There are multiple kinds of techniques and frameworks are used to make its performance efficient *Table 7*. *In* most of articles machine vision techniques is used but the methods (conventional naked-eye examination or culturing methods)**(Chung, Huang et al. 2016)** they used that are subjective and time consuming In this we proposed a suggestion for this to overcome its gap. In majority of articles they proposed solutions for particular type of disease as well as they are applicable on particular region (**Liundi, Darma et al. 2019, Pascual, Plaza et al. 2019**).**In** this research as per our (inclusion criteria) we majorly focus on machine learning, image processing and classification, AI models therefore, In this filed we found most of article that are using the techniques of image segmentation and it divide image by assigning different kinds of colors to it after that they apply image processing techniques to identify the spots that it would be declared and compared with different kinds of samples. Automation based model we shall also produced in futures that will be an innovation in this era of technology that work are also pending in this field. Most of the techniques in this study defined are used in a well manner but more works on these studies are also required just as its efficiency of detecting results are very low to produced outstanding model. In Future, there should be a new proposed method to the extract pigment through feature analysis and to differentiate the type of diseases from image classification.

Table 7
Proposed Techniques

S.No	**Frameworks and Techniques & framework** :
1	machine vision (SVM)
2	Computing methodologies
3	Image manipulation
4	Semantic-Based Framework
5	Image Segmentation
6	Computer Vision based Detect Rice Leaf Diseases using Texture and Color Descriptors
7	FCM based clustering

Table 8
different Aspects

S.NO	**Aspects**
1	detection of rice disease in leaves of rice plant
2	Suggest proper solution for blast disease by using different techniques of images Processing and Machine Learning
3	Different Semantic-Based Framework for Rice Plant Disease Management
5	Image processing techniques to automate the process to rice disease techniques

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