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Study of Turmeric Plant Diseases and Methods of Disease Identification using Digital Image Processing Techniques

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Abstract— The vast economic potentiality of the crop can be adequately established by the fact that about 20-30 million people consume turmeric in India on a regular basis besides those in other countries of the world which may include over 2 billion consumers. Its cultivation is highly labor intensive and offers employment to about 2.0 million families engaged in cultivation, trading and commerce in turmeric throughout India. Turmeric powder is used as medicine for certain diseases and also used as an antiseptic. During cultivation turmeric is very much affected by disease and also procedure for to identify diseases early infected stage using digital image processing and pattern recognition techniques, such as rhizome rot disease, leaf spot disease, leaf blotch disease and dry rot disease that result in great loss for the farmers. It occurs in a very virulent form and if not controlled, causes widespread damage and even total destruction of the entire turmeric plantations without any early indications of the diseases. The aim of this paper is to study and identify various diseases in the turmeric plants and also procedure for to identify diseases early infected stage using digital image processing and pattern recognition techniques.

Keywords- *Turmeric, Curcuma longa, Hardi*

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I. INTRODUCTION

Turmeric is popularly known as Manjal in Tamil and also commonly known as Haldi or Hardi in Hindi. The biological name of Curcuma longa is known as Turmeric. It is native to southern Asia. The Turmeric is classified into many varieties based on its size. Around 100 varieties of turmeric are cultivated throughout the world. Among these varieties, around 40 varieties of turmeric are cultivated in India. Tamil Nadu, Uttar Pradesh, Bihar, Maharashtra, Karnataka, West Bengal, Andhra Pradesh and Kerala states are widely cultivated in the Turmeric. In Tamil Nadu, the most popular cultivation varieties are Erode local, Salem local, PTS-10, BSR-1, Roma and Suguna. Among these varieties Erode local, Salem local, PTS-10 Turmeric are considered for this research work.

In Turmeric cultivation, diseases are one of the most important problems that reduce the harvest quantity of the Turmeric. The important diseases that infect the Turmeric plants are Rhizome Rot Disease, Leaf Spot Disease, Leaf Blotch Disease, Dry Rot Disease and Bacterial wilt Disease.

The infection of such disease causes the change in the color and appearance of the Turmeric leaves. The Turmeric cultivators are unable to recognize such changes at an earlier stage, to initiate the preventive actions. But they can visualize such changes only at the matured stage of infections, after which diagnosis cannot save the Turmeric plant. This is an insufficiency of the latest technology in the field of agriculture. In the proposed research work, the Rhizome Rot Disease, Leaf Spot Disease, Leaf Blotch Disease, Dry Rot Disease and Bacterial wilt Disease are identified using digital image processing techniques by investigating the microscopic change in the color and appearance of the Turmeric leaves. The statistical based analysis and histogram based analysis are used to identify the infection of disease and duration of such infection of Turmeric and for selected diseases. Finally, neural network based classifier algorithm is developed to verify the accuracy of classification made by afore mentioned models between healthy and infected Turmeric leaves.

The main motive of this research work is to help the agriculturists who cultivate Turmeric plants on commercial basis, to identify diseases which infect Turmeric plants at the very initial stage, so that preventive measures could be taken at an appropriate time. It also aims to enable them to arrest the negative effect of such diseases and to obtain a good harvest at the end.

The objective of the research work is to develop an image processing technique which could identify the infection of the Rhizome Rot Disease, Leaf Spot Disease, Leaf Blotch Disease, Dry Rot Disease and Bacterial wilt Disease in Erode local, Salem local, PTS-10 variety of Turmeric using the RGB color components through statistical analysis, histogram analysis and neural network based algorithms.

1.1. Rhizome Rot Disease

The disease is soil-borne and rhizomes borne and occurs with the onset of monsoon. This disease mostly occurs during the months of June to September. The infection starts at the collar region of the pseudo stem and progresses upwards as well as downwards. The collar region of the affected pseudo stem becomes water soaked and the rotting spreads to the rhizome resulting in soft rot. At a later stage root infection is also noticed. Foliar symptoms appear as light yellowing of the tips of lower leaves which gradually spreads to the leaf blades. In early stages of the disease, the middle portion of the leaves remain green while the margins become yellow. Later, the yellowing spreads to all leaves of the plant from the lower region upwards and is followed by drooping, withering and drying of pseudo stems. The disease is soil-borne. The fungus multiplies with buildup of soil moisture with the onset of south

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west monsoon. The fungus can survive in two ways: (a) in diseased rhizomes kept for sowing and (b) through resting structures like chlamydospores and oospores that reach the soil from infected rhizomes. Younger sprouts are the most susceptible to the pathogen. Nematode infestation aggravates rhizome rot disease. Temperature above 30° C and high soil moisture are the important predisposing factors favoring the disease. Water logging in the field due to poor drainage increases the intensity of the disease.

1.2. Leaf Spot Disease

Disease is soil-borne noticed on the leaves from July to October. Symptom appears as brown spots of various sizes on the upper surface of the young leaves. The spots are irregular in shape and white or grey in the centre. Later, spots may coalesce and form an irregular patch covering almost the whole leaf. The centre of spots contains fruit head shaped fruiting structures. Disease is soil borne and survives in plant debris. The disease spreads through rain splashes during intermittent showers. The incidence of the disease is severe in turmeric grown under exposed conditions. High soil moisture, temperature 25° C and leaf wetness.

1.3. Leaf Blotch Disease

Disease symptom appears as small, oval, rectangular or irregular brown spots on either side of the leaves which soon become dirty yellow or dark brown. The leaves also turn yellow. In severe cases the plants present a scorched appearance and the rhizome yield is reduced. Soil and seed borne and survive in soil on infected plant debris. High soil moisture, temperature 25° C and leaf wetness.

1.4. Dry Rot Disease

The disease causes root rot and rhizome rot resulting in typical dry rot of rhizomes from October onwards. The affected rhizomes appear soft and shrunken to start with, later dry up and become hard. Foliar yellowing and drying up of foliage which are the normal symptoms of maturity of the crop during October - November would be indistinguishable from the symptoms of the disease affected clumps. When infected rhizomes are cut open, the infected zones typically appear as dull brown and dark. The pathogen is facultative parasites and lives as a saprophyte on the organic matter in the soil for several years. It spreads from vulnerable plants. The disease is favoured by 35° C soil temperature, 15-20 per cent soil moisture and alluvial or sandy soils.

II. PREVIOUS WORKS ON IDENTIFICATION OF DISEASES IN AGRICULTURAL PLANTS

Basvaraj & Rajesh (2011) developed a modern multilayered back propagation neural network classifier, which uses the combination of color and texture based recognition techniques to identify uninfected and infected fruits and vegetables. The digital images of normal and infected banana, chilli and tomato images are captured by high resolution digital camera. The mean, median, standard deviation, hue, saturation, and intensity values are calculated and trained to the back propagation neural network classifier. The results are categorized between the healthy and infected images of fruits and vegetables. The highest recognition and classification accuracy is 88% for affected fruits, vegetables and 80% for healthy commercial crops. The overall classification accuracy is 80%.

Qinghai et al (2013) designed a color and image enhancement analyzes to identify the pests and disease affected cotton leaves. The images of uninfected and infected cotton leaves are captured by high resolution digital camera and processed by digital image processing techniques. The RGB color images are converted into gray scale, HIS and YCbCr images. The histogram and histogram equalization techniques are plotted for uninfected and infected gray scale cotton images. The comparisons of results proved very good accuracy in extracting the disease infected cotton leaves.

Sanjay (2011) developed an image segmentation technique to identify disease severity and infected area of the sugarcane leaves. The simple threshold segmentation techniques are considered to calculate infected area of the sugarcane leaves. The triangle threshold segmentation techniques are considered to segment the infection region. Using these techniques, accuracies of 98.60% are reported in recognition of the infected region in sugarcane leaves.

Sannakki et al (2011) developed a modern machine vision and fuzzy logic systems to recognize the position of the disease infected in plant leaves. The digital images of infected leaves are captured by high resolution digital camera. The color image segmentation techniques, K-means segmentation algorithm are used to identify the disease infected portion. The positions of the infected leaves are calculated by means of fuzzy inference systems. The results are good in accuracy when compared to manually recognized position of the disease that infected plant leaves.

Sabah & Sharma (2012) performed a color and texture analyzes to identify healthy and affected malus domestic leaves. The digital images of healthy and infected leaves are captured by high resolution digital camera. The RGB color images are converted into a gray scale image and the histograms are plotted for all healthy and infected gray scale images of malus domestic leaves. Finally, the results are compared to identify disease infected malus domestic leaves.

Manoj et al (2012) developed a modern histogram-based technique to identify the blast and bacterial leaf blight diseases that affected in paddy leaves. The digital images of healthy and infected paddy leaves are captured by high resolution digital camera. The RGB color images are converted into a gray scale image and the histograms are plotted for healthy and infected gray scale paddy leaf images. Finally, the results are compared to identify infected paddy leaves. Using these techniques, accuracy of 92% is reported in recognition of the infected region in the paddy leaves.

Jagadeesh et al (2013) developed a segmentation technique and neural network classifier technique to recognize healthy and anthracnose disease that affect on mango, grape and pomegranate fruits. The thresholding, region growing and k means clustering techniques are used to separate the anthracnose disease infected areas if the fruits and the percentage of anthracnose disease infected areas is calculated. The texture features are extracted from the run-length matrix. These extracted features are loaded in neural network classifiers to classify uninfected and anthracnose disease infected fruits. The accuracies of 84.65% and 76.6% are reported in classification of uninfected and anthracnose disease infected the mango, grape and pomegranate.

Piyush & Anand (2012) developed modern color transform techniques for recognition of disease spot on plant leaves. The digital images of infected leaves are captured by high resolution digital camera. The RGB color images are converted into CIELAB color model. The median filters techniques are applied on images of the disease infected leaves for image smoothing process. Finally, OTSU threshold techniques are applied to segment the disease spots. In this method, different disease spots are detected accurately.

Zhihua et al (2013) developed modern histogram technique for recognition of cotton mite disease. The digital images of healthy cotton leaves and cotton mite disease infected cotton leaves are captured by a high resolution digital camera. The RGB color images are converted into gray scale images. Three main steps are included in this algorithm. In first step, disease spots are extracted from green plants. In second step, histograms are plotted for all healthy and cotton mite disease infected cotton leaves. Finally, the disease spot areas are calculated and compared. Using these techniques, accuracies of 94.79% are reported for the separation of the uninfected and cotton mite disease infected region of the cotton leaves.

Sanjay & Nitin (2013) developed a color transform based technique for recognition of agricultural plant leaf diseases. The digital images of healthy and infected leaves are captured by a high resolution digital camera. The RGB color images are converted into HSI images. The texture parameters are calculated for healthy and infected leaves. Finally, texture parameters are compared. The presence of diseases on the plant leaves is evaluated.

Bindu & Toran (2013) developed a modern machine vision and fuzzy logic system to recognize the position of the bacterial blight disease infected on pomegranate plant leaves. The digital images of infected leaves are captured by high resolution digital camera. The color image segmentation techniques and K-means segmentation algorithm are used to identify the bacterial blight disease infected portion. The positions of the disease infected leaves are calculated using fuzzy inference systems. The results showed good accuracy when compared to manually recognizing the position of the Bacterial Blight disease that infected pomegranate plant leaves.

Fang & Huijie (2014) developed a image processing technique and artificial neural network for detecting diseases early and accurately in pomegranate plants. The digital images of infected pomegranate leaves are captured by a high-resolution digital camera. The Gabor filter techniques are used to preprocess and segment the infected pomegranate leaves. The color and texture features are extracted from the results of segmentation and back propagation neural network techniques are used to train the feature values that could differentiate the uninfected and disease infected samples correctly. Using these techniques, accuracies of 91% are reported for the separation of the uninfected and infected leaves for the Pomegranate leaves.

Pokharkar & Thool (2012) developed a modern machine vision system to identify pest infected rose leaves. The digital images of infected rose plant leaves are captured by a high-resolution digital camera. The image region growing and image segmentation techniques are considered to calculate the percentage of the infected area of the rose leaves. Using these techniques, accuracies of 67% are reported for recognition of pest infected in rose leaves.

Arivazhagan et al (2013) developed an image analysis technology based technique to identify the diseases from the symptoms that appear on the plant leaves. The digital images of various leaves are acquired using a digital camera. The RGB color images of plant leaves are converted into HSI color image. The green pixels are masked and removed using specific threshold value followed by the segmentation process, the texture statistics are computed. Finally, the extracted features are passed through the support vector machine classifier. Using these techniques, accuracy of 94.74% is reported in the identification of disease infection in plant leaves.

Anand & AshwinPatil (2012) developed a modern segmentation based image processing technique for automatic detection and classification of plant leaf diseases. The digital images of infected plant leaves are captured by a high-resolution digital camera and stored in JPEG format. These collected RGB color images are converted into YCbCr, HSI and CIELAB color space models. The color transformed images are passed through median filtering technique for removing unnecessary spots. The disease spot segmented images, obtained by all the three methods are compared and recognized as the best method for disease spot detection. Finally, CIELAB color space method accurately detects the disease spots.

Das et al (2012) introduced a modern Bayes and Support Vector Machine (SVM) classifier for automatic classification of uninfected paddy leaves and brown spot disease infected paddy leaves. Uninfected and infected paddy leaves images are collected from different plantations of south Bengal. The digital images of uninfected and infected paddy leaves are acquired using a digital camera and collected RGB color images are converted into gray scale images. The quality of the paddy leaves is enhanced by mean filtering technique. The uninfected paddy leaves and brown spot disease infected paddy leaves are given to the Bayes and support vector machine classifiers and the performance of the outputs is compared. Using these techniques, accuracies of 79.5% and 68.1% are reported for Bayes and SVM classifier in classifications of paddy Leaves.

Sumathi & SenthilKumar (2014) developed a modern image processing technique for automatic detection and classification of plant leaves diseases. The digital images are acquired using the digital camera. The red, green and blue components are separated from collected RGB color images. If the pixel intensity values of the green component are less than the threshold value, then the red and blue components of the pixel values are assigned to zero because green colored pixels mostly represent the healthy areas of the leaf. The red, green and blue components are completely removed for pixels with zero value and the remaining pixels are converted into a binary image and stored in the system. The binary images are given to the back propagation neural network and the performance of the outputs is compared. Finally, the infected plant leaves are detected.

The review of previous research works has explained the different image processing techniques and algorithms that are used for identification of disease in different plant leaves, vegetables and fruits. In this research paper, digital image processing techniques are used to form a database of base values obtained from RGB color components of Turmeric leaves images. The neural network based classifiers are used to find the accuracies of correct and incorrect classifications for healthy Turmeric leaves.

Basvaraj & Rajesh (2011) developed a modern multilayered back propagation neural network classifier, which uses the combination of color and texture based recognition techniques to identify uninfected and infected fruits and vegetables. The digital images of normal and infected banana, chilli and tomato images are captured by high resolution digital camera. The mean, median, standard deviation, hue, saturation, and intensity values are calculated and trained to the back propagation neural network classifier. The results are categorized between the healthy and infected images of fruits and vegetables. The highest recognition and classification accuracy is 88% for affected fruits, vegetables and 80% for healthy commercial crops. The overall classification accuracy is 80%.

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III. MATERIALS AND METHODS

2.1 statistical analysis based disease Identification

Initially, healthy turmeric plants are identified and turmeric leaves selected from the above plants and serially numbered. The selected leaves are kept under observation for next five days from the day of image collection, to identify the sign of disease infection which is not identifiable at the time of image collection. During the observation, if any sign of infection is noticed in any particular leaf, then the image of such leaf will be rejected. For this observation, the digital images of selected healthy turmeric leaves for each variety are collected daily during the period of observation. The collected images are normalized by histogram equalization techniques and the RGB color components are separated and their mean, median and standard deviation values are calculated. If the above statistical values on any particular day are deviating from the statistical values of the previous day for particular leaf, then it is considered as a infected turmeric leaf and this infected turmeric leaf is rejected from the samples[43]. Finally, the statistical values of selected healthy turmeric leaves are stored in a ealthy turmeric plants, which lie nearest to the turmeric plants infected by the Rhizome Rot Disease are identified for each variety. The sample turmeric leaves are selected from the above plants and they are serially numbered. The digital images of selected turmeric leaves are collected and normalized. The RGB color components are separated. The mean, median and standard deviation values are calculated and compared with the stored database values of healthy turmeric leaves[42]. If the calculated values and stored statistical values are in the same range for all color components, then the selected healthy turmeric leaves are accepted and included in the selection list otherwise, samples of turmeric leaves are rejected.These selected healthy turmeric leaves are kept under observation for next three days to identify any sign of disease infection. For this purpose, the digital images of turmeric leaves are collected serially. The collected images are normalized and the RGB color components are separated and the mean, median and standard deviation values are calculated for all the selected turmeric leaves on a daily basis. These calculated values are compared with the stored database values of healthy turmeric leaves[48]. If any differences are identified between calculated values and stored database values on any one particular day for the particular turmeric leaf, that particular day is counted as the first day of infection for the particular turmeric leaf and they are selected for analysis. The images of turmeric leaves infected with the Rhizome Rot Disease are collected serially for first five days after identification of infection and normalized by histogram equalization techniques and the RGB color components are separated, and its mean, median and standard deviation values are calculated for all color components and calculated values are stored in a database for all the selected varieties of turmeric leaves.

2.2 Histogram Analysis Based Disease Identification

The processes of collecting the images for healthy turmeric leaves and turmeric leaves infected by the Rhizome Rot disease for first five days after its identification are already discussed in statistical analysis based disease identification. For the histogram based analysis, the RGB color images of turmeric leaves are converted into gray scale images. Histograms are plotted and stored in a database for healthy turmeric leaves and turmeric leaves infected by the Rhizome Rot disease for first five days after its identification from its front and back view of all the selected varieties[46].

2.3 Neural Network Based Disease Identification

The pro cedures for collecting the images of healthy turmeric leaves and turmeric leaves infected by the Rhizome Rot diseases are already discussed in statistical analysis based disease identification. For the neural network based analysis for identification of Rhizome Rot disease, the RGB color images of turmeric leaves are converted into gray scale images[46]. The back propagation neural network algorithm is created. The gray scale images of healthy turmeric leaves and turmeric leaves infected with the Rhizome Rot disease are loaded and trained. Finally, the percentages of accuracy in classification of healthy turmeric leaves and turmeric leaves infected by the Rhizome Rot disease for first five days after its identification from its front and back view are calculated for all the selected varieties[46].

IV. CONCLUSION

The statistical analysis of RGB color components for healthy and infected turmeric leaves, the variations in the values of infected leaves on the basis of duration of infection. The mean, median and standard deviation of above values show the changing trend as the day of infection increases.

The histogram analysis on gray scale images of healthy and infected leaves, the variations in the gray scale values of infected leaves on the basis of duration of infection. The gray scale values show the changing trend as the day of infection increases.

In neural network based back propagation analysis, the percentage of correct and incorrect classifications are calculated for healthy turmeric leaves and turmeric leaves infected by the Rhizome Rot Disease, Leaf Spot Disease, Leaf Blotch Disease, Dry Rot Disease and Bacterial wilt Disease for first five days after its identification from its front and back view images for all the selected varieties.

The above proposed results convey that the Rhizome Rot Disease, Leaf Spot Disease, Leaf Blotch Disease, Dry Rot Disease and Bacterial wilt Disease can be identified at an early stage and thus preventive action can be taken well in advance such that the entire plantation can be saved before the disease starts to spread. This can also be extended to detect diseases of all kind to initiate early preventive action.

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