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Recognizing and Estimating the Severity of Paddy Plant Diseases using Digital Image Processing Techniques

[1]Rajendra Prasad Bellapu*, [2]RamashriTirumala, [3]Rama Naidu Kurukundu
[1][3] Department of ECE, JNTUA CEA: Jawaharlal Nehru Technological University Anantapur College of Engineering, Ananthapuramu, Andhra Pradesh, INDIA.
[2] Department of ECE, SVUCE: Sri Venkateswara University College of Engineering, Tirupati, Andhra Pradesh, INDIA.

Abstract:As India is an agricultural country, almost 80% of India's total population depends directly or indirectly on agriculture. Agriculture is one of the most significant contributors to the Gross Domestic Product (GDP) for India. According to experts, India has to play a bigger role in the global markets in agriculture products in the future. The country is expected to reinforce its position among the world's leading exporters of rice. Presently it is the second-largest rice producer after China; India produces 155.682 Million Metric Tons of rice. Now India, as well as the whole world, is facing nutritional starvation. The naked eye observation of experts is the primary approach adopted to detect and identify plant diseases. But this requires continuous monitoring of experts, which might be prohibitively expensive in large farms. Farmers usually apply chemical pesticides to cure plant diseases as suggested by agricultural-trained raters. Pesticides use has increased since 1960, WHO estimated in 2009 that 4.2 million pesticide poisonings occur annually, causing 225,000 deaths.

Therefore the Pressure has been increased during recent years to develop non-chemical approaches to control plant diseases. The idea is instead of identifying the plant diseases through the naked eye or through agricultural experts, identifying these crop diseases at its early stages through software using computer vision toolbox is efficient. Multi-Band Thresholding algorithm (MBT) and OTSU algorithm gives the best results in detecting the paddy plant disease at its early stage. Next, region growing and fuzzy logic algorithms are used to quantify disease colour analysis and compare the results.

Keywords: Rice blast, Blight, Brown Spot, MBT, and OTSU.

1. INTRODUCTION

As India is an agricultural country, almost 80% of India's total population depends directly or indirectly on agriculture. India earns 65% of money in agriculture. According to experts, India has to play a bigger role in the global markets in agriculture products in the future. The country is expected to reinforce its position among the world's leading exporters of rice. Presently it is the second-largest rice producer after China; India produces 155.682 Million Metric Tons of rice. In a data released by the Bangkok-based Thai Rice Exporters Association, India has beaten Thailand and Vietnam to become the largest exporter of rice in the world. According to export statistics report, India has exported 10.23 million tons of rice in the year 2016 as compared to Thailand's 9.9 million tons. Agriculture is rural India's predominant profession. India's environment is ideal for cultivation, which is why India is a largest supplier of agricultural commodities.

With all these shreds of evidence, we can confidently say farmers are the backbone of India. Almost 60% of Indians population direct occupation is cultivation. A farmer is someone who works under the umbrella of agriculture, producing a variety of food products for human and animal consumption. They produce food grains, Sugar and Starch Crops, Root Crops, vegetables, and fruits etc. The products that farmers are producing have very less nutritional values because of many reasons like environmental issues, genetic dilution effect, and extensive use of chemical pesticides to cure plant diseases. Now India, as well as the whole world, is facing nutritional starvation.

The naked eye observation of experts is the main approach adopted in practice for detection and identification of plant diseases. But this requires continuous monitoring of experts, which might be prohibitively expensive in large farms. Furthermore, farmers will have to go long distances to meet experts in certain developed countries; this renders it too complicated and time-consuming to consult experts, and, moreover, farmers were ignorant about non-native infections.

These diseases minimize yields, lower the commodity's

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consistency, decrease the nutritional content, and often contaminate toxic compounds in food and feed. In order to provide a sufficient supply of fuel, feed, fiber, and esthetics, plant disease management is vital. However, every year, farmers expend millions of rupees only to partially monitor the pathogens threatening their crops and other plants. It has long been a high priority for agriculture experts and the Agricultural Research Service (ARS) stations to reduce these losses.

Farmers usually apply chemical pesticides to cure plant diseases as suggested by agricultural-trained raters. This procedure further complicating the situation; these chemical pesticides may contaminate food and accumulate in the soil and groundwater. According to the recent survey, doctors identified that almost all the diseases that human beings are getting are due to nutritional deficiencies. The usage of pesticides has grown to 2.6 million short tons a year worldwide since 1960, and crop losses from pests have stayed comparatively steady. In 2009, the International Health Organization [WHO] reported that 4.2 million pesticide poisonings took place per year, causing 225,000 deaths. In the pesticide community, pesticides prefer pesticide tolerance, resulting in a situation dubbed the "pesticide treadmill" in which the production of a new pesticide is justified by pest resistance.

According to Tropical Medicine and International Health, in Andhra Pradesh, southern India, Warangal district reports over 1000 pesticide poisoning cases per year and hundreds of deaths. The southern Indian state of Andhra Pradesh is a region of heavy agricultural development. The usage of pesticides is high, and the state has one of India's highest recorded pesticide poisoning levels.

Data on all pesticide poisoning patients admitted to the Mahatma Gandhi Memorial (MGM) Hospital, a district government hospital in the city and district of Warangal, were gathered and checked from 1997 to 2002. From 1997 to 2002, 8040 patients with pesticide toxicity were admitted to the hospital, and 1819 of them died.

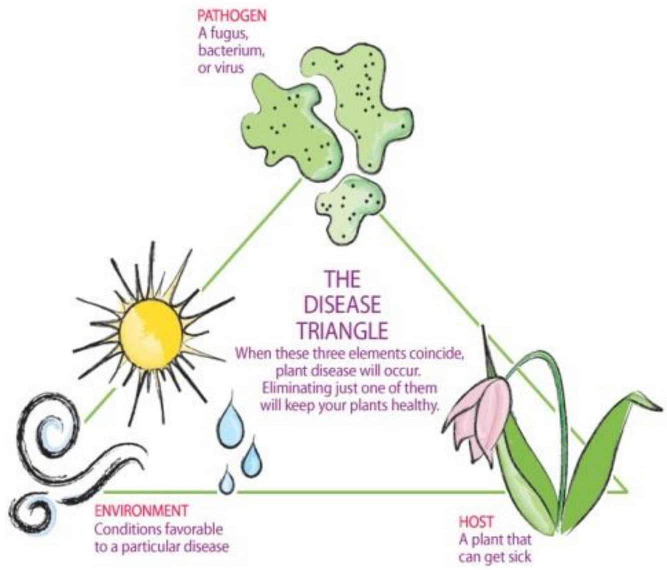

Fig.1 Plant Disease Triangle

Pressure has been increased during recent years to develop non-chemical approaches to control plant diseases. But typically, non-chemical controls do not exist. So to avoid these problems, research is undergoing to identifying the diseases in an accurate & timely way.

Often, agricultural expert advice may not be affordable; most times, the availability of experts and their services may consume time and require money. In the mean, while the disease may spread over a larger area. We suggest an idea which helps farmers to get out of these problems.

The idea is instead of identifying the plant diseases through the naked eye, or through agricultural experts, identifying these crop diseases at its early stages through software using computer vision toolbox is efficient and is not time-consuming, and can help to cure diseases using very few amounts of pesticides timely and accurate diagnosis can significantly reduce losses as well as it will increase nutritional values.

Reacting to the plant diseases at its early stages gives better results instead of reacting to the diseases late. By using this procedure instead of using huge amounts of pesticides farmers can cure diseases using very less quantity of pesticides which helps in increasing plant nutritional values.

More than 40 diseases affect the rice crop, which is one of the reasons for the low yields of rice in the world, including in India. Diseases can occur at any stage of plant growth and development, attacking the seed

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sown, the root system, the foliage, the stalk, the sheath of the leaf, the inflorescence, and even the grain that develops.
To shorten this paper, we are limited to only four types of Paddy plant diseases.

TYPES OF RICE PLANT DISEASES

***1. The Rice blast*:** For traditional glutinous rice varieties, Rice Blast caused significant yield losses and farmers sprayed fungicides up to seven times. Inter-planting prevents the fungus from continually producing inoculums that had previously occurred in the glutinous varieties' monoculture fields.
***2. The Bacterial blight*:** Xanthomonasoryzaepv triggers bacterial blight. At the seedling stage, during which leaf spots turn greyish-green and roll-up, oryzae (Xoo) affects the rice plant. Grain stops developing as the disease progresses, leaves turn yellow to straw-colored and wilt, leading thought the entire seedlings to dry up and die.
***3. The Sheath blight*:** Sheath blight is a Rhizoctoniasolani-induced fungal disease. In a rice crop, symptoms are typically observed from tillering to milk stage. It occurs in temperate, subtropical, and tropical countries throughout the rice-growing regions. Rice sheath blight occurs in all areas of rice production and decreases rice production, particularly in intensified production systems. Studies at IRRI have shown that sheath blight in tropical Asia causes a yield loss of 6% across lowland rice fields.
***4. The Brown Spot*:** Typical spots are oval, about the size and shape of sesame seeds on the leaves. Over the leaf surface, the spots are relatively uniform and relatively evenly distributed. The young spots are small, circular and usually dark brown (0.05 to 0.10 mm in diameter). Around their margins, most spots have a light-yellow halo. Proper fertilization, good water management and soil change are suggested as management options, since the infection is considered to be associated with soil deficiency in nutrients.
Identifying the diseases is the primary task; the following are the methods usually followed to identify the type of diseases:
1. Using the colour of the diseases
2. Using the shape of the diseases
3. Using the size of the disease

Table 1. Rice Plant Diseases and its Symptoms

S.no	Disease	Symptoms
1	Rice blast	On the leaves, nodes, panicles and grains, small spots appear and sometimes on the leaf sheaths. As tiny, water-soaked, whitish, greyish or bluish dots, the spots begin. In the center, these spots rapidly increase and become gray. The inflorescence and glumes also develop from brown to black spots. The diseased heads appear blasted in later stages and whitish in color.
2	Bacterial blight	Along the margin of leaf blades, which later enlarge and turn yellow, water-soaked stripes appear. These lesions may cover the whole blade, extending to the lower end of the leaf's sheath.
3	Sheath blight	Greenish-grey oval or ellipsoidal lesions, normally 1-3 cm long, on the sheath of the leaf
4	Brown Spot	A light colour appears on the leaves in small dots or circular eye-shaped or oval spots. These spots coalesce and result in brown-colored linear spots.

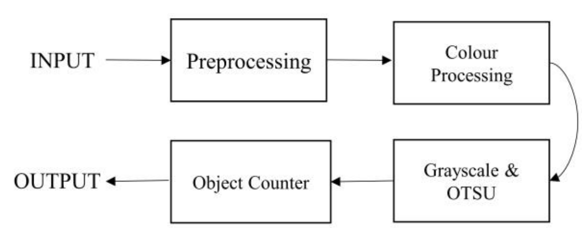

Fig.2 Block diagram for the proposed technique

The algorithms used to identify the paddy plant disease based on the colour of the disease.
1. Colour-map to Gray
2. Colour Analysis
Using an image segmentation algorithm, we can identify the shape of the disease affected by a plant.
Image segmentation algorithms:-
1. OTSU
2. Multi-Band Thresholding algorithm (MBT)
After segmentation now the task is to classify the disease,

i.e. identifying the type of disease; the disease can be identified from the predefined database; we identify the type of a disease based on the colour and shape using different fuzzy logic algorithms.

Fuzzy Algorithms:

1. Fuzzy Classifier
2. Feature-based rules
3. Neural Networks

Our aim is to Identify the efficient algorithm and develop user-friendly hardware with digital image processing software.

The Maharashtra government is focusing on a project called the Crop Pest Monitoring and Advisory Project (CROPSAP). This project is mainly classified into three parts i.e.

1. Monitoring of pests-cum-surveillance enabled advisory framework
2. Creating awareness,
3. Supply of biological and chemical pesticides with a 50 percent subsidy as a plant protection measure in critical situations.

For this problem, I have an idea of controlling the plant diseases one way by early detection of symptoms of plant diseases. By identifying the plant diseases in the early stage help the farmers to use fewer amounts of chemicals to cure diseases.

The Proposed Technique:

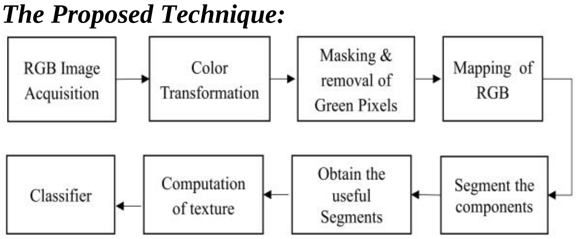

Fig. Block Diagram for colour analysis and segmentation

The RGB colour images of all leaf samples were collected in the initial phase. The step-by-step procedure of the proposed system:

1) Image Acquisition: RGB colour images are acquired using a DSLR Camera
2) Preprocessing: Convert the acquired colour images from RGB to HIS colour space
3) Masking: Green-Pixels (Healthy Pixels) are masked.
4) Remove masked green pixels;
5) Segmentation: Segment the components;
6) Obtain the useful segments;
7) Computing the texture features using Color-Co-Occurrence methodology;
8) Configure Neural Network for recognition.

RESULTS AND DISCUSSION

Fig.4 *Paddy* plant affected with the brown spot disease

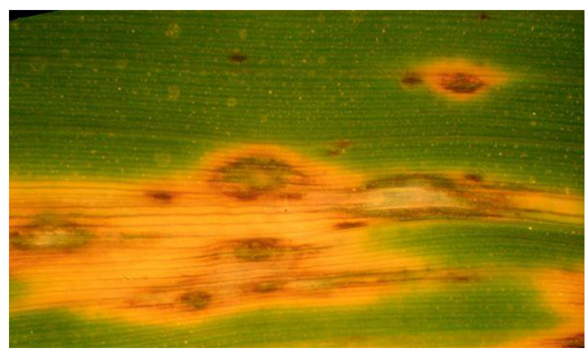

Fig.5 *Paddy* plant affected with the rice blast disease

Fig.6 Paddy plant affected with Bacterial blight disease

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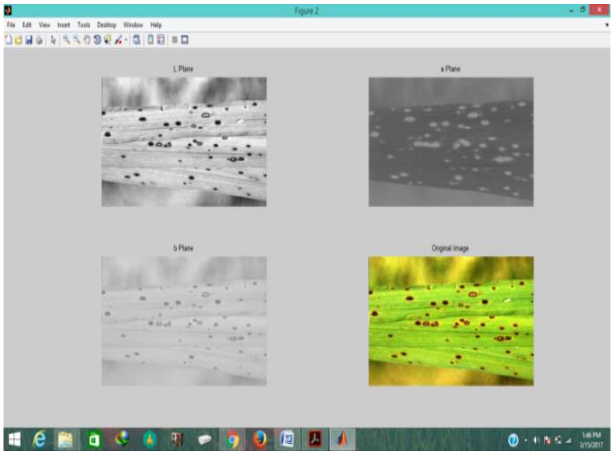

Fig.7 MATLAB output which highlights the affected portion of the disease

Percent Disease Index:

$$PDI = \frac{\text{Disease effected portion area}}{\text{Total area of the leaf}} * 100$$

Table.2 Severity estimation

S.No	Paddy Leaf	PDI
1	***Fig.4*** *Paddy* plant affected with the brown spot disease	40%
2	***Fig.5*** *Paddy* plant affected with the rice blast disease	75%
3	***Fig.6*** Paddy plant affected with Bacterial blight disease	55%

The above table shows the percentage of leaf affected with disease. If the above index is less than 10%, suggest the need for action to the farmer; if the above index is less than 50%, then advise a different action to be taken based on the PDI, we can decide what action to be taken. Based on the above result, we can estimate the severity of the paddy plant leaf.

First, the RGB images of the leaves are converted into a representation of the HIS color space. The aim of the colour space is to make it easier to specify colour schemes in some standard, commonly acknowledged way. The HSI color model (hue, saturation, intensity) is a common color model since it is associated with human perception (Gonzalez and Woods, 2008). Hue is a colour attribute which, as perceived by an observer, refers to the dominant colour. Saturation focuses on the relative purity or quantity added to a hue by white light, and intensity refers to the light amplitude. Colour spaces can be easily converted from one space to the next. The H component is taken into account after the transformation process for further analysis. As it does not give additional information, S and I components are dropped.

Masking green pixels:

We identify the mostly green coloured pixels in this step. Afterwards, based on the selected threshold value calculated for these pixels, most green pixels are masked as follows: if the green pixel intensity component is lower than the pre-calculated threshold value, the red, green, and blue pixel components are assigned a zero value. This is done in the sense that the green-colored pixels mostly represent the leaf's healthy areas and do not add any valuable weight to the identification of diseases. In addition, the processing time is significantly reduced by this.

Removing of masked cells:

The pixels with zero red, green, and blue values were completely removed in this step. This is helpful as it gives a more precise classification of the disease and reduces the processing time significantly.

Segmentation:

The affected part of the leaf is taken from the measures above. A number of patches of similar size are then segmented into the infected area. The scale of the patch is selected in such a way that critical data is not damaged. A patch scale of 32x32pixels is taken in this method. The next stage is removing the segments that are useful.

Not all segments include a large amount of data. Thus, for more study, updates that include more than fifty percent of the details are taken into consideration.

CONCLUSION

This paper discusses the use of texture analysis in the diagnosis and classification of plant leaf diseases. The proposed algorithm was therefore evaluated on paddy plants.

For our strategy, the diseases unique to certain plants were adopted. The experimental results demonstrate that the proposed solution will, with a little computational effort, identify and distinguish leaf diseases. The plant pests can be detected by this approach at the initial stage itself, and the pest management instruments can be used to fix the problems of the pest while minimizing threats to humans and the ecosystem. The explanations for misclassification are as follows: the signs of the diseased plant leaves differ (small, dark brown to black spots at the outset, with the phenomena of withered leaves, black or partial leaf deletion at a later time), and the characteristic detection vectors that need to be more refined are also taken. Training samples can be increased to boost the

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disease identification rate at different levels, and shape and color characteristics along with optimal characteristics can be provided as an input condition for disease identification.

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