REAL TIME DEPLOYMENT AND PREDICTING DIFFERENT CROP DISEASES WITH A MOBILE APPLICATION

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ABSTRACT

Over last few decades there has been an effort of developing automatic plant disease detection and recognition. So that in this consequence, the farmer can take precaution on that time with apposite treatment. The disease detection and identification in large field through automatic technique is really useful as it reduces the work, time and cost for observation and evaluation of disease symptoms. Earlier MPEG-7 visual descriptors were used to detect diseases in maize plants and the drawback is it as low accuracy rate, in this project we use a modified squeezenet algorithm which is a low weighted algorithm. We are using modified squeezenet instead normal squeezenet algorithm because to increase accuracy by increasing the convolutional layers. Mobile application is developed where we can capture image of the affected agricultural crop plant and as well as suggests the type of chemical fertilizer to be used to the farmer to decrease the loss of yield due to the use of wrong fertilizers. The accuracy of the result is found to be better than the existing algorithms.

Keywords: Mobile Application, Javascript Framework, Oryza Glaberrima.

I. INTRODUCTION

1.1 Paddy Production

Paddy cultivation is a very water intensive and laborious job. If you want to do rice cultivation then here is the complete guide on scientifically growing rice in India. Rice is the staple food of people from Southern and eastern parts of India. It is hence widely cultivated in India and other parts of Asia such as China, Japan, Indonesia, Bangladesh, Thailand, etc. Cultivating rice is indeed laborious and it needs a lot of water. Rice is the seed of a grass variety called Oryza sativa and Oryza glaberrima. Paddy plant has a fibrous root with the plant growing up to 6 feet tall. It has a round jointed stem with leaves being long and pointed. The edible seeds which are sold commercially as ‘rice’ grow on the top in the form of separate stalks. Technically this is called paddy as the seeds are covered with a brown coloured husk. The paddy is then harvested and de husked resulting in the commercially important rice. Often people confuse rice and paddy. Rice fields are also called as paddy fields. The sowing time is June-July and is harvested during November-December months. 84% of the country’s rice supply is grown in the kharif crop. Rice cultivated during Rabi season is also called as ‘summer rice’. It is sown in the months of November to February and harvested during March to June. 9% of total rice crop is grown in this season.

The pre-kharif or ‘autumn rice’ is sown during May to August. The sowing time also depends on the rainfall and weather condition. Hence the timing may differ slightly from place to place. Generally, it is harvested during September-October months. 7% of the total rice crop in India grows in this season and short duration varieties which mature within 90-110 days are cultivated. Almost every type of soil can be used for rice cultivation provided the region has a high level of humidity, sufficient rainfall with irrigational facilities, and a high temperature. The major types of soils for rice cultivation are black soil, red soil (loamy and yellow), laterite soil, laterite soil,
red sandy, terrain, hill and medium to shallow black soil. It can be even cultivated on silts and gravels. If the cultivating soil has rich organic matter and if it powders easily on drying or forms a puddle when wet then it is considered to be ideal. Rice can be cultivated in both acidic as well as alkaline soil.

1.2 Diseases Discussed and Predicted

1.2.1 Bacterial Blight

**Causal organism:** Xanthomonas oryzaepvoryzae

Symptoms: Blighting of seedling occurs in nursery. In main field, “Kresek’ phase i.e. death of seedling is usually observed one or two weeks after transplanting. Symptoms are chiefly confined to leaves. Initial infection is seen as water-soaked lesion at the tip of leaf. Infection proceeds along the leaf margin in an irregular wavy manner. The affected portion turns straw colored and the central leaf blade remains green for some time. Finally, the entire leaf gets blighted. Bacterial ooze can be seen on the infected leaf surface, which dries up forming encrustation. Bacterial ooze can be observed from the cut end of the infected leaf when immersed in clearwater.

**Favorable Conditions:** Clipping of tip of the seedling at the time of transplanting; Heavy rain, heavy dew, flooding, deep irrigation water; Severe wind and temperature of 25-30°C; Application of excessive nitrogen, especially late top dressing.

1.2.2 Blast

**Causal organism:** Magnaporthe grisea.

Symptoms: The fungus infects leaf, leaf sheath, culm, node and neck of the panicle. On leaves, the spots are typically spindle shaped (Eye shaped) with dark brown margin and grey center (**Leaf blast**). Spots are sometimes encircled by yellow halo. Several spots coalesce resulting in bigger lesions, leading to drying offoliage.

**Node infection (Node blast):** On nodes, necrotic black lesions are observed which because weakening and breaking of nodes.

**Neck infection (Neck blast):** The neck region of affected panicle becomes black, brittle, and necrotic and breaks. Grains become chaffy or partially filled.

**Favorable Conditions:** Intermittent drizzles, cloudy weather, more of rainy days, longer duration of dew high relative humidity (93-99 per cent); Low night temperature (between 15-20°C or less than 26°C); Availability of collateral hosts and excess dose of nitrogen.

1.2.3 Tungro

**Causal organism:** rice tungrovirus

Symptoms: Infection occurs in nursery and main field. The chief symptoms are stunted growth of plant, reduced till, coloration of leaves in various shades of yellow to orange. The coloration starts from the tip and proceeds downwards. Older leaves exhibit rusty spots or dots of different sizes. The ear heads are small and grains are ill-filled. The virus is transmitted by green leafhoppers.

1.2.4 Brownspot

**Causal organism:** Helminthsporium oryzae (Drechslera oryzae)

Symptoms: Symptoms of the disease appear on leaves, leaf sheath, glumes and grains.

On leaves, the spots are rectangular or oval resembling a sesame seed. They are uniformly brown or reddish brown with discrete margin; Spots have a halo. On the surface of glumes and grains, brown lesions are observed leading to grain.

**Favorable Conditions:** Temperature of 25-30°C with relative humidity above 80 per cent are highly favorable; Excess of nitrogen aggravates the diseases severity.
1.2.5 False-SMUT

**Causal organism:** ustilaginoideavirens

**Symptoms:** Few grains in the earhead exhibit the symptoms. Affected grains get converted into green velvety mass that are much bigger than the normal grains. Spore balls are visible between glumes, and the glumes are not affected. Rainfall and cloudy weather during flowering and maturity favors the disease development. The fungus produces chlamydospores which later develop to sclerotia. Severe outbreak of this disease is recorded in recent years.

1.2.6 Grain Discolouration

**Causal organism:** Helminthosporium, Curvularia, Alternaria Fusarium

**Symptoms:** The grains are discolored red, yellow, orange, pink or black, depending upon the organism involved and the degree of infection. The infection may be external or internal leading to discoloration of glumes, kernels or both. Dark brown or black spots appear on grains. Under humid conditions, the fungal growth may be prominently seen on grains.

1.2.7 Sheath Blight

**Causal organism:** Rhizoctonia solani

**Stage of infection:** Tillering stage

**Symptoms:** Lesions are formed on the leaf sheath near water level. The lesions become oval or ellipsoid and greyish green. As the disease progresses lesions enlarge and their centers turn greyish white with brown margin. Under favorable conditions lesions are formed on upper leaf sheath and on leaf blades resulting in leaf blight. Infection may extend to culm leading to rot. Inside the culm and on the leaf sheath, large number of small spherical, brown sclerotia are formed.

**Favorable Conditions:** High relative humidity (96-97 per cent), high temperature (30-32°C); Closer planting; Heavy doses of nitrogenous fertilizers

1.2.8 Sheath Rot

**Causal organism:** Sarocladiumoryzae

**Stage of infection:** Boot leaf stage

**Symptoms:** Upper most leaf sheath enclosing the ear head exhibits dark brown or black, circular to irregular patches. The panicle does not emerge fully from the flag leaf. The glumes are discolored. White powdery growth of mycelium is seen inside the leaf sheath and also on the panicle. Grains get discolored. Young panicles may not emerge from infected sheaths.

**Favourable Conditions:** Closer planting; High doses of nitrogen; High humidity and temperature around 25-30°C; Injuries made by leaf folder, brown plant hopper and mites increase infection

1.2.9 Leaf Blight

**Causal organism:** Exserohilumturcicum& Helminthosporium maydis

**Turcicum Leaf Blight Symptoms:** The fungus affects the crop at young stage. Early symptoms are oval, water-soaked spots on leaves. Mature symptoms are characteristic cigar shaped lesions that are 3 to 15cm long. Lesions are elliptical and tan in color, developing distinct dark areas as they mature that are associated with fungal sporulation. Lesions typically first appear on lower leaves, spreading to upper leaves and the ear sheaths as the crop matures. Under severe infection, lesions may coalesce, blighting the entire leaf.

**Maydis Leaf Blight Symptoms:** Small yellowish round or oval spots appear on the leaves. These spots enlarge become elliptical and the center becomes straw colored with a reddish brown margin. Conidia and conidiophores are formed in the center.

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Favorable Conditions: Optimum temperature for the germination of conidia is 8 °C to 27 °C, with free water on the leaf. Infection takes place early in the wet season.

II. LITERATURE SURVEY

Manjarrez et al. (2020). Proposed several descriptors for a variety of images. One proposal is the set of standard MPEG-7 visual descriptors. They address their suitability to efficiently describe plagues and diseases in images of maize plants. Colour Structure Descriptor with the Bray-Curtis distance is the most efficient and provides around 68% precision in most cases.

Pros: GPR has the potential to become a coherent and practical tool for detecting tree decay associated with EIDs. 

Cons: The method uses GPR, which is the principal disadvantage of GPR that it is severely limited by less-than-ideal environmental conditions.[1]

J.G.A. Barbedo et al. (2018). Uses a database called PDDB which has 2326 images of 171 diseases and other disorders affecting 21 plant species. PDDB size, although considerable, is not enough to allow the use of powerful techniques such as deep learning. In order to increase its size, each image was subdivided according to certain criteria, increasing the number of images to 46,513.

Pros: It is free available to perform the operation for results.

Cons: The data is primarily stored in databases; hence this process is not viable when there is a problem with the internet.[2]

J.G.A. Barbedo et al. (2016). Organizes all the information that has been published on the subject in the last four decades by presenting a brief individual description of each proposed system, and then condensing all the information into a critical analysis of how the problem was handled in the past, how it evolved into the current scenario, and which are the possible directions to be explored in the future.

Pros: The results have been confirmed to be useful.

Cons: There is no such specific algorithm that is used to diagnose the diseases in plants.[3]

Fumiaki Mitsugi et al. (2019). In this paper the author has proposed the indirect use of plasma to exterminate soil-borne pathogens and worms as a technique in chemical-free agriculture. In this paper, an ozone diffusion treatment system was developed and used on an actual agricultural site for soil disinfection. The working depth of ozone in soil was evaluated by measuring the soil acidity and nitrogen nutrients. After the treatment, radish seeds were planted in the ozone-treated area and control area and was found that radishes grown in the ozone-treated area showed enhanced growth compared to the control and were not infected with scab. The ozone diffusion treatment system developed for eliminating soil pathogens and/or worms was used in an actual agricultural field infested with Streptomyces and its effectiveness was evaluated through the cultivation of radishes.

Pros: The effectiveness of this method shows that the soil acidity and nitrate near the soil surface increased and that these changes depended on the presence of organic substances in the soil.

Cons: The results are not very accurate, hence is not recommended for real life processes. recommended for long term purposes.[4]

Davoud Ashourloo et al. (2016), This paper investigated on using partial least square regression (PLSR), ν support vector regression (ν-SVR), and Gaussian process regression (GPR) methods for wheat leaf rust disease detection, evaluating the impact of training sample size on the results, the influence of disease symptoms effects on the predictions performances of the above-mentioned methods, and 4) comparisons between the performances of SVIs and machine learning techniques. Different sample sizes of collected datasets were utilized to train each
method. PLSR showed coefficient of determination (R²) values of 0.98 (root mean square error (RMSE) = 0.6) and 0.92 (RMSE = 0.11) at leaf and canopy, respectively. SVR showed R² and RMSE close to PLSR at leaf (R² = 0.98, RMSE = 0.05) and canopy (R² = 0.95, RMSE = 0.12) scales. GPR showed R² values of 0.98 (RMSE = 0.03) and 0.97 (RMSE = 0.11) at leaf and canopy scale, respectively. Moreover, GPR represents better performances than others using small training sample size.

**Pros:** This methodology is much accurate compared to other approaches.

**Cons:** The Spectral Vegetation Indices (SVI) are not specific in identifying the disease a plant is affected with.[5]

### III. SYSTEM ANALYSIS

#### 3.1 Existing System

Feature description is a fundamental process in the analysis of images for content-based retrieval and classification. In other tasks in which the image feature descriptor should have enough discriminative power to differentiate similar from dissimilar images according to a distance measure. Although several descriptors have been proposed for a variety of images, the challenge is their suitability to solve these tasks efficiently. One proposal is the set of standard MPEG-7 visual descriptors. We address their suitability to efficiently describe plagues and diseases in images of maize plants. The importance of this crop is its worldwide relevance for human and animal consumption. Experiments for similarity search queries using a set of distance measures, show that the Colour Structure Descriptor with the Bray-Curtis distance is the most efficient and provides around 68% precision in most cases.

**Disadvantages of the Existing System**

1. The existing system uses image feature based visual descriptor, which is an old method for image classification.
2. The highest accurate prediction of the disease is only 68%.
3. The feature extraction can be automated but needs a software.

#### 3.2 Proposed System

In India the economic, political and social stability depend directly as well as indirectly on the annual production of rice. The income of hundreds of millions of people depends only on rice production and nothing else. However, as per the report of International Rice Research Institute (IRRI), 37% of the rice yield loss is due to diseases. In this consequence, the farmer can take care of crop on-time with appropriate treatment. As a crop, rice is the most significant human nutrient in the world, which can be fed directly than any other harvest. Chronologically, the main objective of farming is to yield and feed food to the nation. So, these leaf diseases in any forms in rice crop tends to cause reduction in quality, yield and fiscal progression respectively. The disease detection and identification in large field through automatic technique is really useful as it reduces the work, time and cost for observation and evaluation of disease symptoms.

The modified squeezenet approach for detection and identification of rice leaf diseases by using various advanced algorithms. To apply loss minimization technique such as categorical cross entropy to increase the accuracy. It increases accuracy with use of hybrid algorithms by performing fine-tuning. A mobile application using react native is developed that is used to scan the images of a plant. As well as suggests the type of chemical fertilizer to be used when any type of disease is detected. A hardware module is developed effectively to spray the pesticide for the concerned plant disease. As well as suggests the type of chemical fertilizer to be used when any type of disease is detected.

**Advantages of Proposed System**

- To predict the presence of disease in paddy
- Classifying the type of disease and prescribing required chemical fertilizer
• Reduces inefficient and improper use of fertilizers

Comparison between Existing System and Proposed System

<table>
<thead>
<tr>
<th>FACTORS</th>
<th>EXISTING SYSTEM</th>
<th>PROPOSED SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALGORITHM</td>
<td>A detection framework based on a modified Kirchhoff and a reverse-time migration</td>
<td>Modified SqueezeNet</td>
</tr>
<tr>
<td>ACCURACY</td>
<td>Has low accuracy rate of 68%</td>
<td>Has accuracy rate of 88%</td>
</tr>
<tr>
<td>USER-FRIENDLY</td>
<td>The system is not user friendly.</td>
<td>The system is very user friendly uses a mobile application as interface.</td>
</tr>
<tr>
<td>APPLICATION</td>
<td>The method is applicable only for diagnosis of a single type of plant disease.</td>
<td>The method is applicable only for diagnosis of six types of plant diseases. And also provides the necessary recommendation for such diseases.</td>
</tr>
</tbody>
</table>

IV. IMPLEMENTATION

The lightweight algorithm is implemented using python. The modules used for the project are as follows.

• System Architecture

Dataset Collection and Pre Processing

Data are collected from Scraping from the Web, Third-party images, Own images using camera. Data pre-processing is used to convert the raw data into a clean data set and we will be using pre-processing technique such as uniform aspect ratio, image scaling.

Training with modified SqueezeNet

Using 1x1(point-wise) filters to replace 3x3 filters, as the former only 1/9 of computation. Using 1x1 filters as a bottleneck layer to reduce depth to reduce computation of the following 3x3 filters. Downsample late to keep a big feature map. The building brick of modified squeezeNet architecture is called fire module, which contains two layers: a squeeze layer and an expand layer. A modified squeezeNet architecture stacks a bunch of fire modules and a few pooling layers. The squeeze layer and expand layer keep the same feature map size, while the former reduce the depth to a smaller number.
5.1 Dataset Collection Output

Dataset collection involves the process of collecting different paddy dataset. Various datasets were collected from various different resources. The image of the dataset collection can be seen as follows.

5.2 Data Preprocessing and Augmentation

These datasets are then preprocessed to form an equal aspect ratio so that it can be made ready for training with the model. The datasets are separated into different categories to undergo preprocessing. The next step is data augmentation, which duplicates the collected data into many images so that the prediction percentage can be increased.
5.3 Training with Modified Squeezenet and Fine Tuning

Finding the learning rate finder to train the model with maximum accuracy.

![Learning Rate](image)

The formula for the standard F1-score is the harmonic mean of the precision and recall. A perfect model has an F-score of 1.

\[
\text{Precision} = \frac{tp}{tp+fp} \quad \text{recall} = \frac{tp}{tp+fn}
\]

\[
F1 = \frac{2 \times \text{precision} \times \text{recall}}{\text{precision} + \text{recall}} = \frac{2 \times \frac{tp}{tp+fp} \times \frac{tp}{tp+fn}}{\frac{tp}{tp+fp} + \frac{tp}{tp+fn}}
\]

<table>
<thead>
<tr>
<th>Type of disease</th>
<th>Precision</th>
<th>Recall</th>
<th>F1 score</th>
<th>support</th>
</tr>
</thead>
<tbody>
<tr>
<td>False_smut</td>
<td>1.00</td>
<td>0.90</td>
<td>0.95</td>
<td>40</td>
</tr>
<tr>
<td>Bacterial_blight</td>
<td>0.90</td>
<td>0.84</td>
<td>0.87</td>
<td>76</td>
</tr>
<tr>
<td>Blast</td>
<td>0.63</td>
<td>0.76</td>
<td>0.69</td>
<td>45</td>
</tr>
<tr>
<td>Brownspot</td>
<td>0.80</td>
<td>0.71</td>
<td>0.75</td>
<td>56</td>
</tr>
<tr>
<td>Grain_discoloration</td>
<td>0.93</td>
<td>1.00</td>
<td>0.97</td>
<td>28</td>
</tr>
<tr>
<td>Leaf_streak</td>
<td>0.83</td>
<td>1.00</td>
<td>0.91</td>
<td>28</td>
</tr>
<tr>
<td>Sheath_blight</td>
<td>0.93</td>
<td>0.84</td>
<td>0.88</td>
<td>31</td>
</tr>
<tr>
<td>Sheath_rot</td>
<td>1.00</td>
<td>0.92</td>
<td>0.96</td>
<td>24</td>
</tr>
<tr>
<td>Tungro</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>55</td>
</tr>
</tbody>
</table>

| Macro avg            | 0.89      | 0.89   | 0.89     | 398     |
| Weighted avg         | 0.88      | 0.87   | 0.88     | 398     |
The above mentioned details tells us that the model is been trained and we have got the weighted average of the model as 88% which is the maximum accuracy of the model.

5.4 Loss Minimization and Optimization

After performing loss minimization, we obtained the plot, which can be seen in the graph below.

![Fig. 5.5.Loss Minimization and Output Graph](image.png)

VI. MOBILE APPLICATION

A mobile application using a javascript framework react native is developed to scan the images of the plant to test for any diseases in the paddy.
On successful login to the application (figure 6.1), the home page is displayed(6.2). On capturing an image of the paddy plant the image is uploaded to the server and the results are sent back as response to the mobile application. Just like the above mentioned images in the same procedure nine types of paddy diseases can be detected and provided suggestions for remedy. This, from the above results and discussion, it is clear that we have efficiently made a project for predicting and providing suggestions for remedy for all types of paddy diseases. Thus, we have successfully implemented the scope of the project.

VII. CONCLUSION

The drastic environment change urges the need of devising new methodology for agriculture i.e. paddy crop plantation. In this project we suggest a method of dissimilar disease cataloguing for the nine different types of diseases in the infected plants. It also recommends and assesses an instinctive image dissection and cataloguing techniques by framing a layered set of rules for the infected plants. From the execution point of view, the proposed methodology was tried and verified on various kind of rice leaf diseases like bacterial blight, brown spot, leaf scald and leaf blast successfully. Over and above it has been seen that, by means of least methodical pains the finest outcome can be gained resourcefully to verify the productivity of planned methods. Another perspective of employing this method is that, the plant disease can be documented at the early stage as possible. Thus, our project provides a solution to classify and predict the presence of disease in paddy effectively.

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