ORYZA: AN IOT APPLICATION TO DETECT RICE CROP DISEASES USES IMAGE PROCESSING

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***Abstract*: Being an agricultural country, most of the people of Bangladesh are dependent on agriculture directly or indirectly. It is the fourth largest rice producing country in the world. Main hindrance in rice production is paddy diseases. So in this research the main objective is to develop a prototype system for detecting the paddy diseases, which are Paddy Blast, Brown Spot and Narrow Brown Spot diseases. This concentrate on the image processing techniques used to find pattern in the image and artificial neural network technique to classify the diseases. The methodology involves image collection, image processing, feature extraction and classification. Features are extracted from the images using Haralick's texture feature from color co-occurrence matrix. Then an artificial neural network is trained by these features and a trained model is found. In testing phase, all paddy samples are passed through the leaf color analysis to detect the normal paddy leaf image. If the sample passes leaf color analysis, then it is automatically classified as Normal Paddy leaf image. Otherwise, all the segmented paddy disease samples are converted into the features data and are passed through the artificial neural network. Consequently, by employing the artificial neural network technique, the paddy diseases are recognized. The accuracy to detect diseases of this model is good enough to use in practical life.**

Index Terms: Internet of Things, Image Processing, Rice crop disease detection, Haralick's texture feature matrix

I. Introduction:

Now a day's Growing potential of Indian processing sector poised India's contribution to world food trade. India's economy is one of the fastest growing economies of the world, and livelihood of 58% of rural household depends on agriculture [1]. Indian retail market of food industry contributing 70% of the sales and grocery market becomes sixth largest is the world. Recent trends of technical advancement in food processing industry establish ranked fifth in terms of production, consumption, export and expected growth. A large number of the crops grown in our country are rice, wheat, sugarcane, pulses etc. Instead of huge production, we are still lagging behind, because existing literature does not derive any comprehensive technique, which can deal with the complete identification of the plant disease. We should develop a technique or framework for soil testing and disease identification via single platform. Some basic steps required for image processing are discussed in later parts of this study. Image processing deals with image acquisition, image preprocessing, disease segmentation, feature extraction and disease classification [1].

Problem Statement:

Paddy will be harvest twice in a year. Most of paddy farmer faces many problems to harvest their paddy because they used to attack by snail, worm and fungi. Furthermore, when the paddy had been infected or attacked, the others areas had been exposed to be infected [2]. Thus, it will decrease paddy farmer's income and lead to significance losses to farmer. Currently, the paddy farmer determines the type of disease manually. The errors might occur in order to determine the type of diseases. Paddy farmer also have to spend a lot of time to detect the type of disease. It also takes a time as the paddy farmers manually check the disease since the paddy field is in wide area.

Objective:

There are three goals to accomplish in this paper:

- To propose a model of Paddy Disease Detection framework.
- Apply Image Processing strategy to investigate the example of Paddy Disease.

Existing System:

An examination led by University Kebangsaan Malaysia means to build up a model framework to consequently and effectively recognize and characterize the paddy diseases with Blast Disease (BD), Brown Spot Disease (BSD), and Narrow Brown Spot Disease (NBSD) utilizing picture preparing system as an option or supplemental to the conventional manual technique. Primarily the image is blurred in order reduce noise. Then the image is converted from RGB to HSV form, after this color thresholding is done.

After thresholding foreground or background detection is performed. Background detection leads to feature extractions of the leaf. Then k-means algorithm is applied which can help to clot the clusters. There is a software-based solution for detecting the disease with which the leaf is infected [8]. This thesis presented the common method for detecting paddy disease. By previewing various methods, we learned advantage and disadvantage of various methods and their characteristic for simple and clean paddy disease detection.

II. Proposed Methodology:

The purpose of this chapter is to discuss the approach and system of proposed methodology. This chapter also explains about the justification of method or approach used and hardware and software necessity [2]

Work Flow:

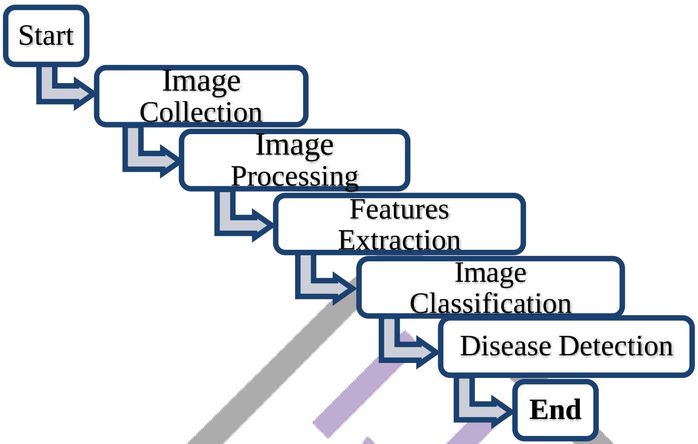
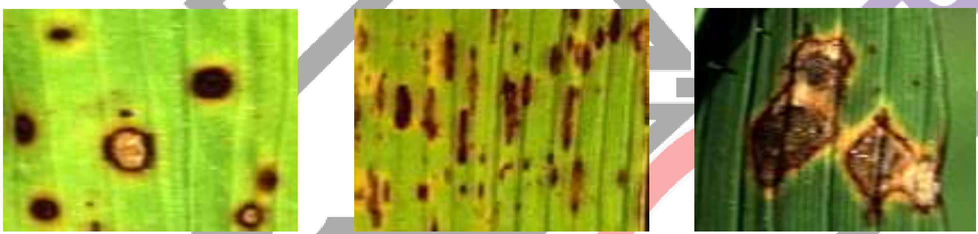


Fig 1: Work Flow of proposed methodology

Image Collection:

The RGB images of paddy leaf are collected from Internet. Those image cropped into a smaller image with dimension of 64 x 64 pixels as training data [4]. We have collected about 180 data samples with the four rotations from each image. It consists of three types of paddy diseases (Paddy Blast, Brown Spot, Narrow Brown Spot) as shown in below Images are stored in jpg format [4].



(a) (b) (c)

Fig 2: Sample of collected images (a) Brown Spot Disease; (b) Narrow Brown Spot Disease; (c) Blast Disease

Image Processing:

The image acquired is preprocessed. The preprocessing starts by converting the RGB image to L*a*b* color space. The L*a*b* color space consists of Luminosity layer L*, chromacity layer a* and b* [2]. All of the color information is stored in the layers a* and b*. It requires to make color form so that the RGB colored image is converted to L*a*b* space. The function is makecform(), later the format is applied to the image that was acquired [2]

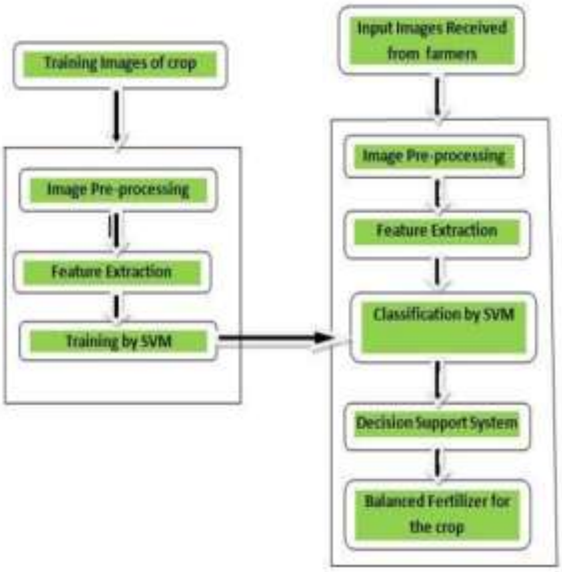


Fig 3: DFD for image processing.

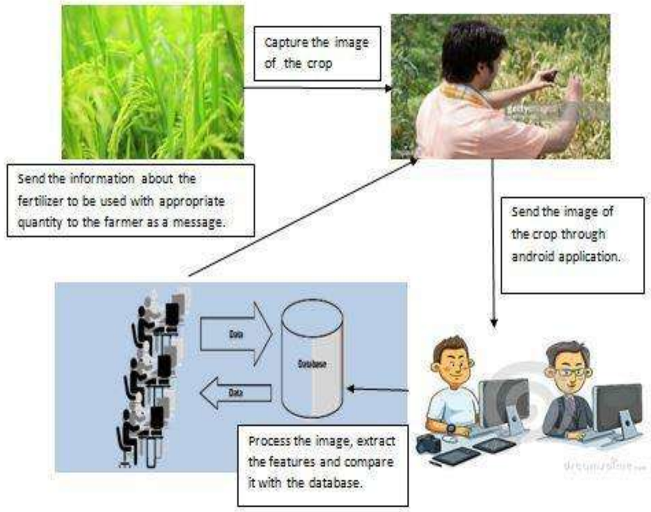


Fig 4: Fertilization Management for crops.

Classification:

After extracting features from the images, now a classifier is needed to classify the images. Here an artificial neural network with three hidden layeris used as a classifier. In the classifier two steps are followed. If an image does not pass leaf color analysis, classifier algorithm will be used to detect the diseases [2].

Leaf Color Analysis:

First the whole image is scanned through and calculates the minimum and maximum value for each channel. The RGB calculation will be passed [1]

$$93 \le R_{min} \le 211 \& 93 \le R_{max} \le 211$$

$$142 \le G_{min} \le 222 \& 142 \le G_{max} \le 222$$

$$64 \le B_{min} \le 155 \& 64 \le B_{max} \le 155$$

If an image passes all the above conditions, then the image is normal leaf image. Otherwise, it is an affected image [1]

To calculate those values first we took some normal paddy leaf images and calculate the histogram values. From those histogram values the minimum and maximum values were calculated.

III. Requirement Specification:

Functional Requirements:

Functional requirements define the internal workings of the software: that is, the technical details, data manipulation and processing and other specific functionality that show how the use cases are to be satisfied. They are supported by non-functional requirements, which impose constraints on the design or implementation [10].

Software Requirements:
Language : Python
Operating System: Windows 10 (64-bit)
IDE : MIT App Inventor, Jupiter Notebook
Hardware Requirements:
Micro Processor: Raspberry Pi Kit
Processor : Intel i3
Hard Disk : 1TB
RAM : 8GB
Sensors : Temperature and Humidity sensor, Soil Moisture sensor

IV. EXPERIMENTAL ANALYSIS

There are 220 samples of paddy image used as sample data in the testing phase of this development [11]. The paddy images samples had gone through the phases as discuss in the chapter 3. This chapter will briefly describe about the output result of each phases.

Experimental Setup:

The experiments and analysis processes are done on a computer with Core-I5 processor having 4 cores with each core having 2.5GHz Speed. Also the system had 4GB of RAM, and 1GB of internal intel HD video memory [12]. For software, PyCharm Community Edition 2017.1 is used and program is done with python language with OpenCV and deep learning framework, TensorFlow. OpenCV (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. The reason for using OpenCV because it gives easy functionality to do different processes without going into implementations. Moreover, it gives the benefit to use GPU by which processes can be made faster than using CPU only for computation works.

TensorFlow™ is an open source software library for numerical computation using data flow graphs [9]. TensorFlow was originally developed by researchers and engineers working on the Google Brain Team within Google's Machine Intelligence research organization for the purposes of conducting machine learning and deep artificial neural networks research [12], but the system is general enough to be applicable in a wide variety of other domains as well.

PERFORMANCE ANALYSIS:

Accuracy– Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observation to the total observations. One may think that, if we have high accuracy then our model is best[9]. Yes, accuracy is a great measure but only when you have symmetric datasets, where values of false positive and false negatives are almost same. Therefore, one has to look at other parameters to evaluate the performance of the model [3].

$$Accuracy = \frac{TP + TN}{TP + FP + TN + FN}$$

Precision– Precision is the ratio of correctly predicted positive observations to the total predicted positive observations. The question that this metric answer is of all passengers that labeled as survived, how many actually survived? High precision relates to the low false positive rate.

$$Precision = \frac{TP}{TP + FP}$$

Recall – Recall is the ratio of correctly predicted positive observations to the all observations in actual class - yes. The question recall answers, is: Of all the leaves that truly are in this particular class, how many did we label?

$$Recall = \frac{TP}{TP + FN}$$

Classification Result:

Paddy Blast:

Total 87 leaves which are affected by Paddy Blast disease are used for experiment. In those leaves, 10 images were misclassified and the other 77 images are correctly classified [3]

Correctly classified:

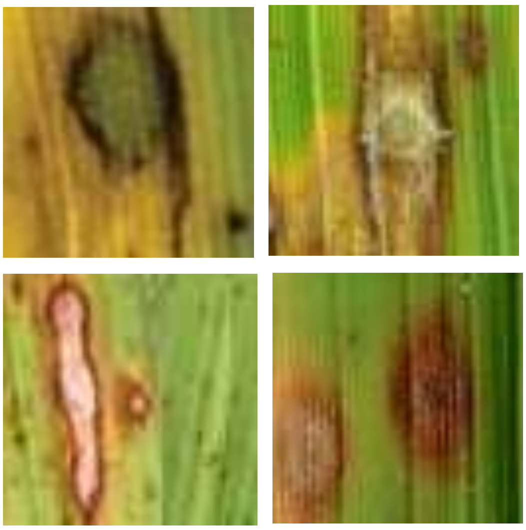


Fig 5: Correctly classified 4 Paddy Blast images

Incorrectly classified:

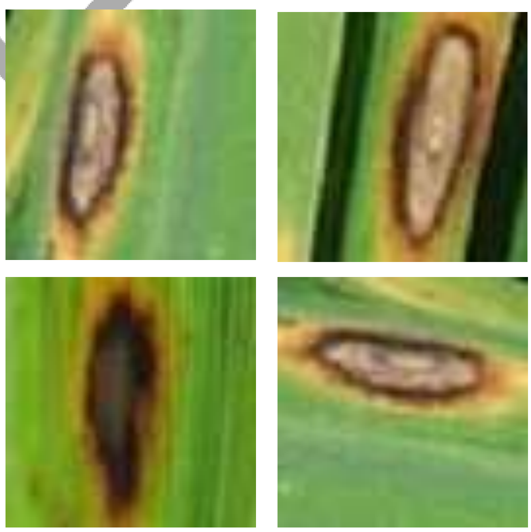


Fig 6: Incorrectly classified 4 Paddy Blast images

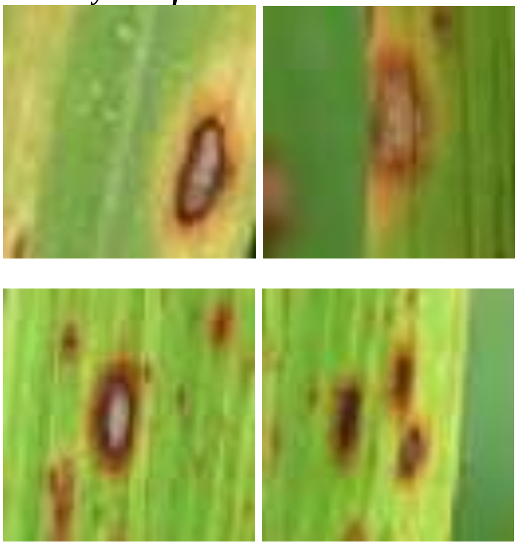
Accuracy of Paddy Blast = 88.51%

Brown Spot:

Total 56 leaves which are affected by Paddy Blast disease are used for experiment. In those leaves, 14 images were misclassified and the other 42 images are correctly classified [3]

Examples:

Correctly classified: ***Incorrectly classified:***



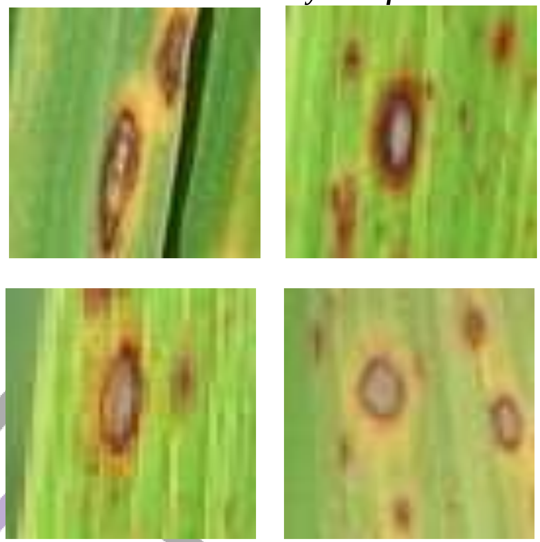


Fig 7: Correctly classified 4 Brown Spot images [4] Fig 8: Incorrectly classified 4 Brown Spot images[4]

Narrow Brown Spot:

Total 33 leaves which are affected by Paddy Blast disease are used for experiment. In those leaves, 4 images were misclassified and the other 29 images are correctly classified[3].

Examples:

Correctly classified:

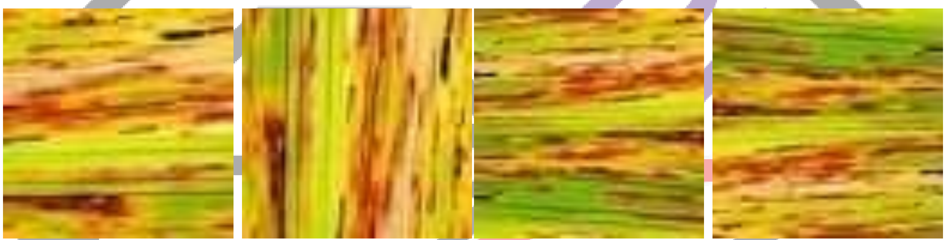


Fig 9: Correctly classified 4 Narrow Brown Spot images

Incorrectly classified:

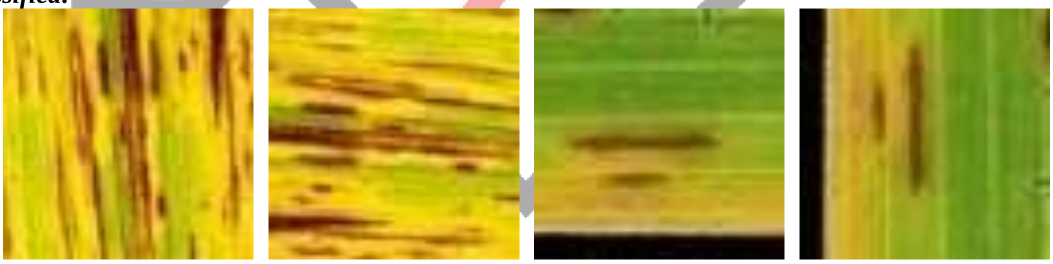


Fig 10: Incorrectly classified 4 Narrow Brown Spot images [4]

V. Working of Soil Moisture Sensor:

The working of the Soil Moisture Sensor is very simple. It works on the principle of voltage comparison. The following circuit will be helpful in understanding the working of a typical soil moisture sensor.

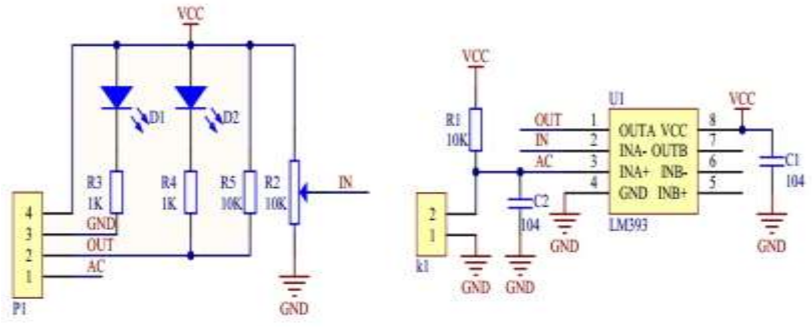


Fig 11: Working of Soil Moisture Sensor

As you can see, one input of the comparator is connected to a 10KΩ Potentiometer while the other input is connected to a voltage divider network formed by a 10KΩ Resistor and the Soil Moisture Probe. Based on the amount of water in the soil, the conductivity in the probe varies. If the water content is less, the conductivity through the probe is also less and hence the input to the comparator will be high. This means that the output of the comparator is HIGH and as a result, the LED will be OFF. Similarly, when there is adequate water, the conductivity of the probe increases and the output of the comparator becomes LOW. The LED then starts glowing.

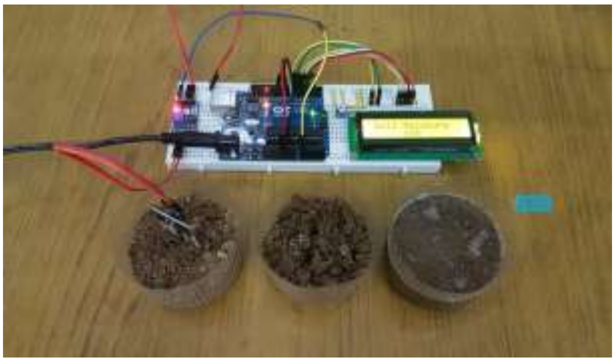


Fig 12: Working of Soil Moisture Sensor

Components Required:
The components used in soil moisture sensor are as follows:

- Raspberry Pi 3 Model B
- Soil moisture Sensor
- Connecting Wires
- Power Supply
- Computer

Circuit Design:

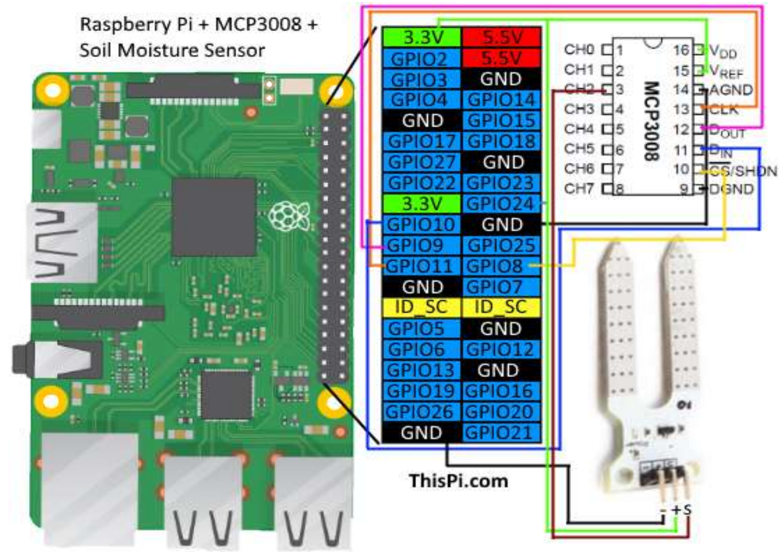


Fig 13: Circuit Design

The soil Moisture sensor FC-28 has four pins
VCC: For power
A0: Analog output
D0: Digital output
GND: Ground

The Module also contains a potentiometer which will set the threshold value and then this threshold value will be compared by the LM393 comparator. The output LED will light up and down according to this threshold value.

Raspberry Pi DHT11 Module
3.3v P4 ———————— VCC (V)
GND P9 ————————- GND (G)
GPIO4 P40 ———————— DATA (S)

VI. CONCLUSION

This paper presents an application for detecting the crop diseases and providing the solution for particular disease and necessary suggestions and that will be received by the farmer using the Raspberry Pi kit and sensors. Thus, the objective of this paper was implemented on sampled Rice crops. The diseases are specific to these crops were considered for testing of the algorithm. The experimental results indicate the proposed approach can recognize the diseases with a little computational effort. By this method, the crop diseases will be identified at the initial stage itself and the pest control tools will be applied to solve pest problems while minimizing risks to people and the environment.

Future Enhancement:

In future, will implement more crop disease detection on various samples based on accuracy rate. In order to implement need to improve disease identification rate at various stages, the training samples can be increased with the optimal features given as input condition for disease identification and fertilization management of the crops. In Future Enhancement, the ORYZA application will be implementing to complete process described in this paper and can be automated so that the result can be delivered in a very short time and the accuracy value is quite good for this method to the farmers, so that they can save their crops before lose.

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