Seed of rice plant classification using coarse tree classifier

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ABSTRACT

The goal of this paper is to help the agriculture to have consistent observation in the status of seeds in rice plants and have a good quality post-production by classifying the seeds automatically leading to reduction of low-quality rice plants while achieving higher demands in exportation as the quality increases. Additionally, manually observing the seeds of rice plants does not give an accurate evaluation as factors such as fatigue and emotion can affect the result. Using image processing and color feature extraction, it extracted the red, green, and blue (RGB) color feature lying in the pixel point of the seed in the healthy and unhealthy images of rice plants and classified by coarse tree classifier (CTC). The classifier achieved a 100% accuracy and training time of 0.32189 seconds, hence the fitted machine learning approach in the study.

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1. INTRODUCTION

The 3.5 billion people living particularly in Asia, Latin America, and parts of Africa have the staple food named rice and its scientific name is Oryza sativa. It is the main source of energy in their everyday living amounting to about 90% as it supplies nutritional needs in the body [1]. Due to its high demand in the market, there is a need to carefully check and analyze the product before exportation. Without checking of this staple food, it can affect the process of production that may decrease nutrients it can provide to people.

The origin of rice is a small seed growing in a daily basis until it forms into a rice plant full of seeds, waited for number of days until ready for harvest. The planting process of rice has a very long way to go, and even depending on the specific class/type of rice seed the farmer planted. On the other hand, having different classes of seeds does not imply difference in factors to consider because their growing is very similar but not the span of time and its harvest phase. In order to obtain a successful planting and a quality-based harvest, one of the most factors to consider is the environment where the rice seeds will be located. Aside from the environment, things such as insects, humidity, temperature, and bacteria can affect the result of growing phase that can lead into a more serious problem, so the quality of the harvest.

There is a reduction in quality and quantity of agricultural crops due to plant diseases [2] and both of those aspects directly affect the overall production of the crop in a certain country [3]. As the quality and quantity of crops reduce, the production and exportation in the field of rice will be affected so as the balance cycle in the market. Lack of continuous monitoring is one of the main problems in planting as there are newbies in the field of agriculture that are sometimes not aware of the diseases happening in the plants and its occurrence given that it can occur any time and grow in any kind [4]. The detection of irregularities in a plant and classify it according to its category is one of the important research topics in the agricultural field and will help to produce a quality product before exporting in the marketplace achieving a higher percentage in its goodness. Additionally, the manual evaluation using the naked eye of farmers does not always imply a right classification of seeds in a rice seed plant knowing that fatigue and personal emotions can affect the process of evaluation and observation.

With that, the authors attempt to make this paper to classify healthy and unhealthy seeds in rice plant images from dataset [5] taken using digital cameras. Using image processing, this technique can be used as an effective instrument to extract features from objects in an image [6]–[13] while using machine learning approach as the efficient tools in discriminating the extracted features from the object in an image [14]–[16]. The method applied in order to classify the images is the use of red, green, and blue (RGB) color feature from the pixel point of the images and the coarse tree classifier (CTC) as the machine learning approach to classify the extracted color feature. The dataset were already classified using simple coding of convolutional neural network in [5] and achieved an accuracy from 44-69%. On the other hand, the authors used different approach in this study, the used of RGB value lying in the pixel point of the seed of rice plant images. This study was expected to help the agriculture to classify the seeds of rice plants automatically reducing the chances of having low-quality rice plants and achieving higher demands of exportation as the quality assurance increases.

2. RELATED WORK

As defined by the experts, machine learning (ML) is the study that gives computer the ability to learn without explicit programming. It makes the machines carry out certain tasks smartly through learning on their own. Moreover, Machine Learning is known for its capability of dealing 'big data', as big data means bigger accuracy as there is more to learn during the training of ML [17]. The bigger the data, the higher the knowledge the machine learning can gain from training, the higher the accuracy it can produce.

In Malaysia, the techniques of ML is widely used such as decision trees (DT), M5P tree algorithms, artificial neural network (ANN), and k-nearest neighbours (KNN) in many field including economy and agriculture. For example, is to classify the herbs in the country, as it is critical in the development of its economy, the fact of being one of the main exporters of herbs. On the other hand, a recent study on 2019 in Malaysia, they use the application of ML in order to predict the flood risks and achieved a 99.92% accuracy using decision trees with synthetic minority over sampling technique (SMOTE) [18]. Decision trees is one of the machine learning approaches that has simplest form of implementation yet having a good characteristic in dealing with data.

Rice classification, maize, leaf disease, they are three of the most beneficiaries in the application of ML together with the involvement of an image processing. Image processing is a technique that extract necessary data from the object in an image and use it to have findings, the weakness point of the manual process in today's technology. The manual process of classifying things, especially in the agriculture does not give a consistent and assured classification as it is done manually, hence, the existence of the automated system due to progression of technology. Image processing is use recently in the various applications of computer vision [19]. It introduces fast, consistent techniques used in varieties of industries [20], [21].

The manual classification of rice grain is poor in its performance, less accurate and needs enough professionals in order to get a well-evaluated rice grain. Using image processing as the proposed technique for feature extraction and multi-class support vector machine (SVM), a machine learning approach, the classification of rice grain was classified automatically. This study in 2019 achieved an accuracy of 92.22% in classifying the three types of rice grain namely: Basmathi, Ponni, and Brown based from their shape and color [21]. On the other hand, using RGB values in a study from [22], the immature and mature beans classified with the help also of different machine learning algorithms. The study extracted RGB values from the beans, subjected to MATLAB classification learner app, and achieved a 94% accuracy using the quadratic SVM as the classifier with training time of 0.62 seconds.

In year 2020, a recent study of detecting nutrient defiency in maize (Zea mays L.) leaves happen using image processing. The technique is a combination of gray-level co-occurrence matrix (GLCM), hu-histogram and color histogram in order to detect the nutrient deficiency. Random forest is the classifier that classifies the data extracted from the proposed technique manage to get an accuracy of 78.35% [23]. It is indeed the use of machine learning approach as well as image processing can turn the world upside-down, changing the traditional routine of doing things manually, modernizing into automation systems.

3. RESEARCH METHOD

The study aims to classify the seeds of rice plant images using CTC and to see the accuracy from the usage of said machine learning approach. Figure 1 shows the flowchart of image processing technique used to classify the seed of rice plants. First, inserting the rice plant images then image analysis by using pixel region pointer. After the analysis, the color feature extraction happens. The color feature extraction is a process of extracting color feature from the object of an image. After the extraction, it undergoes the classification using the machine learning approach to classify the extracted color feature. After classifying the extracted color feature, it will reveal the result of the classification of which is healthy and unhealthy.

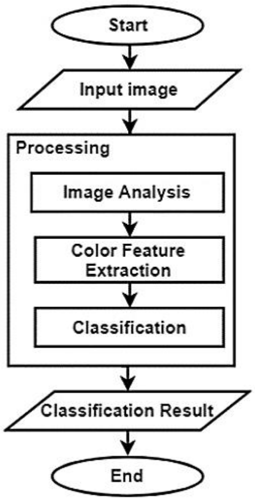


Figure 1. Flowchart of classifying seed of rice plant

3.1. Input image

There is a total of 200 images of rice plant used in this study, 100 for healthy and another 100 for unhealthy. The Figure 2 are the sample images of both categories of rice plant that came from the dataset in [5] with difference in its color combination and shows true visual as in Figure 2(a) healthy rice plant and Figure 2(b) shows unhealthy rice plant. These images are subjected as the data of the study.

(a) (b)

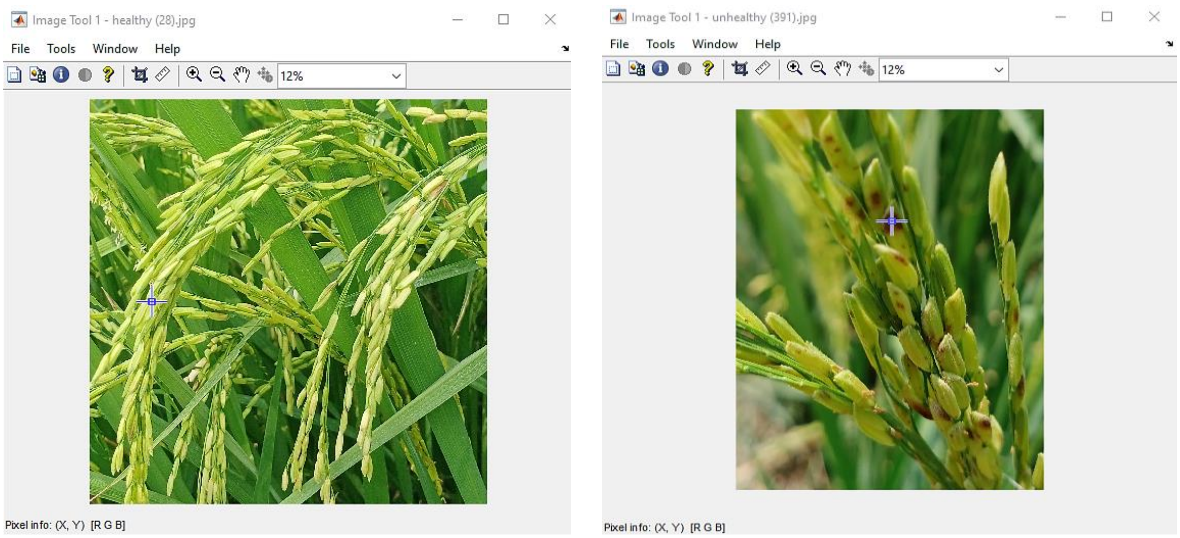
Figure 2. Sample images of seeds in rice plant (a) healthy rice plant and (b) unhealthy rice plant

3.2. Processing

The processing are divided into three sub-processes: the image analysis, color feature extraction and classification. These processes are the key to make this study possible as it extracted important data from the images of healthy and unhealthy rice seed plants. Below are the sub-processes labelled as 3.2.1, 3.2.2, and 3.2.3 with explanation of every method used.

3.2.1. Image analysis

By inputting the image in the image viewer of MATLAB software [24], analyzation will happen. The used of pixel region function [25] analyze the object existing in an image and extracting necessary data from it. The blue part in the image is the cursor/pointer responsible for analyzing and enables extraction of important data. The Figure 3 is the sample analysis of object in an image for both healthy and unhealthy rice plant denoted correspondingly by Figures 3(a) and (b).

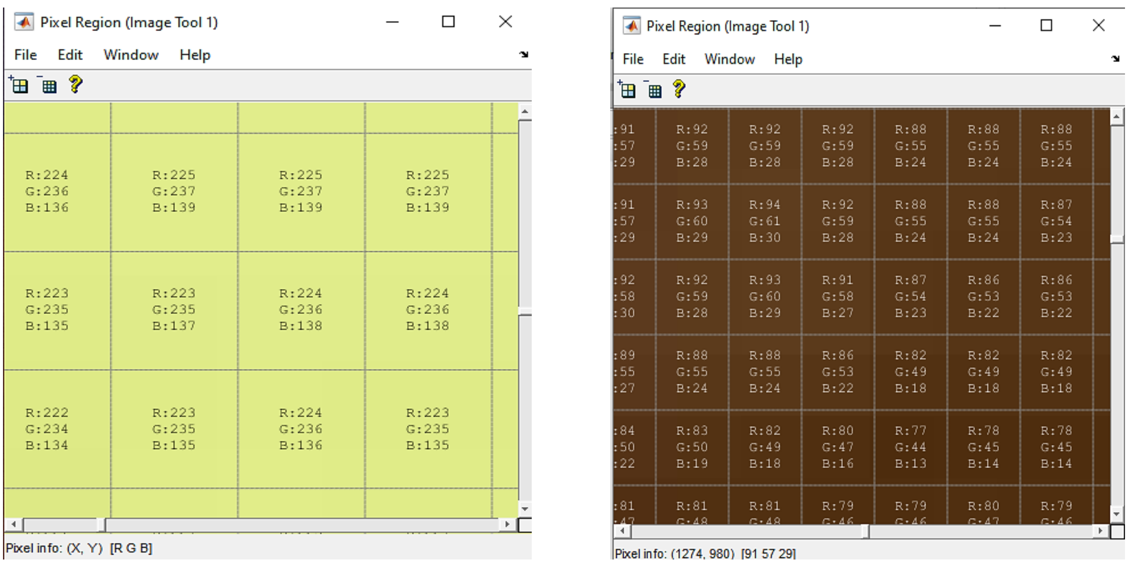


(a) (b)

Figure 3. Sample of analyzing seed in rice plant images (a) healthy rice plant and (b) unhealthy rice plant

3.2.2. Color feature extraction

One of the most important requirements to be able to have a successful process in image retrieval, indexing, classification, and clustering, is to extract efficient features from images. It is also one of the most widely used visual features as it has the power of visual content representation, simplified extraction of color information, high efficiency in image separation from each other, relatively robust to background complication and independently working of image size and orientation [6], [26]–[30]. This study uses the RGB values as the important data from the images of healthy and unhealthy rice plant. The RGB stands for red, green, and blue color values in a pixel point that forms true color of a whole image. The Figure 4 shows the extracted color feature from the image analysis section. The Figure 4(a) is for the healthy rice plant while the Figure 4(b) is for the unhealthy as mentioned.



(a) (b)

Figure 4. The extracted RGB values from rice plant images (a) healthy rice plant and (b) unhealthy rice plant

The Table 1 shows the range of RGB values extracted from 200 images of healthy and unhealthy seed of rice plants revealing that the range of unhealthy is lower than the range of the healthy ones. On the other hand, the Figure 4 is the actual sample of that RGB color feature extraction from the presented Figure 3. A single image has many pixel points so the RGB values lying on it. As the color range is close with each other, the RGB value in that very point and the others near with it does not have significant difference.

Table 1. The RGB range values for healthy and unhealthy seed of rice plant images

Category of Seed of Rice Plant	Red	Green	Blue
Healthy	120-255	143-255	75-224
Unhealthy	52-180	23-96	11-95

3.2.3. Classification

CTC belongs to the family of decision trees: fine tree and medium tree. The CTC has fast prediction speed, easy interpretability and small memory usage. Moreover, the tree model of a CTC is easy to understand as it has root (node), few branches and leaves. The Figure 5 is the tree model of the CTC.

The Figure 5 is the model for coarse tree, the chosen machine learning approach of the authors. CTC has the simplest implementation of tree model with few leaves leading to faster classification, reducing the training time so the waiting of result. The bigger box is the root (node), the place for the condition while the arrows are the branches. The smaller box are the leaves, the potential outcomes of each decision. The higher the number of leaves, the higher the distinction of classes. On the other hand, there are only two categories of classification in this study, which is the healthy and unhealthy and it is the main reason why the authors chose the CTC as the classifier because it is the best path to take.

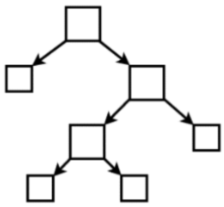
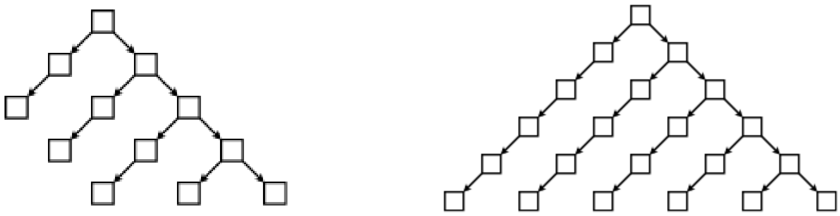


Figure 5. The tree model of the CTC

On the other hand, the Figure 6 is the two sample tree models of mentioned classifiers above namely the medium tree and fine tree. At Figure 6(a), it is a medium tree model that shows more branches in comparison with the chosen classifier, the CTC. The more branches, the more choices of result, an addition of complexity. The Medium Tree is not the classifier in the family that has the most branches, but it is the Fine Tree as displayed in Figure 6(b). The Figure 6(b) is a representation of refined but more implemented branches than CTC and Medium Tree. This is an indication that it is a lot more complex than the Medium Tree as there are different ways or paths the outputs can come from. These two models really have the complexity in nature of implemented algorithm, thus it is not advisable to be used as the classifier of the study.



(a) (b)

Figure 6. The tree model of other mentioned classifiers (a) medium tree and (b) fine tree

3.3. Testing

Using (1), the classification accuracy is calculated [21]. This formula will achieved the percent accuracy by having the number of true accuracy result divided by the total number of testing data. Once the quotient is obtained, the quotient will be multiplied in a hundred percent getting the output as percentage. See in (1):

$$\%of accuracy = \left(\frac{No.ofTRUEAccuracyResult}{TotalNo.ofTestingData}\right) x100\% \quad (1)$$

4. RESULTS AND DISCUSSION

Table 2 presents the machine learning approaches for classifying the RGB value extracted from the seed in the images of healthy and unhealthy rice plants. However, this study only focuses in the coarse tree classifier as the classifier of the study, highlighted by the use of bold letters. This classifier is known for its simple structure in terms of the tree model, see section 3.2.3, hence the chosen classifier for the study.

Table 2. Rice seed classification

Classifier Type	Accuracy (%)	Training Time (Seconds)
Fine tree	100	9.0801
Medium tree	100	0.37642
Coarse tree	**100**	**0.32189**
Linear discriminant	98	3.147
Quadratic discriminant	100	1.72
Logistic regression	100	16.106
Linear support vector machine	99.5	3.0328
Quadratic SVM	100	0.33663
Cubic SVM	100	0.35206
Fine gaussian SVM	99.5	0.36181
Medium gaussian SVM	99	0.36026
Coarse gaussian SVM	98.5	0.29832
Fine KNN	100	2.4239
Medium KNN	99	0.34463
Coarse KNN	98	0.32387
Cosine KNN	98.5	0.57245
Cubic KNN	99	0.42052
Weighted KNN	99	0.32329
Boosted trees	50	4.3609
Bagged trees	100	6.5868
Subspace discriminant	99	4.3594
Subspace KNN	100	3.887
RUS boosted trees	50	0.87523

Highlight legend:
Bold classifier–Classifier of the study

Table 2 shows 10 classifiers achieved an accuracy of 100% such as fine tree, medium tree, coarse tree, quadratic discriminant, logistic regression, quadratic SVM, cubic SVM, fine KNN, bagged trees, and subspace KNN with variations in their training time of classifying. The implemented classifier for this study is the CTC and it achieved an accuracy of 100% with a training time of 0.32189 seconds, the fastest time among the others. The fact that the CTC has the simplest form of algorithm as shown in its tree model under 3.2.3; it is the exact machine learning for the study. This happen because every machine learning approach has its own characteristic and choosing the right classifier is a thing to consider. If the implemented classifier for the study fits the available data, the accuracy will be higher while training time become smaller. Other machine learning approach achieved a 100% accuracy but high in training time because the available data fits the algorithm but inefficient in the speed and its memory capacity can be one of the factor. If the machine learning approach is design for dealing with bigger data but the availability of yours is limited, it can affect the training time because the machine learning itself is adjusting its algorithm. The key is to understand and have insight about the machine learning approaches to pick the right one for the preferred study.

The Figure 7 is the representation between gaps of time and accuracy of machine learning approaches in Table 2. The CTC has the smallest training time of 0.32189, so the lowest in the line graph. Logistic regression has the highest training time, 16.106 seconds as pointed line shown in the illustration. At the middle part with 9.0801 seconds, it is the fine tree. Fine tree is a family of decision trees with coarse tree classifier yet got the second highest training time.

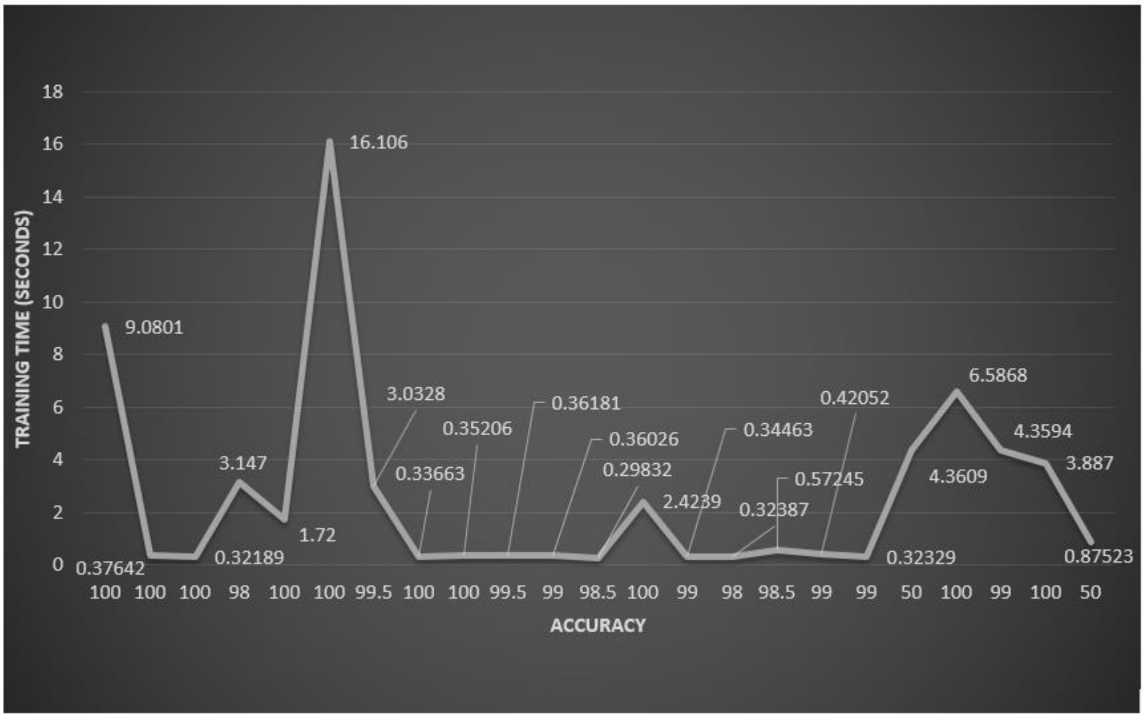


Figure 7. Visualization of time and accuracy of Table 2

The confusion matrix in Figure 8 shows that the preferred classifier of this study, the coarse tree classifier classified the 100 RGB values extracted from healthy and unhealthy seeds in rice plant images. There are 100 identified healthy rice seed plants as well as unhealthy ones. On the other hand, the Table 3 is the accuracy result with a mean of 100% as the number of true classification for both healthy and unhealthy is 100 as shown in the confusion matrix. The CTC is the preferred machine learning approach for this study.

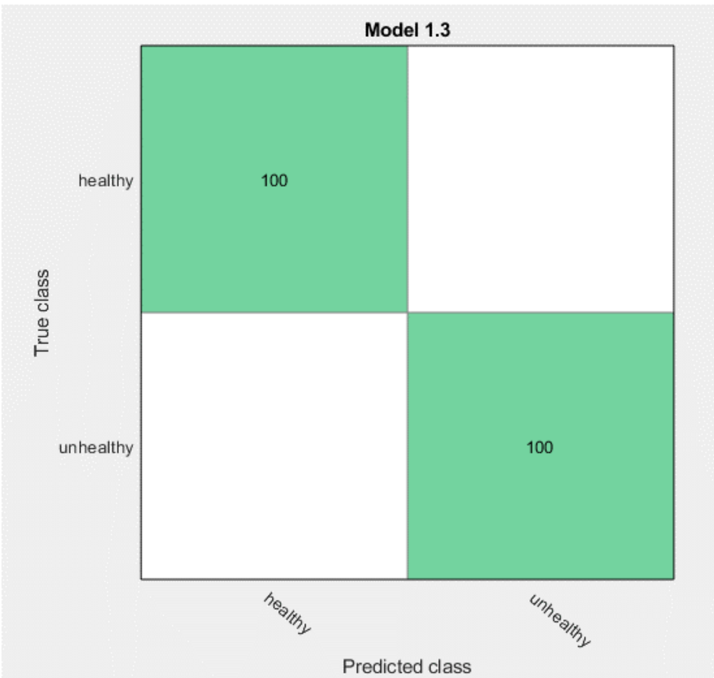


Figure 8. The confusion matrix of CTC

Table 3. Accuracy result

Category of Seed of Rice Plant	No. of TRUE Classification	% of Accurcay
Healthy	100	100
Unhealthy	100	10
	MEAN	100

5. CONCLUSION

The purpose of this paper is to classify the healthy and unhealthy seed in rice plant images by using the extracted RGB values and classified using CTC that can introduce good quality in the post-production of rice and observation in its status. With a 100% accuracy and best training time of 0.32189 for the CTC, and a mean of 100% as the number of true classification shown in confusion matrix, it is possible to classify a healthy and unhealthy rice seed plant using extracted RGB values and obtain a perfect accuracy by picking a right machine learning approach. In the terminology of color feature extraction, if the green color in the combination of RGB is less than 109, the seed of that rice plant is unhealthy. On the other hand, if the green color is equal to 109 and above, it is a healthy seed in rice plant given that the color feature red and blue are in the range of 200 and above, different from red and blue of color feature the unhealthy plant has. In simple terms, if the color of the seed in rice plant is brown, it is more likely unhealthy, if not, then the latter. The 100% accuracy is greater compared with the simple coding of convolutional neural network that has 44-69% only. Since the classification only happens in 200 samples, in the future, it is hope that the study undergo classification using bigger data. If this will happen, it will give more interesting outcome and tackles engineering problem in the simplicity of classification the fact that larger data is used with the machine learning approach. The owner already classifies the dataset as healthy and unhealthy, the authors of this study does not have any control with that and does not have the knowledge of any consultation, thus, it is really an advantage to own a dataset when doing a study. Owning a dataset means knowing its origin, ability to have different perspective and approaches with it and explain the dataset in a concise way. Additionally, doing a study wherein the dataset is owned by authors established familiarity and will enable them to ask opinions from professionals regarding with the related field that can build and strengthens fact and conciseness.

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