Machine Vision Based Papaya Maturity Recognition

BY

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Master of Science in Computer Science and Engineering

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APPROVAL

This project titled **"Machine Vision Based Papaya Maturity Recognition"**, submitted by Md. Khalid Rayhan Asif to the Department of Computer Science and Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of M.Sc. in Computer Science and Engineering (MSc) and approved as to its style and contents. The presentation has been held on September 21, 2022.

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DECLARATION

I hereby declare that this project has been done by me under the supervision of **Dr. Md. Tarek Habib, Assistant Professor, Department of CSE,** and Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree or diploma.

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Finally, I acknowledge with due respect to my parents who are always supporting me and praying for me.

ABSTRACT

Throughout the world, papaya seems to be very familiar both as a vegetable and as a fruit, depending on the stage of maturity level. If we look over other countries, we can find that papaya has a large amount of values because of its health benefits & also protect against a number of health conditions which is proved by medical science from many years before. A tropical fruit with excellent nutritional & therapeutic appraisal due to its abundant origin of vitamins A & C is the Papaya (Carica Papaya). South Mexico and Costa Rica are where papaya harvesting first began. Fruit output is expected to be 6 million metric tons annually throughout the planet. With an annual output of approximately 3 million tons, India is the globe's top producer of papaya. Brazil, Mexico, Nigeria, Indonesia, China, Peru, Thailand, & the Filipinos all additional top inventor. It's very much sensitive to frost, strong winds and water stagnation and also rotten very fast. The main objective of this study would present non-intrusive classification system for papaya fruit perfection stages. For this project we want to build a system using Machine Learning also known as python programming language or Deep learning which can perfectly detect papaya maturity and its classification. When developing we learn about different types of machine learning algorithms and techniques like GoogleNet, AlexNet, VggNet, Resnet, LeeNet, CNN, KNN, Linear Regression, Logistic Regression, SVM, Random Forest, K-Means cluster, Decision Tree, Naive Bayes etc. to understand the whole thing and to complete the project also. The main purpose of this study is to show the maturity level & its classification perfectly. For image classification, CNN model performs best then other models so we decide to build a sequential model for this project. In this case to detect our algorithm, we need to use a huge number of image dataset for training, testing & validation purpose. The model we choose & offered for detection successfully found the outcome. Our preliminary findings demonstrate that the methodology we provided achieved 100% consistency.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The papaya is among the most nutritious tropical fruits. It is known to be rich, which could also aid humans stay healthy, resist sickness, & maintain our youthful appearance, help us to remain our skin smooth and youthful. Papaya also help us to prevent many disease such as heart disease & cancer. The luscious fruit papaya contains a box of essential vitamins. As in well-known Bangladesh is an agrarian nation & produce many varieties fruits & vegetables among them papaya plays a vital role in agriculture sector and economic sector. According by global survey about papaya productivity, India came in first with a tons annually of 3 million, followed by other best manufacturers like Brazil, Mexico, Nigeria, and Indonesian. Bangladesh is as well trying to produce more and more with the help of agriculture sector. In 2018 & 2019 the production stood at about more than 9 lac tons, statistics from the Department of Agricultural Extension's (DAE). Imaging classifiers & recognizers can help with a wide variety of issues. With machine learning method, we could truly find solutions to a great deal of problems people encounter every day. The ability to tell if a fruit is good or rotted by only looking at it has since been lost. We can use CNN and the recurring analysis approach to address a lot extra products & problems in everyday life. Several healthy foods and products are not categorized; we can be duped by buying subpar items merely by looking at them in a superstore under adequate illumination. Thus, by employing a deep learning image processing method, we may classify any items according to their appropriate quality grade. Throughout this study, we are using an image analysis classifier to analyze the precise state of papaya. In the worst-case scenario, we are unable to manage for genuine fruits. We can guarantee that individuals will receive adequate information about purchasing such things by applying our strategy to this viewpoint. As a result, several consumers are ill-equipped to buy those things. There are numerous types of algorithms that we can employ, however for that project, we're utilizing form of (CNN). We can now at last confirm that fresh papaya is regarded as a healthy food. Our daily lives will become simpler as a result. We have complete control over the image

classification & identification process. This technique works with nearly everything, both organic and inorganic, including fruits, chemicals, etc.

1.2 Motivation

Many individuals buy fruits these days from wholesale markets or big-box stores. They can't tell if the fruit is fresh or rotten because of a lack of time. Because it takes time, examine each fruit individually. Most of us didn't inspect fruits before purchasing them. So, whether intentionally or accidentally, a lot of fruit is bad. These spoiled fruits are expensive to buy and bad for our health. We are planning to create an automated system that will help to determine that papaya is either healthy or not. With the most current improvements in AI and image processing methods, we can create this solution from scratch. Therefore, the goal of this research is to reduce this issue and develop a system that would enable users to scan quickly and obtain results. We can employ this in order to give completely hygienic fruits. Therefore, there is a high likelihood that the fruits will spoil as they have traveled a very long transportation route to get to us. Deep learning techniques can be used to alleviate this kind of uncertain situation.

1.3 Rationale of the study

Through recent decades, Machine learning has transformed a variety of sectors. We are able to solve a wide range of issues with the aid of AI. Convolutional neural network (CNN), also known as an image classifier, is utilized in numerous industries to address a variety of issues, such as the ability to locate cancer cells or identify sickness in leaves. So, we believe it will be helpful in solving our own issue. We also discover that employing CNN performs better when using a modern, state-of-the-art tensor flow library. AI is currently used extensively, and the classification of Papaya fruit maturity level is currently experiencing a crisis. So, using AI, we decide to try something new to distinguish between the maturity levels of papaya.

1.4 Research Question

In order to achieve the best results for our study on papaya maturity categorization using machine learning techniques, we must carefully research and choose the algorithms. If a dataset contains a low number of images then it will be a problem when a huge number of image dataset is going to be detected so we have to collect a big dataset of potato leaf image. When the image number is huge, we can say that it will give us a more accurate result as well. For collecting the image dataset, we have to face many types of questions and also when we select the algorithms. They are given below-

The question we have faced:

- How can we gather papaya pictures?
- How can our data be formalized?
- Does the project recognize the different papaya types in a single image, such as rotten, fully matured, partially mature, or unmature?
- Will we receive the anticipated results?
- What benefits may applying machine learning techniques provide?
- Who are the target audiences for this task?

1.5 Expected Output

We focus on four different maturity level types. Rotting, mature, partially mature, and unmature. From a given papaya image, our provided method can successfully determine the maturation level. In this way, machine learning approaches assist us in predicting the outcome.

1.6 Report Layout

Chapter 1:

The beginning of the study is vital. In the introduction to this chapter, it was explained what the goal of the research is, what the testable theory has been, what results were anticipated, and how the pages were organized.

Chapter 2:

Everything depends on the research's historical context. This section describes the extent of the issue, related works, research summary, and obstacles.

Chapter 3:

All discussion is related to research methodology. In this stage finding topics are discussed briefly, methodology, data analysis, and functional requirement also.

Chapter 4:

Conversation and the outcomes of experiments are the main topics. This section describes the experiment's results through a descriptive analysis as well as conclusion.

Chapter 5:

This chapter's overview, finding, advice, and plan for further research all are addressed.

CHAPTER 2
BACKGROUND

2.1 Introduction

In this stage of study focuses on our prior work, which was connected to and related to the current effort. In this section, we go over the summary of our result scenario and our linked work principle. We also give a quick explanation of our advantages and usefulness and discuss our professional experiences with reference to the difficulties of this work as a project. Our good work plan and how we were able to do this task perfectly with the bare minimum of effort. Additionally, we talk about the precision and how we obtain it.

2.2 Related works

Numerous industries, including agribusiness, medical, & others have been transformed by machine learning methods. Machine learning would be the subject of many studies. S. Behera et al [1], categorization of papaya fruit maturation stage the categorization of papaya maturity level was presented by the researchers using 2 techniques constructed using Deep learning & Transfer learning. With 100% accuracy and 1 minute 52 seconds of training, the VGG19 was executed. S. Tu et al [2], Passion fruit detection and maturity classification using RGB-D images were developed by researchers. Using natural outdoor RGB-D pictures, this could identify enthusiast fruit & categorize the age of the discovered fruits. Fruits were categorized according to their development phases into 5 groups: young(y), near-young (ny), near-mature (nm), mature (m), & after-mature (am). It has been confirmed that the suggested strategy achieves 91.52 percent maturity classification accuracy and 92.71 percent detection accuracy. B. Ashqar et al [3], disease detection on tomato leaves using images the researchers employed machine learning to identify 5 tomato leaf diseases. In identifying the tomato illness, they had good detection accuracy. Y. Sun et al [4], Deep learning for plant identification in natural environments was used by the authors to classify 10 thousands photos of 1 hundred ornamental plant species, with classification rates reaching 91.78 percent. This deep learning model has 26 layers and 8 residual blocks. M. M. Al-Masawabe et al [5] it made advantage of machine learning method that has been widely employed

in picture recognition. The trained model's accuracy on a held-out test set was 100%, proving the viability of this strategy. The VGG16 classification model trained in 112 seconds and has a 100% accuracy rate.

2.3 Research Summary

After reviewing a substantial amount of research papers and internet materials on our subject, we finally commit to using convolutional neural networks (CNN). On organic products like fruits, vegetables, etc., this algorithm operates flawlessly. Additionally, it matches our intentions and the nature of our work and is similar to our working perspective. When properly trained, CNN outperforms other picture classification and recognition algorithms with an accuracy of at least 95%. With the right progression understanding, we may readily employ it in our future career strategy. Additionally, there are many online resources that are simple to acquire. It works on practically any item, however when it comes to fruit quality, it performs significantly more intelligently than other algorithms. And it's simple to determine whether a fruit is bad or not. Utilizing neural networks, we could produce the best outcomes with absolute precision. Considering that CNN model was chosen as the main classifiers, CNN layers and deep learning techniques will be used. In order to implement the model, we use Keras and Tensorflow on the backend. Utilizing an internal database and Anaconda is our key objective. We picked Googlecolab due of the widespread use of Colab and its rapid and simple deployment. We used Google and Colab GPUs to make the most of it while it was running. As a result, in order to use the database with Google Drive, we must use a mounted drive. And the creation of a machine that can distinguish between fresh and bad fruit is our main objective. Thus, to form the CNN layer, we combined the Merge, Con2d, and Trigger layers. We use papaya for the first time. We cannot employ a classifier for hard-to-find objects because doing so will reduce accuracy and performance. To compare your good and negative ranks, find the best comparison. It appears that we have a wide range between good and poor, and we can determine whether or not this fruit is edible and how much mature it is.

2.4 Scope of the problem

The main goal is to build a method that makes it simple to distinguish between rotting and healthy fruits. Our research has shown that the Convolutional Neural Network excels at this kind of task. We will be able to deploy such systems in a variety of locations in the future, including large factory super stores. To enable easy use by everyone, we will make our work open source and accessible to everybody. Magistrates can readily carry out their duties under our system in many areas of our country's wholesale markets where rotten fruit is sold.

2.5 Challenges

The image dataset is the project's primary key, as we've already stated. The task of gathering several image collections is highly challenging. However, in this situation, the detection result is hindered, so we must take verities papaya pictures in accordance with their needs, with good resolution and accuracy as well. This means that we must be extremely careful when collecting the images. We also need to consider the size of the image. One of the other tough aspects of this endeavor is selecting the algorithms. To choose them carefully, we must carefully research a variety of items and algorithms. Finally, after making numerous considerations and distinctions, we reached a decision and carefully chose our model. Therefore, we can state that the main issue and difficult aspect of this research is selecting algorithms and gathering image datasets.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

Deep learning is another name for machine learning. A significant and well-known phenomenon in the modern period for numerous reasons. Because it performs well across a variety of dataset types, deep learning is increasingly in demand. Convolutional Neural Networks, or CNNs, are the best model for processing and classifying picture data. This CNN model builds up quite quickly thanks to Keras library [13].

Images are visible to computers thanks to pixels. By using these pixels, CNN (Convolutional Neural Network) models analyze and classify the photos. As we worked on photos, four distinct image types could be identified. We used the machine learning software Keras to build our model layer by layer. This method, which uses a classification model, divides the photos into four categories: mature, partially mature, unmature, and rotten.

3.2 Research Subject and Instrumentation

Using machine learning in this project we were aiming to identify the papaya's maturity state. Python is a machine learning language that we utilize in the Anaconda command line interface. We incorporate the confusion matrix, learning rate, and CNN (Convolutional Neural Network) algorithm into it. We employ a sequential model to properly determine the forecast. To assess the degree of accuracy of our forecast and to validate it, we used a confusion matrix. In order to make the validation accuracy and loss function more comprehensible, we also utilize the learning rate graph during training the dataset. Dropbox allows us to store our dataset and provide easy access from anywhere. When we train our model, we additionally leverage the Google Colab capability to access an external GPU.

3.3 Data collection procedure

As the main dataset for this study, we chose four different types of papaya photos. To accomplish this project, we also gather raw data from many sources.

3.3.1 Gathering Dataset

A crucial part of this project is the data. Because this project deal with images so, we need a lot of photos. When gathering photographs, we must be conscious of various crucial factors such as image sizes, resolutions, and image quality, as well as the dataset for four classes. We first get our image data from Kaggle (just 300 images total, including mature, unmature, and partial mature) and then capture some manual images with rotten papaya as much as possible. Over 3245 photographs were acquired and merged. However, we did not find all of the photographs we used to be useful. Certain photographs have a low quality, making it difficult to distinguish between those that are affected and those that are not. As a result, 1200 photos for mature, partial mature, unmature, and rotten are allocated for the training goal. Similarly, 300 photographs are chosen for each class to assess ambition. The dataset utilized in this study is not considered to be reasonably safe. This is why, in order to obtain our preferred modeling data, we must complete a data processing system.

3.3.2 Working Flowchart

Detecting papaya maturity necessitates a series of effective steps. A block schematic of the model is shown below:

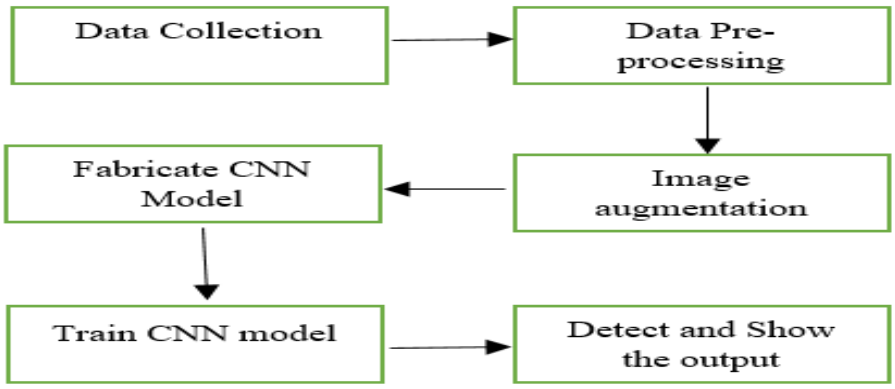

Fig. 1. Diagram of our methodology

3.4 Statistical Analysis

The saddest aspect is that we collected about 3245 photographs for our research, but none of them were helpful to us. Some photographs have extremely low resolution, while others may only be labeled as partially ripe and rotting. So, in the end, we chose to take a total of 1200 photographs for the training function, 300 images for mature along with partially mature, unmature and rotten images of papaya. In line with this, we choose 300 photographs per folder for the validation as well. For this research endeavor, we are employing an image dataset that is not exactly clean. As a result, we must process our data in order to prepare it for the model that is being presented. We must continue to follow certain basic processes for data processing. Below are some examples.

3.4.1 Image Acquisition

The process of getting a picture from a hardware-based source for processing is known as image acquisition. It is the first stage of picture acquisition since processing cannot take place without an image. For the digital acquisition of this study endeavor, a digital camera is employed. A magnifying lens attached to a digital camera allows it to take tiny spot photos of papaya. These

images are then connected to a computer for additional assessment. The digital camera and magnifying lens used to take these images are what determines their resolution.

3.4.2 Image Enhancement

Enhancement is unavoidably required to raise the image quality and information content of the image collection. Image improvement includes contrast boosting, spatial filtering, and density slicing. The picture's linear look was created by the use of contrast enhancement. The continuous gray tone spectrum is split into many intervals by densities dicing, and each interval is identified by a distinct color or indication to denote a particular attribute. Picture enhancement is used before image segmentation. Its purpose is to dampen vibrations as well as adjust brightness to create better-looking images.

3.4.3 Image Segmentation

This method that separates images to a number of segments or a collection of pixels. The primary aim of employing segmentation for this project is to simplify the image. It is now easier to study the photos after segmenting them. We must split our picture collection and provide these images additional context for a smooth analysis. Every pixel of the picture is given permission for the label. The primary goal of this part is to gather crucial information from various papaya photos.

3.5 Implementation Requirements

3.5.1 CNN Model

Both monitored and unmonitored CNN learning architectures exist. It is possible to utilize them to predict or classify anything. CNN, on the other hand, primarily used a controlled procedure. CNN categorizes images based on certain features [7]. Activation functions are used by CNN to compute potential maps. The following is the function:

$$y_j^l = f(z_j^l) \qquad (1)$$

From the above equation y_j^l has been known as an upcoming chart and $f(z_j^l)$ has been known as stimulation method. CNN operates upon material using 2-d convolution

$$O = \frac{(W-F+2P)}{(S+1)} \quad (2)$$

In this case, stature-breadth, input stature-breadth, strainer area, cushioning, and step be represented as conjunction using K, O, P, S, and W [8-9].

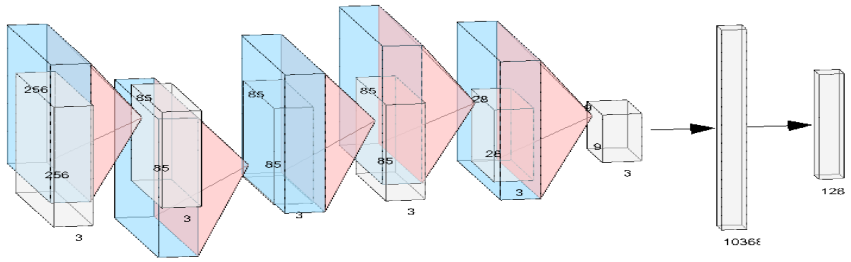

Fig. 2. CNN architecture

Fig.2 The exterior, border, stature, breadth, and density designated the model's fundamental CNN architecture.

3.5.2 Building the model

The sequential model is constructed via the CNN approach [10]. Regardless of the dimension of the picture inputs, convolution 2-d stratum can handle visuals and image input dimensions (256, 256), Keras assists in the construction of this model section by section [10]. Between the thick coating and the 2-d convolution layer, there was a flat layer that served as a bridge. ReLUs, or linearly adjusted units have been employed in this framework like an assisting feature. SoftMax was introduced like a frame activator to predicting estimation probabilities [11]. SoftMax function's equation is shown below:

$$P(x) = \frac{e^{X^T W^l}}{\sum_{k=1}^{k} e^{X^T W^l}} \quad (3)$$

From the above equation X^TW denotes the inner component of W & X.

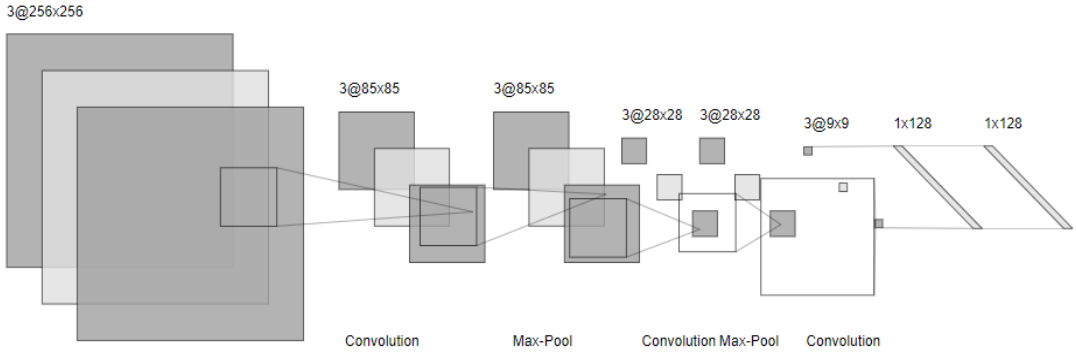

Fig. 3. Visualization of the framework.

3.5.3 Compiling the model

Using optimizer 'adam' to change the learning pace throughout the training period is a handy tool. In order to facilitate grasp, we use employing Softmax loss for generate a set & obtain its "precision" stat to illustrate the classification performance on the testing data.

3.5.4 Training the model

This "fit ()" technique has been used to construct the system. The dataset's fit operation that rhythmically cycles the program through the samples using testing data, has a number of epochs that we specify. Following the completion of the training process, the testing method is set up. It applauds the CNN model's training potential.

CHAPTER 4
EXPERIMENTAL OUTCOME AND DISCUSSIONS

4.1 Introduction

When a papaya were mature, unmature, partially mature, or rotten, it is classified as such in the papaya maturity forecast. With the goal of the study being to regulate papaya maturity level, the research result is provided and analyzed in this chapter. In order to compare several methods, such as AlexNet, LeNet, VggNet, and ResNet, we employed the CNN (Convolutional Neural Network) architecture in this study project. We discover our anticipated consequence and the research question for this project at the conclusion of our testing and justification. In this section, we'll provide the conclusion we came at and briefly discuss it. The greatest results from this research will be achieved in the future by extending the four classes of papaya photos.

4.2 Experimental Outcome

4.2.1 Confusion / Error matrix:

Confusion matrix is also known as the machine learning error matrix, and it is a tool for visualizing an algorithm's performance. To test the effectiveness of our approach, we employ a confusion matrix. We may conclude that our model works well because the confusion matrix diagonally displays the greatest value. To determine the ideal confusion matrix, we employ the sequential model, alexnet, leenet, vggnet, and resnet. The greatest diagonal value of these sequential models is provided to us. Below is a list of every confusion matrix for those models and algorithms:

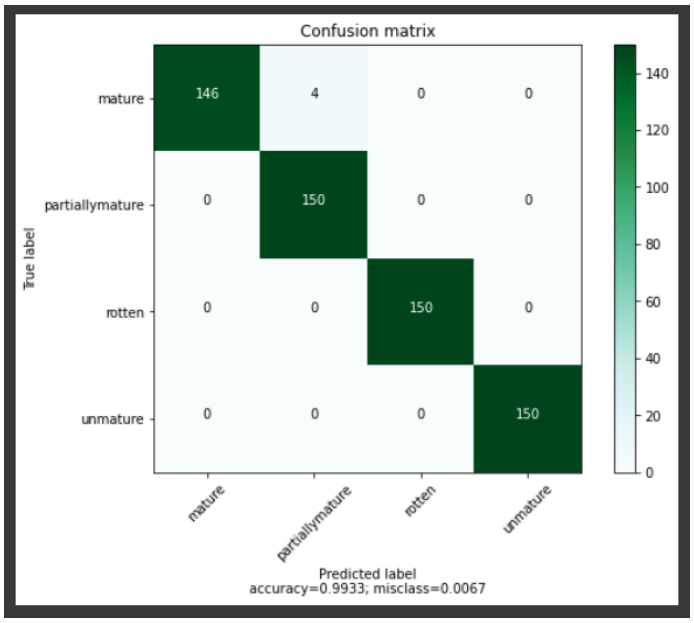

Fig. 4. Confusion matrix (Sequential)

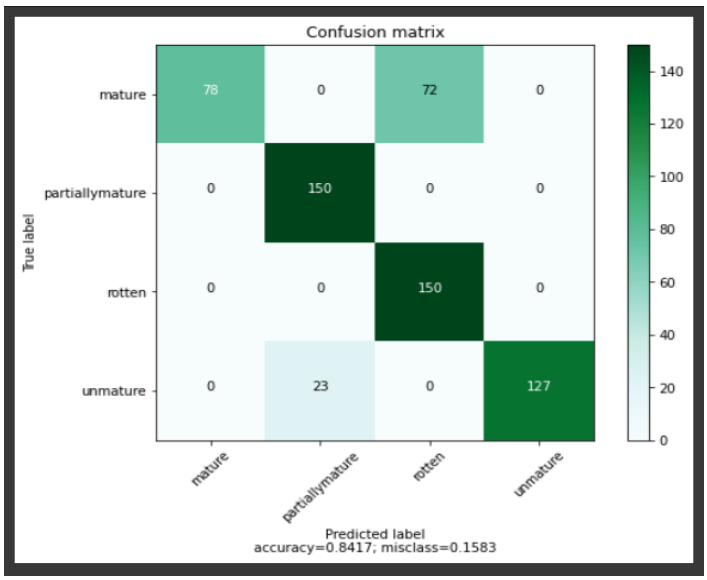

Fig. 5. Confusion matrix (LeNet)

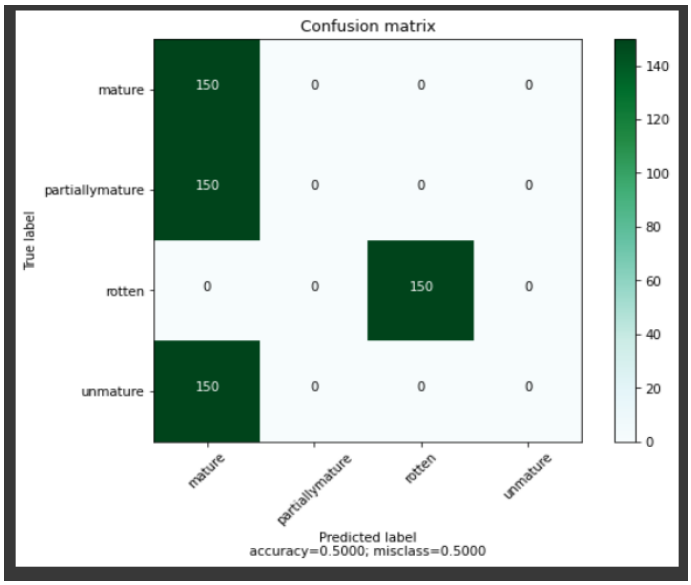

Fig. 6. Confusion matrix (AlexNet)

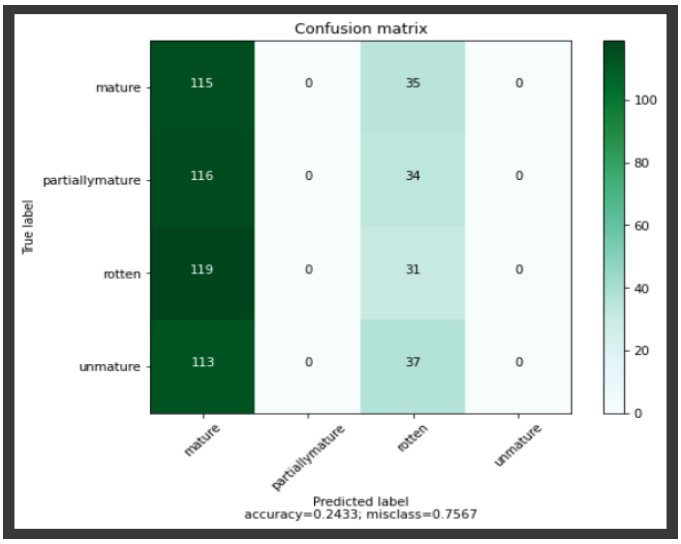

Fig. 7. Confusion matrix (VggNet)

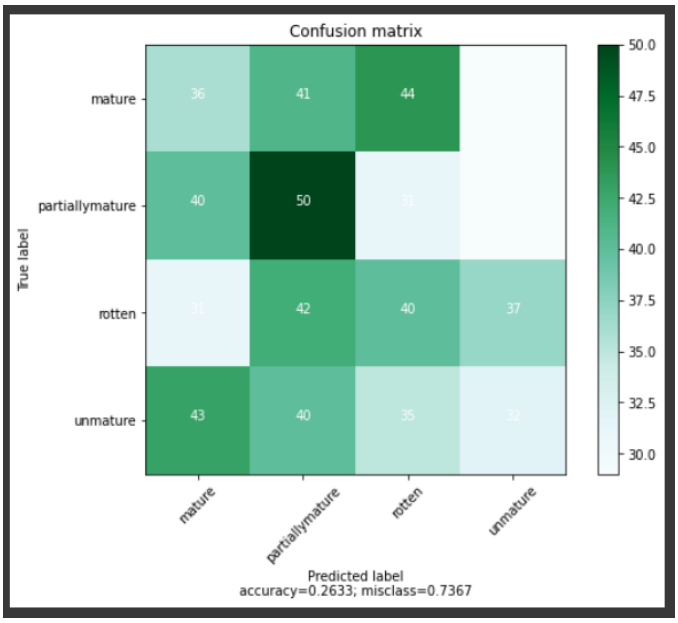

Fig. 8. Confusion matrix (Resnet)

4.2.2 Learning Rate:

The speed or scale of learning is a hyperparameter in machine learning that controls how much freshly learned information supersedes previously learned information. After testing, we also discovered our learning plot. For determining the optimal learning rate, we employ the sequential model, alexnet, leenet, vggnet, and resnet. The sequential model provides the most consistent learning rate of these. Below is a list of all the learning rates for those models and algorithms.

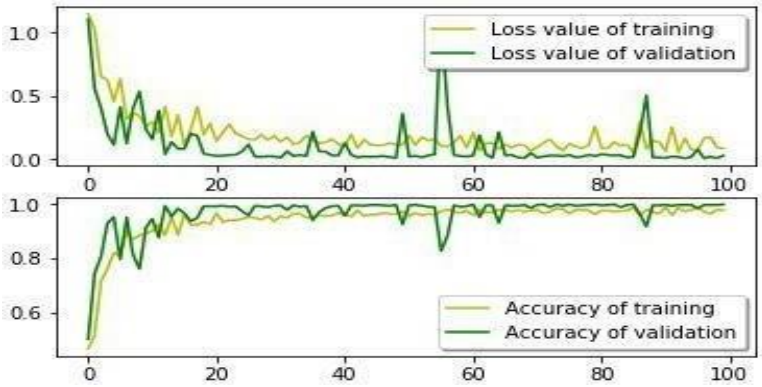

Fig. 9. Accuracy and loss graph (Sequential)

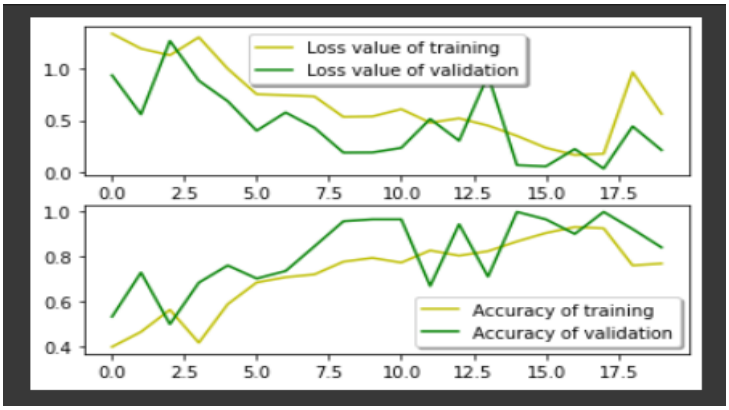

Fig. 10. Accuracy and loss graph (LeNet)

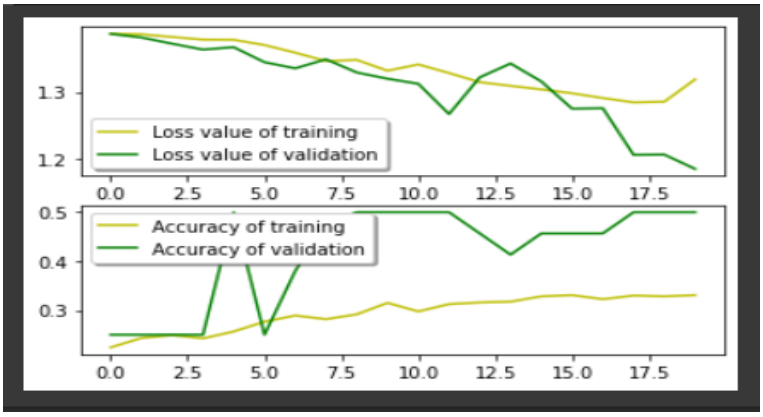

Fig. 11. Accuracy and loss graph (AlexNet)

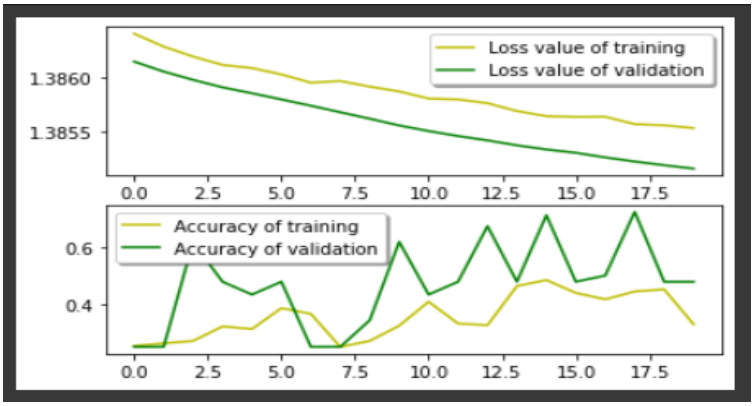

Fig. 12. Accuracy and loss graph (VggNet)

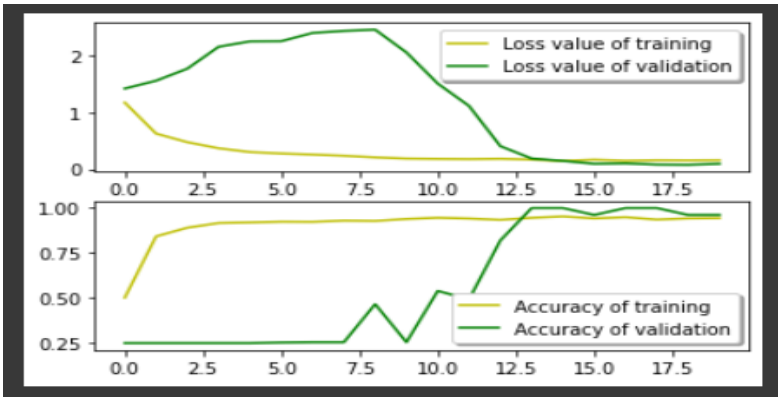

Fig. 13. Accuracy and loss graph (ResNet)

4.2.3 Prediction:

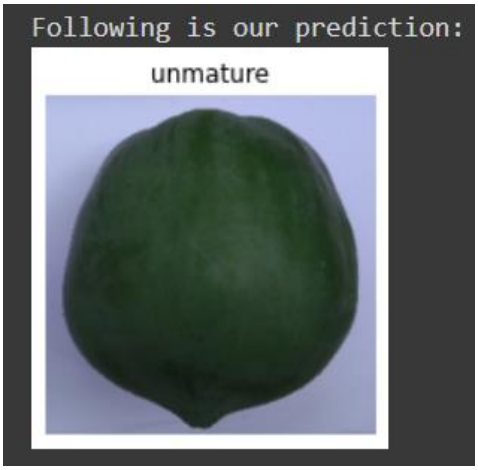

Fig. 14. Unmature

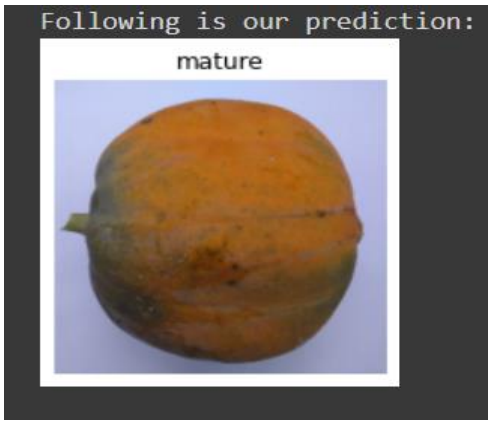

Fig. 15. Mature

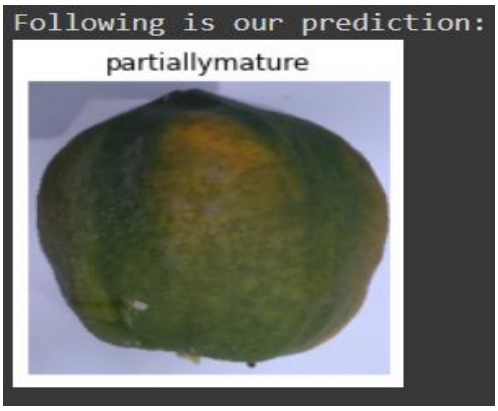

Fig. 16. Partially Mature

Fig. 17. Rotten

4.3 Descriptive analysis

A method's output is shown graphically in the confusion matrix. Statistical value of appropriate and faulty hypotheses is assessed. The following figures demonstrate actual accuracy of the classification rate equation as well as the model formulation variance.

$$ACCURACY = \frac{(TP+TN)}{(TP+TN+FN+FP)} \quad (5)$$

Product's efficiency could be determined by how well it can discriminate among good and harmful circumstances.

$$ERROR = 1 - ACCURACY \quad (6)$$

The accuracy graph and loss graph are then displayed using a learning graph when training and verifying data. Initially, validation loss is quite high and accuracy is very poor, but over time, validation loss decreases and accuracy increases. It can correctly determine if a random picture we enter is totally mature, half mature, unmature, or rotten.

4.4 Summary

After we ran our dataset and built a model using the supplied data, we discovered the desired results. After training and testing, we discovered that our model works really well and can properly distinguish between fresh and rotting fruits. We got to the conclusion that our approach may be used to more research using other comparisons and datasetsResnet, LeNet, AlexNet, and VggNet were the other four models we looked at. Almost 84 percent of our predictions using the LeeNet model are accurate. ResNet model provides 51% accuracy, VggNet provides 47%, while AlexNet provides 50%. Additionally, we wished to implement this idea on Android so that it would benefit all people and be more effective.

CHAPTER 5
SUMMARY, CONCLUSION, RECOMMENDATION, IMPLICATION FOR FUTURE RESEARCH AND LIMITATONS

5.1 Summary of the Study

Major purpose of this project is discover if maturity level of papaya could be determined from its image. In our article, we discovered that CNN classifies photos quite effectively. We first gathered data for our inquiry from a variety of sources. To finish our work after preprocessing, we separate the training from the testing. Later, we got the results we wanted. The major objective of our study was to investigate the ability of a certain image to discriminate between fresh and rotten apples. In our article, we discovered that CNN classifies photos quite effectively. We first gathered data for our inquiry from a variety of sources. To finish our work after preprocessing, we separate the training from the testing. Later, we got the results we wanted.

5.2 Conclusions

It will be easier for us to succeed in our task if we can tell the difference between fresh and rotting papaya. People would undoubtedly benefit from knowing which papayas are excellent and which are bad. In order to accomplish it precisely and get a flawless outcome, we apply the CNN model in this work paper. As I previously stated, the majority of the younger generation in our nation is growing up with no understanding of how to purchase fruit products. In order to learn how to tell if a papaya is fresh or rotten, we use four different varieties of papaya to demonstrate the maturity level of the fruit in our work. With the least amount of inaccuracy, CNN can quickly determine if a papaya is fresh or rotting. The complex neural network model can decrease mistake by performing flawlessly. As we obtained 100% accuracy with this dataset, we can state that it will be worked on with the best accuracy on other data sets.

5.3 Recommendations

Numerous algorithms exist that can quickly distinguish various things from a single picture. The use of computer vision in so many industries means that in the future, the AI industry will rely increasingly on jobs involving images. Therefore, we need to start learning how to accomplish these tasks right now. It will introduce our next generation to a new realm.

5.4 Implementation for future study

It's not easy to tell if a papaya is mature just on its color and appearance. We'll use the outcome of our research to create a system that can tell if papaya is mature, unmature, partially mature, or rotten with real-time performance to enhance recognition accuracy. It's a project with both software and hardware components. By implementing the suggested model in a user friendly mobile application anyone can be able to identify quickly and take necessary measures.

5.5 Limitations

Every nation on earth has a unique climate, which has a significant impact on its economic system. Fruits, vegetables, harvests, etc. are grown around the world, yet they differ in terms of size, weight, and shape. In our investigation of this tropical fruit, we found that papaya is grown in several nations. The obvious fact is that different countries' papayas come in a variety of sizes and forms. So, in order to execute this system globally with great success and be able to anticipate any type of papaya regardless of origin, we need to gather these various papaya varieties.

APPENDIX

Appendix A: Research Reflection

In order to accomplish this Papaya maturity recognition project, we began our study in June 2022. The main objective of this project is to provide a system for detecting papaya maturity level using artificial intelligence. Keeping the illness and healthy photos in the dataset is crucial for effective prediction. This study will make it easier and more accurate for local businesspeople and consumers to determine when papayas are fully mature. We arrive at our destination after a difficult and lengthy travel.

Appendix B: Related Issues

We need review different articles and publications before starting this inquiry. Disease identification is a highly difficult task that requires a huge dataset containing photos. To collect this huge dataset, we must go into the field. We use the Python language to carry out our project on the Jupyter notebook.

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