

Fresh and Rotten Fruit Classification Using Deep Learning

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This Report Presented in Partial Fulfillment of the Requirements for the
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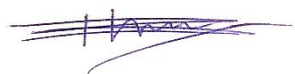
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APPROVAL

This Project/internship titled “**Fresh and Rotten Fruit Classification Using Deep Learning**”, submitted by Md Mehedi Hasan, ID No: 172-15-9900, Md Moinul Hasan, ID No: 172-15-9672 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 B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on June, 2021.

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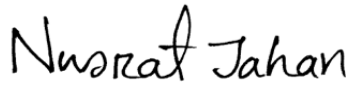
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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Nusrat Jahan Lecturer, Department of CSE** Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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ABSTRACT

Fruit cultivation has been a traditional part of the agricultural practices in Bangladesh. There has been a revolution in fruit farming. From fruits we get nutrition. It is a source of vitamins and minerals. Sometimes fruits are rotten in the consumer end also the packing end. so, to avoid these rotten fruits we came up with this research work. In the recent advancements of computer vision & deep learning our approach is to recognize whether a fruit is fresh or rotten. Now the whole lot have become smart and generation dependent. We can see the usage of AI and gadget learning everywhere. Following this, I constructed right here a device. A device this is smart, fast and that device can perceive clean and rotten fruits. I use right here python CNN version to classifying the rotten fruit and clean fruit. This device can perceive the share of rotten and freshness of fruit by the use of photograph data. This device could make our paintings easy with massive farm and juice manufacturing unit to perceive rotted fruit. We wish that it's going to make our paintings extra correct in much less time.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Image classification and recognizer is most useful examiner for finding man made reasoning and acute deep learning study. This is now most using advancement examination to take care our daily life thing and work. So basically it will run over almost every aspect in daily life. In future may be it will be increase more and spread more widely. There are so many things will be solved by image classifier and recognizer. In image processing with deep learning approach we can actually solve so many issues we are facing in our daily life. In present time we are not able to recognize a fresh or rotten fruit just by seeing them. There are many more product and real life problem we can solve by using CNN and relapse calculation method. There are many organic food and products are not classify its class just seeing them there are proper lighting in super shop which can make us fool by given ill products. So by the using of deep learning image processing system we can categorized any products with its proper condition level.

In our research work we are working on such fruits like apple, banana, oranges we using these fruit as demo to classify there exact condition by image processing system. In maximum case we are not able to take care of natural fruits. Therefore many people also have very less knowledge to purchase those products. By using our method on this perspective we can assure people will get decent knowledge on buying these products. There are many type algorithm which we can use but on this work we using one type variant of (CNN). So we can finally find out a fresh apple or it rotten apple same like in banana and orange. It will make our life easier than before. In image classification and recognition system we can do anything which is also man made. This system work on almost every organic and non-organic thing like fruits, chemical etc.

1.2 Objective

Now, we are passing a great time of science and technology. We can't skip our daily life from this technology era. Our main motive to find out fresh and rotten fruits from proposed fruits. There are some type of fruits we used in our research work. We want to identify those fresh and rotten fruits by deep learning method Convolutional network. So here is our goal is given below down there. There are many more thing to discuss but we only focus on those importance thing which is very essential to our paper work.

Our main goal is classify fresh and rotten fruits from the all fruits sets. To give better experience human being. Nowadays it's almost a very tough task to find out fresh and rotten fruits from the all fruits.

So our second goal is work on implementation this type of technology in future. It will be possible. Make sure to make a platform where we can detect a fresh and rotten fruits by this deep learning method. We want to make visualize and detect all sorts of fruits which is clearly say either it's fresh or rotten in apple, bananas, oranges.

So all these objective are given up here is main point to do in our future work.

1.3 Motivation

Nowadays lots of people buy fruits from wholesale market or super shop. Due to lack of time they cannot determine whether the fruits is fresh or rotten. Because it is time consuming fact test a fruit one by one. Most of us never checked fruits before buying. So, knowingly or unknowingly, a lot of fruit is rotten. These rotten fruits are harmful to our health and it's waste a lot of money. To reduce this cost & with the concern of health issues - we are going to build an automated system that will help to determine whether the fruit is fresh or rotten. With the recent advancements of AI and image processing techniques we can come up this solutions from the very beginning. So in this piece of research is focused to minimize this problem and creating a system which will make user able to scan fast and

get the result. To provide full hygienic fruits we can use implement of this. And in our country almost 95% apple and oranges are imported from foreign country.

So this fruits are passing a very long shipping way to reach us so there are too much probability to fruits can rotten. To avoid this type of uncertain condition we can use deep learning method to reduce this.

1.4 Rationale of the Study

AI is a revolution in recent times in so many fields. With the help of AI we can solve numerous problems. Convolutional neural network (CNN) also known as image classifier can used in many types of fields to solve various problems like - find cancer cell or can detect disease in leaf. So, we find it useful to solve our problem also. We also find that recent state of art tensor flow library gives better performance in terms of using CNN.

In present time, AI is everywhere and we can also see the crisis with the fresh fruit classification. So we decide to do something new to detect fresh fruit and rotten fruit with the help of AI.

1.5 Expected Output

There are many benefits or expected output of using AI in fruit detection. Some of them are given below:

- Develop an efficient model to identify fresh or rotten fruits.
- Help the young people especially kid to detect rotten fruits.
- Help to identify the fresh or rotten fruits easily.
- Help to all over people and save their valuable time.

1.6 Research questions

This is so tough and challenging work for us, as we are very beginner to do our first professional work. Here are the main questions those are focuses in this thesis are given below

- Can we identify the rotten or fresh fruits based on given image?
- What are the limitations to identify rotten or fresh fruits with AI?
- Do the project identify the various rotten or fresh fruits in one picture?
- What kind of people will benefit from this work?

1.7 Layout of the Report

This work attempts to conduct a comprehensive analysis of how these visual features are applied to human perception to determine the degree of fetal deterioration.

Chapter one we already have discussed about introduction of research material, motivation of why we work on this topic and motivation to go for this specific fruits, Problem Definition are discussed, Research Question and research Methodology are briefly explained.

Chapter two we will discuss about background of this research, the related work which we need to do in this paper. We also discuss about challenges we face to fulfill our work properly. Also discuss about research summery.

Chapter three will describe the methodology of this thesis. In this section we will briefly describe our full working process coding work and work flow with proper diagram and table. This chapter is main part of our paper.

Chapter Four will describe the performance of the proposed model. Experimental set up and all sorts of testing and experiment repots will be there.

Chapter Five will describe the result comparison & analysis. And will discuss about future work

Chapter six It describes the conclusion of this research.

Chapter seven Here all the references we used for this research.

CHAPTER 2

BACKGROUND

2.1 Introduction

In this part we mainly focus on our previous work which already connected and related to our work. We discuss on this part our result scenario summary and study of our related work principle. We also describe briefly on our benefits and usefulness and also talk about our working experience regarding this work as a project challenges. Proper work plan and how we able to do this work on perfect way by our minimum attempt and try. And we also discuss about accuracy level and discuss about how we get this accuracy.

2.2 Related works

Deep learning has been revolutionized and used in many fields such as agriculture, healthcare and so on. There is a lot of research going on about deep learning. The author [1] used deep neural nets to classify medicinal plants from the perspective of Bangladesh. They used limited data but found better accuracy. The author [2] used in-depth education to diagnose plant diseases. They used a very primitive architecture for this.

The authors [3] used a machine vision system in their study to detect defects in the skin of the fruit. The main feature and support used in color for classification is a machine learning algorithm called Vector Machine (SVM) used in classification and as a recognizer. Support vector machines (SVMs) give perfect and suitable results for a fewer number of datasets. The accuracy of the classification method using machine learning is mostly depends on the drawn features. And the features are selected to go into the machine learning algorithm. We can easily improve our performance by using the deep learning models on this particular perspective. These models help to classify images in large datasets. Author [4] Image processing helps to classify faulty and non-faulty. This is helps us to finding what is wrong on the surface of apple and banana fruits. First, the fruits are collected manually and the researchers themselves classify those fruits as fragile and defective. This is done in

pre-processing images and given to the CNN model for classification. The accuracy of this model is 97.5%. Based on laser backscattering imaging analysis and CNN theory, this method gives an knowledge and theoretical basis for maximum productivity, non-destructive fruit quality identification. This work shows that the method is effective and non-destructive and can automatically identify defective areas. This method can easily meet the requirements for detecting Apple errors. The effect of error detection based on the CNN model is better than conventional algorithms [5]. In the study, an artificial vision system was developed to detect defects in the fruit peel [7]. Color is the main characteristic of categorization and the classification used a machine learning algorithm called Support Vector Machine (SVM). SVM) provides reasonable results for a small number of data sets. The accuracy of classification using machine learning is mainly based on the extracted features and the features chosen to be passed to the machine learning algorithm. We can improve performance by using deep learning models. These models help classify images in large amounts of data. Image processing [8] can help in the classification of the defect and non-defect fruits.

In our work, the proposed CNN version offers excessive accuracy with inside the type undertaking of clean and rotten culmination. Here the proposed version's accuracy is in comparison to wards the switch mastering fashions. Three sorts of culmination are decided on from numerous sorts of culmination. The dataset is received from Kaggle with 6 training i.e. every fruit is split as clean and rotten. This paper introduces an effective CNN version which has greater accuracy for clean and rotten culmination type undertaking than switch mastering fashions at the same time as investigating the impact of very vital hyper parameters to acquire higher out comes and additionally keep away from overfitting.

2.3 Research Summary

We are go through so many research paper and online material about our topic after been checked more than enough materials we finally assure to work with Convolutional neural network(CNN)

- This algorithm perfectly work on organic product like fruit, vegetable etc. And it is similar to our working perspective and match with our intention and type of our works.
- CNN gives most number of accuracy for other image classification and recognition algorithms with an accuracy 95% or more with proper training.
- We can easily use it in our future work plan with proper advancement knowledge. Along with that there are lots of online resource we can gather easily.
- Its work almost on every product but in the case of fruits quality it's work far smarter than other algorithm. And easy to find out either a fruit is rotten or not.
- We can make decent results and good accuracy by using CNN layers,

Since we are chose CNN (Convolutional Neural Network) as the main classification model, we will use CNN layers and deep learning algorithms. We use Tensorflow and Keras on the backend to implement the model. Our main goal is to use internal database and anaconda. Because of the wide use of Colab and its quick and easy implementation, we are chose Googlecolab. I used colab and Google GPUs to take full advantage of it at runtime. Therefore, we have to use a mounted drive to use the database with Google Drive.

And our main goal is to make a fresh and rotten fruit sorting machine, and constantly compare it to get results. Therefore, we used the Merge layer, Con2d and Trigger layer to create the CNN layer. As the first time, we use apples, bananas and other user-friendly items. We cannot use a classifier for objects that are difficult to find, which will result in a decrease in accuracy and performance. Using apples, bananas and mangoes, we should be able to get good accuracy. Find the best comparison between your good and bad rankings. It seems that we have a good range between good and bad, and we can tell how good or bad this fruit is and whether it is edible.

Scope of the Problem

The key to our work is to create a system through which rotten or good fruits can be easily identified.

We have seen through our work that the Convolutional Neural Network performs very well in this type of work. In the future, we will be able to use such systems in different places including big factory super shops.

We will make our work open source and open to all so that anyone can use it easily. In many parts of our country's wholesale markets where rotten fruit is sold, magistrates can easily perform their duties using our system.

2.4 Challenges

Data Collection

First of all we are not use to machine learning work before. It is completely new for us. Beside all these odd the most miserable thing is current pandemic situation when we first start work on this paper we are facing these pandemic situation. So that our main thing of raw data collection is effected due to this pandemic. As we are not able work together because of pandemic we are not able to give our full potential on this paper. For this reason we have face so many problem to working on this. After that we have done preprocessing of our data and clean it to work perfectly. After that we have maintain training and validation so many time to get proper accuracy and loss. To find better output we patience till our final output.

Model selection

There are many deep learning models out there. From them choosing the right model is a very important task. In fact, choosing good data and the right model makes the job much easier. There are many types of image classification models found. From that we tested with a fewvariants of CNN model to see how our model performs. We're using Google's tensor flow library for implementing our model.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

In this part we will discuss almost everything of our research paper. It is most significant part of our research paper. Here we discuss details about methodology of research and discuss procedures briefly. We also briefly discuss about our working process like how we collect data, data processing system and also talk about our analytical section how we use our algorithm. The proposed methodology is shown in fig.1

3.2 Research Subject and Instrumentation

Data is very crucial and the most important part of our research. Then second most important part is find out the perfect data and perfect algorithm for research work. There are several variant of CNN out there. So, we are going to study about similar research work already done by some other publisher. After that we will make necessary step to do our work perfectly.

- Which data should we collect for our work?
- We must need to know that these collected data is ok?
- How should each and every data be well organized?
- How should each data be labeled?

3.3 Workflow

Firstly we are collected our image data. It was challenge for us in covid situation. Then we are data preprocessing and we build a CNN model. Then we train CNN model and evaluate our model.

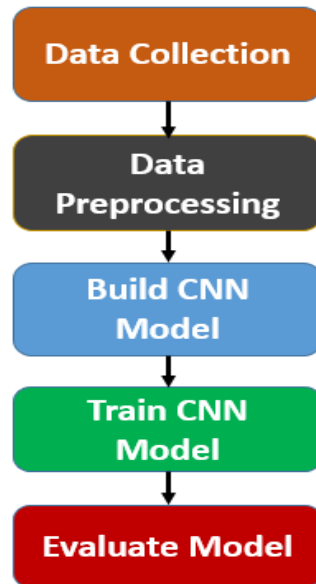


Figure 1: Workflow of our methodology

3.4 Data collection procedure:

Data is important in data-driven techniques. Our dataset is obtained from Kaggle which has three types of fruits-apples, bananas and oranges with 6 classes i.e. each fruit divided as fresh and rotten. The total size of the dataset used in this work is 5989 images. The training images are of 3596, the validation set contains 596 images belongs to 6 classes, and the test set contains of 1797 images which belong to 6classes. The samples for each class in the dataset are shown Figure 2.

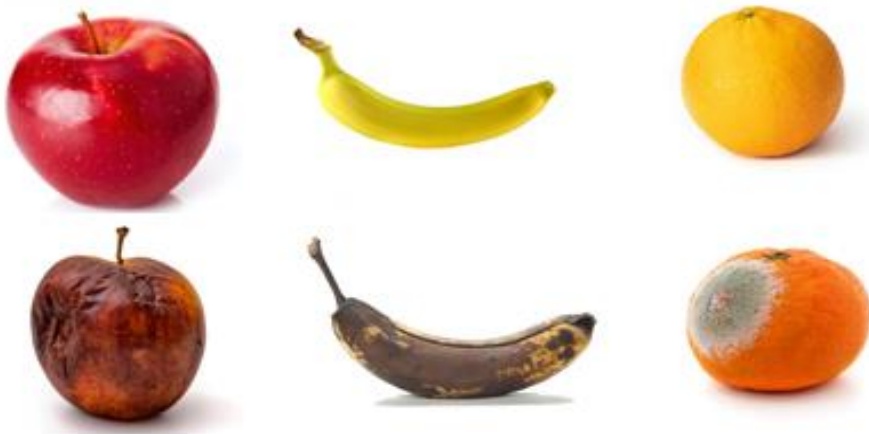


Figure 2: Sample dataset

Statistical Analysis

Our total image data is more than 6000 that we collected. After pre-processing we get total data is 5989. Total accurate data amount are given below.

Table 3.1: Train image data amount

<i>Fruits Name</i>	<i>Amount</i>
<i>Fresh Apple</i>	1693
<i>Fresh Banana</i>	1581
<i>Fresh Orange</i>	1466
<i>Rotten Apple</i>	2342
<i>Rotten Banana</i>	2224
<i>Rotten Orange</i>	1595

Table 3.2: Test image data amount

<i>Fruits Name</i>	<i>Amount</i>
<i>Fresh Apple</i>	395
<i>Fresh Banana</i>	381
<i>Fresh Orange</i>	388
<i>Rotten Apple</i>	601
<i>Rotten Banana</i>	503
<i>Rotten Orange</i>	403

3.5 Data Pre-processing

Data processing is a very important state. Data processing after data collection becomes very important for image classification-related problems. We have divided our data set into eighty percent training and the rest for testing. We gather greater than 10000 picture facts from specific assets and strive to needless or noisy facts. Since we have used RGB images, it is recommended that all of these images have the same size & shape. We used 32x32x3 for this set.

3.6 Data Organizing

Data Augmentation Over fitting is a common problem when the dataset is limited. As far our dataset is limited we may be get trouble in over fitting. For eliminating over fitting we implement data augmentation. It is actually artificially expanded the dataset. In this segment we divided records and keep them in records folder check and educate, we additionally use right here validation folder for test educate records validation. Then we divided the ones check and educate folder's records in greater folder like freshapple, rottenapple, freshbanana or rottenbanana etc.

Labeling Data

In this segment I renamed all snap shots as their name and additionally numbered them sequentially.

3.7 Proposed Methodology

CNN works with two significant parts first one is feature extraction and next one is classification. Convolutional layers used for feature extraction and fully connected layer used for classification. In our proposed model 2 convolutional layer, 2 pooling layer introduced. At first, CNN takes input images dimension of 32x32x3. For getting better result RGB channel used here. In first convolutional layer filter size of 32 with 3x3 kernel introduced with a ReLU activation function to adding non-linearity. Later a max-pooling size 2x2 used for reduce the dimensionality. Filter size of 64 with 3x3 kernel used again with a ReLU activation in second convolutional layer. Later 2x2 max-pooling used. Reduce over fitting again a dropout rate of 0.35 used after forth layer. A flattening layer used for make 2D sequences into 1D matrices. Later a fully connected layer 128 nodes used with ReLU activation. Again dropout rate of 0.25 used for reduce over fitting. Last a dense layer of 6 units used along with a soft ax activation as for classification.

Model: "sequential_8"

Layer (type)	Output Shape	Param #
con2d_1 (Conv2D)	(None, 30, 30, 32)	896
max-pool_1 (MaxPooling2D)	(None, 15, 15, 32)	0
con2d_2 (Conv2D)	(None, 13, 13, 64)	18496
max-pool_2 (MaxPooling2D)	(None, 6, 6, 64)	0
flatten (Flatten)	(None, 2304)	0
dense_1 (Dense)	(None, 128)	295040
classifier (Dense)	(None, 6)	774
Total params: 315,206		
Trainable params: 315,206		
Non-trainable params: 0		

Figure 3: Proposed model

3.8 Implementation Requirements

•Python:

We use Python 3.8 is Python version in which we can work almost all of our research work. Python is now most used language as high level programming language. Most of the research use it to do their research perfectly and smoothly. It is mainly use for AI based work and it is very popular among new generation's programmer because it is very easy to learn and understand. Not only this sector we can use this in almost every sector in computer

•Google CoLab:

Google CoLab is a free and open source publisher of the Python programming language. We can work online in the browser like a Jupiter laptop here. However, the main advantage of this Google CoLab is that we can access the virtual GPU online for free.

Hardware and Software Requirements:

- Operating System (Windows 10 preferable)
- Must need a browser it is may chrome or something else
- Hard Disk (more than 4 GB)
- Ram(minimum 4 GB)

CHAPTER 4

EXPERIMENTAL RESULTS AND DISCUSSION

4.1 Experimental Setup

In this section, we will usually analyze the result of the proposed model of our work and explain the result of our work with proper logic. We trained our model using Tensor flow 2.0.1. Setting hyper parameters to our model was the first step. Define Batch size as 45. The ratio of our training and testing data as follow 80%, 20%. After that we compiled our model using adam[6] optimizer and our learning rate was 0.0001. Then fit () used for start the training.

4.2 Performance Evaluation

After finishing training our model got an accuracy of 98.04% with just 10 epoch. Fig- 3 which is the accuracy curve of our model where we observed our training accuracy 98.04% and validation accuracy 98.21%.

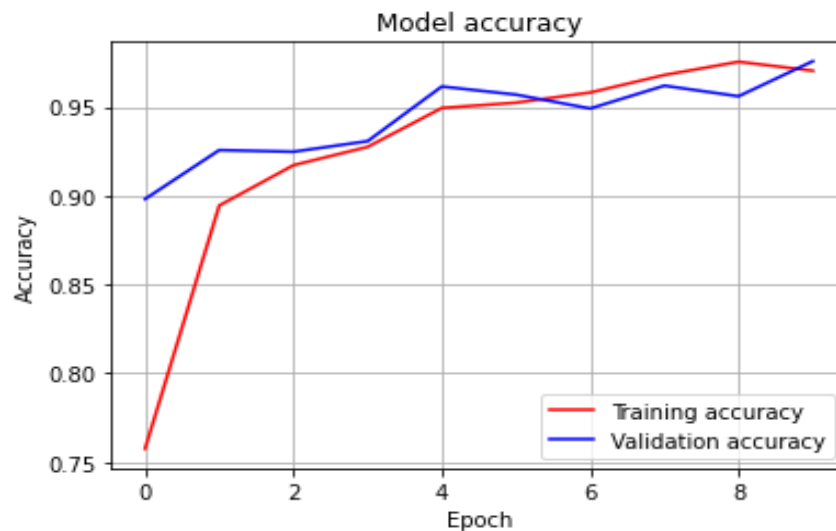


Figure 4: Training vs Validation accuracy

Fig- 4 represents the loss curve of our model. Where we observed our training loss 0.0545 and validation loss is 0.0797

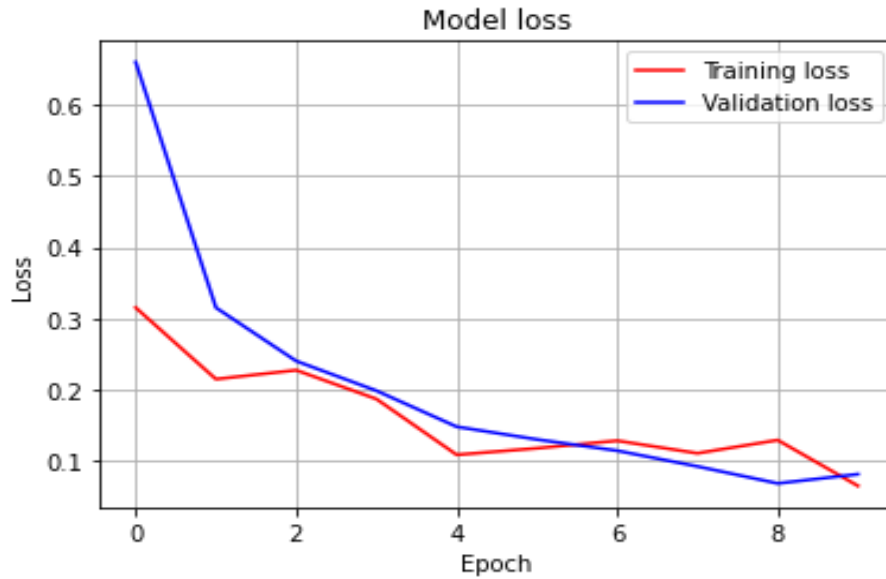


Figure 5: Training vs Validation loss

Later, in our testing our model performs better with loss 0.0765 and accuracy of 97.39%.

In figure-6 represents the layer visualization of first convolutional layer, Max-pool layer & 2nd convolutional layer.

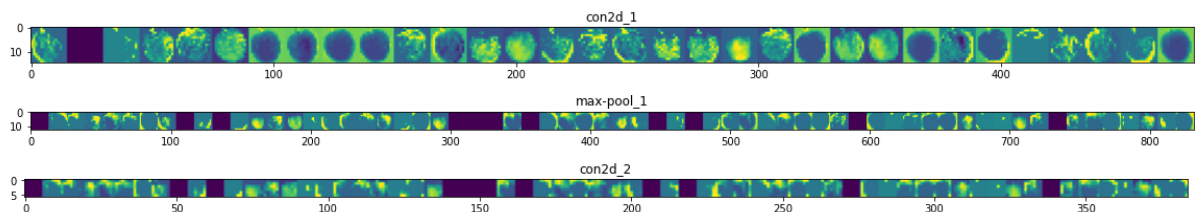


Figure 6: Layer visualization

4.3 Result Discussion

After we are ran our dataset and created the model from the given data, we found the output what we needed. Training and testing stuff, we found that our model performs very well and it can detect fresh & rotten fruits 98% accurately. We came up with the conclusion that our model can be used for further study with different comparison & dataset.

CHAPTER 5

Summary, Conclusion and Future Research

5.1 Summary

The main purpose of our research was to find out the difference between fresh fruits and rotten fruits from a given image. We have seen that CNN classify images very accurately in our problem. For this study, we first collected data from different places. Then we do preprocessing and then our job done by dividing the training and testing. Later we got our desire results.

5.2 Conclusions

To differentiate between fresh and rotten fruits we will more likely success in our work. It will surely help people to know which fruit is good and which one is bad. In this work paper we use CNN model to do it perfectly and give a perfect result. As I said before in our country the new generation almost 95% of people are growing up without knowledge on buying fruits product. So in our work we show three main fruits to know how can assure a fruits is rotten or fresh. Our build model using by CNN can easily find out fresh or rotten fruits with minimum error. The convoluted neural network model is able to reduce error by work on perfectly. We can say that it will be work on more data set we have already used now. And we get decent and good accuracy level by using it. We got 98.04% accuracy for the given proposed model.

Recommendations

There are different types of algorithms that can easily identify different objects from one image. In the future, the AI sector will more rely on image-related tasks as computer vision is using in so many fields. So we have to learn to do these things now. It will take our future generation to a new dimension.

5.3Future Works

From our perspective one of the primary destinations for what's to come is to improve the exactness of the neural organization. To build up a more robust and exact organic product newness appraisal profound learning model, as a typical profound learning practice, an enormous volume of source information is required.

- As CNN requires a vast amount of data I will add more data to make this model more effective.
- I will use more class with better accuracy
- I will make a web app & android application in future.

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APENDIX

We had started our journey to research work named “Fresh and Rotten Fruit Classification Using Deep Learning”. During this work we faced several problems. Data collection is the major one. Because locally data collection is time consuming and hard for student. Country like Bangladesh, people didn’t take it positively. But we tried to collect our data. Everything was going great until March 2020. The world came to a stand-still due to COVID-19. During the three-four months lockdown period our work did not progress that much. As time was passing, COVID-19 became the new norm. So, we have to collect all the required data from online sources. And after a long time and a lot of attempts and hard work and we got succeed.

Plagiarism Report

As stated above, we have done very hard work for this. We always thought writing the report is also a part of our research work. So we put a lot of hours and effort into this report. Which is reflected in the Turnitin Originality Report. The similarity index was only 15%.

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