

Bangladeshi Local Potatoes Dataset and Classification Using Deep Learning

Shrabosty Deb
dept. of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
shrabosty15-7925@diu.edu.bd

Marfi Akter Laboni
dept. of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
marfi15-6592@diu.edu.bd

Most. Hasna Hena
dept. of Computer Science and
Engineering
Daffodil International University
Dhaka, Bangladesh
hena.cse@diu.edu.bd

Abstract— Potato is one of the major foods in Bangladesh during winter which shows the most environmentally amiable vegetables. Variations of potatoes in Bangladesh that are grown here are extensively categorized into two divisions, high yielding and local. Assuredly, potato is the world's most important crop when it comes to rank according to the volume of the fresh products. Moreover, the minerals, fibers, and vitamins it delivers can serve convenience for human healthiness and guard against diseases. Recently, different kinds of potatoes of Bangladesh has been exporting to various countries worldwide. Hence, a lot of people are engaging in agriculture to cultivate potatoes. It is very essential for the farmers to acknowledge that; which kinds of potato cultivation will be beneficial according to the market price and cultivating process. This system can help agriculturists, farmers, and general people to find out the local species of potatoes. This dataset of locally recognized potatoes like Diamond Alu, Mete Alu, Lal Alu, Jam Alu, Lal Mishti Alu, Chhoto Lal Alu, Mete Chhora Alu, Shunno Alu, Shada Mishti Alu, and Keshar Alu. Using a dataset of potatoes (5190 images) that have been collected by us, this research trained a CNN (Convolutional Neural Network) and deep learning based model to identify potatoes. The model gets an accuracy of 98.87%.

Keywords— *Potato Image Dataset, CNN, Deep learning, Image Processing, Species Detection.*

1. INTRODUCTION

Potatoes are one of the most necessary non-cereal crops in Bangladesh. Bangladesh produces various kinds of potatoes in several areas and now it is one of the foremost foods in Bangladesh which is composed of 20% solids and 80% water. The potato is the world's most main non-cereal food crop globally under the Solanaceae family. Potatoes is produced in more than 125 countries and people of rising countries rely on it for their survival in daily life. In the last 20-30 years, the production of potato in Bangladesh has increased with the cultivation of high yielding varieties. Being the seventh-largest producer of potatoes, Bangladesh produced 109 lakh tonnes of potatoes in 2018-2019. Bangladesh exports potatoes to Sri Lanka, Malaysia, Vietnam, Benin, Canada, United Arab Emirates, Kuwait, Qatar, Bahrain, Nepal, Myanmar, Brunei, Saudi Arabia, Oman, and Singapore. Many species of potatoes are available in Bangladesh as potato is the most popular vegetable in Bangladeshi households. Here picked ten kinds of potatoes that are the most available ones, Diamond Alu(Chittagong),Mete Alu (Barisal),Lal Alu(Rangpur),Jam Alu(Mymensingh),Lal Mishti Alu(Bogura), Chhoto Lal Alu(Rangpur), Mete Chhora Alu(almost everywhere in Bangladesh),Shunno Alu (Chadpur), Shada Mishti Alu (Dinajpur),Keshar Alu (Bagherhat).

Usually, Potatoes are introduced as mashed or as whole or as a vegetable dish also turn of potato flour that is used as a sauce thickener, and used in baking. The turnips are edible and also supply protein, thiamin, niacin, and vitamin C. Potatoes were largely cultivated in South America earlier. After the encounter of the invading Spaniards, potatoes were popularized in Europe during the last half of the 16th century [1]. Potatoes are healthier and affordable than most other popular vegetables and contain more potassium than a banana. A medium-sized potato's skin can contain 27 mg of vitamin C that is 30% of the daily value. Potatoes also consist of fibers that can help to control cholesterol in the blood, thus reduce the chance of heart diseases [2].

Image processing is a method to perform some operations on an image, process the images, and outcome of some useful information. Recently, image processing is one of the speedily increasing technologies worldwide. It forms a major research field within computer science and engineering [3]. In this paper, using deep learning for processing the data and conventional neural network (CNN) to detect an accurate output. Here, ten kinds of potatoes are recognized by image processing and deep learning.

2. LITERATURE REVIEW

We have studied some previous research works on these kinds of topics. Here, pieces of information have been presented by us that had been attained from studying previous works regarding this topic.

Most. Hasna Hena et al, 2019 [4] represented a dataset consisting of three versions of each kind of image are- RGB, Binary, Gray-scale. About 7905 images of the dataset are collected from around 54 mango trees. This dataset can be used in various scopes like Species and Disease detection, Disease severity management, Computer vision, Image processing models, etc. Their dataset contains 1.5% blur and noises which is a minimal number of amounts.

Michaël Defferrard et al, 2017 [5] introduced a Free Music Archive that is easily accessible and open that can be used for various MIR tasks. Their dataset consisted of 1, 06,574 tracks from 14,854 albums and from 16,341 artists, which is classified in 161 genres hierarchically. The size of the dataset is 917 GiB. All the music tracks are in mp3 format and the sampling rate is 44,100 Hz for most of the tracks.

Nived Chebrolu et al, 2017 [6], created a large image dataset of sugar beet fields. They collected these images by using a robot that collected different growth stages of the plants. The authors used an RGB-D sensor and a four-channel multi-spectral camera for capturing the images, they collected data three times a week. As they collected data using a tool,

provided by ROS, the data are in .bag format and converted the data into raw format. In total, a total of 5TB of data by using laser, vision, odometry, and GPS sensors was collected.

Ostermann et al, 2015 [7] showed a dataset that can be used for crop/weed discrimination, single plant phenotyping, and many other computer vision-related tasks. This dataset was created by using a field robot Bonirob from an organic carrot farm. The researchers collected the images when the carrot plants were in the true leaf growth stage. The dataset consisted of 60 top-down field images of carrots. Every image has annotations of vegetarian segmentation masks and crop/weed labels.

Most. Hasna Hena M. H et al, 2020 [8] tried to build a species detecting system that will provide the species of a mango sapling by monitoring the leaf's image of that sapling. This research used Deep Learning and Convolutional Neural Network (CNN) for dataset training. This dataset consisted of more than 4000 images. The system had an accuracy of 78.65%.

Abeer A. Elsharif et al, 2019 [9] classified four kinds of potatoes, which are - White, Red, Sweet, and Red Washed. They made a model by using Deep CNN (Convolutional Neural Network) for identifying the kind of potato from images. They used a dataset of the pictures of different kinds of potatoes which consisted of 2400 images. This model has attained an accuracy of 99.5%.

M. A. Shahin et al, 2002 [10] classified apples on the basis of surface bruises. The authors used Golden Delicious (GD) and Red Delicious (RD) apples that had been line-scanned for the bruise damages. This system achieved the best result using ANN classifiers that had been developed for old and new bruises. In the case of old bruises, an accuracy of 83% for the GD apples (after threshold adjustment, it rose to 93%) has been achieved and an accuracy of 90% for the RD apples has been achieved. In the case of new bruises, they achieved an accuracy of approximately 60% for GD apples and RD app Arabnia.

There is no research work has been done before on the local potatoes of Bangladesh. As there is no public dataset that has enough amounts of data of the local potatoes of this region that can be used for research purposes, it was difficult to work on this topic and classify the species. This research work deals with these barriers and presents a local potato dataset and its classification.

In previous works, [8] had worked on mango leaves and got an accuracy of 78.65%, which would give a moderately accurate result in most of the cases. Whereas [9] had worked on 4 kinds of potatoes and obtained an accuracy of 99.5%. This research had been done on a limited dataset and worked on very few kinds of potatoes. Our research work overcomes these barriers. Here, no limited dataset and worked on a large number of potatoes. In this model, using (CNN) conventional neural network and deep learning for species detection and get a better outcome.







3. AN OVERVIEW OF POTATO DATASET





The data collection process was the most challenging task. Here, 10 kinds of local potatoes have been collected from different areas in Bangladesh. Most potatoes are cultivated in winter in Bangladesh. This data have been collected from Mymensingh, Tangail, Chandpur, Jamalpur, and Rangpur district. We had gone to the fields where the

potatoes are cultivated and verified the potatoes. Then stored the sample potatoes and photographed the samples from different angles by a mobile phone with necessary pixels. The potato images resized in 256 by 256 size and removed the background to reduce the noise. The best part of the work, to gather 5190 images is the largest potato dataset. The proposed dataset will be utilized in many research papers and projects work.

Table I. shown local potatoes information and this table was not collected from any other research work.

TABLE I. Dataset information

Details	Picture
Diamond Alu: This is one of the most cultivated potatoes in Bangladesh. It is generally cultivated in winter and preserved for the whole year. This potato grows in sandy loam soil.	
Mete Alu: Mete Alu originated from the tropical region of Asia. This potato is usually eaten cooked. Each potato weighs from 2 kg to 60 kg. These kinds of potatoes are not cultivated commercially. It is a good resource for calcium and phosphorus.	
Lal Alu: Lal Alu is very prominent in Bangladesh. It is red from the external and yellow from the inside. It is defiant from Potato Leafroll Virus and Potato Virus Y. It is medium in size. This is used as a home remedy for hemorrhoid relief.	
Jam Alu: Jam Al is a kind of potato that is cultivated in the Mymensingh area. Jam alu is purple in color and the average size of this kind is medium. This potato is used to make different kinds of curry and Vorta (a traditional recipe of Bangladeshi Cuisine).	
Lal Mishti Alu: As its name exhibits, this kind of potato is sweet in flavor and its flesh is red in color. These potatoes are usually eaten boiled. It contains natural sugar. A potato contains more than 100 vitamins that meet the daily required amounts of the vitamin.	
Chhoto Lal Alu: Chhoto Lal Alu is very identical to sample 3 but in a smaller size. Baby Red Potato is usually used in curry.	

Mete Chhora Alu: Mete Chhora Alu produced from the same tree as sample 2. But it grows in the upper part of the tree. The size of this potato is very much different from sample 2 but the nutritional quality is the same as sample 2.	
Shunno Alu: Shunno Alu Is mainly cultivated in the Chandpur region of Bangladesh. It weighs 200-250 gm in general. It can be eaten cooked with curry or meat. It is cultivated in winter mainly.	
Shada Mishti Alu: It is similar to Sample 5 but it is white in color. Its characteristics are also similar to the previous one.	
Keshar Alu: This potato originated from America, but now it is cultivated in the whole world. It is sweetish in flavor and it can be eaten raw and cooked. Its root is brownish, white inside, and turnip shaped. It grows in damp sandy and sandy loam soils.	

4. METHODOLOGY OF RESEARCH

In this section, a potato dataset as an input and to train the system image processing techniques and (CNN) convolutional neural network has been used. Then inputting the raw dataset to train, process the images in this system, and gives prospective appropriate outcome. In our country almost all farmers are dwelling in the village, they have small knowledge about different kinds of species and maximum farmers have not sufficient knowledge about the current technology, hence we have the plan to mobilize the system so that they can understand easily and use it without any complication.

4.1 Fundamental steps for detection of potato species

Fig. 1 shows fundamental steps for the detection of potato species.

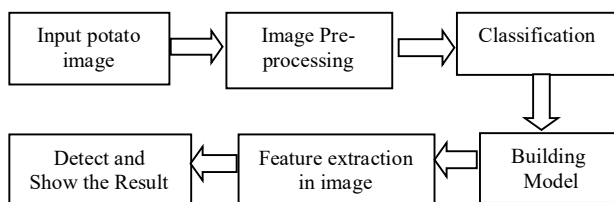


Fig. 1. Fundamental steps for potato species detection

4.2 Input potato image

An important role is played by the dataset in achieving maximum accuracy the proposed dataset consists of a total of 10 kinds of potatoes and all are collected from different areas. Here 5190 images of potatoes are collected and almost all these were efficient for this system. When collected potato images firstly verified the potatoes then clicked the picture, modified the images, fixed the size, and sorted the images in different folders. This System can accept input in .gif, .bmp, .jpg, .NEF format.

4.3 Image Pre-processing and training images

In this section, combined 5190 images of potato from our own dataset and resized them in 256 by 256 pixels. Then combined the dataset into two folders test and train, the proportion of folders 75%, and 25%. Here a total of ten categories- Diamond Alu, Mete Alu, Lal Alu, Jam Alu, Lal Mishti Alu, Chhoto Lal Alu, Mete Chhora Alu, Shunno Alu, Shada Mishti Alu, and Keshar Alu / Shakh. Alu is obtainable in datasets. Then created ten folders for ten categories and each folder contains a minimum of 100 images of potato.

4.4 Building model

This system has different layers of convolutional neural network. The first one is an input layer where the used input shaped (64, 64, 3), kernel size (8 x 8), strides (1 x 1), padding "SAME", filters 64. The second layer has used kernel size (5 x 5), strides (1 x 1), padding "SAME", filters 64. The seventh layer has used kernel size (3 x 3), strides (1 x 1), padding "SAME", filters 32. And the last has used kernel size (3 x 3), strides (1 x 1), padding "SAME", filters 32.

For the 50% dropout the model used dense layers 512. This model also 5 units has been used with activation sigmoid "(3)" and softmax "(2)".

$$\sigma = \frac{e^{z_j}}{\sum_{k=1}^K e^{z_k}} \text{ for } j=1, \dots, K$$

$$\phi(z) = \frac{1}{1 + e^{-z}}$$

Table 2. Shows the model of this research.

TABLE II. Output and Proposed Layer

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 64, 64, 64)	12352
conv2d_2 (Conv2D)	(None, 64, 64, 64)	102464

conv2d_3 (Conv2D)	(None, 64, 64, 64)	102464
conv2d_4 (Conv2D)	(None, 64, 64, 64)	102464
conv2d_5 (Conv2D)	(None, 32, 32, 32)	18464
conv2d_6 (Conv2D)	(None, 32, 32, 32)	9248
conv2d_7 (Conv2D)	(None, 32, 32, 32)	9248
conv2d_8 (Conv2D)	(None, 32, 32, 32)	9248
batch_normalization_2 (Batch Normalization)	(None, 16, 16, 32)	128
flatten_1 (Flatten)	(None, 8192)	0
dense_1 (Dense)	(None, 512)	4194816
dense_2 (Dense)	(None, 5)	2565

The model of this research architecture shown in Fig. 2.

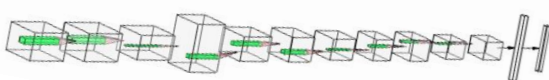


Fig. 2 Building of this proposed model

Adam algorithm has been used for the reduction of the value loss and after completed the learning rate each successful epoch. Here Adam value(0.0001) has been used in the model.

5. RESULTS

In this research, our own collected dataset has been used for the proposed model. We used 75% of the data as training data, and 25% of the data as test data. This model has given an immensely good result from this data. The result is significantly well as expected.

5.1 Statistical Analysis

Statistical analysis is the process of planning, collecting, and organizing data. Using collecting data you can analyze

and summarize the data. This paper shows that, the proposed model worked successfully and described this using numeric grade. The numeric values and accuracy graph explain how well the model is working properly. In this paper, the first epoch attempt got 0.7% training accuracy with a learning rate of 0.0005. We have often a significant successful result of 96.44% training accuracy and learning rate 0.00025 in the fifth attempt. The success rate had grown to a training accuracy of 98.51% and testing accuracy of 97.42 after eight epochs. After ten fruitful runs epoch, we have achieved an almost accurate result where 98.24% testing and 98.87 training accuracy and 1.56 learning rate.

5.2 Accuracy Graph

In this research, we have represented an accuracy graph of the proposed model by using the (CNN) convolutional neural network, and image processing is shown in Fig. 3. This graph demonstrates the performance of the model that can easily be understood without facing any difficulties. The best part of knowledge, the results of the research of this model performance is well from the accuracy graph is the outcome of the model, and received 98.87% at last. The validation accuracy graph and training accuracy graph & Validation loss and graph training loss of the research are shown in Fig.3.

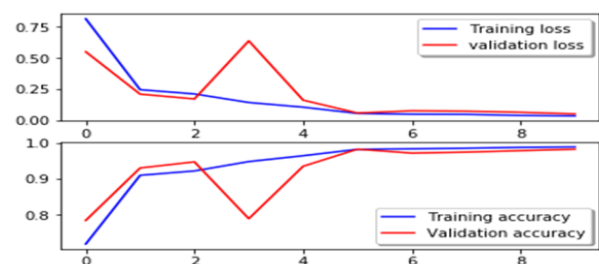


Fig. 3 Accuracy Graph

5.3 Confusion Matrix

This table is used to describe the representation of a classification model on a set of data for which the real values are known. In this paper, the representation of an algorithm visually shown in the confusion matrix. It computes the values of true and false predictions. The accuracy formula of this classification model in the below:

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

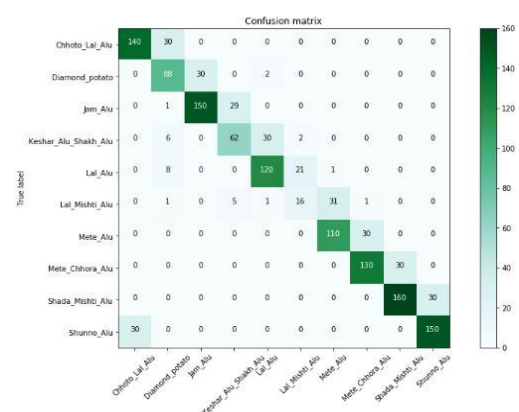


Fig. 4 Confusion Matrix

The confusion matrix in the building model of this system is shown in Fig.4. This matrix (10 x 10), displays that the diagonal value in each row is highest than the others. It concludes that the proposed model will give proper accuracy.

TABLE III. CLASSIFICATION REPORT

Name	Precision	Recall	F1-score	Support
Diamond Alu	0.99	0.96	0.98	103
Mete Alu	1.00	1.00	1.00	239
Lal Alu	1.00	1.00	1.00	233
Jam Alu	0.99	0.99	0.99	459
Lal Mishti Alu	0.97	0.99	0.98	72
Chhoto Lal Alu	0.95	0.98	0.92	78
Mete Chhora Alu	1.00	1.00	1.00	50
Shunno Alu	0.99	0.97	0.92	202
Shada Mishti Alu	0.88	0.87	0.86	180
Keshar Alu	0.89	0.88	0.86	564
Micro avg	0.98	0.97	0.99	1106
Macro avg	0.95	0.98	0.99	1106
Weighted avg	0.97	0.98	0.98	1106

5.4 Species detection

Potato has humongous diversity of species. That's why recognizing the species of potatoes is a very hard task. This research can be beneficial for recognizing the potatoes as we, here used modern technology CNN and image processing that will detect the species by the images of the potatoes. So, if a random image of a potato is given as an input in this system, it will show the features of the particular potato as output. Similarly, Fig.3. indicates almost the highest percentage of

accuracy. Thus, this system concludes that the model works successfully and can detect species of potato images.

CONCLUSION

For the purpose of detecting potatoes, we have presented a potato classification system by using (CNN) convolutional neural network and image processing in this research. The proposed system gives 98.87% accuracy. Our dataset has 5190 images. There are more than 100 images for each species of potato. The result of the implementation of the model is insignificantly high. An almost accurate result has been achieved from the model. This classification will be immensely helpful for farmers and agriculturists in the future. Also, here already collecting diseased potatoes of these species so that can work on disease detection of local potatoes in the future.

REFERENCES

- [1] "Potato plant Britannica." <https://www.britannica.com/plant/potato>. [Accessed: 02-April 2020].
- [2] "Potato Nutrition Guide from Potatoes usa" [website]. <https://www.potatogoodness.com/nutrition/>. [Accessed: 2020].
- [3] "Digital Image Processing" [University of Tartu]. <https://sisu.ut.ee/imageprocessing/book/1#:~:text=Image%20processing%20is%20a%20method,features%20associated%20with%20that%20image>
- [4] Most. Hasna Hena, Ahmed Al Marouf, Rezwana Sultana., Jr. 2019. MangoLDB: A Dataset of Mango Leaves RGB, Binary and Gray-Scale Image. ISSN: 2278-3075, 1-5.
- [5] Michaël Defferrard, Kirell Benzi, Pierre Vandergheynst, Xavier Bresson. FMA: A DATASET FOR MUSIC ANALYSIS. 18th International Society for Music Information, (p. 1-8). China
- [6] Nived Chebrolu, Philipp Lottes, Alexander Schaefer, Wera Winterhalter, Wolfram Burgard and Cyrill Stachniss. Agricultural Robot Dataset for Plant Classification, Localization and Mapping on Sugar Beet Fields., (p. 1-7).
- [7] Nived Chebrolu, Philipp Lottes, Alexander Schaefer, Wera Winterhalter, Wolfram Burgard and Cyrill Stachniss. Agricultural Robot Dataset for Plant Classification, Localization and Mapping on Sugar Beet Fields. (p. 1-7).
- [8] Most. Hasna Hena, Md. Helal Sheikh, Md. Shamim Reza, and Ahmed Al Marouf, 2020. Mango Species Detection from Raw Leaves Using Image Processing System.
- [9] Abeer A. Elsharif, Ibtesam M. Dheir, Alaa Soliman Abu Mettleq, Samy S. Abu-Naser, Potato Classification Using Deep Learning. ISSN: 2643-9603. Vol. 3 Issue 12, December – 2019, Pages: 1-8.
- [10] M. A. Shahin, E. W. Tollner, R. W. McClendon, H. R. Arabnia, 2002. APPLE CLASSIFICATION BASED ON SURFACE BRUISES USING IMAGE PROCESSING AND NEURAL NETWORKS. ISSN: 0001-2351. (pp. 1-10).