Species Identification of Oriental Magpie-Robin using Convolutional Neural Network in Bangladesh

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

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DHAKA,
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APPROVAL

This Project titled "**Species identification of Oriental Magpie-Robin using Convolutional Neural Network in Bangladesh**", submitted by **Sagar Barmon (172-15-10072) and A.M. Hossainuzzaman (172-15-9831)** 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 (BSc) and approved as to its style and contents. The presentation has been held on 9 September 2021.

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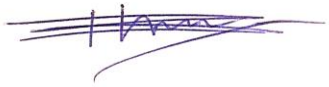

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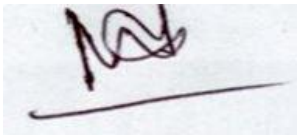

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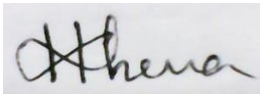

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DECLARATION

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

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Finally, with proper respect, we must appreciate our parents' relentless support and passion.

ABSTRACT

To understand the behavior of animals, monitoring the population of animals is necessity. Extinction is a common phenomenon nowadays. So, understanding and ecosystem is a must to preserve each species. The global climate change is a common issue which affecting human race. Change in nature directly affects ecosystem, and a gradual change in bird's pattern is seen. Monitoring the movement and population of bird gives us any indication about changes in environment.

We have used convolutional neural network (CNN) model to classify birds with better accuracy to identify Magpie Robin which is the national bird of Bangladesh. By the use of Image Rotation and Noise injection, our data is augmented. First we have feed our data into the CNN model for training. The stochastic gradient descent was used along with mini batch size 32. Our model has brought an accuracy of 91.44%. By comparing many other models, our model proved to be effective and productive in classification of bird based on image processing.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Birds are sensitive to changes in ecosystem and they are too responsive changes in environment such global climate change. The changes are such sensitive that a small change in the environment speaks of their mortality rate or travelling places. The changes are visibly seen. Both zoologists and ecologists monitor the changes and can conclude to find the factors causing the changes. And work can be done to alter the change that is causing such adverse effect in the ecosystem. They can propose stes to protect the species. But first and foremost, monitoring population of an individual species manually is impossible task to be done. Through the advancement of technology, we can easily detect the count of birds after a change and compare with the data collected before. Both nationally and internationally, millions are spent on monitoring as this particular species specifically establish important indicators of an environment.

While monitoring the number of population, an important process of classifying these birds has been less on focus and we fulfil this purpose by classifying using technology. Facial recognition is easily done due to development of algorithms, but bird is even more complex as setting different species of birds are tough task to handle. The issues that are commonly faced are lighting conditions, tilted angle of captures. We intend to learn and classify different bird species from a classified data set that was compiled.

The hottest research topic nowadays is CNN, and we can use this method to solve the problems mentioned above. In the ImageNet competition [1], it was showcased that this happens to be excellent method in object recognition. The application of CNN is huge, it was applied in medical imaging to analyze choroid segmentation [2]. So, we would like to investigate the performance of bird classification using CNN.

1.2 Motivation

The worldwide news about animal is scarce as such huge area to cover. Correct sampling is difficult to obtain too. The national bird of Bangladesh is due to Robin ability sing, voice recognition is a way to go. But correctly separating voices of Magpie Robin from other species difficult task to obtain. Hence we were motivated to use bird facial recognition to work on the population, identification and recognition of Magpie Robin.

1.3 Objectives

- Recording video of Magpie Robin in the remote village
- Using a system to check testing image can be recognized or not
  Some issues that followed with objectives-
- Hard to capture as going to remote areas in such a time of pandemic couldn't be done
- Searching pictures online, data was scarce too given not much work is done on Magpie Robin

CHAPTER 2
BACKGROUND

2.1 Related Work

Due to good accuracy of image based classification using deep learning, most scholars are researching using this method. Yu-Dong Zhang [8] showed fruit classification using 13 layer CNN. They used three types of data augmentation method with the stochastic gradient descent with momentum to train the CNN. The accuracy was spectacular with 94.94%.

Önsen Toygar[9] found fusion of CNN for extraction of features and KFA based appearance method which has positive results on accuracy. Their method showed excellent accuracy of 95.31%. An advancement studies which further scholar can use to develop more layers.

He Yan [10] used middle layers CNN using latent fusion to train classifier. They utilized the pretrained CNN models by caffe to extract visual features of 3-layer.Then used the SVM classifier for 3-layer features respectively to get their trained classifier. Finally, they combined three pre trained classifier into a classifier which is compared with 3-layer SVM classifier. Their model had a accuracy of 95.83%.

Tibor TRNOVSZKY[11] proposed classification of animal input images using Convolutional Neural Network (CNN). What they did was used their method and compared with existing methods such Linear Discriminant Analysis (LDA), Principal Component Analysis (PCA) and SVM which stands for Support Vector Machine. They compared extensively their method with these mentioned above and greatest thing about their proposal is that they had an accuracy of about 98%.

Karan Chauhan [12] used keras and tensorfow based CNN using python in the backend for processing for binary image classification. Lots of images of cats and dogs were taken and classified. Using four different activation functions and combinations of classifiers combined with four different structures of CNN using CPU system, they found an accuracy

of 90.54%.

Patil, M. N. C. et. al worked on identifying bird poses and instead of classifying birds classes on different parametersthey worked on to classify by some specific parameters[17].

Rui Wang et. al [13] focused on blurring effect such as Gaussian blur, haze blur defocus blur and motion blur and classified in accordance to blurring effect. This classification they proposed using convolution neural network (CNN) based on Simplified-Fast-Alexnet (SFA). The performance was bragging and resulted in for natural blur dataset 92.8% and for simulated blur 97.

Md. Mahbubur Rahman et. al [14] used MobileNet with transfer learning for recognition of bird species and found that the mentioned method outperforms the three other method tested and they have found the accuracy to be 91.00%.

Chandra Giri et. al [15] used satellite images of Bangladesh Mangrove Forest and brought in the research how the wildlife is being affected now and also mortality rate is higher than ever. The top of the food chain is dying rapidly all due to deforestation,erosion.

Seneviratne, L.[16] et. al worked on observing wild animals by tracking them and their face detection from videos of wildlife. They used deep learning methods for this research approach and they worked on wild animal detection and classification.

CHAPTER-3

RESEARCH METHODOLOGY

3.1 Introduction

The methodology covers an absolute of six steps which conclude our research that is displayed in Fig. 3.1. The steps are the following:

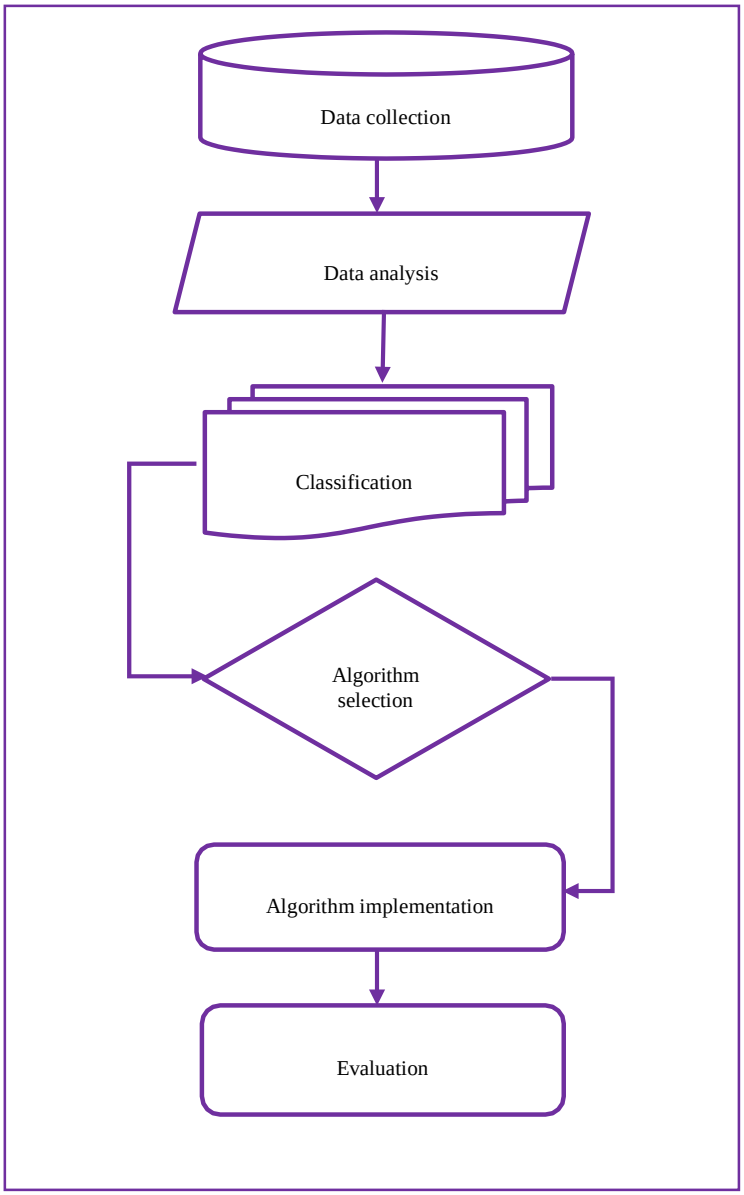

Fig 3.1.1: Methodology diagram

3.2 Data Collection

Data collection is always a difficult responsibility for every research. We assembled our data by thyself using digital cameras and some from reliable internet resources. Our dataset is divided into two parts. The first part was applied for training and testing. And another part was employed for prediction.

Table 3.2.1: Description of Attributes

SL No.	**Name of Attributes**	**Description**
1	Time	It took us more than 3 months to collect data.
2	Data Processing.	We have pre-processed this dataset to get a better outcome.
3	Noise Removal	We had to remove noise from this dataset to get a better outcome.
4	Data Dividing	We divided the dataset into training set and testing set.

3.3 Dataset and Preprocessing

Even though the original plan was to click pictures on site, but covid scenario didn't allow us. We used dataset from the internet for training and testing purpose.

Finally we obtained 700 images of Oriental Magpie Robin. Then we splitted the dataset for the purpose of training and the ones we didn't select used for testing. We had 560 images to train our algorithm and after feeding it we used 240 images for testing.

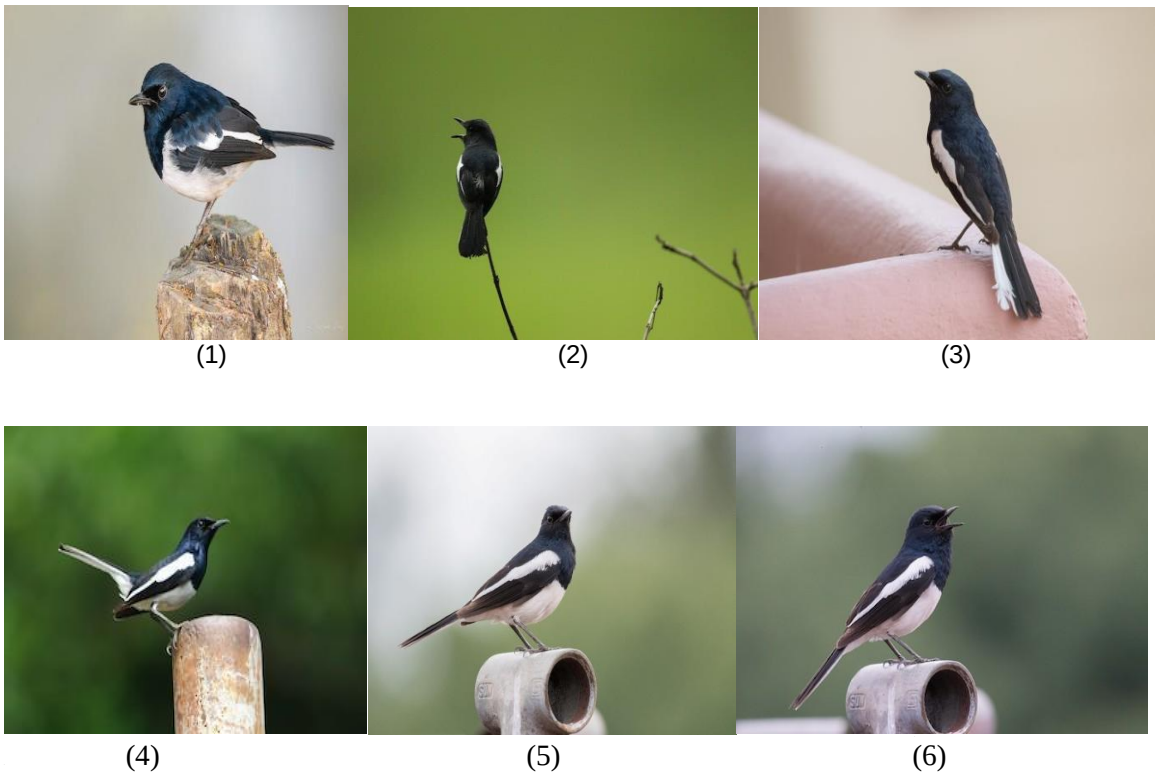

Fig 3.3.1: Sample data.

3.4 Data Set

Table 3.4.1 Data Set (Original)

Splitting	ratio of images
Training Data set	560
Testing Data set	240
Total	800

Here, we have used 560 images for training purpose and 240 images of testing purpose. Overall, we used total of 800 images. To train the images we used three steps. Firstly, due to some pictures being tilted, we had to center their faces. After which each images were resized to 64 * 64 matrix and that resulted in a cropped image than the original. Finally, we had to label each image manually to varying classes. The figure 3.1.1 shows sample images that we used for preprocessing.

CHAPTER 4

ALGORITHM AND WORK FLOW

4.1 Introduction

The researches by scholars has used convolutional neural network (CNN) in both text and non-text classification, fruit, vegetables, fish classification, not to mention about object detection. Fig 2 shows the architecture of (CNN).

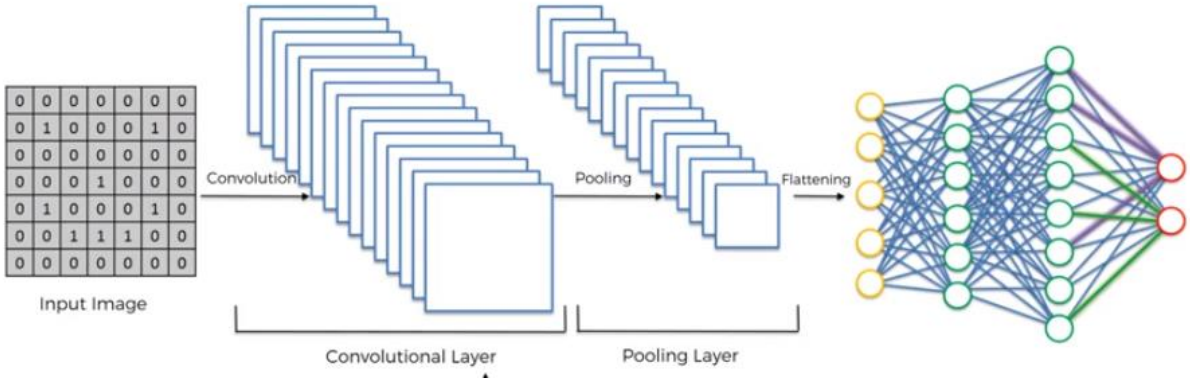

Fig 4.1.1: Architecture of CNN.

4.2 Convolution layer

For three dimensional input and filters, two dimensional convolution is performed. Let us consider our input as HI × WI × C, where HI stands for height, WI for width and C for channels. And let us consider HF as height filter and WF as width filter. Then the size of the filter is HF × WF × C. We must maintain equivalency for both input and filter of the channel size. So, along with height and width directions 2D convolution is implemented.

Let us consider Stride size as S and P as margin and H_0 as height and width as W_0 .Then the output is as follows –

$$H_0 = \frac{H_1 - H_F + 2P}{S} + 1 \qquad (a)$$

$$W_0 = \frac{W_1 - W_F + 2P}{S} + 1 \qquad (b)$$

From above formulas we can decode that the output is also 3D bearing size of $H_0 \times W_0 \times$ N, as we have explained what two variable stands for, however we didn't explain what N stands for. N stands for filters number. The feature map has neurons and it passes through convolution layer after which is passed through a nonlinear activation function. To be specific will pass through rectified linear unit (ReLU) layer, which explains a function as follows.

$$\text{ReLU(x)} = \{x \quad x \geq 0 \qquad 0 \quad x < 0 \qquad (c)$$

4.3 Pooling layer

The outputs from the ReLU layer is substituted with a summary statistic of nearby outputs [7]. This process has two advantages, one that guarantees the representation which is invariant to small input translation. And the other is to reduce the burden of the computation.

If we let R be the pooling region, then the activation set could be defined by A included in R is

$$\text{A} = \{i \in R\} \qquad (d)$$

The most popular pooling strategy is known as max-pooling denoted by PM [26]. And the function is

$$\text{PM} = \max(A_R) \qquad (e)$$

4.4 Fully Connected Layer

The output of the last convolution layer is flattened in a fully connected layer. And then

connect every node layer with the node of the next layer. Neurons in a fully connected layer have full connections to all activations layer in the previous layers. They work exactly like the way it works in regular Neural Network.

The bottom layer which is known as the last layer in our CNN model, we have calculated our CNN model with class probability scores , which resulted in a volume of size.

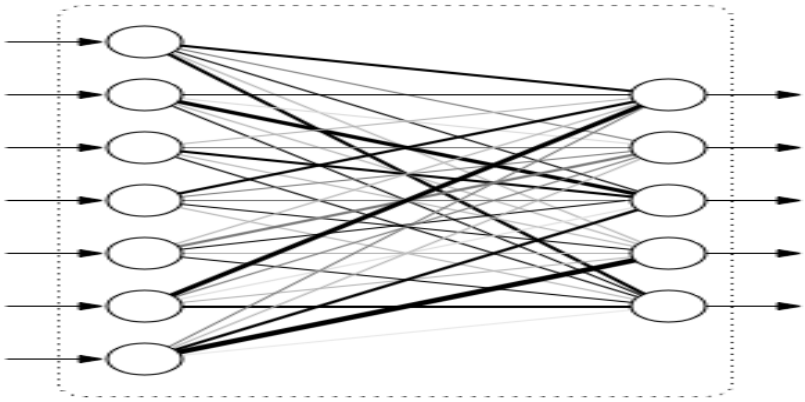

Fig 4.4.1: Fully Connected Layers.

Here is the Pseudo code of CNN:

Input: k, X, d, n, t and $N = |X| > (2n - 1)$.
Output: Outliersin X

1 Collects n data as the first training set;
2 Searches the kNN, RkNN, and SkNN for x_i, and $1 \leq i \leq n$;
3 Calculates CLOF(x_i), if CLOF(x_i) > 1, outlier count of x_i increased by 1;
4 Collects a new data x_{n+1}, deletes the obsolete data point x_1;
5 if the outlier count of $x_1 \geq t$ $(1 \leq t \leq n)$, x_1 is an outlier;
6 Searches the kNN, RkNN, and SkNN for x_{n+1}, and $2 \leq i \leq n + 1$;
7 Updates the kNN, RkNN, SkNN, and CLOF for affected data;
8 Calculates CLOF(x_i), if CLOF(x_i) > 1, outlier count of x_i increased by 1;
9 Collects a new data x_{n+2}, deletes the obsolete data point x_2;
10 if the outlier count of $x_2 \geq t$ $(1 \leq t \leq n)$, x_2 is an outlier;
11 Searches the kNN, RkNN, and SkNN for x_{n+2}, and $3 \leq i \leq n + 2$;
12 Updates the kNN, RkNN, SkNN, and CLOF for affected data;
13 Calculates CLOF(x_i), if CLOF(x_i) > 1, outlier count of x_i increased by 1;
14 Continue with steps 4–13;

Fig 4.4.2: Pseudo code of CNN

Table 4.1.1 Summary of our model.

Layer (type)	Output Shape	Param #
conv2d_1 (Conv2D)	(None, 60, 60, 30)	890
max_pooling2d_1 (MaxPooling2	(None, 29, 29, 30)	0
conv2d_2 (Conv2D)	(None, 27, 27, 30)	9246
max_pooling2d_2 (MaxPooling2	(None, 12, 12, 30)	0
flatten_1 (Flatten)	(None, 6268)	0
dense_1 (Dense)	(None, 126)	802940
dense_2 (Dense)	(None, 1)	126

Total params: 813,202
Trainable params: 813,202
Non-trainable params: 0

Here is the summary of the the research work where in conv2d_1 (Conv2D) layer the output shape was (60, 60, 30). In max_pooling2d_1 layer the output shape was (MaxPooling2 (None, 29, 29, 30). In conv2d_2 (Conv2D) layer the output shape was (None, 27, 27, 30). In max_pooling2d_2 layer the output shape was (MaxPooling2 (None, 12, 12, 30). In flatten_1 (Flatten), dense_1 (Dense), and dense_2 (Dense) the output layer were None, 6268), (None, 126),) and (None, 1).

We used python in the background and used in built Keras library and implemented our code. In different layers we have used two convolution-filters. Filter size of CNN was taken as (3*3). And the default size of each CNN filter was (2*2). In this model we have used ReLU activation function. What this function does is mapping values. To simply put it keeps positive value as it is, however it maps negative values to zero. We have used here binary crossentropy with Adam as an optimizer to be used as a loss function. The constraints we used was time and memory which was limiting, and we have set number of epochs to 20. We had choose variable batch size and tested the data and ultimately used 32 as the typical batch size.

4.5 Work Flow Diagram:

Work flow of the model will be like user uploading an image for classification as input. The Deep Learning model will fetch the image and the Convolutional layers will be applied on the image. And then we will get the desired classified output of the image as the final result.

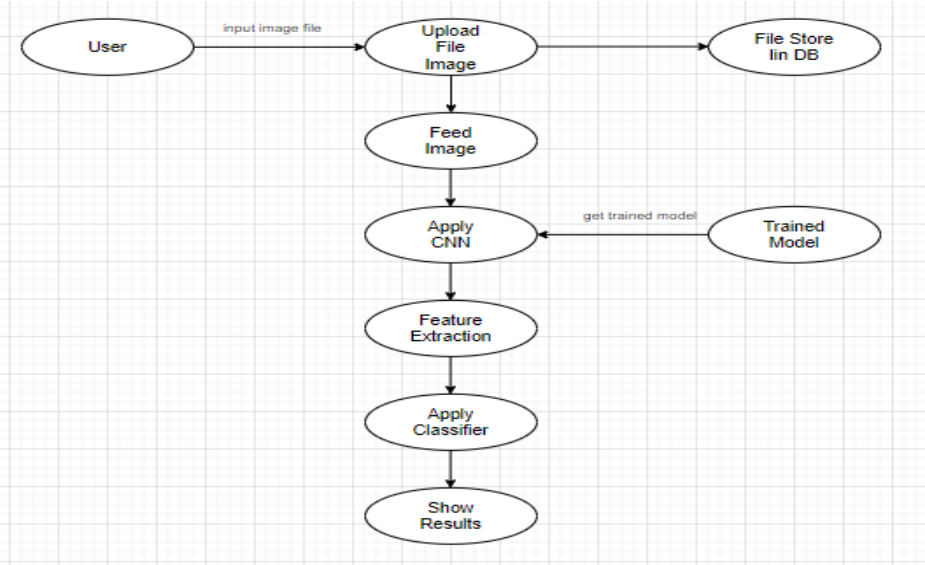

Fig 4.5.1: Workflow Diagram

4.6 Use Case Diagram:

An example use case has been shown in the fig below. There'll be two participants in this use case. If a user wants to classify any image then he will have to login in the system to get the service. On the other hand the system administrator would have the all access of the services and he can control who can use this service and who can't.

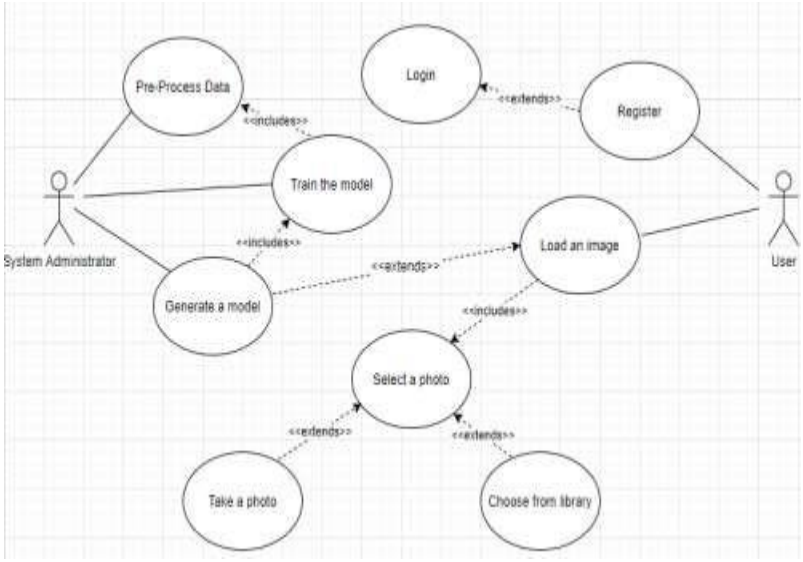

Fig 4.6.1: Use case Diagram

CHAPTER 5

RESULT COMPARISON AND ANALYSIS

To estimate the efficiency of our research, we implemented four conventional ML algorithms in pre-organized data. We entered the efficiency value produced by those algorithms into an accuracy Table 4.1.1 so we can clearly understand and perform a correlation among them based on their accomplishment. We used five types of training and test sets of complete datasets like 30%, 40%, 50%, 60% and 70% to calculate the efficiency of our selected algorithms. By comparing those four algorithms, we have perceived a spectacular consequence. In our research Decision Tree and Random Forest performed perfectly with almost the same high-level accuracy.

Table 5.1.1 Accuracy Compression

Training Data Set	Training Accuracy	Testing Accuracy
80%	96.73%	91.43%
70%	95.21%	88.73%
60%	91.33%	71.70%
50%	75.04%	66.83%
40%	71.03%	54.03%

Fig : 5.1 showing the training accuracy which is 96.73% and on the other hand it's showing the testing accuracy which is 91.43%

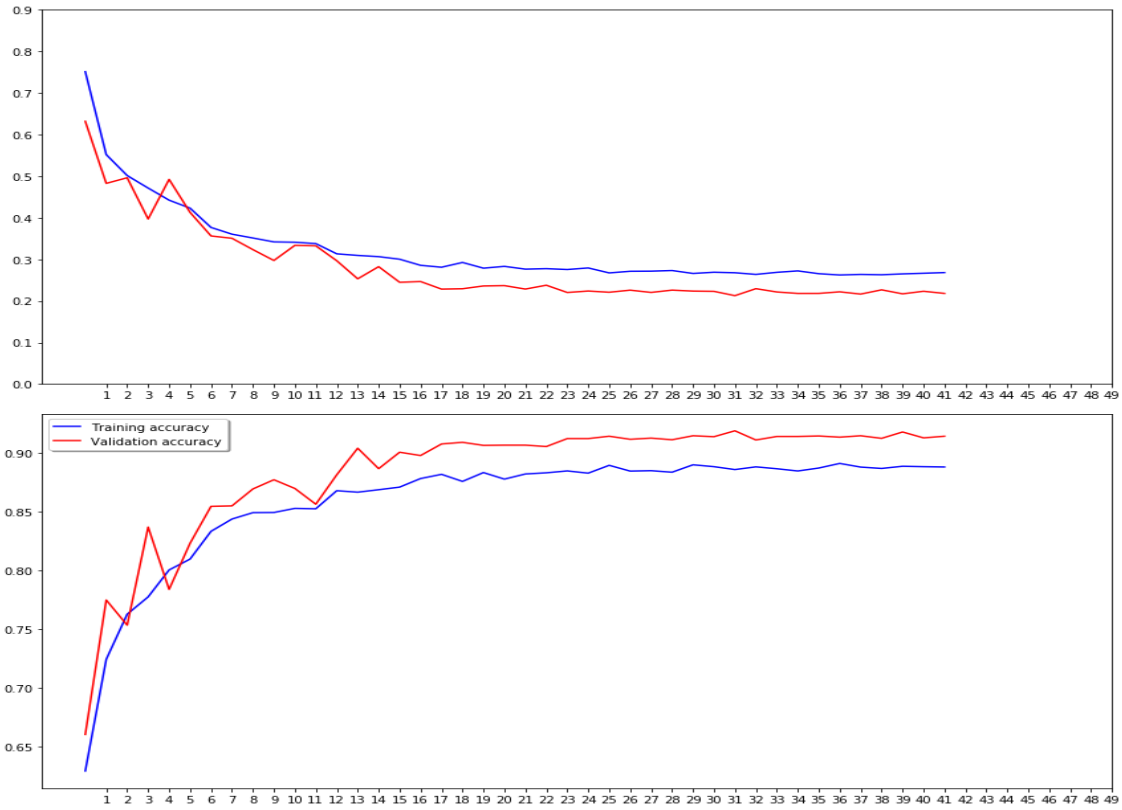

Fig 5.1: Accuracy graph

Table 5.1.2 The Classification accuracies.

Arch.	Train acc(%)	Test acc(%)
Convolutional Neural Networks(CNN)	96.73	91.43
Support Vector Machines(SVM)	88.51	82.38
Decision Trees	83.02	79.84

In this study we've worked on developing a model for a software platform which will use deep learning for processing images to identify bird images in real time. This software

platform can be a mobile phone application or a web application. To develop such deep learning based system we need a trained dataset for image classification. Dataset which is trained consists two parts, one is train result and the other one is test result. It is expected that the dataset will be retained to get a higher accuracy. The dataset is created with a total of 800 images and by using Convolutional Neural Network, we got a accuracy of 91.43% which is pretty impressive. When an image is processed by Convolutional Neural Network then many features like shape, color, head, beak, body etc. available in an entire image are considered while classification to get a better accuracy. Each available features are passed through deep convolutional neural network to extract each available information's available in every features. Then after collecting this features they are forwarded to the classifier. After that, the trained dataset is compared with the input and results are generated on the basis of extracted information's and features which are collected form input images.

CHAPTER 6
CONCLUSION AND FUTURE WORK

The goal of this project was to improve upon the state-of-the-art bird species classifier because there has not been much work done on bird classification. The intention of this prototype was to develop a model to classify the birds of Bangladesh. By this we'll get to know about the population of birds whether it is increasing or decreasing and it'll help us to predict the current situation of our nature. We'll get to know whether our nature is in a stable situation or it's getting damaged day by day.

In this work we were able to classify bird species without computer vision with a great accuracy of 91.43% by using the Convolutional Neural Network. In our dataset we used images captured by digital cameras and collected from reliable sources was the main reason behind getting better accuracy.

6.1 Future work

In this project we just classified the national bird of Bangladesh (**Oriental Magpie-Robin**) but our future goal is to classify every Bangladeshi bird. It's pretty much tough but I am sure we can make it happen.

We are aiming to enrich this research work and develop a mobile app which will be able to classify bird species by their image instantly.

Fig 6.1.1: User interface-1

In Fig 6.1.1 is a sample of the mobile phone app where user can upload image and then the app will use Deep Learning to classify it.

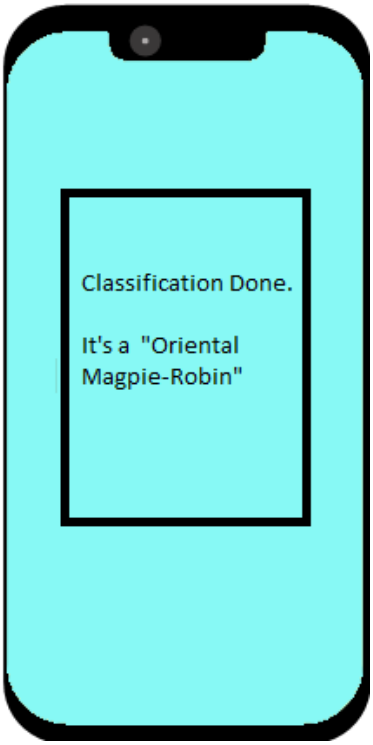

Fig 6.1.2: User interface-2

Fig 6.1.2 Is the example of the outcome of using the app for species classification of bird. After uploading the image the app will be able to classify its species and an example interface is fig 6.1.2

It will help us to know more about local Bangladeshi birds and its nature.
We also goal to track features of birds from videos. We can extract specific features from the nodes only if we can develop our model based on CNN.

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