# A DEEP LEARNING APPROACH FOR ANIMAL RECOGNITION FROM ANIMAL IMAGE

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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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## APPROVAL

This Project/internship titled **"A DEEP LEARNING APPROACH FOR ANIMAL RECOGNITION FROM ANIMAL IMAGE"**, submitted by Khandaker Monjir-Ul-Morsalin, ID No: 171-15-9421 and Marina Naznin, ID No: 171-15-9568 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 02.06.21.

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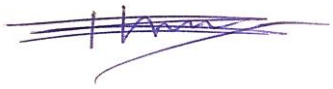

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# DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Aniruddha Rakshit, Senior 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

This is a deep learning approach to recognizing animals. We have used images of various domesticated and wild animals. The deep learning procedure instructs machines to detect and bring out the features from images. We believed that we would be able to build a model which could analyze animals and give a more efficient outcome. Firstly we have collected images to create datasets and completed preprocessing. Then we applied various processes to get the result and then applied Deep CNN and trained the dataset. Then completed the detection process of the animal (Example: Elephant). For this approach, we have used python. Implementation is done on a previously trained model EfficientNet B5. To give the best and true outcome with higher accuracy, Deep CNN formatted the image dataset in several ways. The training accuracy of the image is around 94.29%. The CNN model classified most of the image dataset of animals where only 118 images were misclassified. We got a validation accuracy of around 93.95%. The testing accuracy was around 93.45%.In this animal detection approach, we have used algorithms for classifying animals. We have used a huge amount of images for this purpose. To get more accurate results, we recommend using more data. Working with a lot of data has the potential to be 100% accurate. Another thing is that this study can be done based on animal voices.

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# CHAPTER 1
# INTRODUCTION

## 1.1 Introduction

We live on earth. Not only we but also flora and fauna created the ecosystem and animals are part and parcel of it. There are many various animals in different types of areas in the world. Some are wild and some are domesticated. Some are herbivorous and some are cannibalistic in nature. Wildlife and domestic animals have different lifestyles. There is also diversity in animals [1]. Some animals can fly in the sky, some live on land and some live in water. At the starting of 1970, the first system was built that can identify animals. That was an electronic system and the research institutes behind it were from various countries. [2]

They can be classified in different ways. An animal survives by adapting to a specific environment. Thus, after one generation has left, a new generation is coming. To recognize an animal is important as well as interesting. Manually identifying these animals can be more complicated. Many animals have not been recognized so far. There are innumerable such animals and there are variations based on their age or size. This is a deep learning approach to recognizing animals.

For this approach, we have used images of various domesticated and wild animals. The deep learning procedure instructs machines to detect and bring out the features from images. We can track any animal by classifying the animals based on the image. We believed that we would be able to build a model which could analyze animals and give a more efficient outcome. This method makes it easier to identify animals. The results obtained from this process are more effective.

## 1.2 Motivation

From an image, we can find which animal it is. Animal recognition can be said to be important in many ways. There are many animals that are not properly recognized by us.

To complete this work, we have to use deep learning. Because by using deep learning we can analyze animals' images. By using deep learning animal's images we can recognize specific animals. This can be an easy and proper way for animal recognition.

### 1.3 Objectives

We will be able to recognize a specific animal by analyzing the image of various well known animals. We can also predict the animal by time analyzing previous data. For that our purpose was to create a dataset using a huge amount of data that can give us good results in the model training, testing, and validating.

### 1.4 Research Questions

Many questions come up in any study. More questions come to mind in finding solutions to these questions. We have faced some issues and questions. The answers to these questions have come out after the various steps of our research. Which made our research complete and bring out more effective results.

- Is there any procedure to identify animals?
- What kind of data would be right to work with?
- What should be the size of the images?
- From where to collect data?
- Which model to follow?

### 1.5 Expected Outcome

We have done our proposed work in a few steps. First, we have collected data. Then we optimize the collected data before implementation. After that, we trained the optimized data. We collected data from various sites to create our dataset. Most of the images are collected from imagenet and google images. Also, we took some animal pictures by ourselves. We gave all the pictures a certain size. Then using a pre-trained model, we have done the implementation process.

- To analyze animals from their image
- To predict the animals based on their image

### 1.6 Report Layout

This report is made in such a way that it can give a proper idea of the reasons and outcomes of each step. This report has been written by following the standard thesis report template provided by Daffodil International University.

In chapter 1: We have narrated the basic concepts of "Animal Detection" and with practice with motivation, the rationale of the study, some research questions, expected output from this, and the report layout of our research-based project.

In chapter 2: Here we have narrated related previous studies, a summary of the research, the scope of the problem, and faced challenges.

In chapter 3: Based on research methodology. Also described the research subject and Instrumentation, the procedure of data collection, statistical analysis, and requirements in this approach.

In chapter 4: We described the results we have got from overall research. It is based on these portions such as results from the experiment, narrative analysis, and Summary of results.

In chapter 5: We have discussed the results of our research. Also, a few features are discussed. Which may contribute to the improvement of our research work in the future.

# CHAPTER 2
# BACKGROUND

## 2.1 Introduction

In this part, we have discussed some of the previous works which are related to our research. We have reviewed the research and specially analyzed which areas are basically hinting about our work. Then, the problem area of our research is discussed. Lastly, we have mentioned the challenges that we have faced in our work.

## 2.2 Related Works

Identification procedures of animals are a little bit complex. To identify giant panda individuals applied the deep learning technology and developed a novel face identification model. That was based on CNN. [3]

In the validation dataset, the model was able to identify 95% of giant panda individuals. That also accurately identified more than 90% of panda individuals after degrading the quality photo of data in all simulated field situations. [3]

A novel deep CNN was introduced by them. That was based on the algorithm for species recognition. Purpose was wild animal classification on very complex camera-trap image data. For that approach images were captured with motion triggered camera traps. Used an algorithm called the state of the art graph-cut to complete data segmentation. [4]

That recognition algorithm had given a better outcome than the usual BOW based species recognition algorithm on the very challenging real camera-trap imagery data set. It showed promising results but performance has not met the requirements of full automation. [4]

The moving foreground was selected as the region of interest. It was fed to the proposed species recognition algorithm. For comparison, the traditional bag of visual words model was used as the baseline species recognition algorithm. [4]

An approach to wildlife monitoring and analysis. Overall that was based on animal recognition from natural scenarios. That was analyzed by camera-trap networks. [5]

Provided an animal detection model. Used self-learned features of deep CNN. After that, an efficient feature set was used for classification. To do that, state-of-the-art machine learning algorithms, namely support vector machine, k-nearest neighbor, and ensemble tree were used. They got an accuracy of 91.4% on the standard camera-trap dataset. [5]

In computer vision, based on some of the advanced deep learning based works a framework was presented. That's purpose was to present a framework for automated recognition and monitoring methods of wild animals. [6]

Used a project of wildlife spotter and trained computer for filtering animal's pictures which can simply identify any of those species. The result provided 96.6% accuracy of those animals containing pictures. And the most popular 3 image set of wild animals, which were picked from Australia, South-central Victoria, got 90.4% of accuracy after observing. [6]

To recognize animals, a comparative analysis was done between Deep CNN and two bags of visual words which are BOW and HOG BOW. Tested both types of color information (white and gray) with separate procedures of pooling. [7]

### 2.3 Categories of Animal

There are about 8.7 million animal species in the world. According to the latest update, only 1.6 million of them have been identified and this is not surprising at all [8]. With different lifestyles, they have their own characteristics for survival in nature. We have collected imagery data of 12 animals for this research. In this study, we have worked with the data of domestic animals as well as some wild animals. Those are Butterfly, Cat, Dog, Elephant, Hen, Lion, Rabbit, Sheep, Spider, Squirrel, Tiger, and Spider Monkey.


Figure 2.3.1: Categories of animals

## 2.4 Research Summary

There have been several animal analyses. Those were also based on the Deep CNN. From that, they got better results. Many studies have brought different thoughts following this way in various procedures. We have implemented a deep learning approach for animal recognition by this process. The overview of the animal recognition research has been given below.

First step

- Data collection and preprocessing
- Input data Categorization and unnecessary data cleaning

Second step

- XML file loading
- Animal detection as an object and faces of them

Third step

- Feeding those processed data into deep CNN
- Using cross-validation procedure for divided data into train, validation, and test set

Fourth step

- Classifier training of Deep CNN

Fifth step

- Detecting animals from animal images
- Getting final expected outcome

The sixth and final step

- From animal detection getting the accuracy of the result.

### 2.5 Scope of the Problem

Animal detection is a procedure that helps to perceive an animal. Dataset categorization of images of various animals has been done by using the deep learning procedure.

In this way, we have tried to inspect the datasets and find out any of the animals from the image. After finishing the analysis of the image dataset, we will get the result (Which animal in the picture? Such as Elephant).

Through these steps, we have tried to find out the animal. Therefore, the method can make sure which animal exists in an image.

### 2.6 Challenges

Naturally, we will face challenges in doing anything differently. In the case of our study on this, we have faced some obstacles in many steps. Facing the problems, overcoming them, and then implementing them properly was a bit challenging. We were new to research. The first question that came to our mind was how does deep learning work? We wanted to work with different categories of animals. At first, we thought we would

implement this on audio data. But that seemed a little complicated to us. And this is the reason we decided to apply it to the images. And for that, we needed a lot of imagery data. Then came the question, will we apply deep learning to domestic animals or wild animals or both? Then we decided to work with data on both domestic and wild animals.

We have taken images of 12 different animals from different sources. Besides, we had some images collections that we took. Animal identification looked a little bit tough because there are different animal's images of different qualities. Besides the size of the images were not same to do the research.

# CHAPTER 3
# RESEARCH METHODOLOGY

## 3.1 Introduction

Every task requires proper strategy. Strategies need to be prepared to complete research properly. It combines the behind theory of the research topic and the implementation procedures. An overall outcome will be available at the end of all processes. Several steps are considered in the overall discussion of this chapter.

Firstly we have collected images to create datasets and completed preprocessing.

Then we applied various processes to get the result and then applied Deep CNN and trained the dataset.

Then completed the detection process of the animal (Example: Elephant).

## 3.2 Research Subject and Instrumentation

Recognition of animals is the field of our research that has been done using deep learning. This is a difficult and challenging task in research but interesting. People are always looking for innovative and creative things to do. Many animals are not properly recognized yet. Especially wild animals. Because of this, we thought we would apply a method that would make it easier to recognize animals. For this approach, we have used python. Implementation is done on a previously trained model EfficientNet B5 [9].

## 3.3 Data Collection Procedure

We have discussed the process of data collection here. It has been discussed below in the overall two experiments.

**Experiment 01:**

Data collection was an important part of this research. We have collected pictures of the animals through various websites and our own cameras. Pictures of some animals were collected from real time data sets.

Some of the images collected from internet sources were in zipped format. We extracted those zipped files and collected images for several classes. Then for each animal, the images were then placed in separate folders. A data set has been created for the approach with those images. This process is shown below.

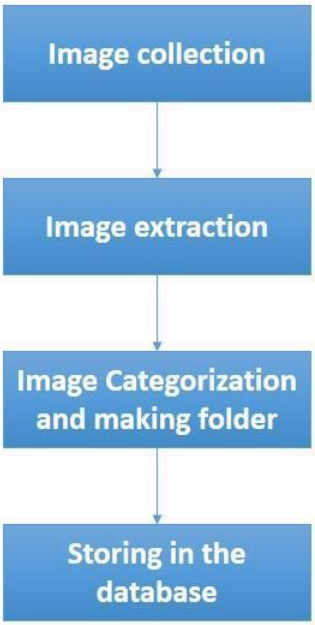


Figure 3.3.1: Data collection procedure

**Experiment 02:**

Table 3.3.1: Image collection statistics in detail

| Animal | Total number of images per animal | Image format | Image size |
|---|---|---|---|
| Butterfly | 1000 | JPG | Various |
| Cat | 1000 | JPG | Various |
| Dog | 1000 | JPG | Various |
| Elephant | 1000 | JPG | Various |

| | | | |
|---|---|---|---|
| Hen | 1000 | JPG | Various |
| Lion | 1000 | JPG | Various |
| Rabbit | 1000 | JPG | Various |
| Sheep | 1000 | JPG | Various |
| Spider | 1000 | JPG | Various |
| Squirrel | 1000 | JPG | Various |
| Tiger | 1000 | JPG | Various |
| Spider Monkey | 1000 | JPG | Various |

As we can see from the Table 3.3.1, there are 12 image datasets of animals. In total, we have collected 12000 images of 12 different animals for this deep learning approach. Those animals are Butterfly, Cat, Dog, Elephant, Hen, Lion, Rabbit, Sheep, Spider, Squirrel, Tiger, Spider, and Monkey, etc. After that, we added the image datasets to the database.

Then the next step was training the created image datasets within the deep CNN model. Alongside, applying the deep learning algorithm we will get the performance for this procedure.

Images were kept at 80% for each class of training. The remaining 10% images are for testing, and 10% for validation. These are summarized in the Table 3.3.2.

Table 3.3.2: Separate dataset for training, testing and validation

| Animal | Total number of images per animal | Train datasets (80%) | Testing datasets (10%) | Validation datasets (10%) |
|---|---|---|---|---|
| Butterfly | 1000 | 80 | 10 | 10 |
| Cat | 1000 | 80 | 10 | 10 |
| Dog | 1000 | 80 | 10 | 10 |

| | | | | |
|---|---|---|---|---|
| Elephant | 1000 | 80 | 10 | 10 |
| Hen | 1000 | 80 | 10 | 10 |
| Lion | 1000 | 80 | 10 | 10 |
| Rabbit | 1000 | 80 | 10 | 10 |
| Sheep | 1000 | 80 | 10 | 10 |
| Spider | 1000 | 80 | 10 | 10 |
| Squirrel | 1000 | 80 | 10 | 10 |
| Tiger | 1000 | 80 | 10 | 10 |
| Spider Monkey | 1000 | 80 | 10 | 10 |

### 3.4 Statistical Analysis

For the procedure of neural networks, data should be perfect. Otherwise, we will not get the proper outcome that we expect. Data should be modified for the implementation process. And obviously, those have to be unique for getting the best performance, and because of this, the accuracy will be high. After completing various procedures, data will be ready for the final deep learning approach.

#### 3.4.1 Data Augmentation

The more data a model is trained with, the better it will work. Any deep learning approach requires a large amount of data. Only then it is possible to get the expected results from the implementation. We needed a lot of image data since we were working with images. The amount of data samples is increased using the data augmentation process. There are different types of data augmentation processes. We have applied the following techniques from those.

Those are,

- Rotation (30 degrees)
- Horizontal Flip
- Vertical Flip
- Height Shift (0.2)

- Width Shift (0.2)

After this step, we have got enough data for completing the next procedures which is summarized in the Table 3.4.1.1.

Table 3.4.1.1: Dataset Description

| Class number | Class | Training Images | Testing Images | Validation Images | Total number |
|---|---|---|---|---|---|
| 1 | Butterfly | 1200 | 150 | 150 | 1500 |
| 2 | Cat | 1200 | 150 | 150 | 1500 |
| 3 | Dog | 1200 | 150 | 150 | 1500 |
| 4 | Elephant | 1200 | 150 | 150 | 1500 |
| 5 | Hen | 1200 | 150 | 150 | 1500 |
| 6 | Lion | 1200 | 150 | 150 | 1500 |
| 7 | Rabbit | 1200 | 150 | 150 | 1500 |
| 8 | Sheep | 1200 | 150 | 150 | 1500 |
| 9 | Spider | 1200 | 150 | 150 | 1500 |
| 10 | Squirrel | 1200 | 150 | 150 | 1500 |
| 11 | Tiger | 1200 | 150 | 150 | 1500 |
| 12 | Spider Monkey | 1200 | 150 | 150 | 1500 |
| **Total** | | **14400** | **1800** | **1800** | **18000** |

### 3.4.2 Reshape images

The pictures we collected were different in size. Different sized images create computational problems. That's why we had to take pictures in square shape. Besides, the length and width of all the pictures had to be the same. Images have resized into 456×456 pixels. That means 456 pixels for a row and 456 pixels for a column. And after that, images got a standard size.

For that, we have used Pillow which is a library of Python 3. It is used to complete various operations on images simply. We can manipulate per pixel, can do some filters like contrast updating, color changing, increasing or decreasing the brightness and sharpness etc. And also text can be added by using the pillow library.


Figure 3.4.2.1: Reshape Images

### 3.5 Proposed procedure

After creating the dataset, we have executed this by following some steps.

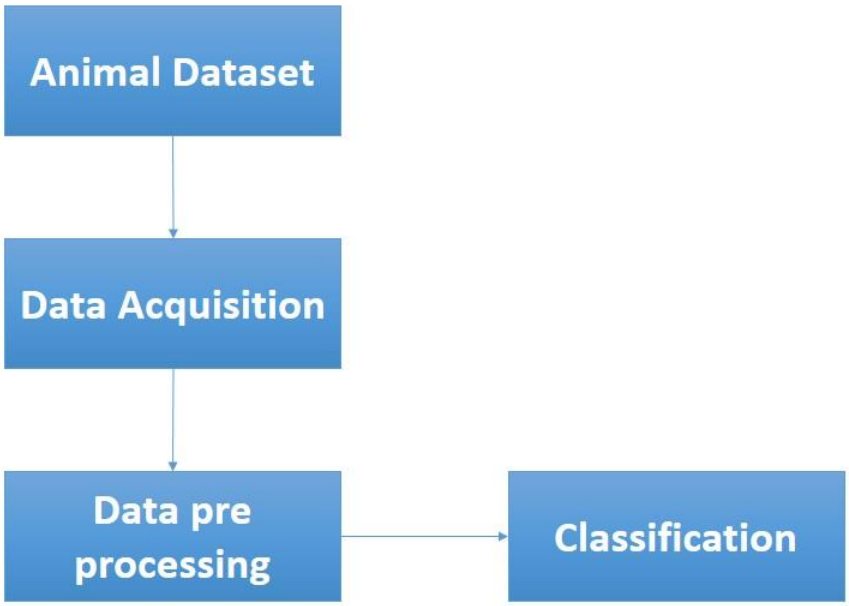


Figure 3.5.1: Proposed procedure

### 3.6 Deep CNN

The CNN is an amazing and well-known identification processing algorithm. It is better than the ANN because of its power and flexibility. We can directly fit images on CNN, which is not possible in ANN. It is also better than RNN because of its features, which makes the classification procedure easier. CNN has one of the biggest advantages. That is, after giving data, CNN creates different types of filters based on our data. Selects various features of the image and detects the components from there. Even if we take pictures from different angles, CNN can easily detect it. The deep CNN process is shown in the figure 3.6.1 [10].

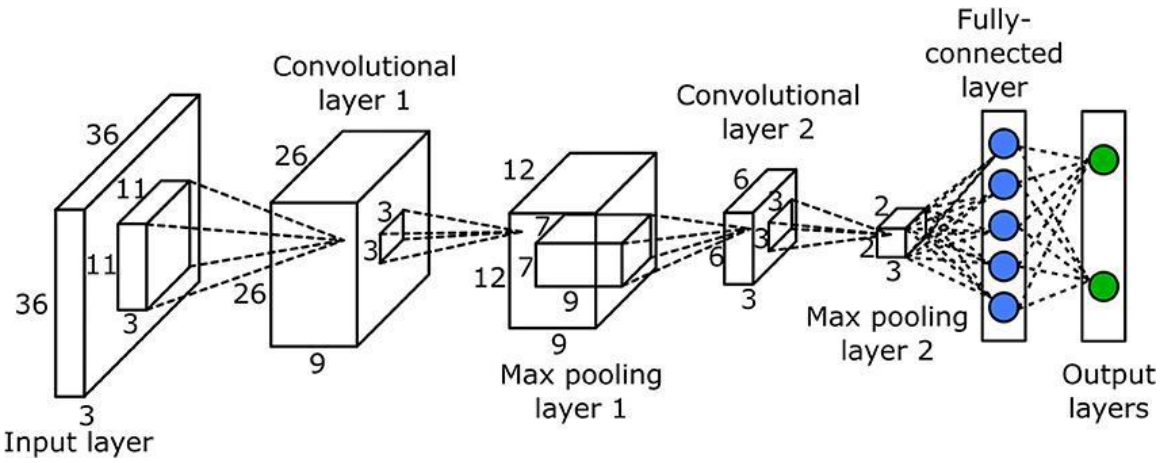


Figure 3.6.1: Deep CNN

It performs for both supervised learning and unsupervised learning procedures. This neural network created interrelation with classified problems. This solves any problem similar to a flow diagram. We want to get more authentic results. And because of this, we have used Deep CNN to get the proper identification outcome.

### 3.7 EfficientNet B5

This model was predefined in TensorFlow, which an open-source medium for machine learning procedures. On the ImageNet database, all the models of EfficientNet have been pretrained. [11].

The special reason for using EfficientNets is, on imagenet, it performs perfectly. [12]

### 3.8 Adam Optimizer

Adam optimizer was used for stochastic gradient descent to train deep learning models. [13]

### 3.9 Model Training Information

Learning rate was 0.001. We have got 30,574,539 params. Of these 30,401,796 were trainable params and the rest of the 172,743 were Non-trainable.

### 3.10 Modified Model Summary

Modified model is "sequential".

```
Model: "sequential"
_________________________________________________________________
__
Layer (type)                 Output Shape              Param #
=================================================================
==
efficientnetb5 (Functional)  (None, 1000)              30562527
_________________________________________________________________
__
dropout (Dropout)            (None, 1000)              0
_________________________________________________________________
__
dense (Dense)                (None, 12)                12012
=================================================================
==
Total params: 30,574,539
Trainable params: 30,401,796
Non-trainable params: 172,743
```

Figure 3.10.1: Modified Model Summary

### 3.11 Model Developing Process

At first, we loaded the EfficientNet B5 model into the model. Then created a new model named new_model. Next, in the first layer of new_model, the model is added as a layer. Then a dropout layer has been added to control over fitting. Finally, a dense layer has been added to classify images of 12 classes with softmax function.

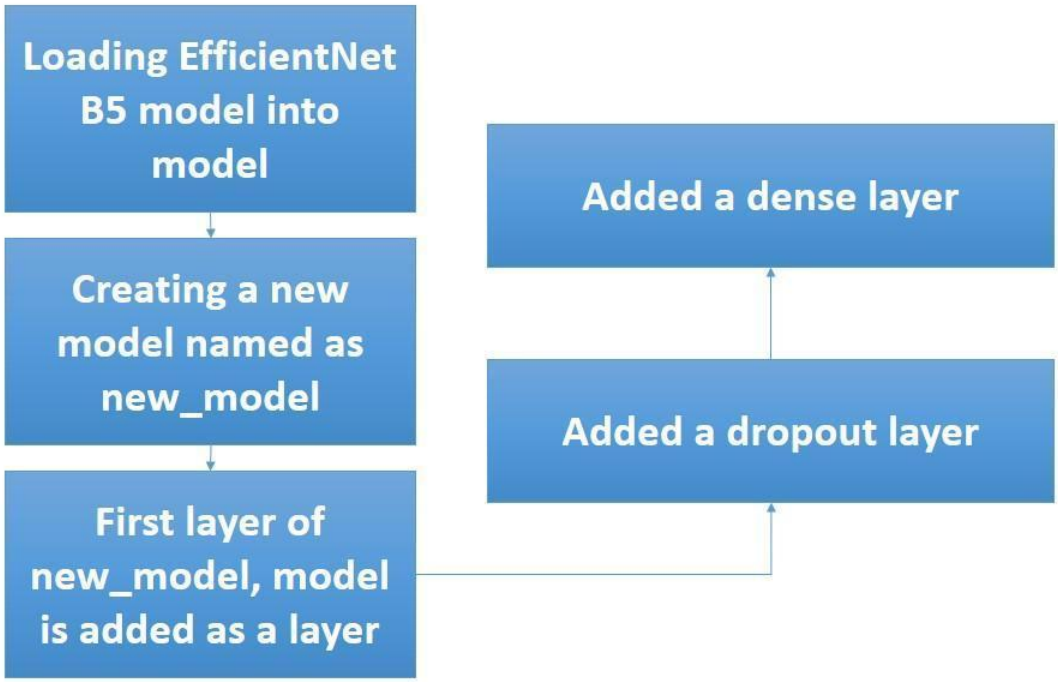


Figure 3.11.1: Model developing process

### 3.12 Feed to Deep CNN

The previous work of our model processing has been completed. Here first we have to rip the data to feed the CNN EfficientNet B5 model. Then we fed our deep CNN sequential model.

### 3.13 Implementation Requirements

Hardware requirements

The deep learning approach requires fast working hardware.

- At least Dual-Core processor and hardware.
- Minimum RAM required 2GB or more than that.
- Processor speed has to be 2.0GHz or more than that.
- Minimum hard disk: 80GB or above.

Software Needed

- Computer operating system: 64-bit
- Software for approach: Python: Any version of Visual Studio Code or Jupiter Notebook.

# CHAPTER 4
# EXPERIMENTAL RESULTS AND DISCUSSION

## 4.1 Introduction

The animal detection accuracy is immensely appropriate. After working with more data and completing some important steps, we got the results that we have expected. Our approach was animal detection from images of various animals, but in some cases it failed to detect animals. As a result, the classifier failed to categorize. Some methods are applied to get the best results from the overall research. Adam optimizer played a good role in training deep learning models.

## 4.2 Experimental setup

After various data augmentation procedures, we have got 1500 images per animal for this method. There were a total of 18000 images of a total of 12 classes. From there 14400 images were for training the model, 1800 for the testing the model after training, and 1800 images were used for the validation process of the model in this CNN. Validation dataset was important because we wanted to ensure that our model is not overfitting to the data and training set. And as we said before, Adam Optimizer was used to optimize.

## 4.3 Training Information

- Early stopping have used as after 23 epochs models have started overfitting.
- Number of total epochs: 23
- Time per epoch: 1453 seconds
- Total training time: 9 hours 17 minutes

## 4.4 Experimental Results

The model was trained by the Deep CNN. Classification is done in 12 different animal classes. Those were Butterfly, Cat, Dog, Elephant, Hen, Lion, Rabbit, Sheep, Spider, Squirrel, Tiger, and Spider Monkey.

To give the best and true outcome with higher accuracy, Deep CNN formatted the image dataset in several ways. In the Table 4.4.1 the experimental results are presented. The training accuracy of the image is around 94.29%. The CNN model classified most of the image dataset of animals where only 118 images were misclassified. We got a validation accuracy of around 93.95%. The testing accuracy was around 93.45%.

Table 4.4.1: Experimental result

| Procedures | Accuracy |
|---|---|
| Training | 94.29% |
| Validation | 93.95% |
| Testing | 93.45% |

The histogram is given in Figure: 8 which is presenting the training and validation accuracy.

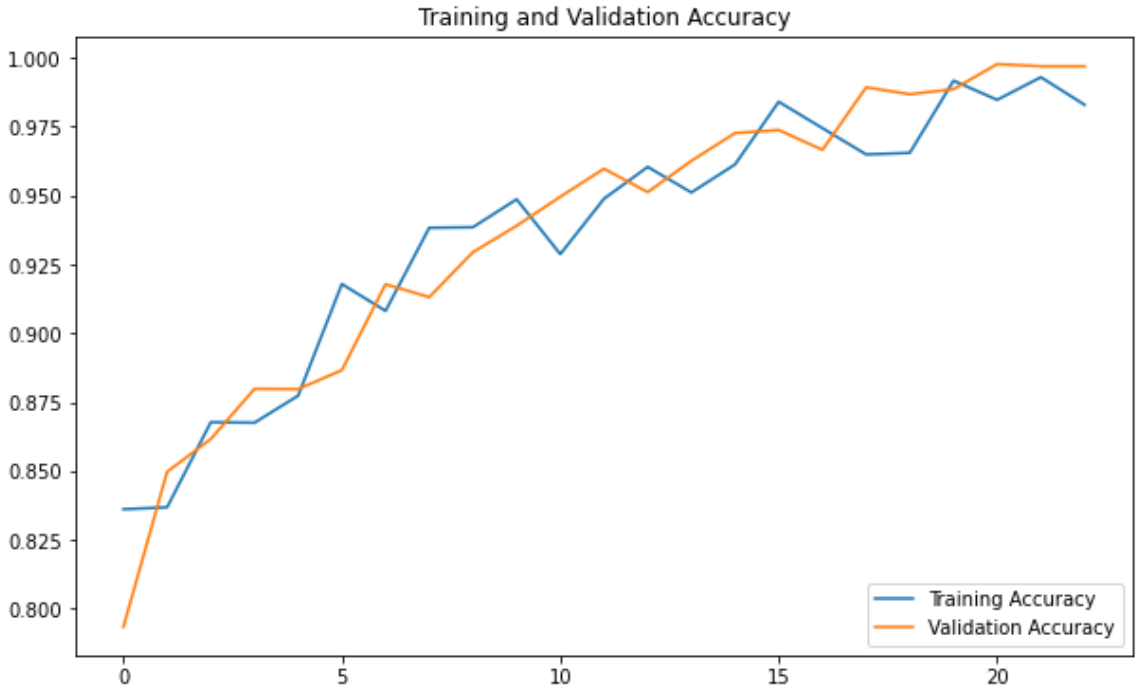


Figure 4.4.1: Training and validation accuracy

The histogram in Figure: 9 presenting the loss of training and validation.

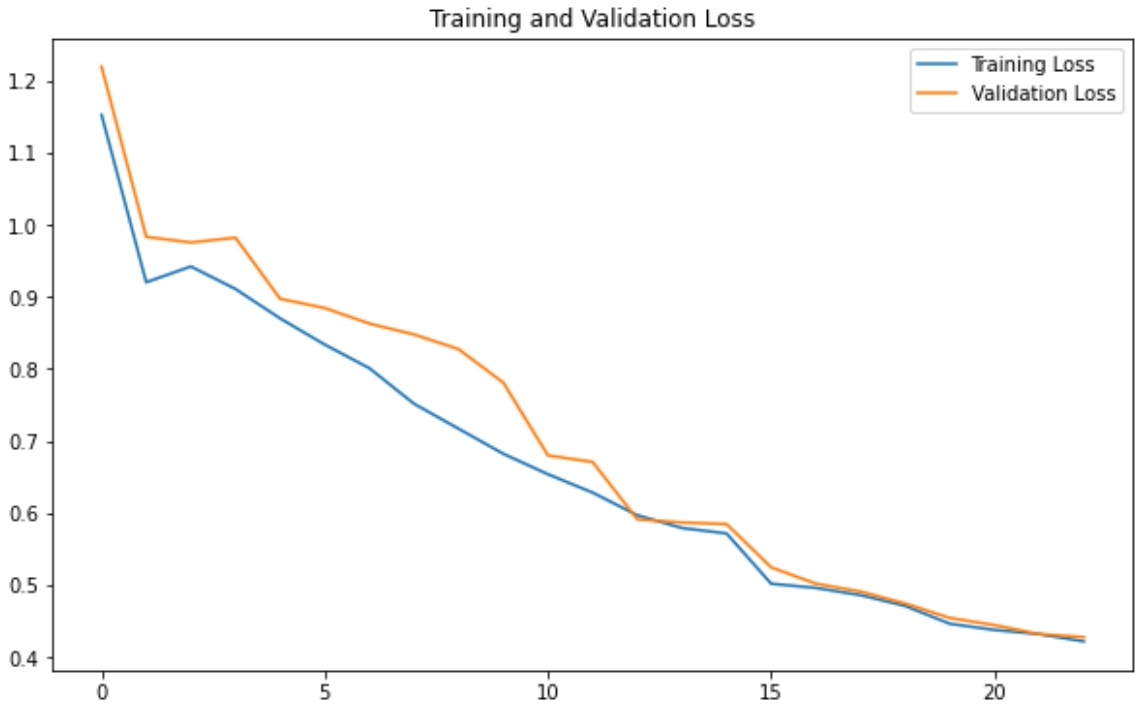


Figure 4.4.2: Training and validation loss

### 4.5 Descriptive Analysis

An important part of this research was testing data. And at the beginning of the research, we had kept 10% for testing, 80% data for training, and 10% for the validation process of each of the classes. The classifier almost accurately classifies every 12 classes. In the table Experimental result, you have seen the accuracy for training, testing, and validation.

### 4.6 Summary

In this deep learning-based animal detection research, we have used Deep CNN and got an accuracy of more than 93% for training, testing, and validation. 94.29% was the Training accuracy. Validation accuracy was 93.95%. Testing accuracy was 93.45%. Only 118 images were misclassified.

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

## 5.1 Summary of the Research

After analyzing previous studies, we completed an approach of deep learning for recognizing an animal. We have used CNN to do this. The overall summary of the research is presented below.

First step

- Collecting necessary data and pre-processing
- Preparing data for input by cleaning inessential data (Data Augmentation, Image Resizing).

Second step

- Loading the XML file for implementation
- Detecting animal as an object and their faces

Third step

- Classification of animals faces by using the Deep Convolutional Network
- Keeping data for each procedure (Training, Testing, and Validation)

Fourth Step

- Training the classifier of Deep Convolutional Network

Fifth step

- Animal detection test from the images.
- Getting the output result from the procedures

The sixth and final step

- Getting the accuracy for training, testing, and validation processes from animal detection.

### 5.2 Conclusions

We have created a proper system using deep learning for animal identification. We have trained it for 12 classes (Butterfly, Cat, Dog, Elephant, Hen, Lion, Rabbit, Sheep, Spider, Squirrel, Tiger, and Spider Monkey). So, our system has only been able to identify these 12 animals. Classification of Deep learning played a key role in our research which is based on CNN.

Finally it can be said that our system can detect animals from pictures and gives accuracy high.

### 5.3 Recommendations

In this animal detection approach, we have used algorithms for classifying animals. We have used a huge amount of images for this purpose. To get more accurate results, we recommend using more data. Working with a lot of data has the potential to be 100% accurate. Another thing is that this study can be done based on animal voices.

### 5.4 Implications for Further Study

Different approaches can be taken to develop the model. Detecting specific animal from image was the main goal in our study. Doing so can lead to better results. We have worked on only 12 classes. In the future, training the model for more classes can be made a good system. Which will give a more accurate outcome for analyzing a lot of animals from images.

# APPENDICES

## Appendix A: Research Reflection

During the research, various issues come in each case. Resolving those issues is needed to go forward. Some techniques and methods had to learn in our study. For this purpose, we gained knowledge about updated deep learning and Deep CNN.

In this procedure, we learned some techniques which were necessary to optimize the data. Next, we needed to learn the training processes. Overall different theoretical and practical knowledge on the deep neural networks was a need and we think, this study can play a big role in our future studies and career.

## Appendix B: Related topics

CNN: Convolutional Neural Network

ANN: Artificial Neural Network

Adam optimizer: Adam is also recognized as Adaptive Moment Estimation. Adam is an alternative algorithm for optimization. It is a combination of two optimizers. One is the momentum and another one is the RMSprop. [13]

Softmax function: A function that turns a vector of K real values into a vector of K real values that sum to 1. [14]

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