TEST Engineering & Management

*May - June 2020*
*ISSN: 0193-4120 Page No. 4201-4208*

# An Approach to Animal Face Identification and Classification System using CNN

**[1]Rakesh T M, [2]Vishwanath R Hulipalled**

[1,2]Computer Science, REVA University, Bengaluru, Karnataka, India

***Article Info***
***Volume 83***
***Page Number: 4201-4208***
***Publication Issue:***
***May - June 2020***

***Article History***
***Article Received:****19 November 2019*
***Revised:*** *27 January 2020*
***Accepted:*** *24 February 2020*
***Publication:*** *12 May 2020*

## Abstract

The Proposed work gives a significant contribution to classification and identification of animal faces in the low-resolution images using most commonly and widely used neural network system. We have adopted Convolutional Neural Network (CNN), which gives promising results in classifying the images using neural network system. CNN helps to extract features of animal faces automatically, also helps to learn and classify them. For the proposed work, we have used the CIFAR-10 dataset (Canadian Institute For Advanced Research), more than 6000 images are used to identify and classify the animal faces. Comparing to other classification techniques, CNN is progressive method to extract features and classify dynamically, where as other conventional algorithms were hand-engineered which means programmer has to extract the features from the dataset explicitly. In our work, we have gained 92% accuracy in identifying and classification of the animal faces for low-resolution images.

***Keywords*****:** *Animal classification, Threshold, Segmentation, Convolution Neural Network, Digital image processing, natural scene.*

## 1. Introduction

Animal face identification and classification problem domain is a need of hour. It is very much necessary for us to look after it. But, proofs advocate that even in normal cases like cats and cheetah, it is difficult to bifurcate them automatically. Animals have its own structure, which projects its identity. Also, as all bits and pieces, they may look alike under different radiance situations, views and scales. There are several researches going on to apply classification methods on animal face images but the specific problem of animal face categorization has engrossed adequate interest. Many good old methods giving end-result for animal face recognition rate, are not proper for low-resolution images. Proposed approach describes extracting features, which are very difficult to extract from low resolution images. But, extracting those features at critical images is very difficult. So, information obtained from the feature extraction phase is used to decision-making.

In our proposed work, we show that CNN method can be used for animal face identification and classification complications. We believe that our proposed method gives a promising performance rate compared to all the good old technologies. We believe multiple layer classification system can be more useful in extracting features.

Generally, in animal classification technique, we use binary pattern classification procedure. To extract the feature from the original image, it is processed by dividing in blocks. The animal face identification and classification domain can be demonstrated as:

• Identification – matching the subjected image with all the images in the database. Which gives the percentage of features matched in the identification process.

• Classification (authentication) – Classification is the process of conforming the identified animal faces.

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Animals, like human beings, will not give any pose. Images captured will be very raw like low resolution or blurred images. Also, some animals faces are looks same like cat and tiger, dog and horse. All these challenges necessitate a promising algorithm for classification. The proposed system works on Low Resolution Dataset. It gives similar accuracy on low-resolution images, as that of high-resolution images. Performance and accuracy is more when compared to other similar applications. It also reduces the Time Complexity.

## 2. Literature Survey

Authors in [1] have discussed on a method finding distance of the animals. Their proposed work gives 82.5 % accuracy. They have used around 2500 images for testing. They have also considered various video clips for testing. Authors in [2] have presented a system of detecting various large sized animals from traffic scenes. Visual data is obtained from monocular vision. They have used SVM classifier and obtained 90% accuracy. Authors in [3] have built an automated framework to detect the animals in wildlife. They have used computational method to classify the animals. They have gained around 96% accuracy in detecting animals. Researchers in [4] have used WSN based UWB technique to detect the animals. They have also used SVM classifier to differentiate the different types of animals. Their accuracy is not so promising in their proposed work. Authors in [5] described TPRPN to trap animal's images. TPRPN helps to capture high-resolution images. They have also used depth cue method to extract local information. Authors in [6] have coupled effective dynamic Method. Fast learning methodology using DCNN has been used to classify the animals. Authors in [7] have developed shape model to scan the animals. This helps to identify the shapes of different types of animals. Authors in [8] have proposed a method on computer vision domain. They have used 5-component detection pipeline. They have achieved 81.67% in localization map, and 94.28% and 87.11%, respectively for species and viewpoint annotation classification. Authors in [9] worked on PCA, they have used PCA to recognize and classify the different types of animals. They have experimented on animals like rabbit, cow, dog, cat and goat. They claim that they have achieved 92% accuracy. Authors in [10] have used Deep Neural Networks DNN. They also worked on transfer learning technique to identify animals. Authors in [11] have worked on removal of occlusion nature in Convolution Network. They claim that their work minimizes the errors in feature extraction. They have used loss function to reduce the errors. Researchers in [12] have worked on BC Network. This technique helps in extracting image features. They have also used location network concept to track the location of the animals. They claim that their work gives 85.6% accuracy. Authors in [13] have used the data store called LDM- Local Dynamic Map to for identifying location. They have also used the algorithms like SVM using ML techniques to classify the animals. Authors in [14] have used novel techniques like TESPAR for analysis purpose. They have experimented on 10 different species. Feature detection is done based on the analysis results done by their novel approach. We in [15] have done a rigorous analysis on all the existing methods and have done the comparison analysis with all the methodologies to gain the knowledge on animal classification domain. The comparison results in our previous analysis work shows that CNN is the best of all its kind and the same has been used only with the high-resolution images. Also according to the future scope discussed in our previous work, working on low resolution images is a need of hour. In the proposed work, we have tried to give promising results in identifying the animal faces even for low-resolution images.

## 3. Functional Procedure of the Proposed Method

The functional procedure used for the proposed methodology of the system is given below.

- This system is able to classify the animal with low resolution images (32 Pixel x 32 Pixel)
- The proposed system is implemented in two phases, first phase for Training the Dataset and second for Testing the data, that means to predict the sample input classification.
- The Training module is able to read the training dataset from the system directory and convert the images into numerical data, which are stored in Numpy arrays.
- Once dataset is read, 80% of the data has to be allotted for training process and remaining 20% of data is allotted for testing process.
- Once training dataset were prepared, then it has to enter into CNN process.
- In CNN, following layers are executed one by one:
- Convolution Layer
- Rectified Linear Unit and
- Max Polling.
- The above step has to be repeated until training dataset accuracy reached.
- Once training dataset accuracy is reached, then fully connected layer process has to start.
- Once training process is completed, testing process has to be performed and confusion matrix has to be printed.
- This system has to achieve minimum 92% accuracy.

### 3.1 Convolutional Neural Network

Computer understands the machine level language in 0's and 1's. The input image for human being looks like a scene or an object but for the machine, it looks like the combination of pixel values in a matrix format. Each pixel in the image is given a value between 0 and 255. So, the machine needs some artificial intelligence system to understand the patterns or features in the image. Machine learning domain using CNN is the best way to understand the information present in the image. CNN followed by

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above-mentioned layers and classifiers helps the machine to understand the image and give the expected results. The problem chosen in this work is to identify and classify the animal faces present in the low-resolution images.

Machine Learning needs the features of the image in the initial level. Next, the proposed methodology chooses a minor matrix in the image, which is called a mask. This helps to generate the convolution network in the image. Using this filter, we have doubled the values of the original pixels. Later all these doubled values are summed up and the number obtained from the summation is used to create the new matrix and is minor than the original matrix.

The system will be framed using many convolution networks and pooling and nonlinear layers. Then the image is subjected to one of the convolution layer to gain the output. The result is then subjected to second layer and continued for every further convolutional layers to gain the refined and tuned output. After the convolution operation, non-linear layer will be added. To reduce the image volume, the pooling layer is applied after the nonlinear layer. To perform a down sampling and to identify the height and width of the image, Pooling layer will be used.

Fully connected layer is attached along with the sequences of convolution, non-linear and pooling layers. Connected layer helps to gather the endpoint statistics with convolutional networks. Also, the linked layer helps in generating the N dimensional network.

**Phase 1: Conventional**

Gather all original pixels and low contrast pixels of the CNN to a small value.
Start learning rate L such that 0 <L<1
m= 1 (initial value of the matrix)
repeat (until the summation value is gained)
for n=1 to N do
generate pattern x from the network
for k= 1 to the pixels in the output layer
Find error (if present)
end of for (end of 1st iteration)
end of for (end of 2nd iteration)
for layers a-1 to 1 do (first layer)
for maps b = 1 to b do (mapping the pixels in the image)
find error factor
end of for (end of 3rd iteration)
end of for (end of 4th iteration)
for a=1 to a do (to calculate the conventional layer)
for b=1 to b do (to calculate the nonlinear layer)
for c=1 to c do (to calculate the pooling layer)
for all weights j do
end of for (end of 5th iteration)
end of for (end of 6th iteration)
end 0f for (end of 7th iteration)
m = m + 1 (final matrix which is less than original matrix)

**Phase 2: Transfer Knowledge**

repeat
for r= 1 to R
broadcast pattern xr from the network
for y= 1 to the pixel in the convolutional layer(Y)
find result Pz of last layer of the convolutional layer.
Pz = ( P1,P2, P3 ..... PZ)
end of for (end of 1st iteration)
end of for (end of 2nd iteration)

## 4. Proposed System Architecture and Design

Following description explains the proposed model as showed in fig 1.

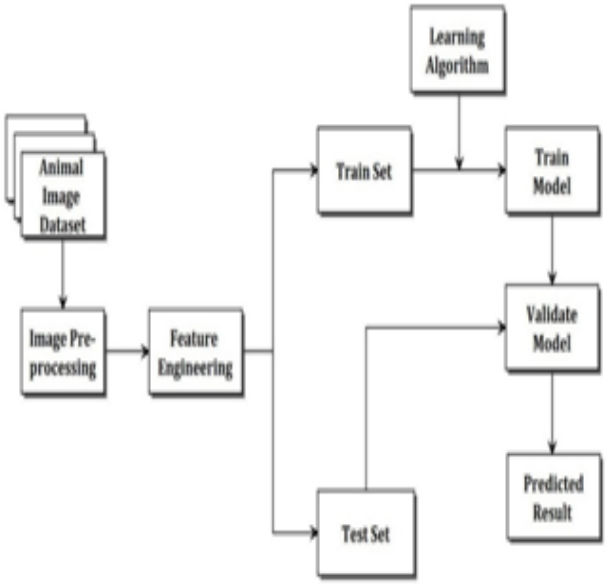


Figure 1: Proposed System Architecture

In the proposed system architecture CIFAR -10 animal dataset will be acquired. The acquired dataset will be raw and cannot be processed to extract the features from the image. This results in getting the low accuracy in the final results. To overcome from this problem, pre-processing will be done on the given images. Techniques like converting of color image to grey image, noise removal and resizing will be done. In feature engineering step multi-layer convolution method will be used to extract the features, which is very much necessary in training and testing phases. The feature-engineered dataset will be divided into Train Set & Test Set. We then apply the algorithm on Train Set and get the Trained Model. By using this Trained Model, Test Set is validated and result is predicted. Following fig 2 explains the flow of the proposed model.

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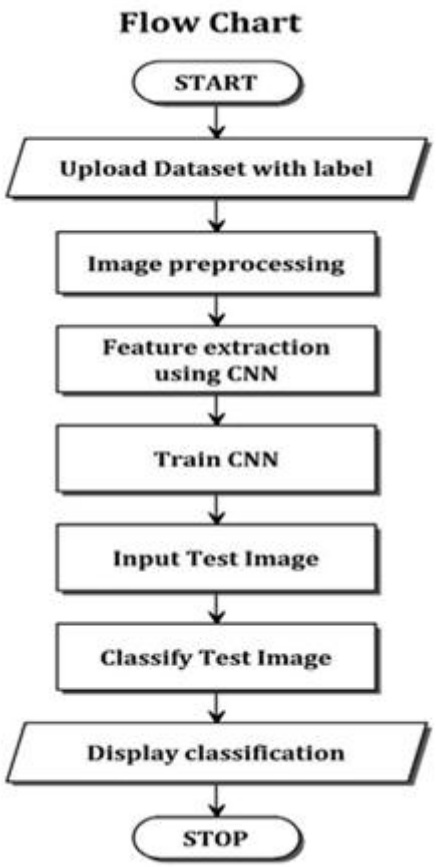


Figure 2: Flow Chart Diagram

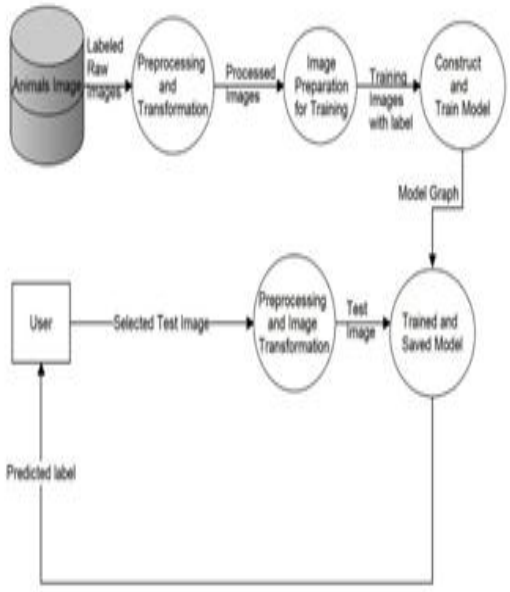


Figure 3: Level 0Data Flow diagram

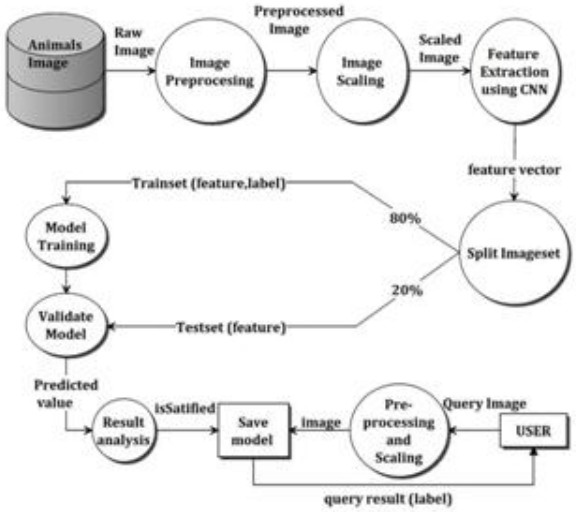


Figure 4: Level 1 Data Flow Diagram

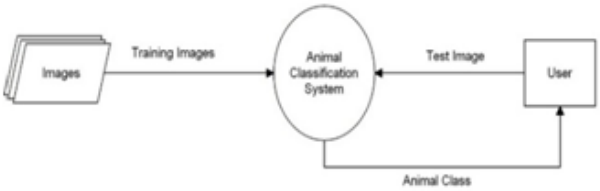


Figure 5: Level 2 Data Flow Diagram

Fig 3 explains about the data flow procedure of Level-0. In Level-0, training dataset is done in the backend and stored the data in the database. User is just allowed to test the data using abstract data type. Level-0 is the outer layer of our proposed system. Level-1 consists of preprocessing and feature extraction phases in both training and testing phases. Both the trainer and users follow the above procedure using Level-0. Level-1 is the middle layer of our proposed system. Level-2 explains in detail process of the preprocessing, feature extraction and classification phases. Both trainer and user use Level 0& 1 in this process. Level-2 is the inner layer of our proposed system. Levels 0-2 are explained in the figs 3-5.

## 5. Proposed Methodology: Step by Step Procedure

### Step 1: Data Pre-processing

Collect the low-resolution animal image dataset from trustable source. The gathered data is raw and not able to work. Also computer cannot able to understand. The image will be transformed to grayscale. Matrix will be extracted from the transformed image using pandas. In our work, Convolutional Neural Network (CNN) is used to build the model. CNN uses visual cortex, which is a special feature of artificial neural network.

### Step 2: Separating Training and Testing Datasets

To train and test the model, the features extracted from the images are stored in different dataset. Multilayer convolution method is used in this phase.

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**Step 3: Transforming the Data**

We have scaled the data to build the deep learning model. Standard scaler is used to ensure the values are unit variable and have a mean values of zero. The raw image data will be transformed to matrix data to extract the information.

**Step 4: Building the CNN**

The deep learning model used in our work uses Keras python library. We have used a high-level neural networks API. To enable the fast experimentation. To train the proposed work, we have used CIFAR-10 (Canadian Institute For Advanced Research) dataset. The dataset consists of 36000 colored images, which is divided into 6 classes in 32x32 dimensions. Each class consists of 6000 images. In the later phase we have adopted sequential application program interface. We have created a Sequential model and defined all of the layers in the constructor

It allows us to build a multi-layer model. Every layer has weights that corresponds to the subsequent layers. The 'add()' function is used to add layers to the model. Keras Layers used in proposed work are as follows:
from keras.models import Sequential. model = Sequential (1)

❖ **Dense Layer:** In our proposed work, dense layer function is explained below.

result = activation(dot(I, W) + B)(2)

where,

- I is the input data
- W is the weight data
- dot is the numpy dot product of I, W
- B is a biased value to optimize the data
- activation is the function.

❖ **Dropout:** To set a rate of inputs to zero, Dropout module has been adopted in our work. It helps in prevention of overfitting. A unit will be dropped out, i.e., temporarily it is removed from the system.

❖ **Flatten Layer:** Flatten Layer is used to flatten the input; it helps to change the shape of the data from a vector of 2D formats to correct format. In our work, input shape is (batch_size, 2,2), after applying the flatten later the output shape of the layer was
(batch_size, 4).(3)

❖ **Convolutional 2D:** To create a convolutional kernel to produce a tensor output, we have incorporated Convolution 2D method. If W is true and activation is not null, Vector is created. Next argument I_S (group of integer numbers) will be used.
data = "layers_last"(4)

❖ **Max_Polling 2D:** In this step, the highest values of pixels in the grid are considered and we reduce the dimensions of the image. By doing this, over fitting can be removed. A flattening layer is required as a middle layer between the 2 dimensional input layer & 4 dimensional output convolutional layer. After all these steps, soft-max layer is obtained at the end.

**Step 5: Running Predictions on the Test Set**
Predict function is used to test the dataset.

**Step 6: Checking the Confusion Matrix**
To check the accurate predictions, confusion matrix is used. A confusion matrix is a collection of (tp), (fp), (tn) & (fn) of a classifier.
Where,

- (tp) is true positive values,
- (fp) is false positive values,
- (tn) is true negative values, &
- (fn) is false negative values

**Step 7: Improving the Model Accuracy**
We have trained our model several times to get promising results. K-fold X Validation technique is used to improve the accuracy of the model.

**Step 8:Over-Fitting:Dropout Regularization**
Any ML models will have problem of overfitting. To overcome from this problem, we have used dropout regularization function.

**Step 9: Tuning: Hyper-parameter**

To gain the best accuracy we have used Grid search technique with our multi models. It gives the best results by returning the different parameters.

**Step 10: optimizer: Adam**

To train the deep learning models and to extract gradient features, Adam function is used to optimize the model. The properties of AdaGrad and RMSProp algorithms are used in Adam optimizer.

**5.1Use of compile function in the deep learning model**
**Loss function:**
To make the machine learn automatically loss function is used in our model. If the results are going away too much from actual results, then the loss function value goes high. In any deep learning model, there is no fixed value for loss function. In our work, we have tried to get low loss function value.

**Matrix function:** While training the model, this function is used in processing of input images.

**Optimizer:** This function always varies the weight values in order to get less loss value. Optimization helps in searching for parameters that minimize or maximize our functions.

**5.2 Train the model:**

ML model is used to train the model. Automated learning algorithm is used to train the data. The training data consists of target/target attributes. To find patterns and map the input learning algorithm is used. The captured patterns output the ML model as shown in the fig 6.

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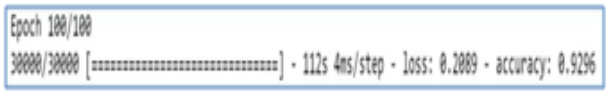


Figure 6: Training accuracy of our proposed model for low resolution images

### 5.3Test the model

Testing the model is the main part of our proposed methodology as shown in fig 7. Overfitting is one of the major drawbacks of the current approaches to overcome from this problem we have uses following steps:

- Create test data.
- Execute tests.
- Save data.


Figure 7: Testing accuracy of our proposed model for low resolution images

### 5.4 Use of evaluate function

The built-in Eval function of python is used in our work to convert expressions into integer as shown in fig 7.
eval("2 + 3") gives 5.

### 5.5Confusion matrix

Confusion matrix is used in our work to predict the actual and predicted classes as shown in figs 8 and 9. Below table 1 explains how confusion matrix is plotted against the actual vs predicted classes. Here, Class1is Positive and Class 2 is Negative.

Table 1: Actual class Vs Predicted class.

| Actual class\Predicted class | Class 1: Predicted | Class 2: Predicted |
|---|---|---|
| Class 1: Actual | TN | FP |
| Class 2: Actual | FN | TP |

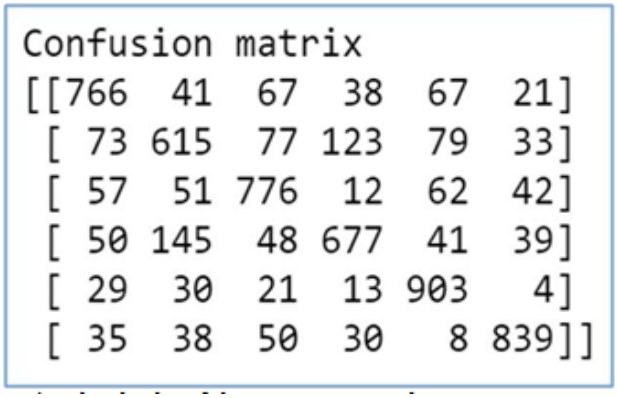


Figure 8: Result of confusion matrix for low resolution images

### Performance Metrics

### TPR: True Positive Rate

Sensitivity will be mentioned by TPR. Sensitivity is used to calculate the actual positive results in the end results. Table 1 explains about the distributed sensitivity.

$$\text{True Positive Rate} = \frac{TP}{TP+FN} \quad (5)$$

### FPR: False Positive Rate

To calculate the actual negatives in the end result FPR is used.

$$\text{False Positive Rate} = \frac{TP}{FP+TN} \quad (6)$$

### Precision

Close rate of non-matching samples is predicted by precession.

$$\text{Precision} = \frac{TP}{TP+FP} \quad (7)$$

### Recall

Recall is used in our work to recall the original values wherever it is necessary like in matching the testing and training phases.

$$\text{Recall} = \frac{TP}{TP+FN} \quad (8)$$

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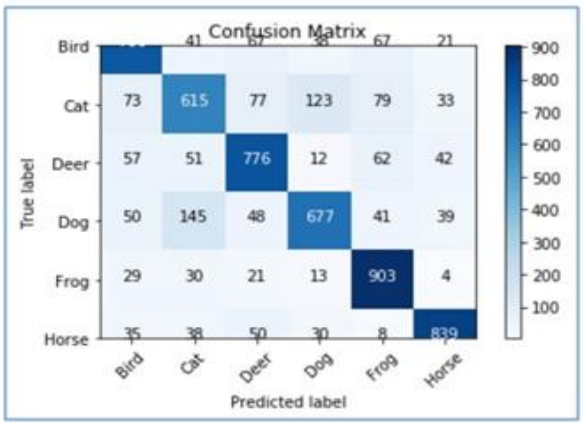


Figure 9: Graphical analysis of Low-resolution images: Confusion Matrix

## 6. Implementation and Comparison Results

We have developed an intelligent mechanism to identify and classify the different animal faces. We have used multi layered Convolutional Neural Network (CNN) to gain the promising results. Fig 10 shows the identification of animal face with confidence score of 1.0 for low-resolution image as same as for the high resolution image as shown in fig 11.


Figure 10: Identification of animal face with Confidence score 1.0 for low resolution image


Figure 11: Identification of animal face with Confidence score 1.0 for high resolution image

## 7. Summary of the proposed work

For the identified problems in the literature survey, we have tried to give promising results with our proposed model. Also from the above results, it is proved that CNN approach is the best algorithm for animal classification system for low-resolution images. For both high &low-resolution images we have got confidence score 1.0. Our proposed model has given the results approximately 93% in training phase and 95% in testing phase. Following tables 2 & 3 explains about the graphical comparison analysis of the low & high resolution images and the same has been captured in the graph as shown in fig 12 & 13.

Table 2: Accuracy for each set of epochs for low-resolution images

| Epochs | Accuracy (%) |
|---|---|
| 1-10 | 65.86 |
| 11-20 | 81.26 |
| 21-30 | 86.01 |
| 31-40 | 88.27 |
| 41-50 | 89.72 |
| 51-60 | 90.66 |
| 61-70 | 91.24 |
| 71-80 | 91.87 |
| 81-90 | 92.32 |
| 91-100 | 92.76 |

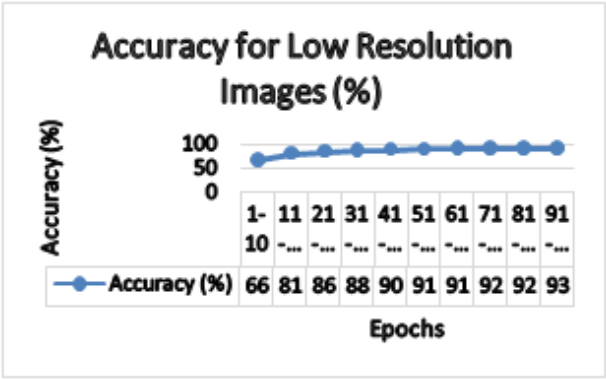


Figure 12: Graphical Analysis of accuracy for low-resolution images

Table 3: Accuracy for each set of epochs for high-resolution images

| Epochs | Accuracy (%) |
|---|---|
| 1-10 | 56.72 |
| 11-20 | 71.88 |
| 21-30 | 78.31 |
| 31-40 | 82.67 |

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| | |
|---|---|
| 41-50 | 85.25 |
| 51-60 | 87.44 |
| 61-70 | 88.92 |
| 71-80 | 89.91 |
| 81-90 | 90.95 |
| 91-100 | 91.56 |

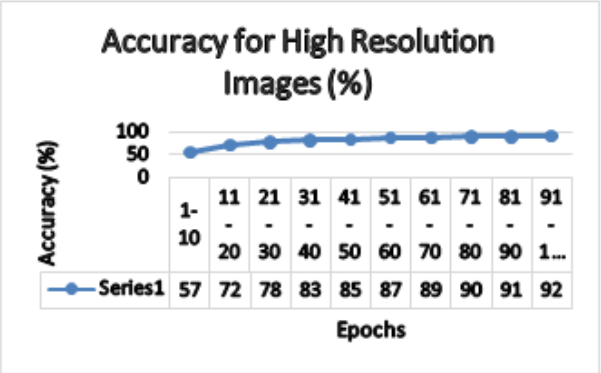


Figure 13: Graphical Analysis of accuracy for high-resolution images

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