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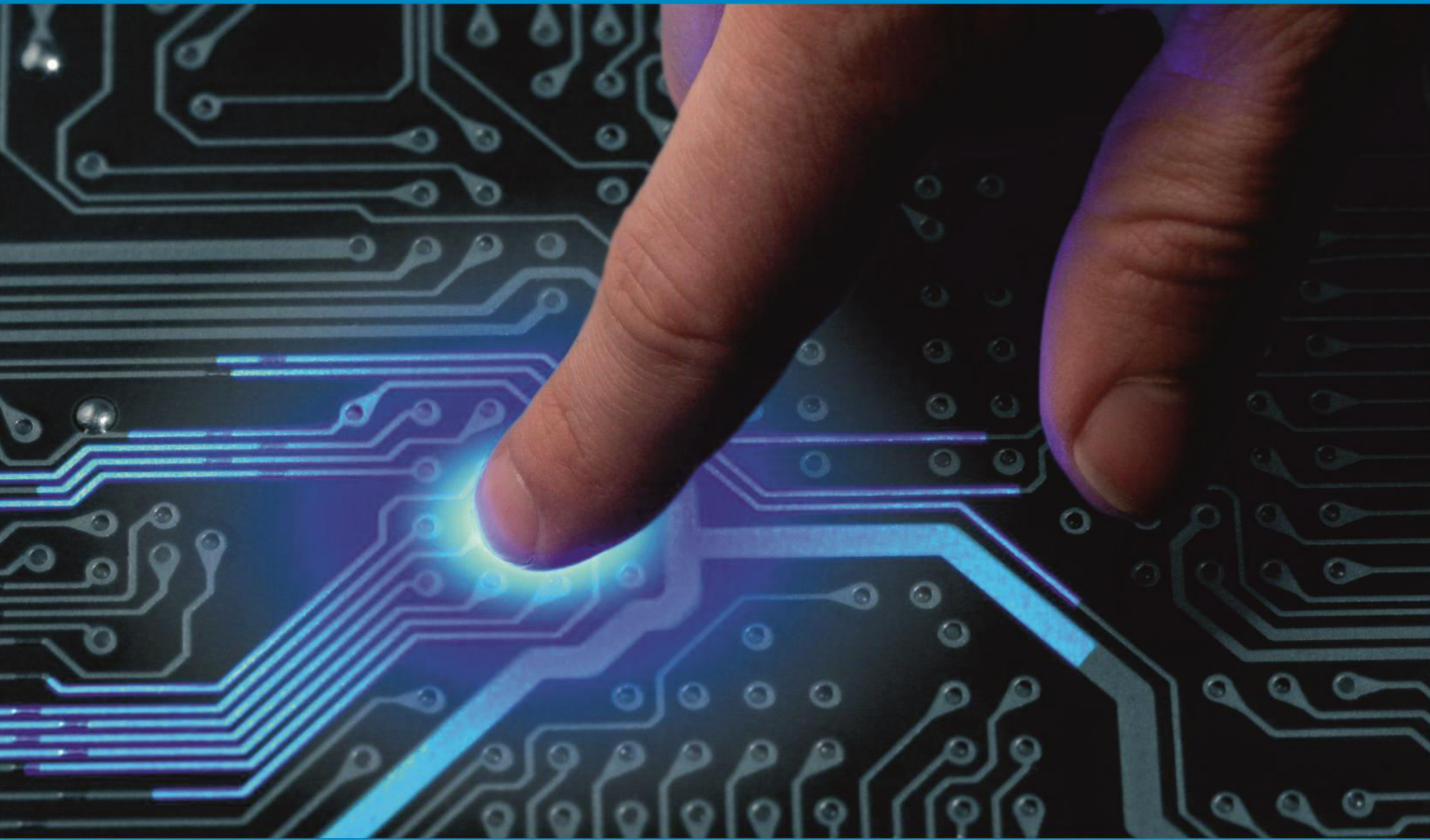

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Face Detection in illuminated and Partially Occluded images using Deep learning

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ABSTRACT: Face Recognition is one among the foremost challenging applications of image analysis and pattern recognition. Face Detection is the basis of the Face recognition system. Face recognition methods perform well on the images that are collected with the careful cooperation of the themes . The face of a private 's plays an important role in inter course for conveying the identity and feelings of an individual . Nowadays, many systems involve automatic face detection as an important feature, like face recognition , expression recognition, human-computer interaction, etc. Age changes the facial texture and shape while occluded images left partial countenance for processing, thus making the matter of face recognition much harder. During this paper, we are proposing a solution for detecting faces in two unconstrained environments, i.e., Illumination and Occlusion.

I. INTRODUCTION

Face detection estimation are important for face recognition. In personal identification with surveillance cameras, for instance , it's necessary to detect the face whose size, position, and pose are unknown. After the face detection, the face direction estimation is beneficial for the right face recognition because we will select the face image of the foremost desirable direction from the face images taken by the multiple cameras. Many methods are proposed within the sector of face detection. one among them is predicated on the matching of facial template images.

However, the dimensions and pose of the face are limited because it takes terrible computation cost to think about all sizes and poses of the template image. On the opposite hand, the tactic supported complexion can detect any size and pose of the face. Because it's difficult to detect the face from a complexion background, the methods use additionally a head shape information or hair colour information. Moreover, it's necessary to form sure that there's a face actually within the region detected by the methods so as to reject the false detection. to form sure whether there's a face actually or not, the approach to extracting countenance like pupils, a nostril, and a mouth is taken into account . For the countenance extraction, the tactic supporting the geometric face model is proposed. However, the tactic assumes the nearly frontal face. But there are few cases where the countenance within the image isn't needless to say . Such cases include complex background, too many faces in images, odd expressions, illuminations, less resolution, face occlusion, complexion , distance, and orientation, etc. the simplest way for prediction and extracting the face from a picture is through Convolutional Neural Network.

II.LITERATURE SURVEY

The earliest pioneers of face recognition were Woody Bledsoe, Helen Chan Wolf and Charles Bisson. In 1964 and 1965, Bledsoe, alongside Wolf and Bisson began work using computers to recognise the face .Due to the funding of the project originating from an unnamed intelligence , much of their work was never published. However it had been later revealed that their initial work involved the manual marking of varied “landmarks” on the face like eye centres, mouth etc. Carrying on from the initial work of Bledsoe, the baton was picked up

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within the 1970s by Goldstein, Harmon and Lesk who extended the work to incorporate 21 specific subjective markers including hair colour and lip thickness so as to automate the popularity .

While the accuracy advanced, the measurements and locations still needed to be manually computed which proved to be extremely labour intensive yet still represents an advancement on Bledsoe's RAND Tablet technology.A system that came to be known as Eigenface showed that feature analysis on a collection of facial images could form a set of basic features. They were also able to show that less than one hundred values were required in order to accurately code a normalized facial image.

Our first example of a face-detection model supported early visual processing was developed by Viola and Jones. As within the Malsburg model, the choice of primitive features was motivated by the finding that Gabor-like receptive fields are found in primary visual area .

However, instead of using true Gabor filters to process the image, this model utilizes a stimulating abstraction of those functions to shop for more speed for his or her algorithm. Box-like features are used as a proxy for Gabors because they're much faster to compute across a picture and that they can roughly approximate many of the spatial characteristics of the first functions. By constructing a particularly large set of those box features, the experimenters were ready to determine which computations were the foremost useful at discriminating faces from background.Many methods of face detection are proposed during the past 30 years. Face detection is such a challenging yet interesting problem that it's at tracted researchers who have different backgrounds: psychology, pattern recognition, neural networks, computer vision, and special effects .

Challenges in face detection

Challenges in face detection, are the explanations which reduce the accuracy and detection rate of face detection. These challenges are complex background, too many faces in images, odd expressions, illuminations, less resolution, face occlusion, complexion , distance and orientation etc. Odd expressions face in a picture may have odd expressions unlike normal, which is challenge for face detection. Face occlusion is hiding face by any object. it's going to be glasses, scarf, hand, hairs, hats and the other object etc. It also reduces the face detection rate.Illuminations lighting effects might not be uniform within the image. Some a part of the image may have very high illumination and other may have very low illumination. Complex background Complex background means tons of objects presents within the image, which reduces the accuracy and rate of face detection. Too many faces within the image It means image contains too many human faces, which is challenge for face detection. Less resolution of image could also be very poor, which is additionally challenging for face detection.

Face detection techniques

Face detection may be a technology that determines the situation and size of a person's face within the digital image. The countenance are detected and the other objects like trees, buildings and bodies are ignored from the digital image. It is often considered a selected case of object-class detection, where the task is finding the situation and sizes of all objects in a picture that belongs to a given class. Face detection, are often seen as a more general case of face localization. In face localization, the task is to spot the locations and sizes of a known number of faces (usually one). Basically, there are two sorts of approaches to detect facial part within the given digital image i.e. feature based and image based approach. Feature based approach tries to extract features of the image and match it against the knowledge of the countenance . While image based approach tries to urge the simplest match between training and testing images

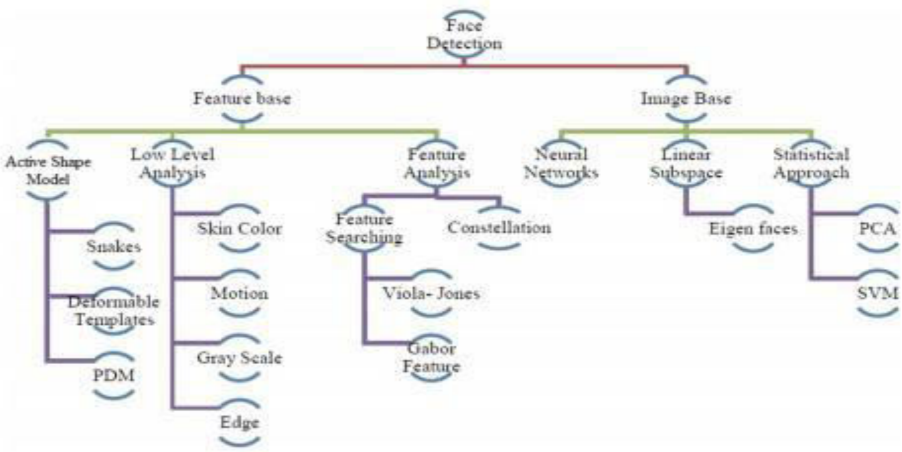

Figure 1.1 face detection methods

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Active shape model

Active shape model(ASM) specialise in complex non-rigid features like actual physical and better level appearance of features. Main aim of ASM is automatically locating landmark points that outline the form of any statistically modelled object in a picture . For examples, in a picture of person face, extracted features like the eyes, lips, nose, mouth and eyebrows. The training stage of an ASM involves in building of a statistical facial model containing images with manually annotated landmarks.

Low Level Analysis

Low level analysis Skin colour base Colour is an important feature of human faces. Using skin colour as a feature for tracking a face has several advantages. Colour processing is far faster than other countenance . Under certain lighting conditions, colour is orientation invariant. This property makes motion estimation much easier because only a translation model is required for motion estimation. Tracking human faces using colour as a feature has several problems like the colour representation of a face obtained by a camera is influenced by many factors like, ambient light, object movement, etc. The perceived human colour varies as a function of the relative direction to the illumination. Pixels for skin region can be detected using a normalized colour histogram

Feature analysis

These algorithms aim to find out structural features that exist even when the pose, viewpoint, or lighting conditions varies, then use these to locate faces. These methods are designed mainly for face localization

Neural Networks

A rationally attached neural network examines small windows of a picture , and chooses whether each window contains a face. The system arbitrates between several networks to reinforce performance over one network. This eliminates the complex task of manually selecting non-face training examples, which must be selected to hide the whole space of non-face images. In youth most hierarchical neural network was proposed(Agui et al. 1992). The primary stage has two parallel subnetworks during which the inputs are filtered the intensity values from an ingenious image. The inputs to the second stage network contains the outputs of the sub networks and extracted feature values. An output at the second stage shows the presence of a face within the input region

Linear subspace method

Eigenfaces method Eigenvectors has been utilized in face recognition, during which neural network is demonstrated to perform face recognition for aligned and normalized face images. Images of faces are often linearly encoded employing a modest number of basis image.

III. PROPOSED SYSTEM

The below depicts our project system architecture.

The steps are
1. Input image
2. preprocessing
3. Feature Extraction
4. Classification
5. Result

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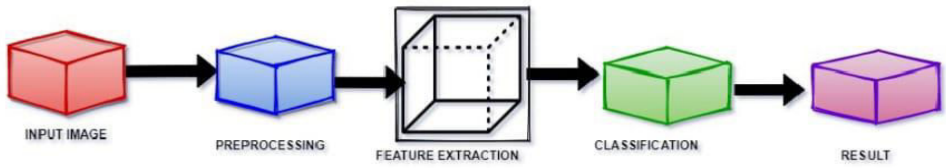

Figure 2.1workflow of system

The input image should be preprocessed before extracting the features of image.Inpreprocessing we are using Histogram equalization.

Histogram equalization is an image preprocessing technique that adjust the contrast of an image.It enhances the contrast of image, it spreads out the most frequency pixel intensity values or stretches the image intensity range of image.So with the help of Histogram equalization we can eliminate the illumination of an image

Feature extraction is a Facial feature extraction is the process of extracting face component features like eyes, nose, mouth, etc from human face image. Facial feature extraction is very much important for the initialization of processing techniques like face tracking, facial expression recognition or face recognition.

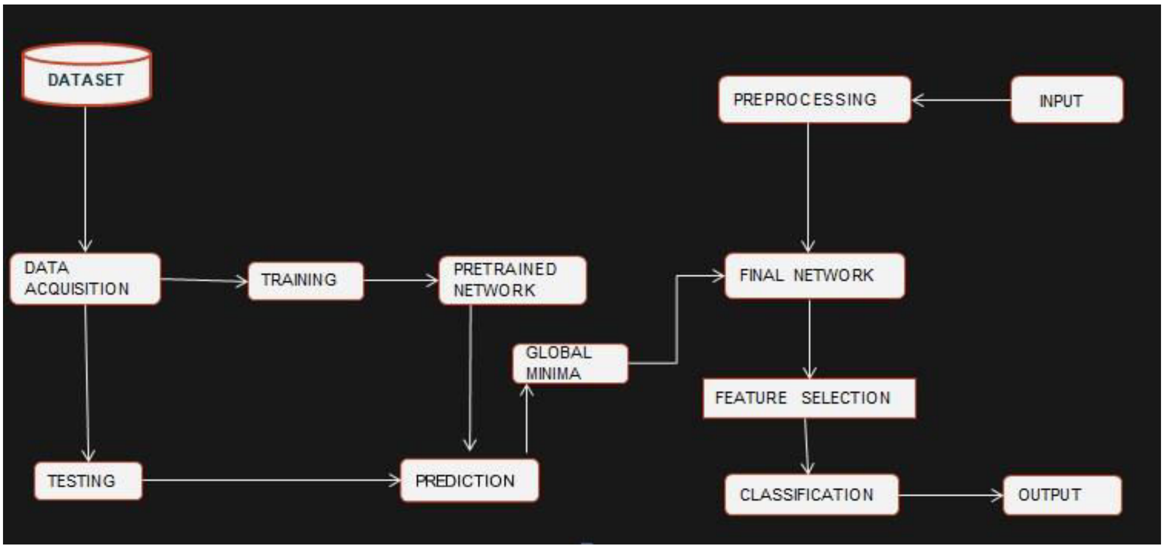

Figure 2.2 architecture of system

Before training and testing the model we need to perform data acquisition.Data acquisition systems will perform the tasks such as conversion of data, storage of data, transmission of data and processing of data.Then model is trained with trained data and test data and predict the output.Now we have to calculate the loss function and try to minimise the errors and fix the weights.The model is trained with best weights,when we pass the input image we have to apply preprocessing and pass the image to the model to extract the features based the extracted values we will classify the presence of image.

Our model consists of thirteen convolution layers and three dense layers.The convolution operations are mentioned below

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IV. CONVOLUTIONAL NEURAL NETWORK

In neural networks, Convolutional neural network(ConvNets or CNNs) is one among the most categories to try image recognition, images classification. Objects detections, recognition faces etc., are a number of the areas where CNNs are widely used.Technically, deep learning CNN models to coach and test, each input image will pass it through a series of convolution layers with filters(kernels), pooling, fully connected layers and apply the softmax function to classify object with probabilistic values between 0 and 1. The below Figure may be a complete flow of CNN to process an input image and classifies the objects supported values

Convolution Layer

Convolution is that the first layer to extract features from given input image. Convolution preserves connection between pixels by learning image.
features using small squares of input data. It is a mathematical operation that takes two inputs like image matrix and a filter or kernel.

Strides
Stride is the number of pixels shifts over the input matrix. When the stride is 1 then we move the filters to 1 pixel at a time. When the stride is 2 then we move the filters to 2 pixels at a time and so on. The below Figure shows convolution would work with a stride of 2.

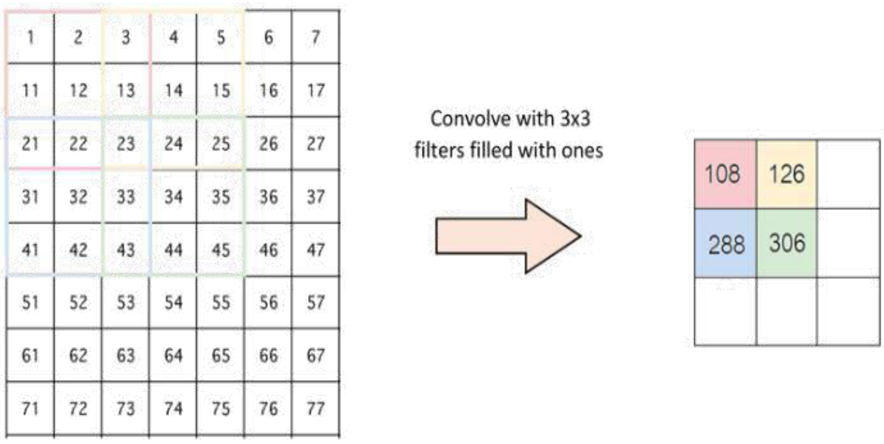

Figure 2.3 extracting values using filters

Padding

Sometimes filter doesn't fit perfectly fit the input image. We have two option
Pad the picture with zeros (zero-padding) is that it fits
Drop the part of the image where the filter didn't fit. This called valid padding which keeps only valid part of the image

Pooling Layer

Pooling layers section would reduce the number of parameters when the images are too large. Spatial pooling also called subsampling or downsampling which reduces the dimensionality of each map but retains important information.

Spatial pooling can be of different types:

- Max Pooling
- Average Pooling
- Sum Pooling

Max pooling takes the most important element from the rectified feature map. Taking the most important element could also take the typical pooling. Sum of all elements within the feature map call as sum pooling.

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Fully Connected Layer

The layer we call as FC layer, we flattened our matrix into vector and feed it into a totally connected layer sort of a neural network.
A fully connected neural network consists of a series of fully connected layers that connect every neuron in one layer to every neuron in the other layer.
The major advantage of fully connected networks is that they're "structure agnostic"

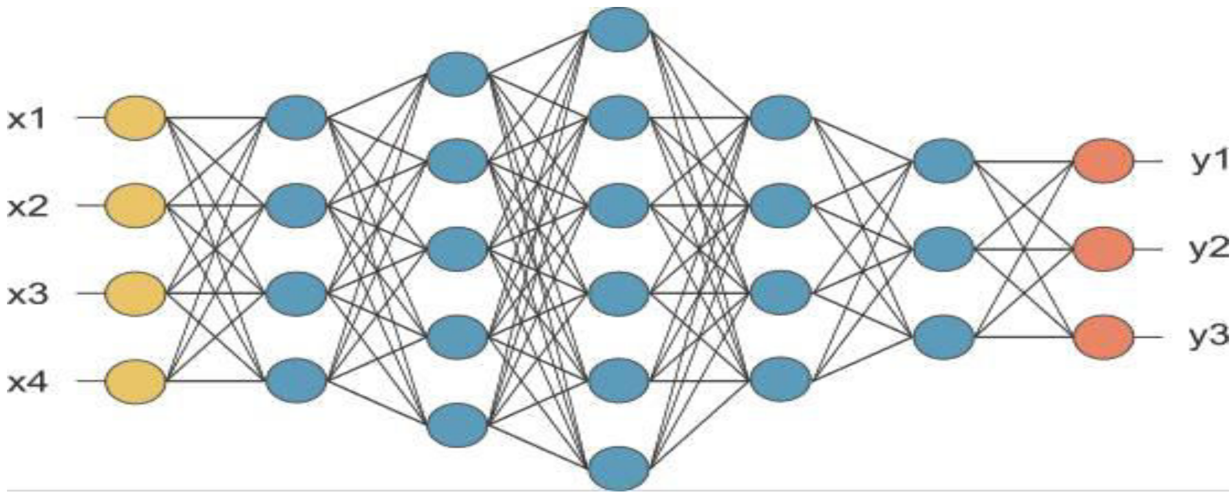

Figure 2.4 architecture of neural network

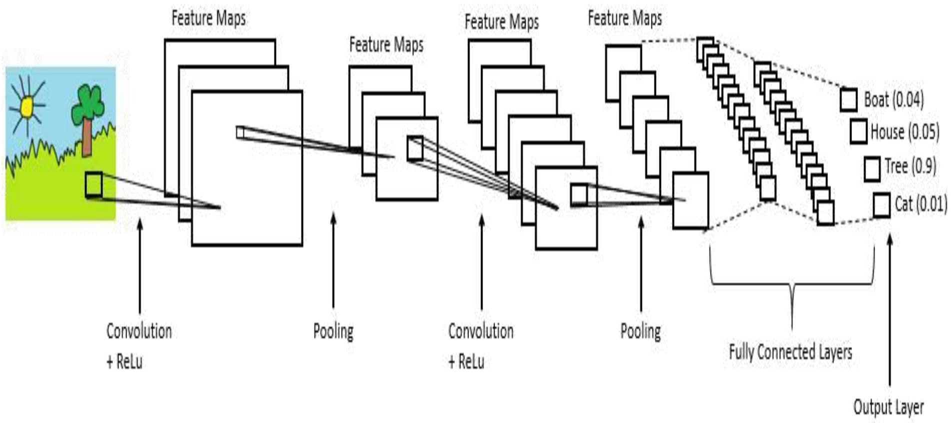

Figure 2.5 working of neural network

In the above diagram, the feature map matrix are going to be converted as vector (x1, x2, x3,..…). With these fully connected layers, we combined these features together to create a model. Finally, we've an activation function like softmax or sigmoid to classify the outputs as
cat, dog, car, truck etc

Optimizer

We should change our weights or learning rates of our neural network to reduce the losses is defined by optimizers we use. Optimization algorithm or strategies are responsible for reducing the losses and to prove the most accurate results possible.

ADAM Optimizer

Adam is often checked out as a mixture of RMSprop and Stochastic Gradient Descent with momentum. It uses the squared gradients to scale the training rate like RMSprop and it takes advantage of momentum by using the

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moving average of the gradient rather than gradient itself like SGD with momentum. Adam is an adaptive learning rate method, which suggests it computes individual learning rates for various parameters. Its name springs from adaptive moment estimation, and therefore the reason it's called that's because Adam uses estimations of first and second moments of gradient to adapt the training rate for every weight of the neural network

Loss function

As a part of the optimization algorithm, the error for the present state of the model must be estimated repeatedly. This needs the selection of an error function, conventionally called a loss function, which will be wont to estimate the loss of the model in order that the weights are often updated to scale back the loss on subsequent evaluation.

I am using model.fit_generator to pass data to the model. In fit_generatorsteps_per_epoch will set the batch size to pass training data to the model and validation_steps will do the same for test data.Once you have trained the model you can see training/validation accuracy and loss.

```
/usr/local/lib/python3.7/dist-packages/keras/engine/training.py:1915: UserWarning: `Model.fit_generator` is deprecate
  warnings.warn('`Model.fit_generator` is deprecated and '
Epoch 1/10
10/10 [==============================] - 1887s 189s/step - loss: 0.7859 - accuracy: 0.0389 - val_loss: 1.3879 - val_a

Epoch 00001: val_accuracy improved from -inf to 0.37500, saving model to vgg16_1.h5
Epoch 2/10
10/10 [==============================] - 1844s 186s/step - loss: 0.6595 - accuracy: 0.7474 - val_loss: 1.4037 - val_a

Epoch 00002: val_accuracy did not improve from 0.37500
Epoch 3/10
10/10 [==============================] - 1779s 178s/step - loss: 0.5563 - accuracy: 1.0000 - val_loss: 1.4449 - val_a

Epoch 00003: val_accuracy did not improve from 0.37500
Epoch 4/10
10/10 [==============================] - 1881s 191s/step - loss: 0.4686 - accuracy: 1.0000 - val_loss: 1.5079 - val_a

Epoch 00004: val_accuracy did not improve from 0.37500
Epoch 5/10
10/10 [==============================] - 1855s 188s/step - loss: 0.3934 - accuracy: 1.0000 - val_loss: 1.5718 - val_a

Epoch 00005: val_accuracy did not improve from 0.37500
Epoch 6/10
10/10 [==============================] - 1841s 186s/step - loss: 0.3285 - accuracy: 1.0000 - val_loss: 1.6749 - val_a

Epoch 00006: val_accuracy did not improve from 0.37500
Epoch 7/10
10/10 [==============================] - ETA: 0s - loss: 0.2802 - accuracy: 1.0000
```

Figure 2.6 analysis of the trained model

V.RESULTS

Occlusion:

Figure 2.7 detecting occluded part of the image

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Illumination:

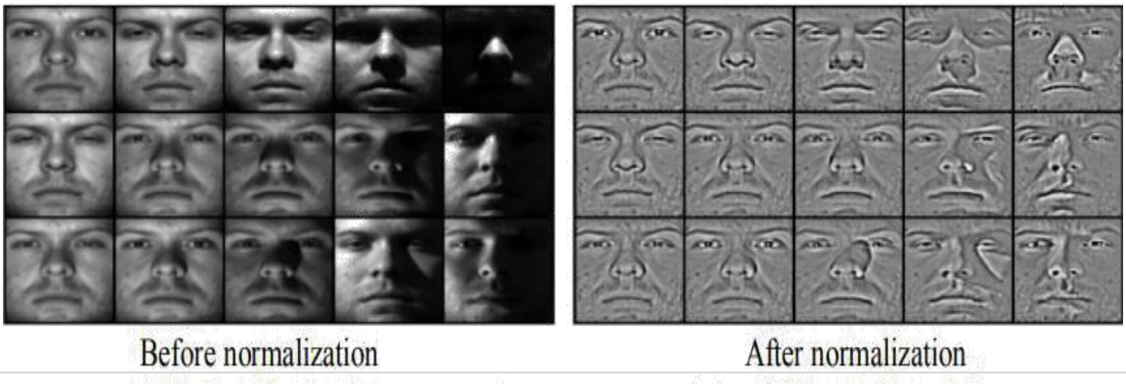

Figure 2.8 before normalization and after normalization

Figure 2.9 output of the model

V. CONCLUSION

When the input is given to the system it will apply Histogram equalization so that the problem of illumination will be eliminated. In the next step the pre processed image is sent to the trained model. Here features of the image are extracted from the trained model. Neural networks help in solving the problem of occluded images and based on the features obtained it will classify whether the face is present or not present.The main advantage of this system is it can process the illuminated and partially Occludedimages.The image detection is a preprocessor step for image recognition. In the future the image is used for face recognition
result :

- accuracy 1.00
- loss 0.2882
- epoch 10

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