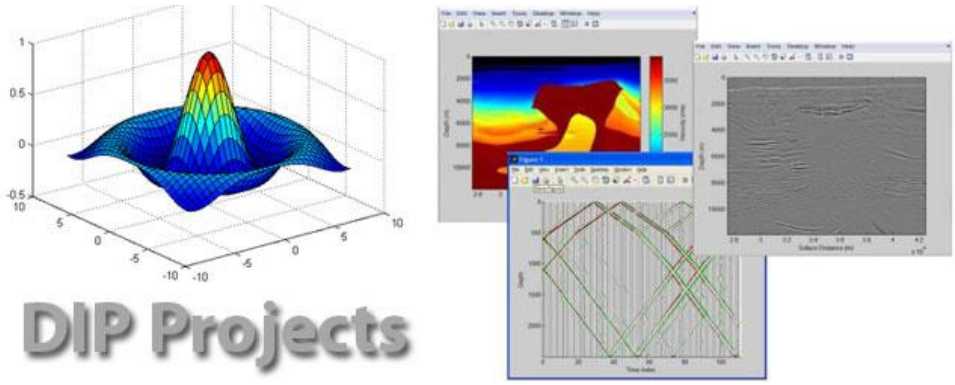
Project Report

Emotion Recognition using Facial Expressions

Digital Image Processing



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Emotion Recognition system using Facial expressions

The emotion recognition from an image or video can be of particular importance for security or even entertainment systems. For example a video game's response can be changed as per the emotions of the player or it can be used for security to interpret the emotions of a person to predict any violent act from him etc. In this project I have implemented the emotion recognition due to their rising demand but its not an easy task because of the amount of computation it needs. However due to the advancement in computational power of the present machine the implementation of such complicated task is possible. In order to make machine take an intelligent decision about a particular emotion by processing the image or video, it needs have been able to learn the patterns in particular image. This is possible due to the increasingly proficient research in the machine learning this type of sophisticated and complicated tasks are possible. Neural networks, support vector machines etc. tools are able to learn patterns in the images but it needs massive learning dataset. This dataset is called features, these feature contains the robust patterns in emotions and help an algorithm learn these patterns called machine learning.

In this project an emotion recognition system has been implemented via neural networks, which quite fascinating results offline. The system has been able to detect the correct emotional state. This report is describes how this particular system has been implemented.

1. System Block Diagram

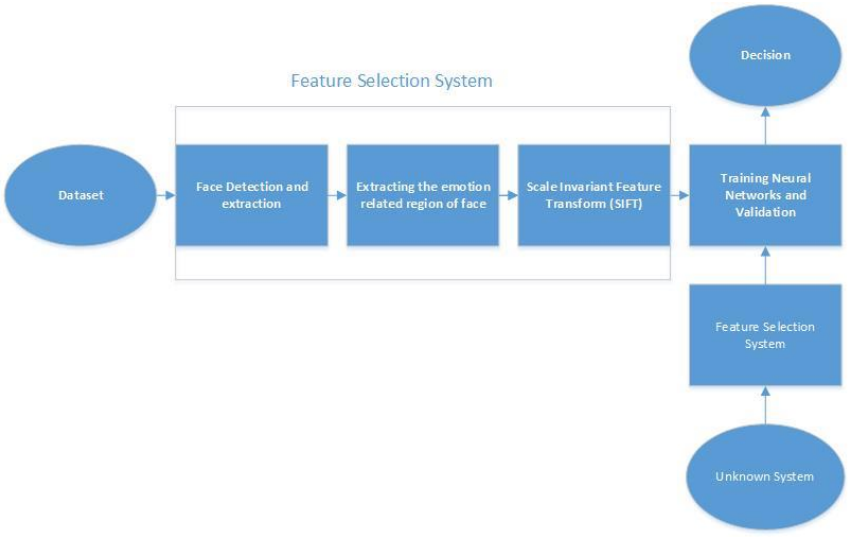


Figure. 1 System Block Diagram

2. Dataset

The dataset has been taken from Karolinska Institute Sweden, It contains images with 7 emotional expression i.e. happy, angry, sad, disgust, afraid, neutral etc. In this study I restrict myself to four emotions

only, namely happy, angry, neutral and disgust and I have used 840 images 210 each for the mentioned four expressions. The dataset is taken from 70 subjects (35 men, 35 woman) and each expression is captured at three angle i.e. left, right and straight. An insight into the dataset is given in the figure below

Figure. 2 Insight into Dataset

3. Feature Extraction

This is the most important part of the project because the type of the features will determine the performance of the system, thus getting the right kind of features is key. This task is done in three steps, first of all face detection and extraction, followed by extraction of region specific to emotions from the face followed applying scale invariant transform on the image to get the feature vector.

1. Face detection
2. Masking
3. SIFT

3.1 Face detection

For this purpose the built-in face detection object was used and to detect the face boundaries as shown in the Fig. 3 bellow.

Figure. 3 Detected faces

In the next step the co-ordinates returned by the face detection objects were used to extract the detected faces.

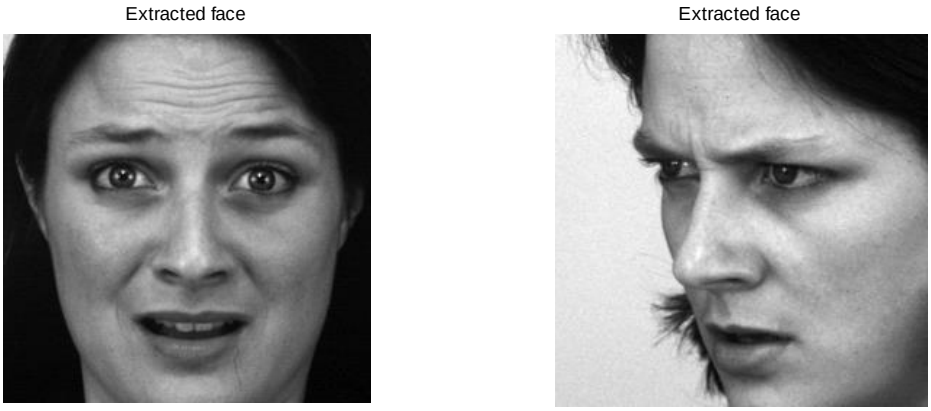
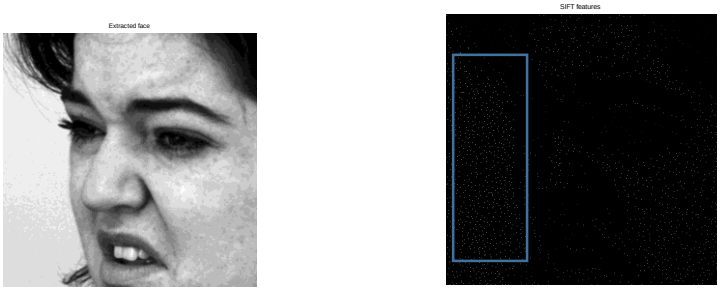


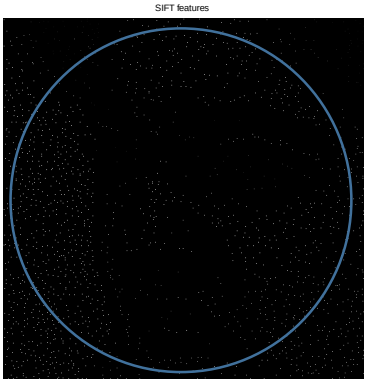
Figure. 4 Extracted faces

After detecting the face its scale invariant feature transform (Which will be discussed later) was taken, and it was realized that some undesired features are present in the feature vector (shown by the blue rectangle) which will degrade the performance of the final system as shown below in the figure.



3.2 Extracting a particular region of face

In order to retrieve the region of eyes, nose and lips (which is mostly responsible for most of the emotions) I first used circular mask but as you can see in the image below it still contains the undesirable information.



Thus keeping in mind the elliptical shape of the desired region I designed following three elliptical masks for straight, left and right image.

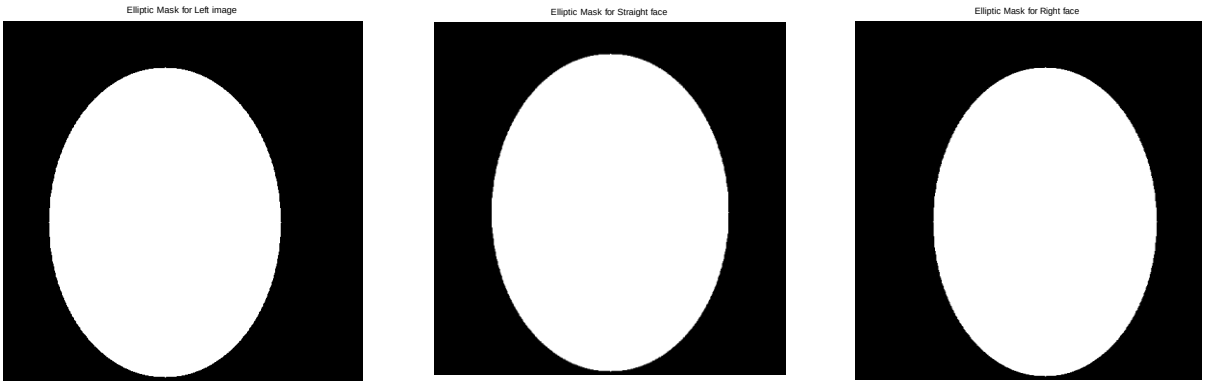


Figure. 7 Elliptical Masks

The mask for left posed image is slightly displaced to the left and similarly for right pose the mask is displaced to the right and for the straight pose the elliptic mask is placed at the center. The figure bellow shows an extracted image using these masks.

3.3 Scale Invariant Feature Transform (SIFT)

This transform is suitable for image recognition because it selects the points which are scale and rotation invariant and these points are used as features in this algorithm.

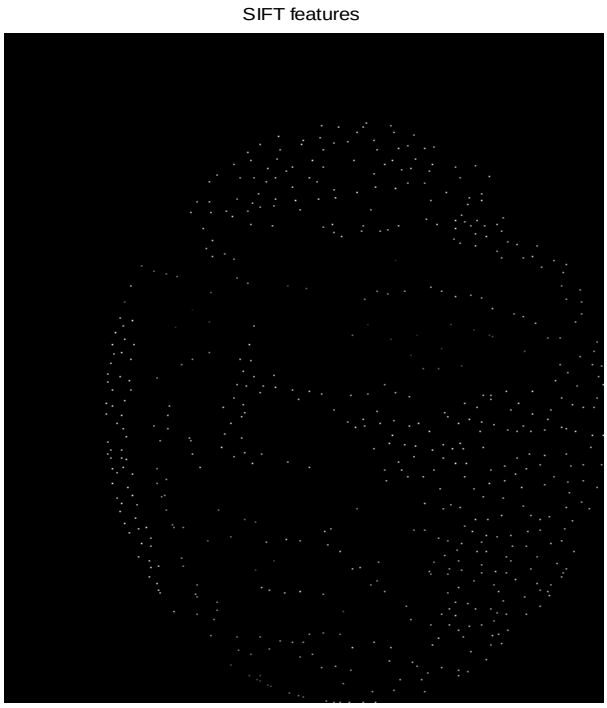
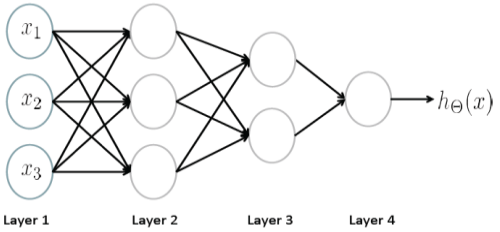


Figure. 9 SIFT featuers

4. Neural Networks

After selecting the appropriate features, The neural networks Matlab toolbox is used as a machine learning tool for emotion recognition system.

Now what are neural networks? It consists of multiple nodes each of which have an associated weight. Actually they behave like neurons i.e. each node communicates with all the nodes of previous layer. All the layers between input and output are called hidden layers. It adaptively updates the weights associated to each node. Effectively NN minimizes a cost function using steepest decent by calculating the gradient via forward and backward propagation of features.



The Matlab tool box is given as follows.

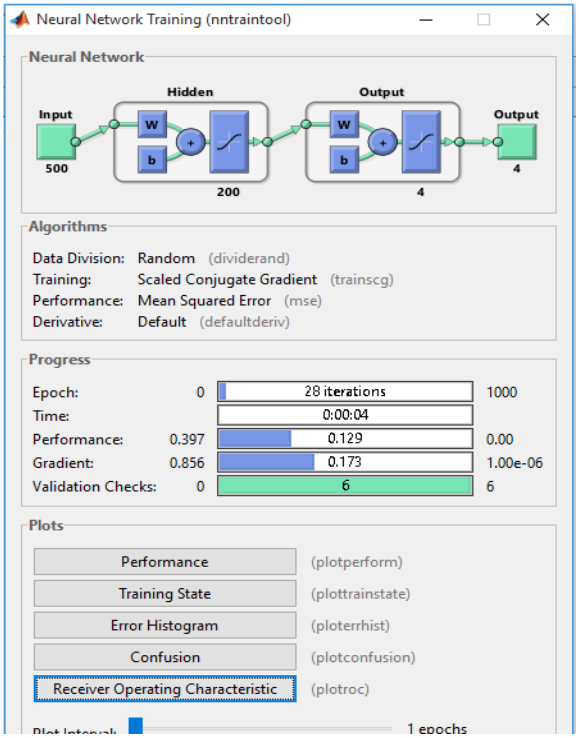


Figure. 10 System Block Diagram

Following operating settings have been used in the implementation of NN learning.

- Feature set contains a variable
    - X of size 500×840
    - Y of size 4×840
- NN layers
    - 500 input nodes
    - 200 nodes in hidden layers
    - 4 nodes of output layers
- Settings
    - 90 % training data
    - 5 % validation
    - 5 % testing
- Decision is made on the basisi of one versus all method

Given bellow are some of the important plots of NN learning and implementation. First the performance curve is given which shows minimum mean squared error of0.16076. followed by the error histogram

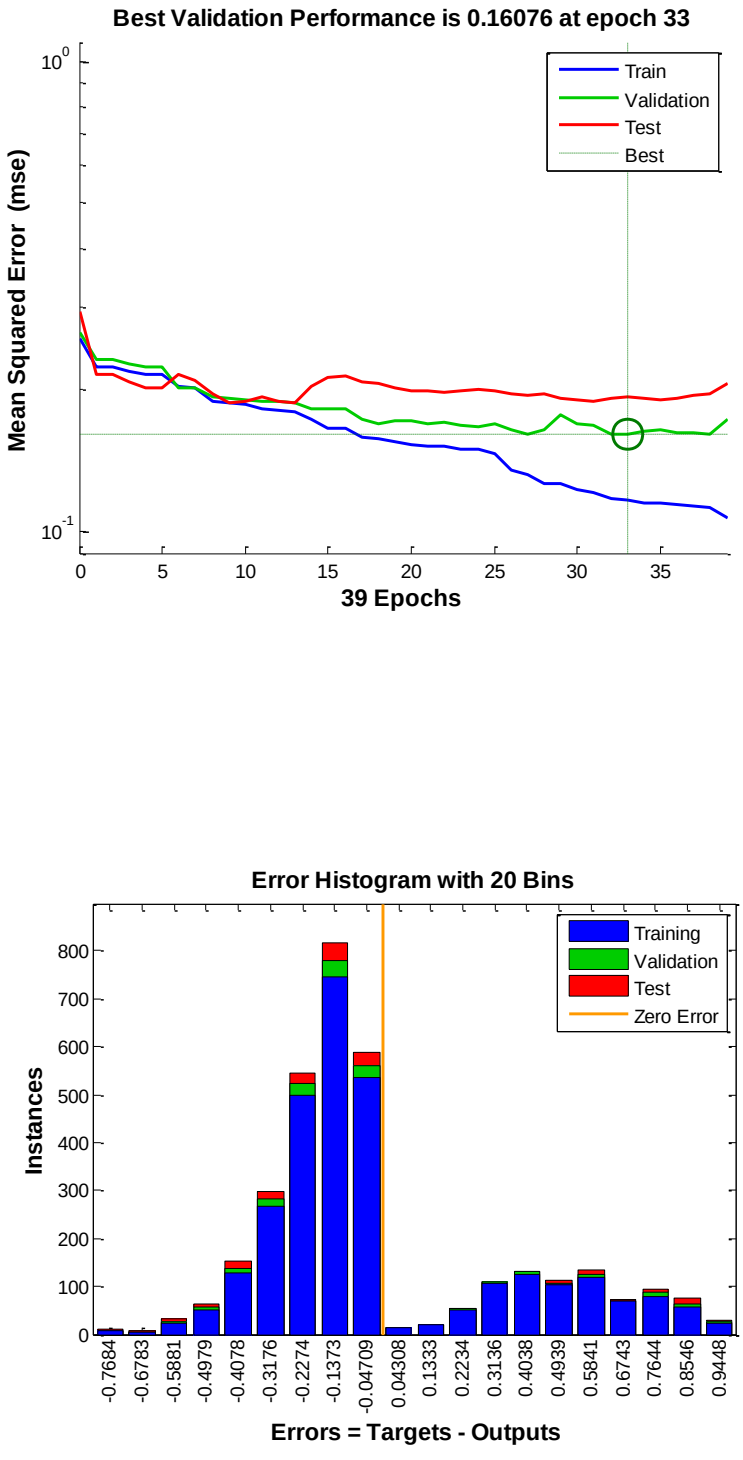


Figure. 11 Error graphs

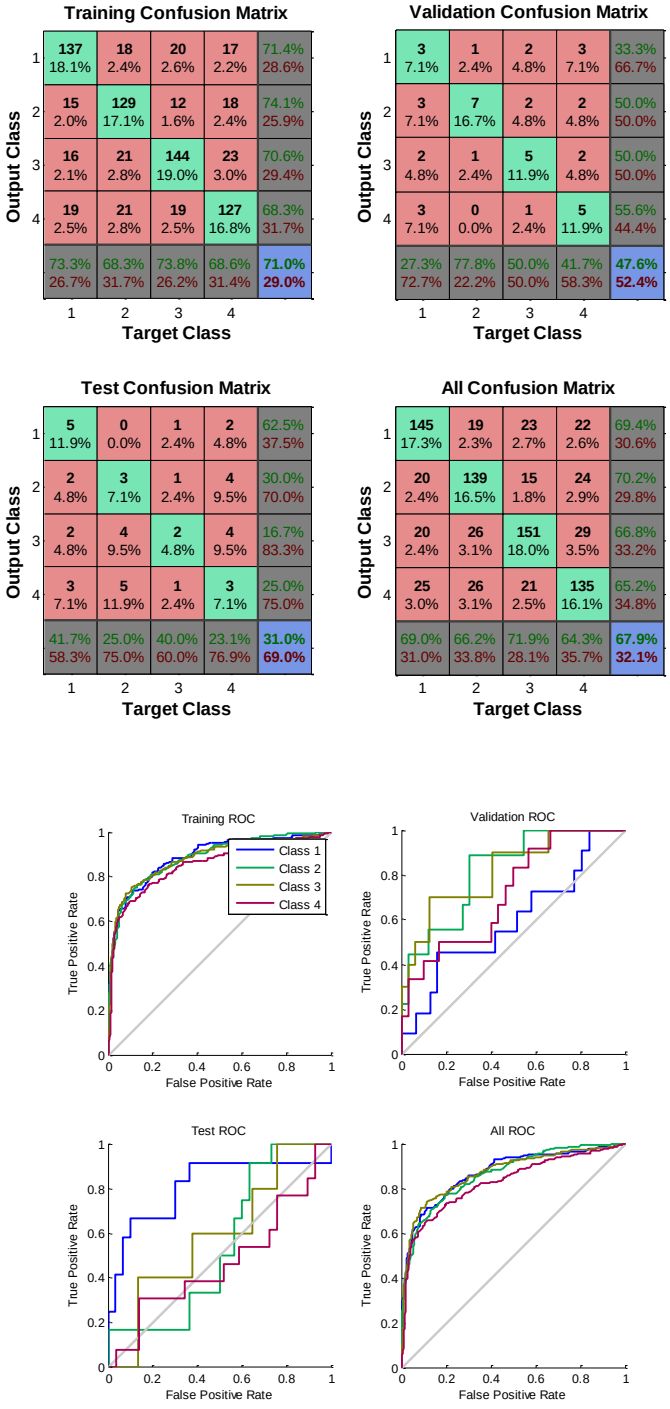


Figure. 12 Confusion matrix and ROC curve

5. Conclusion

Successfully implemented an emotion recognition system using Matlab Neural network tool by utilizing masking along with SIFT was used for feature extraction. In future work; intelligent masking techniques may be used. The system is working fine offline but its online testing is not yet done.