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PREDICTING EMOTIONS IN SOCIAL MEDIA DATA USING MACHINE LEARNING TECHNIQUES

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Abstract: In the current world social media plays a vital role to deliver different kinds of emotions in the form of text, emojis, etc. It is very essential that the emotions are very well identified to detect the feelings of the persons who posted it. In this series many kinds of feelings are available in various forms of database repositories. Analyzing all such kind of emotions is very tedious task. This research work applies the Transfer Learning techniques which are used to identify and analyze the emotions produced by different persons in the social media like Twitter, Face book, WhatsApp etc. This approach uses various techniques like Transfer Learning, Convolutional Neural Network (CNN), Deep Learning, Support Vector Machine (SVM) etc. Based on the data this work detects the six different types of emotions namely Happiness, Sadness, Fear, Disgust, Anger, Surprise and Neutral. From this Experimental approach the performance of the chosen algorithm is tested and reported. Finally, Transfer Learning Technique is suggested as the best method for the identification of emotions. Thus, enables psychiatric analysis of patients and interrogation sessions with the accused easy and effective.

Keywords: Transfer Learning, Emotions Detections, Social media data, Support Vector Machine, Gabor filters, Principal Component Analysis, Convolutional Neural Network

1. INTRODUCTION

Prediction of human emotions is very important, as this nonverbal communication tries to convey some information to the other person. This information conveyed is more accurate and precise than the verbal communication. By predicting emotions we can support the department of cybercrime, psychiatry and product marketing. When interrogating an accused, the images of the accused can be captured and the emotions can be determined, thereby making the investigation process easy. In the case of psychiatric counselling the patient may not be in a position to express their emotions in words, where the images taken are analyzed and the emotions are predicted thereby making the treatment procedure easy and efficient. In marketing of a product the images of the customer watching the clipping is captured and their emotions are predicted which acts as a review about the product. Thereby supporting the marketing of the product as customer review plays a vital role in marketing. Facial expression is the result of movement of one or more muscles underneath the skin. The six basic facial emotions are

classified as happiness, sadness, fear, disgust, anger and surprise along with the neutral expression as shown in figure 1.

Figure 1: Basic Facial Expressions

The technique used for recognizing a facial expression the techniques used are as follows (a) Face Detection (b) Feature Extraction and (c) Classification of Expressions.

Face Detection: This is a pre-processing step where an image is converted to a normal facial image for extracting the facial characteristics. From this the characteristic points are detected, located, rotated to line up and the face region is cropped using a rectangle, according to the face model. Thereby classifying faces in a single image.

Feature Extraction: The pixel data is changed into a higher level representation of shape, motion, colour, texture, and spatial input space in Feature extraction. It is important to retain the essential information in pattern identification system. Feature extraction makes use of different techniques.

Classification of Expressions: Classification is performed by a classifier, where model of pattern sharing is attached to a decision procedure.

2. REVIEW OF LITERATURE

In a research work done by Bartlett et al., in [1], it is stated that the facial expression was fully automatically recognized with a systematic comparison of machine learning methods. The speed and accuracy was enhanced by using Adaboost with SVM. This was a real time system. Chouhayebi et al.[2] have done research on facial expression detection, where two classification methods Support Vector Machine (SVM) and the Multi-Layer Perceptron (MLP) are compared for accuracy. Here two methods were proposed for detection of facial landmarks and feature extraction, one is based on image processing and the other uses Dlib library for detecting facial landmarks. Thereby concludes with an accuracy of 91.5% for SVM and more than 96% for MLP in predicting three different expressions namely happiness, surprise and neutrality. A review on Facial Expression Recognition System using machine learning Techniques was done by AmreenFathima and K.Vaidehi [3] where various facial expressions are identified through geometric, appearances and hybrid features. A literature survey of various strategies used for facial expression recognition is presented. A comparative study of

various pre-processing techniques, feature extraction techniques and classification techniques done to recognize facial expressions were carried out.

In a research work done by Caifeng Shan et al. [7], in which it is given that for recognizing facial expressions of individual persons, the facial representation based on Local Binary Patterns is evaluated empirically. From the experiments it is illustrated that for facial expression recognition LBP features are effective and efficient. And also formulate that the Support Vector Machine classifiers with Boosted-LBP features perform best in recognizing facial expressions. It is proposed by Sanghyuk Kim et al.[8] that there two main process in recognizing facial expressions that is facial detection and Facial Expression Recognition(FER).Haar-like features where the region of interest is reset to reduce the variable of appearance changes is used for face detection. The FER process extracts.TheHistogram of Oriented Gradients (HOG) features is extracted from each facial region by the FER process and then is performed on support vector machine to classify and identify the final facial expression. The F1 score of 0.8759 was achieved by the proposed system.

The work done by Fatima Zahra Salmam and AbdellahMadani[9] focuses on the geometric approach for feature extraction where the six distances that measure the parts of the face to describe the facial expression is calculated and a facial expression classifying system is achieved by applying an automatic supervised learning method called Decision Tree on two databases(JAFFE and COHEN).A recognition rate of 89.20% and 90.61% in JAFFE and COHEN databases respectively was achieved as result of the work. In a research work done by VeenaMayya et al. in [10], a novel method using Deep Convolutional Neural Network features was proposed to recognize facial expressions automatically. The General Purpose Graphic Processing Unit (GPGPU) was used in order to reduce the feature extraction time significantly. State-of –the-art result was achieved. A combination of Convolutional Neural Network and specific image pre-processing steps for recognizing facial expression was proposed by the work done by André TeixeiraLopes et al.[11].A competitive result with an accuracy of 96.76% was achieved when compared with other methods for recognition of facial expression.

A research work presented by TaskeedJabid et al.[12] a new local facial descriptor based on Local Directional Pattern(LDP)was described to recognize facial expression. Here the edge response values in 8 directions at each pixel were computed and it was encoded to 8 bit binary number to obtain an LDP feature. The LDP descriptor showed superiority against other appearance-based feature descriptors in the accuracy of classification of facial expressions. A model consisting of different structured subnet was proposed by Kuang Liu et al.[13] All the subnets were assembled together to form a structured network, where each subnet is a compact CNN model trained separately. An accuracy of 62:44% was achieved by the best single subnet. In a proposed work by Tee Connie et al.[14]uses Scale Invariant Feature Transform(SIFT) features on small data to increase the performance .Dense and regular SIFT are merged with CNN features ,then are studied and compared.CNN with Dense SIFT shows superior results over conventional CNN and CNN with SIFT when demonstrated. Also increases the accuracy of predicting facial expressions.

A research work proposed by Philipp Michel and Rana El Kaliouby [15] an approach was presented to recognize facial expressions. Moreover very unconstrained ad-hoc interactions also achieved usable results. In the application of novel multimodal interfaces to recognize facial expressions this can be considered as a crucial prerequisite. Collection,

Annotation and Analyses of wild facial expressions from the web was studied and results was presented in a research paper by Ali Mollahosseini et al.[16] . Three different training scenarios of deep neural networks and noise modeling were used to find the accuracy of recognition of facial expressions when trained on noisy images from the web, achieving an accuracy of 82.12%.

The performance of facial expression recognition system on the JAFFE database and Mevlana University Facial Expression (MUFE) database is investigated by a paper proposed by Muzammil Abdulrahman and AlaaEleyan [17].The feature extraction technique used was Principal Component Analysis (PCA) and Local Binary Pattern (LBP).Both LBP and PCA with SVM classifier gave high performance than the L2 Euclidean distance classifier for both the databases. In a paper proposed by Serenada Salma Shafira et al.[18] the differences of feature extraction, activation function and number of hidden neuron are used to evaluate the accuracy of the dataset. The performance was affected by the parameters in the Extreme Learning Machine (ELM). In a paper presented by Salam Ullah et al.[19] different machine learning techniques are used to recognize facial expressions.The facial expressions of Japanese Female Facial Expression (JAFFE) and the Cohn-Kanade (CK+) datasets are exploited on the Support Vector Machine(SVM),Convolution Neural Network(CNN) and Artificial Neural Network(ANN) methods together with the face detection and pre-processing techniques. Finally a best accuracy of 98.47% on CK+ dataset using CNN and 89.18% on JAFFE dataset using ANN was achieved. In a paper presented by Junkai Chen et al.[20] Histogram of Oriented Gradients(HOG) was applied to encode facial components as features. The linear SVM was trained on JAFFE and CK+ datasets achieving a classification rate of 94.3% and 88.7% respectively. In future it was proposed that the performance of identifying more subtle expression such as “contempt” will be improved.

3. MATERIALS AND METHODS

This method uses CNN where an existing model is trained using Transfer Learning techniques with the TensorFlow library. The method includes two phases namely the training phase and the testing phase. In the training phase the exiting model is trained with the images taken from the FER database. Later in the testing phase any image can be downloaded from the social media like Twitter, Facebook etc. and given as input to the trained model, which will predict the type of expression with an appreciable accuracy. The detailed explanation of the method implemented is as follows.

3.1. Databases available for Facial Expression Recognition

For the detection of facial expressions a large set of human facial images are required. The three main databases of such facial images used for research purpose is explained as follows: FER Database: From the FER [4] databases many images have been used for relative and extensive experiments. The 2D static images or 2D video sequence are used to calculate human facial expression. The large pose variation and facial behaviour variations bring in complexity in handling 2D images. This database introduces us to a number of 2D and 3D video sequences and motionless images which aid in Facial Expression Recognition.

The Extended Cohn-kanade Dataset (CK+): Both posed and non-posed emotion and 593 video sequences along with added types of metadata are available in CK+ [5]. 123 subjects of the age group from 18–30 years, most of whom are female are available in this database. The images are measured and analyzed using different prototypes and action units. The images available are with a pixel resolution of 640X480 and 640X490.

Japanese Female Facial Expressions (JAFFE): 213 images expressing seven facial emotions (six basic facial emotions and one neutral) are available in the JAFFE database [6]. The images available were posed by ten different female Japanese models. Each facial image is available with an original size of 256X 256 pixels.

Figure 2: Sample images of JAFFE Database

3.2. Packages and Library

The different packages and library that are used in the prediction facial expressions are explained as follows:

Open CV: Open CV (Open Source Computer Vision) is a library of machine learning software. It provides infrastructure for various applications and accelerates the use of machine perception. There are more than 2500 optimized algorithms, including both computer vision and machine learning algorithms that can detect objects, human faces, actions, track movement of camera and objects, produce and extract 3D model of objects.

Numpy: The acronym of "Numeric Python" or "Numerical Python" is Numpy.It consists of precompiled functions for mathematical and numerical routines. The programming language Python is enriched with Numpy by its powerful data structures for better computational efficiency of multidimensional arrays and matrices .Python accomplishes Numpy as an open source extension module.

NumpyArray: It is a grid of values of same type, indexed by tuple of non-negative integers. The rank of the array is the number of dimensions.

TensorFlow: Google has created and released a Python library called TensorFlow for fast numerical computation. Deep Learning Models can be created directly or using wrapper libraries from this foundation library. Data flow and differential programming are used here to carryout different tasks on training and inference of deep neural networks. Various tools, libraries and community resources are used to create different machine learning applications by users. TensorFlow is built in such a way that it is accessible for everyone making it the best library of all. It relies on graph computation. The construction of neural network can be viewed by the developer with the TensorBoard. Both CPU and GPU can used for executing TensorFlow.Following are the algorithms that are supported by TensorFlow:

- Linear regression: if.estimator.LinearRegressor
- Classification:if.estimstor.LinearClassifier

- Deep Learning Classification:if.estimator.DNNClassifier
- Deep Learning wipe and deep:if.estimator.DNNLinearCombinedClassifier
- Boosted Tree Regression:if.estimator.BoostedTreesRegressor
- Boosted Tree Clssification:if.estimator.BoostedTreesClssifier

Thus the above mentioned algorithms can be executed with the TensorFlow library.

3.3. Transfer Learning

In Transfer Learning (TL), a model is taken, trained on a large dataset and then its knowledge is transferred to smaller dataset. We can freeze the early convolution layers of the CNN and train only the last few layers which will be used for prediction of facial expressions. The initial layers extract low level features like edges, patterns, gradients and the specific features in an image such as eyes etc are identified by later layers. The general outline for object recognition in transfer learning is as follows:

1. The input is loaded in a pre-trained CNN model which is already trained on a large dataset
2. The parameters (weights)of lower convolutional layers of the model are freezed
3. Custom classifier with several layers of trainable parameters are added to the model
4. The classifier layers are trained on training data available for proposed task
5. Fine-tune the hyperparameters and more layers can be unfreezed based on the needs

This approach is successful for a wide range of domain, mostly used in computer vision, as the size dataset is reduced. Thereby decreasing the computation time .And also becomes more suitable for traditional algorithms.

3.4 System Flow

Transfer learning method: In figure 3, it gives an elaborate detail on how an image from social media is given as input to the trained model which accurately identifies the facial expressions.

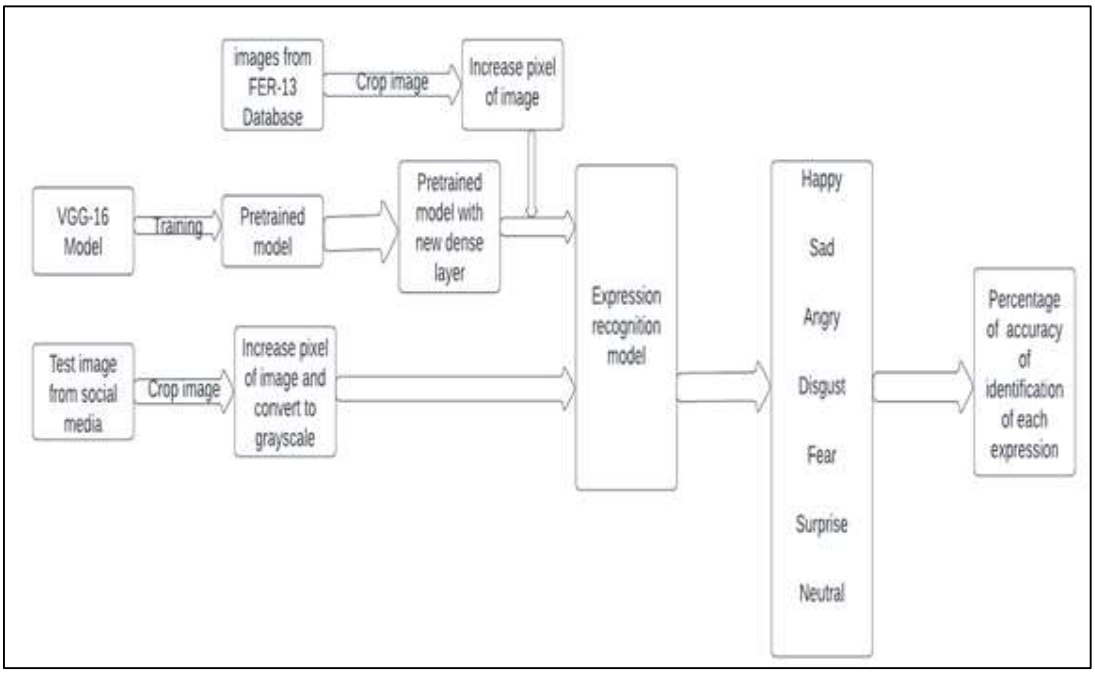

Figure 3: System Flow of Research Work

The system flow is explained in steps as follows:

Step 1: Data set of images with different facial expression is collected from FER2013 database. It consists 48X48 pixel grayscale images of faces categorized based on the seven different facial expressions namely anger, disgust, fear, happy, sad, surprise, and neutral.

Step 2: Pre-processing of images is done by increasing the pixel size to 224X224.

Step3: Now we train the model with the dataset classifying into seven different facial expressions

Step 4: The facial image to be identified for facial expression is downloaded from the social media like face book is given as input to the trained model for testing.

Step 5: This input image is now increased in pixel of 224X224 .It ensured that every image is fed to the input layer as a numpy array.

Step 6: The numpy array is passed through the Convolution layer.

Step 7: The feature maps are generated by the Convolution.

Step 8: After Pooling, the feature map contains the most prominent features of the previous feature map, keeping only the maximum pixel values

Step 9: The Forward and Backward propagations are performed on the pixel values while training the neural network.

Step 10: All the seven different expressions and its probability is identified by the model.

SVM with Principal Component Analysis (PCA) and Gabor features method

Boser, Guyon and Vapnik first introduced Support Vector Machine (SVM) in 1992.Classification and Regression is done by SVM which are a set of related supervised learning methods. It is a general linear classifier. This uses hypothesis space of a linear function in high dimensional feature space .Thereby implementing a learning bias which was derived

from a statistical learning theory. It is used in applications such as analysis of handwriting, face and in many applications where pattern classification and regression is required.

In the SVM with Principal Component Analysis (PCA) and Gabor features model consists of face localization, face detection, extraction of features and classification of expressions. After the image is input, firstly the color information is limit to search area like eyes and mouth .Then face detection is done followed by feature extraction of the region of interest by the Gabor filter where the extracted features are large in size which is reduced by using PCA. The Gabor filter is a tunable band pass filter of multi scale and multi resolution. It has a response as same as the human eye cortex. The dimension of features is reduced by using this PCA which is an unsupervised learning technique. Let I(x, y) be a two dimensional facial image. PCA is used to find the vector that is best to fit into the distribution of face image in the image space. The following are steps for feature extraction:

Step1: A set S with M face images is obtained

$$S = \{\Gamma_1, \Gamma_2, \Gamma_3, ...\Gamma_M\} \quad (1)$$

Step 2: The mean image ψ is obtained

$$\psi = \frac{1}{M}\sum_{n=1}^{M}\Gamma_n \quad (2)$$

Step 3: The difference between the input image and mean image Φ is obtained

$$\Phi_i = \Gamma_i - \psi \quad (3)$$

Step 4: The covariance matrix C is obtained

$$C = \frac{1}{M}\sum_{n=1}^{M}\Phi\Phi_n^T = AA^T \text{ , where } A = \{\Phi_1, \Phi_2, ...\Phi_n\} \quad (4)$$

Step 5: L is M by M matrix constructed to obtain the eigen vector v_l of L where L= AA^T

Step 6: The linear combinations of M training set of face images are determined by v_l vectors which form the eigenfaces u_i

$$u_l \sum_{k=l}^{M} v_{lk}\Phi_k \text{ , where } l = 1,2,3,...M \quad (5)$$

Step 7: Each of the original images are projected onto the eigenspace. Thereby producing a vector comprising of weights that represents contribution of eigenfaces in reconstruction of the input image.

$w_k = u_k^T(\Gamma - \Psi)$, where u_k is the k^{th} eigenvector and w_k is the k^{th} weight in the vector

$$\Omega^T = [w_1, w_2, w_3, ... \ w_m] \quad (6)$$

The features extracted using the above method is stored in knowledge base and then classified using the SVM Classifier.

SVM with the distance feature method

In the SVM with the distance feature model the distance feature is extracted for which the facial landmarks are used for facial detection, recognition and expressions identification. There are 68 facial landmark detectors in the Dlib library that can identify the position of landmarks on human face .The coordinates (x,y) for all the facial points can be extracted from the Dlib library. With the 68 coordinates the distance between two facial points in the face can be calculated by using the following distance formula:

$$D=\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (7)$$

Twenty five such distances were calculated. They are as follows a)Between the eyebrows and upper eye-lid the distance is measured by **d1, d2, d3, d4, d5, d6, d7 and d8**.b)Between the upper eye-lid and lower eye-lid the distance is measured by **d9 ,d10, d11, d12.** c) Between the outer upper lip and outer lower lip the distance is measured by **d13, d14, d15, d16, d17**. d) Between the nose tip and outer upper lip and outer lower lip the distance is measured by **d18 and d25.** e) Between the nose tip and left and right mouth corner the distance is measured by **d19 and d20**. f) Between the left and right mouth corner the distance is measured by **d21**. g) Between the inner points of the eyebrows the distance is measured by **d22**. h) Between the nose tip and the inner points of both the eyebrows is measured by **d23 and d24.**These features extracted are then classified for facial expressions by the SVM Classifier.

4. RESULTS AND DISCUSSION

The performance of three different methods namely SVM with distance features method, SVM with PCA and Gabor features method and Transfer learning method are analysed and percentage of accuracy in predicting the facial expressions is obtained and compared

Table 1: Accuracy based results of prediction for seven facial expressions

	Accuracy in %		
Emotions	**SVM + Distance Features**	**SVM+PCA+ Gabor Features**	**Transfer Learning**
Anger	70	20	85
Sad	75	90	95
Happy	70	80	86
Surprise	45	65	75
Fear	65	30	73
Disgust	60	35	74
Neutral	90	87	95

From the table 1, it is given that the average accuracy of prediction of the seven facial expressions by three different models. The model based on Transfer Learning which was derived by training a convolutional neural network proves to be more potentially able in predicting the seven facial expressions when compared to the other two models.

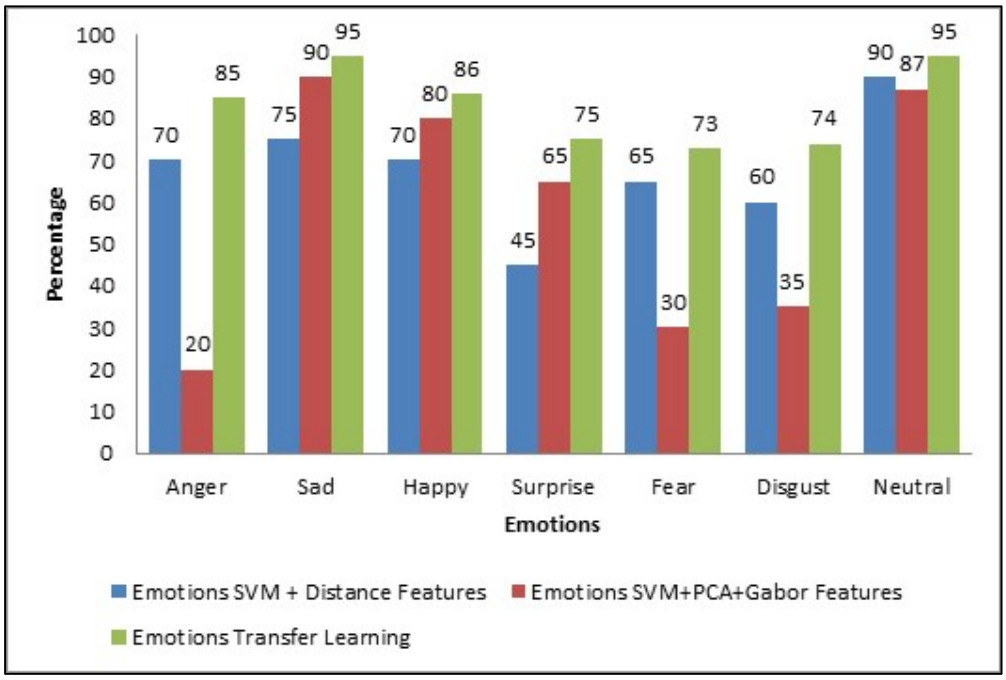

Figure 4: Performance of models to express seven different facial expressions

Figure 4 shows the outstanding performance of the model with transfer learning in detecting seven different facial expressions when compared to other models namely SVM with distance and Gabor features.

Table 2: Comparison of overall accuracy of prediction by three models

Methods	Accuracy (%)
SVM + Distance Features	67.86
SVM+PCA+Gabor Features	58.14
Transfer Learning	83.29

Table 2 predicts the overall percentage of accuracy to recognize the facial expressions by the three models. Thus, observed that the Transfer learning method gives more accuracy in predicting the seven facial expressions when compared with other two methods.

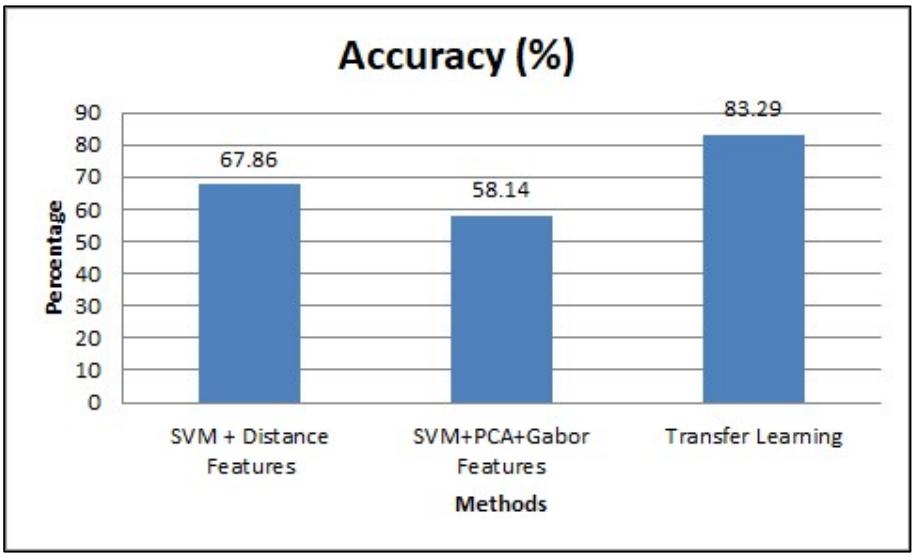

Figure 5: Overall Performance of three models in facial expression prediction

From the figure 5, it is evident that the model based on Transfer Learning achieves an average of 83.29% accuracy in predicting facial expressions which are the highest when compared to other two methods.

5. CONCLUSION

A number of methods used for the analysis of sentiments as well as the facial expressions in terms of its accuracy by different researchers. In this research work, a model in the TensorFlow platform using transfer learning technique was studied which can predict the six basic facial expressions along with neutral expression accurately for the images taken from the social media. An accuracy of 83.29% is achieved in predicting the expressions by the transfer learning method. Hence, it is concluded that this accuracy in prediction is more than the SVM with distance features and SVM with Gabor and PCA features model. From this experimental approach, it is confirmed that the transfer learning method yields best result in predicting the facial expressions. In future, the model can be enhanced to predict few more facial expressions other than the six basic expressions and furthermore the model can also be designed to predict facial expressions of real time images (wild images).

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