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Emotion Recognition using Feed Forward Neural Network & Naïve Bayes

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Abstract: ***In this paper we analyze and predict the emotion of a user by recognizing his/her face. Face recognition is a software application which is used to identify a particular person; it will be mostly useful in security applications to secure our data. Now a day we are using face unlock in mobiles to unlock our phones. We need to know the emotions of a person in some situations. Though we can recognize his emotion through his tone of voice, it would be more helpful if get to know his emotions. This can be much helpful in finding out a criminal by finding out his emotion whether he is feeling nervous or not which expresses his/her fear by this. In order to analyze his/her emotion firstly we need to recognize his/her face, so we need to use face recognition method and then implement emotion analysis. Here we use different algorithms to implement emotion analysis such as CNN. We will have the dataset with pixels and emotion this will be the training data. Then we will be initially taking the picture and then convert them to pixels these will be acting as the testing data. We then use an algorithm to predict these pixels emotion which is nothing but predicting the emotion of the picture taken.***

Key Words: Analyze, Emotions, Naïve Bayes, Neural network, Pixels, Recognition

I. INTRODUCTION

Emotions play a vital role in our day-to-day life. We may not be able to covey all our thoughts through speech, then emotions play their role in exhibiting one's feelings. Every human being expresses their inner thoughts through emotions itself. By looking at persons emotional state at a particular situation one can be able to decide the behavior of that person. Emotional reactions will be varies from person to person, everyone will not be have same emotional state during any situation. A human will not be born with emotions he will be developing them slowly as he grows by observations [15]. A human emotion mainly depends on actions of surrounding people and their reactions.

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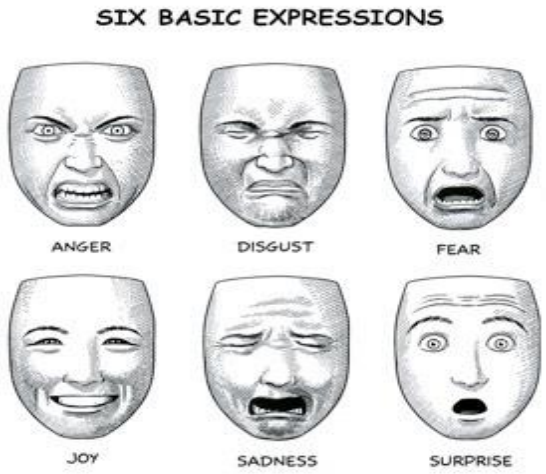
With their growth they form build up different kinds of emotions which gradually turn to be involuntary.
Emotions are learned on their own that does not require any kind of manual training.
Different kinds of Emotions humans tend to show [12]
Happiness, Sadness, Fear, Anger, Disgust, Surprise



This paper mainly focuses on "criminal detection ", we find it difficult to identify a criminal in today's scenario as technology is emerging high in various areas [18][19]. Criminals are also using different technological ways to make their crimes. For example, if a robbery takes place, in olden day's cops found out the criminal using the fingerprints they found at the place by comparing with their previous records, but now criminals found many ways for robbery without leaving a single clue behind [17]. Using this emotion recognition we can find out the robber. If a suspect expresses high level or range of fear he would surely be one of the criminal.
In this paper we will be using Naive Bayes algorithm. Naive Bayes is a classification algorithm, which is used to predict class labels. Naive Bayes is derived from the mathematical theorem termed as "Bayes theorem". Bayes theorem is a way of finding the probabilities of an event with the help of prior knowledge over that domain. Basing on probability we decide whether a event occurs or not. Naive Bayes is a slight modification of Bayes theorem, where we assume that the variables are independent of each other.

We are organizing the remaining part of this article as section II for existing work, section III for problem statement,

section IV for proposed work, section V for work flow and result analysis of a proposed work. Finally we are concluding the paper in section VI.

II. EXISTING WORK

It is important to recognize a human emotion; in the concept of criminal identification the emotion fear plays a vital role. We also find a major use of this emotion recognition in the context of social media. For example, we can really get to know whether a person is really feeling happy, sad, and angry by analyzing his image. We can see different techniques are being used to analyze an emotion of a person. We generally need to identify the face of a person in order to recognize a person's emotion therefore we need to crop the image accordingly.

SVM (Support Vector Machine) is used to classify the emotions, generally SVM classifies two class label predictions but here we have 6 different types of emotions. SVM is extended to classify multi class labels using kernel functions. SVM classifies the data by hyperplanes [1]. It is used for linear as well as non-linear data. It can easily remove outliers from the data if any outlier is present. In linear data we classify using one hyperplane, and the points nearer to the line are called support vectors [16][20]. After that we will be calculating the distance between line and support vector this distance is termed as margin. The line for which the margin is maximum.it is called optimal hyperplane. For data which cannot be classified using one hyperplane is called non-linear data, we use a kernel function for these data. Kernel functions such as polynomial kernel, sigmoid kernel, Gaussian kernel etc. can be used. Kernel function is used to transform the data into required format. The disadvantage with this here is, it is difficult to choose the type of kernel to be used. K-nearest neighbor is used for classification of emotion, it assumes that all the similar points i.e. data are close to each other. It takes the k value as input from the user, and then calculates the distance between the points to point that belongs to k and forms a kind of graph [1]. The disadvantage with this is the value of the k need to be specified by the user before itself which may not lead to accurate results. The predict variable may change with change in k values. Fuzzy inference system is used to classify the type of emotion; it is based on the rules framed [9][21]. The truth values of variables lie between 0 - 1. The rules are of the form of IF-THEN. It uses three operators the form rules, they are AND, OR, NOT [9-11]. Classification of class labels depends on the truth values [2][5]. It classifies emotions according to the rules using a conjunction operator of features extracted. The disadvantage with this is that the rules are framed based on some assumptions which may not be widely accepted [7][8]. These will not always provide accurate results. Combination of CNN with ensemble learning is used in classification of emotions; in this several weak classifiers are combined into one strong classifier [6]. In this we perform two operations transform and flip. Using these two operations accuracy of classification can be increased. In this method using the test image 8 other images are generated using these operations. All the results are averaged to give the final output. It removes if there are any outliers. Parallel computing takes place which increases accuracy [13]. Recurrent neural networks are a type of neural network which is bidirectional .RNN contains three different types of layers-input layer, hidden layer, output layer. In neural network each of the layers has their own set of weights. In RNN each layer has same weights and biases to reduce the complexity. RNN has the ability to memorize the previous output. In RNN the previous output is fed as input to the input layer [3][22].

Steps involved in RNN are:

i. In this the input is given to the input layer of the network.
ii. Then it calculates the present state using current input and previous state
iii. After completing all the steps, final state is used to calculate the output
iv. This output is compared with actual output and error is calculated
v. Then the error is back propagated and the weights are updated and it repeats the process again.
vi. As backpropagation takes place RNN also has good accuracy is predicting the output.

By combining these both methods for predicting the classifier the accuracy increases and will also be useful in detecting the emotion when two or more emotions have same values during prediction in case of any other methods.

III. PROBLEM STATEMENT

Generally, there are many methods to recognize the type of emotion being expressed, but the output ultimately depends on the accuracy of the algorithm and there is another case needed to be considered, if the algorithm predicts the probabilities of different emotions equally it is difficult to decide the emotion. We need to improve the accuracy in order to correctly classify the emotion This can be done using a hybrid model, combination of Artificial Neural Network with Naive Bayes (ANN-NB).

Table 1: Review on existing work

TITLE	AUTHORS	METHODOLOGY	ADVANTAGES	DISADVATAGES	RESULTS
"Emotion recognition from facial expressions using hybrid feature descriptors"	Tehmina Kalsum et.al	SVM (Support Vector Machine) & K-nearest neighbor are used to classify emotions	Decrease in the quantity of pixels that should be handled	If face areas are not detached, feature coinciding occurs and effects in performance degradation.	Programmed emotion recognition framework
"Spatial–Temporal Recurrent Neural Network for Emotion Recognition"	Tong Zhang et.al	Recurrent Neural Network used to classify emotions	Long distance spatial and contextual dependencies of a image.	Doesn't provide accurate results to all the facial expressions compared to other algorithms.	STRNN technique is planned to deal using EEG signal-based and face image based human emotion recognition.
"Physiological Inspired Deep Neural Networks for Emotion Recognition"	Pedro M. Ferreira et .al	Deep Neural Networks used to classify emotions	Loss function can also learn about facial parts	Variations of learning rate may affect output.	Capable to study expression specific Features.
"Neuro-Fuzzy Quantification of Personal Perceptions of Facial Images Based on a Limited Data Set"	Luis Diago et.al	Neuro-Fuzzy used to classify emotions.	Can be used with any type of stimulus	Cannot be tuned with HNN keeping maximum class separation.	Explore the features of facial Pictures observed as Iyashi 114 subjects.
"HERO: Human Emotions Recognition for Realizing Intelligent Internet of Things"	Wentao Hua et.al	CNN and ensemble learning to classify emotions.	Computational efficiency.	Possibility of recognition error rate.	Deep recognition algorithm based on deep learning and ensemble learning was proposed for HERO in IIoT.
" Face Detection and Expression Recognition Using Fuzzy Rule"	Williams. D. Ofor et.al	Fuzzy inference system is used to classify the type of emotion	System can be accessed easily. & Conclusions are drawn even from partial rules.	The application doesn't work correctly for classification.	Fuzzy rule interpolation technique is used to detect face from a static image and classify facial expression.

IV. PROPOSED WORK

Classification of the emotion through face recognition is very important that it can be helpful to know a person's feeling towards a situation. In this regard we are proposing a method to identify the emotion of person in a situation. We propose to classify the type of emotion being expressed by using Naïve Bayes in combination

In Naive Bayes we calculate the probabilities of each and every variable for each and every class labels which is a conditional probability. We then predict the class label which has the highest probability as the output. Naive Bayes gives good performance and accuracy when compared to many other algorithms. Naive Bayes can be used for both discrete as well as continuous variables.

$$P(C_i|x_1,x_2\ldots,x_n)=\frac{P(x_1,x_2\ldots,x_n|C_i).P(C_i)}{P(x_1,x_2\ldots,x_n)}\ for\ 1<i<k$$

The above formula is used to calculate the probability of an occurrence of event and predict class label. Here, k is the number of class labels of an event. We can ignore P(x1,x2,...xn) as it will be same for all the class labels.

Steps in calculation of probability of an event are :

i. Firstly, we need to calculate the prior probability for class labels.

ii. Then, calculate the likelihood probability for each attribute for each class

iii. Calculate the posterior probability using these values with Bayes theorem

iv. Now check which class label has highest probability that will be the output for given input data.

$$P(C_i|x_1,x_2\ldots,x_n)\,\alpha\left(\prod_{j=1}^{j=n}P(x_j|C_i)\right)\cdot P(C_i)\ for\ 1<i<k$$

Feed Forward Neural Network is an artificial neural network (ANN). It used for classification of class labels [14]. It is developed from the biological phenomenon that takes place in human body. In this we have input layer and output layer [4] [13]. Here, we will have an activation function which is used to determine the output for a given input. Information is passed only in a single direction from left to right i.e. from input layer to output layer.

Steps involved in Feedforward Neural Network are:

i. The input layer takes the input

ii. Randomly assign weights

iii. Then it calculates by multiplying the weights with inputs

iv. This will be sent to the activation function

v. After that the output of the activation function is given to the output layer which will be the final output.

V. WORK FLOW & RESULT ANALYSIS

In the proposed method, we will first do data preprocessing on the training dataset to avoid any missing values or any other errors in dataset. The dataset consists of two different attributes one is pixels and the other is emotion which is the class label. This dataset consists of pixels of different emotions of different people and their related emotions. Then we will capture the image using the webcam. This image will be converted into pixels; this will be stored in a different dataset without the class label i.e. the type of emotion and will be used as testing data. Using the dataset we will train the algorithm. Now, we need to identify the emotion for the testing data.

The pixels can be directly given as test data to the Naive Bayes algorithm to classify the emotion basing on probability we will plot a bar graph for visualization and can clearly get to know which emotion is expressed. Naive Bayes gives a better accuracy than other algorithms, to increase the accuracy we construct a hybrid model i.e. using Feedforward Neural Network as well as Naive Bayes. In this we will train both Neural Network and Naive Bayes algorithms with the training dataset, then we will give the input to the Feedforward Neural Network which will be helpful in adjusting the pixels accordingly by using some activation function and weights that will be used to multiply with the input and some bias values. Then the output of the feedforward neural network will be given as input to the Naive Bayes algorithm which is a probabilistic model and will be used to predict the emotion. It gives more accuracy than other normal models.

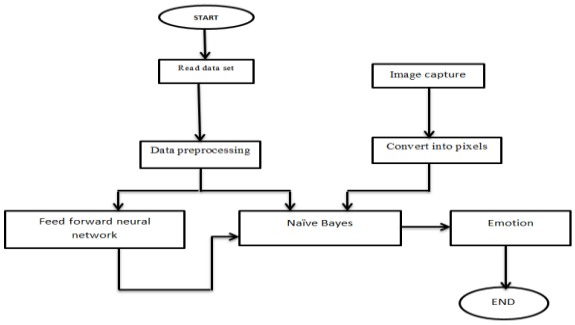


Fig.1 workflow of proposed frame work

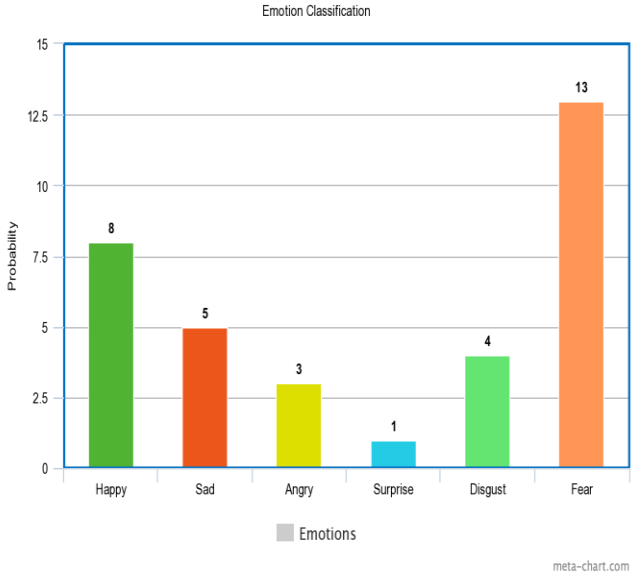


Fig. 2 Bar plot between emotions and probability.

From this bar plot we can visualize that the emotion predicted will be fear which is having more probability when compared to other emotions.

VI. CONCLUSION

Identification of emotion is crucial in identifying a criminal which we do not consider in most of the cases. Researchers have performed analysis using different algorithms for classification. Though there are many algorithms for emotion analysis these may or may not be accurate. In this regard our proposed model would be useful in predicting the emotion and most probably fear in the application of criminal detection with higher accuracy than that of other models.

VII. FUTURE WORK

Emotions can be predicted using this hybrid model of Feedforward Neural Network-Naive Bayes but when the image is converted to pixels if we are not able to classify the emotion as the dataset consist image pixels of different people and this pixel is totally different from all others.

To overcome this we may use a Multi-Layer Perceptron (MLP) rather than the Feedforward Neural Network as we can update the weights by calculating the error in output. Using Naïve Bayes-Multi Layer Perceptron (NB-MLP) model it can overcome these and can be able to increase the accuracy and performance.

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