Emotion Detection of Autistic Children Using Image Processing

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Abstract- *Facial Emotion Detection is an approach towards detecting human emotions through facial expressions. Autism Spectrum Disorder is an advance neurobehavioral disorder. Autistic people have repetitive, rude behavior. They are not ready to do social communication. People with this syndrome have problems with emotion recognition. This paper works on detecting the emotions of autistic children from the expression of their faces. This paper works on four emotions. These emotions are sad, happy, neutral, and angry. To detect the emotion of autistic children is performed with image processing and machine learning algorithms. The features are extracted from the faces of autistic children with local binary pattern. Machine learning algorithms are used for classification of emotions. Machine learning classifiers used in classification process are support vector machine and neural network.*

Keywords- Machine Learning, Support Vector Machine, Neural Network. Emotion Detection, Image Processing, Local Binary Pattern.

I. INTRODUCTION

Detection of emotion is a difficult area for researchers for a very long time. We express our feelings with facial expressions. Once we interact with others, our expressions show some essential signs such as our level of interest, our willingness to participate in speaking and to respond continuously. It helps in improving social communication. However, there are problems in detecting the emotions of people with autism.

Autism spectrum disorder is a neurodevelopment disorder characterized by difficulties with social communication and interactions. The mainstay of social difficulties is the identification of one's own feelings and the feelings of other people. As indicated by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, autism spectrum disorder is characterized by a dye of defects. 1) Impairments in social interaction and communication and 2) restricted, repetitive patterns of behavior, interests or activities. Autism spectrum disorder was introduced in the year 1940 by Leo Kaneural networker and Hans Asperger. According to him autism spectrum disorder is "an example of congenital autistic disturbances of affection contact". It is clearly defined that emotion processing challenges are part of autism spectrum disorder.

The rest of the article is organized as follows. In section 2, the emotion detection system is introduced. In section 3, the local binary pattern is introduced and how it is used in feature extraction. In section 4, techniques for classifying emotions are introduced. In Section 5, local binary pattern, support vector machine and neural network are implemented. Section 6 contains the concluding remarks.

II. EMOTION DETECTION SYSTEM

Emotion recognition is a method that allows emotion to be read on the human face with the help of advanced image processing. In our day-to-day life, we experience various situations and emotions. Emotion can be known as a concrete fallacy about the human condition. These emotions and thoughts are expressed through facial expressions. Facial expression assumes an important function in communication with a human being and falls under a non-verbal communication system. Human emotions are basically represented in different classes of emotions, for example Happy, Sad, Natural, Anger, Surprise, Hatred and Fear. Image processing is a rapidly evolving field of computers in engineering. Its development has been influenced by technological developments in processed imaging, personal computer processors and mass storage gadgets. There are three stages in detecting emotions.

- Selection of Images
- Database Training
- Emotions Classification

A. Selection of Images

The main problem in the process of image selection is: face recognition in the image. For still pictures, we have a tendency to take pictures of the face as a whole. It resolves the case of face detection. If we have pictures of other parts of the body, then we have to manually face cropping from the pictures and capture as a 256 * 256 pixel image. However during this study we have face images of autistic children. The image is of gray scale and has an extension of .gif.

B. Database Training

A folder containing samples of facial images is selected for training the database. Facial features are extracted with local binary pattern algorithm after selection of images. The commas separated values (.CSV) file is used to store facial features.

C. Emotions Classification

The classification of emotions is done in three stages: The first stage objective is to train the classifier with the features of the face images. In this paper, two classifiers named support vector machine and neural network will be used. The second step involves extraction of features from test images. Extraction is performed in this paper with local binary pattern algorithm. In the third stage, emotions are classified. In the classification of emotions the test file features are compared to the feature vector of images.

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If the features are matched with the database images then it will show the detected emotion message. The following diagram shows the proposed emotion recognition system.

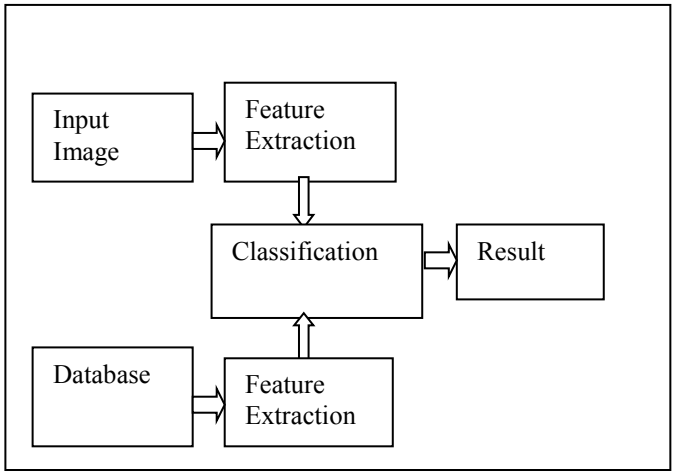

Fig. 1. Emotion Detection System

III. LOCAL BINARY PATTERN FOR FEATURE EXTRACTION

The local binary pattern was first introduced in 1990. This is an amazing method in feature extraction. Local binary pattern is used in a range of undertakings, for example, facial features extraction, facial recognition, classification and so forth. Over the years, local binary pattern has grown step by step into the use of specific personal computer vision and images processing. This approach is not good for monochrome grayscale images. Local binary pattern first splits the image into sub-images, which factor creates a histogram for each sub-image. After that all the features join the structure of the vector. The feature extracted through the use of local binary pattern is quite discriminatory due to the dimensions of the different regions involved. Local binary pattern is a very amazing Technique due to the fact of its computation speed and robust towards illumination variations. The pixels of the image with the local binary pattern are described through a decimal value known as local binary pattern code.

IV. CLASSIFICATION OF EMOTION USING MACHINE LEARNING ALGORITHM

The classification of emotions can be defined as the method by which we can distinguish one emotion from another. The feature extraction algorithm is performed before classification of emotions. Emotion classification is important in the recognition of emotions of autistic children. Machine learning algorithms are used in the classification of emotions.

A. Machine Learning

Machine Learning can be defined as an important subset of artificial intelligence where machines can learn without human intervention. Machine learning is the application/subset of artificial intelligence. Machine learning facilities the advancement of personal computer programs and the essential factor is to enable personal computers to adapt consequentially without human intervention. There are various algorithms that machine can learn. The data we feed to algorithm can be an input-output set or just an input. The supervised algorithm requires input-output units (i.e. they require output).Unsupervised algorithm simply requires input facts (not output).The following graph shows the learning algorithm.

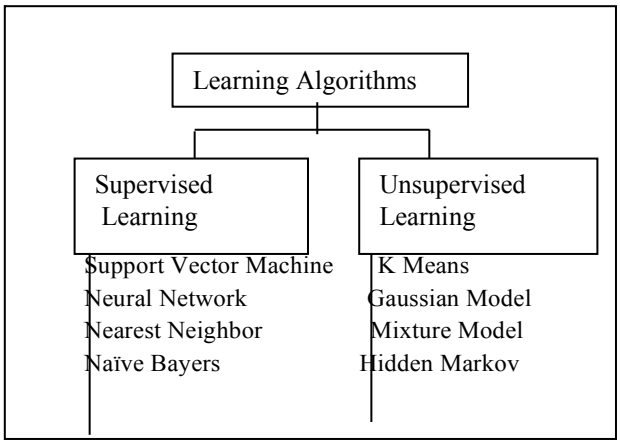

Fig. 2. Machine Learning Algorithms

B. Support vector machine Classifier

Support vector machine is a machine learning algorithm used for characterization and regression examination. The state of the art support vector machine was proposed by Vapnik and Cortes in 1993, and launched in 1995. Furthermore, it is largely seen as one of the hyper-plan grouping strategies, which relies on the concept of statistical learning for statistical superiority. In addition, support vector machine completes one of the most important characterizations, even though the available ready data is the original amount, but is unusually particularly suitable for classification. Support vector machine computation is described through several priorities that make it stand out among the largest classifiers in personal computer vision, for example, images can be classified via support vector machine.

C. Neural Network Classifier

Artificial neural networks were initially intended in some way or another to demonstrate biological utility systems, which are a part of the human mind. There are about 1011 neurons in our brain. Each natural neuron includes a cell body, an accumulation of dendrites, which carry electrochemical data to the cell, and an axon, which transmits electrochemical data from the cell. A neuron gives an output along its axon for example when it fires the total effect of its information sources acquires a distinct edge. The axon from one neuron can affect the dendrite of another neuron crossword at intersections called neurotransmitters. Some neural network sections will produce a beneficial result in the dendrite, For example one that encourages its neuron to flame, 17 and others will create a negative effect, for example, which discourages the neuron from terminating. A single neuron receives contributions from about 105 neurotransmitters and the entire number of neurotransmitters in our brain may request 1016.

V. IMPLEMENTATION

A. Implementation of Local Binary Pattern as Feature Extraction Technique

For feature extraction of autistic images, we use texture feature extraction of images using local binary patterns. Local binary pattern encodes pixel-wise information in textured images. The operator assigns a label to each pixel with the center pixel value and considering the result as a binary number.

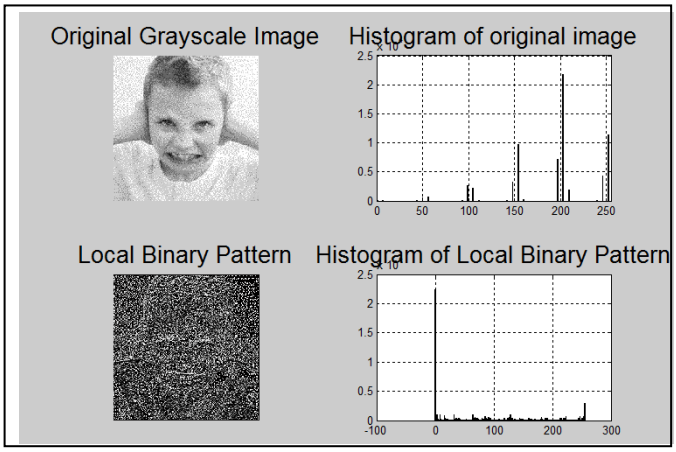

Fig. 3. Implementation of Local Binary Pattern as Feature Extraction

The attributes extracted from the images are stored in a CSV file that will be used in the classification process. The following figure shows the feature vectors of all images.

A	B	C	D	E	F	G	H	I	J	K	L
0.091094	0.001877	0.023281	0.0004	0.068619	0.005549	0.000506	0.000292	7.84E-06	0.000155	0.030938	0.00071
0.070649	0.000937	0.01128	0.000181	0.056854	0.007254	0.000459	0.00068	0.00021	0.000465	0.035929	0.00179
0.11391	0.002268	0.023072	0.002184	0.1029	0.005642	0.000159	0.000392	8.66E-05	0.000248	0.023855	0.00113
0.10566	0.001232	0.025778	0.000811	0.08849	0.010044	0.000266	0.000885	0.00029	0.000465	0.042067	0.00244
0.1091	0.004478	0.023532	0.003871	0.096116	0.005472	0.000279	0.000388	8.48E-05	0.00014	0.029311	0.00357
0.1096	0.000203	0.038347	0.000408	0.10566	0.003596	0.000139	0.000878	0.000158	0.00031	0.041943	0.004
0.079174	0.001798	0.015626	0.000928	0.04774	0.010571	0.000683	0.000965	0.000163	6.20E-05	0.040843	0.0010
0.11106	0.004951	0.024403	0.00383	0.098131	0.008835	0.000366	0.00154	0.000704	3.10E-05	0.036673	0.00115
0.11214	0.002949	0.02473	0.002737	0.098875	0.007099	0.000621	0.0005	0.000337	0.000465	0.029512	0.00138
0.1054	0.003972	0.020026	0.003876	0.10032	0.004433	0.000237	0.000312	0.000322	0.000217	0.057552	0.00321
0.11678	0.00334	0.023142	0.002911	0.1067	0.00479	0.000296	0.000572	7.80E-05	0.000512	0.02976	0.0016
0.09128	0.001756	0.022429	0.000731	0.078384	0.005131	0.000221	0.000187	0.000263	0.000326	0.024351	0.00133
0.086847	0.001675	0.017533	0.000895	0.076989	0.004604	0.000234	0.000423	0.000264	0.000667	0.030535	0.00059
0.11417	0.002152	0.039405	0.001999	0.11151	0.003937	0.000311	0.000426	0.00031	0.000186	0.033434	0.00064

Fig. 4. Feature Vector of Images in CSV File

B. Implementation of Support Vector Machine as classifier

Machine learning algorithm receive input information during the training phase, construct a model of the input and produce a speculative function that can be used for future information. The support vector machine relies on the results of the statistically beneficial knowledge of the hypothesis, pioneered with the aid of Vapnik Rather than inferences or analogies with natural learning structures. These results established that the overall performance of generalization of future inconsistent facts depends on what kind of characteristics it considers as potential rather than unpredictable.

C. Implementation of Artificial Neural Network as Classifier

A two layer feed forward network (multi-layer perception) is created with 256 neurons in the input layer,20 neurons in the hidden layer and 2 neurons in the output layer and using sim as an activation function. The network training instructed with Levenberg Marquart nonlinear optimization algorithm. It is one of the fastest back propagation algorithms with a combination of steepest descent and the gauss Newton Method. When the current solution is far from the correct one, the algorithm behaves like a steepest descent method: slow but guaranteed to converge. When the current solution is close to the correct solution, it becomes Gauss -Newton method. Thus, it continuously switches its approach and can make very rapid progress.

The input neurons receive the input signal from the training data of autistic children images, and this input layer processes the data and passes it to the hidden layer which makes computations of the data further and passes it to the output layer and the output layer compares it with target value and generate error signals, these error signals are sent back for adjustment of weights of each layer to minimize the error. The entire methodology works as:

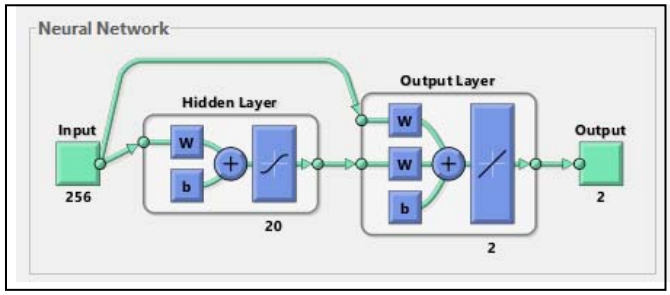

Fig. 5. Implementation of Neural Network

The entire topology consists of 256 neurons in the input layer, 20 neurons in the hidden layer and 2 neurons in the output neuron. While classification the instances which have not been used for training are used threshold value is set and if the values are near to the threshold value then the match is not perfect and output displayed as no match found. If the value is less then it recognizes correctly and display class is detected.

D. Data Collection

The images for the dataset have been downloaded from Google. The dataset consists of 25 images. The dataset images are autistic children images. 40% of dataset are used for testing purpose and for training purpose 60% of the dataset is used. This study works on four emotions i.e. (Angry, Neutral, sad and Happy). If we use 40% dataset for testing purpose then it means that there are 10 images used for testing purpose and 15 images are used for training purpose.

E. Experiments and Results

The test images are given as input to support vector machine classifier and the SVC classifier function is used for training the classifier. After training we get the classifier output as shown in the figure below:

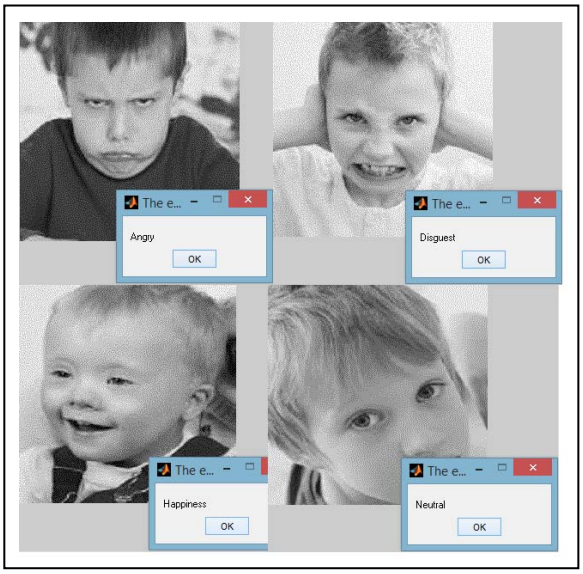

Fig. 6. Support Vector Machine Classifier Results

Autistic children emotions are classified with neural network classifier after extracting features with local binary pattern, which we see in the previous topology of neural network. On that topology, we give input in the form of images and we get emotion result as output. The below table show neural network classifier result.

Table I. Classification Results using neural network

N1=8	Out	Emotion
1	-0.9105 0.5226	Disgust
2	-3.3293 1.9763	Disgust
3	0.0477 1.6806	Happy
4	-0.3392 0.5377	Disgust
5	-3.6072 1.0527	Disgust
6	-0.2720 -1.8161	Happy
7	0.6650 0.6812	Normal
8	0.3623 0.6006	Happy

F. Performance Evaluation

The training of support vector machine with local binary pattern is quite fast as compared to neural network with local binary pattern. The whole network is able to cover by support vector machine with local binary pattern in 10 seconds but the neural network with local binary pattern takes 28 minutes and 40 seconds. The following table shows training time of support vector machine and neural network.

Table II. Training Time of support vector machine and neural network using local binary pattern feature extraction technique

Method	Training Time
LBP+NN	24 minute 40 seconds
LBP+SVM	10 seconds

The accuracy of support vector machine with local binary pattern is better than neural network with local binary pattern. The whole network is able to cover accuracy of 90 % in support vector machine with local binary pattern but the neural network with local binary pattern takes 70 % of accuracy. The following table shows the accuracy of support vector machine and neural network.

Table III. Accuracy of neural network and support vector machine

Method	Accuracy
NN	0.70
SVM	0.90

VI. CONCLUSIONS

In this study, an emotion detection of autistic children from facial expressions is examined by utilizing two techniques namely support vector machine and neural network. I started by describing about importance of this recognizing system and talked about the inspirations that encouraged us to consider this field. Moreover, I described Autism Spectrum disorder, Emotion Recognition, Need of emotion recognition for autistic children.
The experiment achieved different performances, and the overall accuracy was 90% which is achieved local binary pattern + support vector machine method and with local binary pattern + neural network method accuracy achieved is 70%.
Future work: In this study, high performance is achieved by using proposed method. However, I documented some information that may lead to improve the proposed system and proving its quality.

The suggestions are:

1. It can be used further for security models for example criminal detection. Rather than local binary pattern we can use other feature extraction techniques.
2. It can be used in prediction of age and gender from facial expressions.
3. It can be used in the ethnic prediction.

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