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Facial Expression Recognition – A Study and its counterparts

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Abstract:
Automatic emotion detection or recognition is becoming the most fascinating automation implication in recent times. Through automation, technology captures the actual emotions of the person without bothering the individual. The most interesting research field is automated emotion detection using facial expression. The facial emotion recognition is used in security means, feedback systems, human machine interface, etc. Most of the researchers in this field are applying various machine learning and deep learning techniques to interpret human emotions for further and future use. Such results are used to understand customer behavior and future prediction as well. With the remarkable success in deep learning and machine learning, various types of architectures are used to explore these practices for better business decisions and future standpoints. In this paper, various techniques of facial emotion recognition and detection were studied and explored. Along with this, the process involved in emotion detection is also narrated so as the internal process involved in this process can be addressed. Automation involved in the facial expression recognition is also explained though substantial amount of survey. The prime objective of the paper is to offer new standpoints and insights of the research in the field of Facial Expression Recognition.

Keywords: Facial Expression Detection, Emotion Classification, Automatic feedback system

1. Introduction

Verbal communication and non-verbal communication are the most general communication among human. In non-verbal communication, exchanging messages through facial expression is very common way of non-verbal communication. Through facial expression, emotions are detected and used as a means of exchanging emotion. The emotional communication in daily life has huge impact which is just next to the tone of voice [1]. Human emotions are a cognitive state or phase which is perceived by a human and this state of phase is associated with the person's mood[2].

Calibration in the area of face expression detection is not only useful for Mood prediction but it is also useful in identifying the people. It is useful to express the emotional state of mind of the person. Through such expression, the end person also recognizes immediately the feeling of the person. As a result of these, the facial expression information is used often in the automatic system of emotion recognition. [3].

Moreover, facial expression is very important to describe the emotional and mental state of the person. The psychological research shows that only 7% of communication done through language while in 38% of communication or exchange of information is done through auxiliary language. It includes the rhythm of speech, tone, confidence level, etc. The rest 55% of communication is carried out by facial expression [4]. So as, plethora of information can be obtained through study over the facial expression recognition. This is considered as the most effective way to perceive person's consciousness and mental activity. The study of facial expression exhibits some important theoretical research values, practical values and life application values. The natural signals of a person can communicate very effectively whether the person is available for direct communication or the images or videos are available to study the same. Off course, such emotions are not easy to understand and interpret by machines but humans can do it very easily and significantly[2].

As discussed, face expression detection and recognition has huge effect on various aspects like social intelligence, decision making, convincing other people, etc.[5]

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As mentioned in the introduction, the facial expressions can be recognized and interpreted by the human easily but it is not as easy for a machine. Various computed aided techniques are used to determine mood of a person through facial expression of the person. Here in this paper, we have explained various categories of facial expression and its features, related work done in the said area, integration face expression and computer science and proposed approach to do research.

2. Categorizing Facial Expressions & It's Features

The important part of nonverbal communication is caliber to grasp the facial expression.To presenting emotions, each face has its own exclusive way.Human facial expressions change frequently throughout the day according to their mood.Happiness, Fear, Sadness, Anger, Surprise, Disgust and contempt are seven categorized emotions that are universally admitted.[6][7]

Universal Emotion Identification

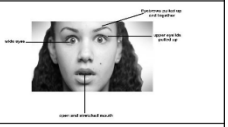
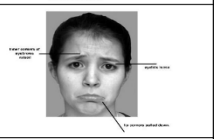
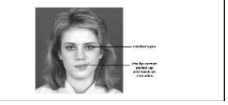
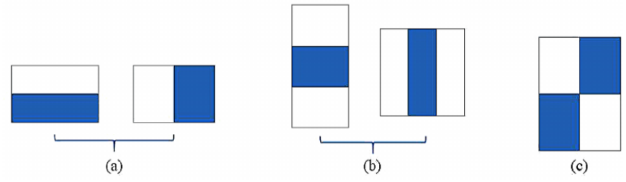
Emotion	Facial Movement	Expression
Happiness	Muscle around the eyes tightened, wrinkles around the eyes, raised cheeks and corners of mouth into a smile, lip corners raised diagonally.	
Fear	Eyebrows pulled up and together, upper eyelids pulled up & wide eyes,open and stretched mouth	
Sadness	Inner corners of eyebrows raised, eyelids loose, lip corners pulled down.	
Anger	Eyebrows pulled down, upper eyelids pulled up, lower eyelids pulled up, margins of lips rolled in, lips may be tightened.	
Surprise	eyebrow pulled up, eyelids pulled up, mouth hangs open, Wide eyes	
Disgust	Eyebrows pulled down, nose wrinkled, upper lip pulled up, lips loose.	
contempt	Eyes neutral with the lip corner pulled up and back on one side.	

Fig.1 Emotion Identification[6][7]

3. Literature Review

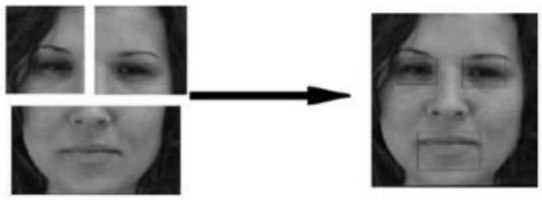
3.1 Emotion Recognition Using Facial Expression Analysis

In this paper, with the use of android application through digital images how to recognize the emotions which is explained by the authors AL.L.Ghali and Mohammad-Bassam Kurdy.To study and analyze human's current state of mind is the prime goal of Facial Expression Recognition System (FERS). Mostly it is implemented using JAVA programming language. While implemented the author is not only required to have good knowledge in Image processing technique but must have very good command over machine learning tools and techniques. Face detection with landmark localization within the image is the first step towards the emotion detection process. Such an example shows in fig., where they usedViola and Jones' Haar feature Detection algorithm which is basedon open cv library.



(a) two-rectangle features. (b) three-rectangle features. (c) four-rectangle features.

two-, three- and fourrectangular features are the possible types of features. Here feature values is calculated through the difference between white rectangle pixels and gray rectangle pixels.



In proposed system, authors are applied algorithm for face, eyes and mouth localization withuse of already trained classifiers from OpenCVlibrary. After completion of detection authors have use following steps for face detection. Firstly, authors convert color image into grayscale. Most researchers assume that the color-to-grayscale method is of little significance when using vigorous descriptors.As per the authors survey grayscale simplifies the algorithm

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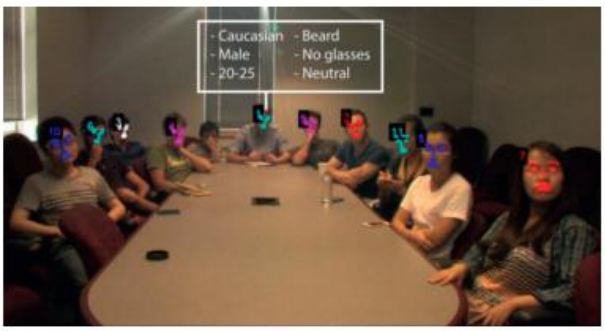
and reduces computational requirements. Second step is Histogram equalization which is useful for the bright or dark image. After completion of step to next one is blurring image by Gaussian function to reduce noise from image.

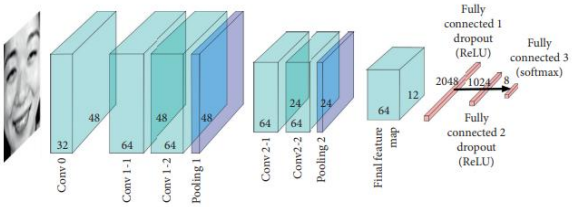
To make the identification process fasterand more accurate they have used Fisherfaces algorithm, which includesPCA algorithm and LDA algorithm, which have been implemented through the OpenCv Library.Authors identified seven types of emotions (neutral- happy- sad- surprised- afraidangry- disgusted). Additionally, emotional images were obtained from a Karolinska database that qualified using OpenCv library. It gave better results when authors may than compare their system with previous implemented system. As per the author the main problem in this system is the time in the training phase. Due to the enlarge database it takes more time in training, but in contrastthe results become betterand more accurate when the database is large.[8]

3.2 A Study – Using Facial Recognition of students during online education to recognize emotion.

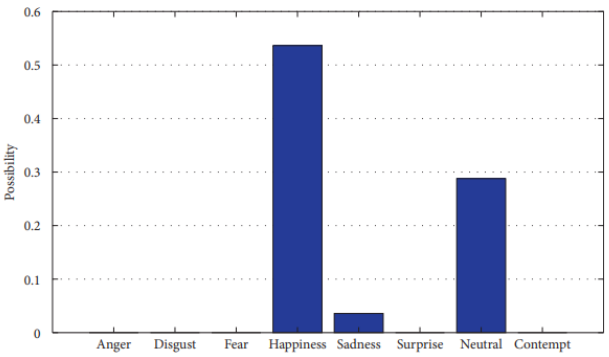
Weiqing Wang, Kunliang Xu, Hongli Niu, and XiangrongMiaohave published their paper, to find out mood of the students at the time of online classes, they have found out from their facial expressions with the use of Facial Expression Recognition algorithm.By combining online education platform and CNN, one can monitor the emotions of students in real time. It can be ultimately improving the quality and efficiency of onlineeducation.Authors have used IntraFace, apublicly available software package that integrates algorithms for face detection as the tool of pre-processing.



As shows in figure, it can also be used to detectmultiple faces at the same time. The structure of CNN model which is shown in figure.



It is created with the use of a compact deep learning model based on the architecture ofCNN. The proposed model was trained by databases Jaffe, CK+ and FER2013 that include the above 8 basic expressions atthe same time.The result that can provide favorablesupportfor the performance of the model when applied.



The expression of happiness was visible on the faces of most of the students because of having already told that the lecture is coming to an end.
The current methods are ineffective to detect face when cause of difficult environments facingproblems, such as backlight, shadows, and facial incompleteness.[9]

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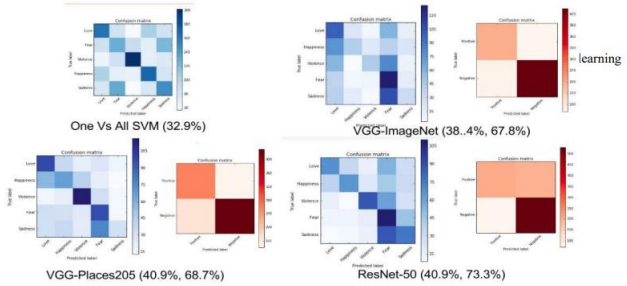
3.3Emotion Detection and Sentiment Analysis of Images

Vasavi Gajarlaand Aditi Gupta authors of this paper have udrf deep learning for prediction of images uploaded on social media websites. Through those images they have understood and analysed the sentiments and mood of the people after the election. The ultimate objective of the process is to classify the image into 5 different categories. To collect the image metadata used the Flickr's API service by authors.Than downloading the images from Flickr server. The Authors had collected total 9854 images for this project in which 1900 images for each category. In which used 75% data is used for training and 25% for testing. These data then had been experimented by various classification methods like SVM on high level features of VGG-ImageNet, fine-tuning on retrained models like RESNET, Places205-VGG16 and VGGImageNet and many more.

Firstly, one vs All SVM Classifier was used to represent input for that they have used VGG-ImageNet as the pertained model then after performing multiple steps they have obtained an accuracy of 32.9 % on the test data.

The One vs. All SVM classifier's results are better than chance (20%) but still far from ideal.

As a result, they tried adjusting the VGGImageNet model and then added a dropout layer and trained it using their dataset. In this a maximum testing accuracy of 38.4% was attained.To understand results better, they perform sentiment analysis on dataset.It gives 67.8% accuracy.

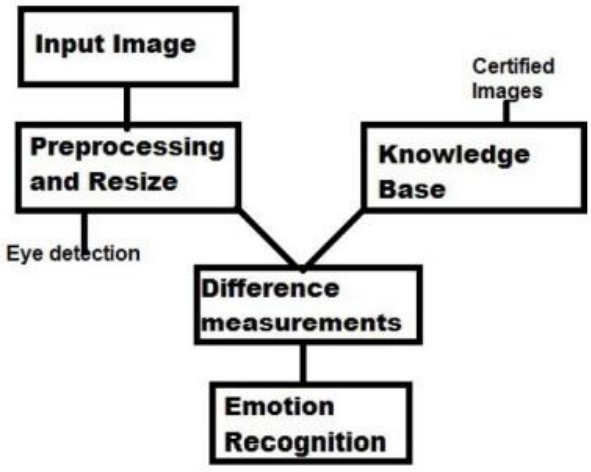


Authors have also experiment with fine-tuning a pretrained ResNet50. This network has 50 layers and trained over the scene-centric and object centric data. They get 40.9% of testing accuracy on emotion classification task and an accuracy of 73% on sentiment analysis task.

As shown in the figure 8, diversity in emotion plays very critical role. In the image, mother sitting with her baby always considered as happy emotion but the image does not support this fact. Some way, candle is considered as pleasant moment object while used along with dinner location and the candle is used in some community as a symbol of sorrow [10] .

3.4Human Emotion Recognition System

The author Dilbag Singh has published a paper for intelligent surveillance systems to detect anomaly behaviors like predict potential terrorist activities in public places using neural network. Design has been developed in visual basic implement it using Matlab.



As per the author's research Luigi Rosa has proposed an algorithm for facial expression recognition. In his research, facial expressions were classified into 3 basic categories. To remove noise from the image author has used preprocessing and resize method which consider

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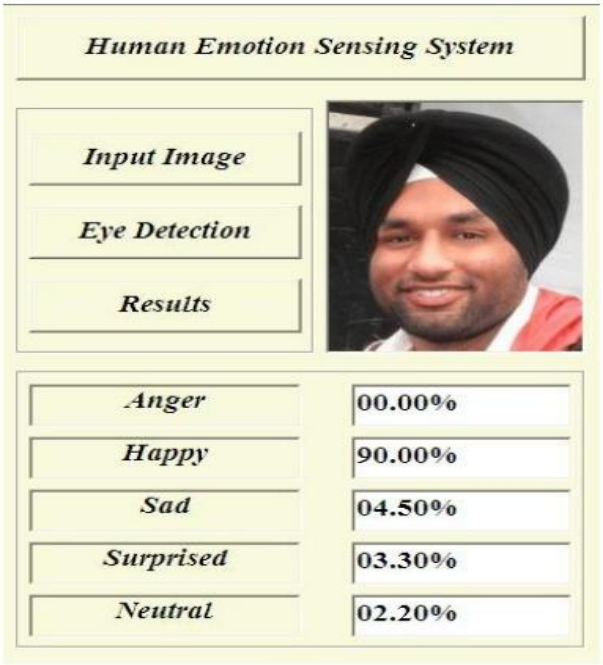
only human face. It's done by using eye selection method.



The result of this way is utmost powerful because it does not require the detection of any reference point. This paper analyzes the limitation of the previous Emotion recognition using brain system with the use of neural network and get 97% more accurate result in easy and simplest way.It is fast and can be used for real-time applications. Limitation of this system is like at a time it will give answer in only Yes/No.[11]

3.5Use of Facial Emotion Recognition in E-Learning System.

Development of a new facial emotion recognition system is the main objective of the author [12]. Here video conference type system is used where motivation level and emotion states have been recognized. This system is developed in python platform. To detect a face authors have been used Viola-Jones algorithm. After completion of face detection,they have used facial landmarks detection algorithm proposed by Sagonas.

Furthermore, next step is emotional recognition which is implemented by various classification method like Support Vector Machine, k-nearest neighbor, Random Forest, Classification & Regression Treesand then comparedit by authors.

The classification results of machine learning algorithms

Tested Algorithms	Accuracy (%)
kNN	96.38
Random Forest	93.36
CART	89.11
SVM	97.15

In most of the instant emotion recognition process, SVM with RBF kernel function is used to achieve best performance [12].

4. Facial Expression Recognition System – An Integrated Approach

Facial Expression is non-verbalway of communication. Emotions areexpressed by different way and facial expression ismost powerful among all.[13]Facial Expressionhas categorists in 7 types(Happiness, Fear, Sadness, Anger, Surprise, Disgust and contempt)process of the Facial Expression Recognition is divided in following stages.

1)Input

Here the input is person's face which is captured through digital video camera or online face capturing.

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2) Face Detection

To detect the face from capture image is the first and main step of the Facial Expression Recognition. face detection is the process that actually verifies that weather the given image has face image or not. The output will be go into the preprocessing step after detecting the face.[14]

- Pre-processing

To extract important features from image, preprocessing techniques are needed to apply.
There aremany types of processes are including in image preprocessing such as it addresses presented noise in image and reduce it, image clarity and scaling.[15][13]

Normalization:

The term normalization purpose is to convert an input image into a range of pixel values that are more familiar or normal to the senses.

Gray scaling:

It is a process of converting a colored image into grayscale as colored images are difficult toprocess by an algorithm.

Resizing:

It is used to remove the redundant parts of the image that increases computation speed.[16]

3)Feature Extraction

The next step of FER process is the feature extraction. This process is carried out to find and analysed positive features for further processing. Implicit data depiction from graphic is the significant stage in image processing. The same data depiction is used as an input of classification. Such feature extraction methods are categorized into 5 categories. Results obtained through this method is used as input for classification [16].

4) Classification

Classification is the final stage of the FER system, where classifiers classify expressions such as smile, sadness, surprise, anger, fear, disgust, and neutrality. Features such as geometric features and appearance features are extracted from the 3D face using various descriptors (possibly 3D surface descriptors, texture filters, covariance region descriptors). The eye and nose regions of facial markers are identified by extracting the main curvature and shape indices Efficient facial expression recognition Lip-based features are easily extracted using geometric descriptors and averaged, median and histogram features are also extracted 3D FER. The descriptor also consists of two face components such as Basic Face Shape Component (BFSC) and Expressional Shape Component (ESC) CNN, Naive Bayes Classifier (NBC). The 3D FER experiments primarily use his 3D facial expression database from Binghamton University and the Bosphorus Strait database to perform classification to find different and unique facial expressions. After doing this classification correctly, one can get the output in the result form.[17]

5. Conclusion

As the conclusion of the paper, various face expressions like fear, happy, anger, sad, surprised, etc were discussed and identified for the purpose of classification. Through identification of such emotions, researchers can move further to conclude something that is dependent on the nature of the application or area of study. Various emotion detection techniques and procedures are also identified and depicted in the paper. Abstract comparative study also conducted among the available techniques. Such kind of survey may lead to implementation of such technique for the future aspects. At a glance, CNN was found the most effective and efficient among all the rest of the techniques.

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