

Analysis of Emotions Using Electrooculography and Pupillary

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Abstract

Today's demand for systems with Human Centered computing grows, systems of automated tools with human gesture and emotion recognition capabilities are the need of the hour. Emotion Analysis and recognition has become an interesting topic of research among the computer vision research community. The model proposed aims to analyze the emotions to give a clear a picture which gives a better emotion recognition and accuracies by EOG and Pupillary Reflex. The eyes are the important part of human beings and are very common in capturing emotions so the techniques used here is Electrooculography (EOG) which is actually captures the eye movements considering the face and forehead as a whole and another technique is Pupillary Reflex of eyes which gives the contraction and retraction of the pupil of the eyes which helps in describing emotions. The model will give the accuracy of capturing emotions and classifying it accordingly.

Introduction

In the world of today, the automation and intelligent systems has grab the whole world where we are considered as a intelligent entity and are exposed to the respective experiments. Human beings are subjected to various situations and human has a feature of reacting or getting emotional which becomes an integral part when a human being is born but emotions, sentiments are present more predominantly in human beings and not very predominantly in animals. Today's world every possible work can be detected by machine and many other possible techniques. In the world of computers, it is automated and can be easily recorded and analysis is possible to get an overall outcome. Hereby the machine and the respective algorithms does a proper analysis than manual set up. So, many researches are going on and its increasing in number as it is very significant in recent days. Nowadays many kinds of learning makes the world within our fist which can be cognitive learning, physiological Learning, non-physiological Learning which helps in the human and machine interaction which usually terms as Human Computer Interaction. Emotional Intelligence can be detected from the different sense organs of the human body. The emotions can be detected from the facial expressions where the emotions can be detected from the cheek cells of the face which helps in detecting the emotions. The emotions can be detected from the eyes which can be through retinal analysis , pupillary reflex, EOG and many more techniques which helps fetching the correct emotions which the person gives at any situation. Emotions can also be detected. Human face and eyes are integral part of detecting human emotions which may be the fear, sad, Happy, Anger and Neutral. The techniques are explained in the following description in brief.

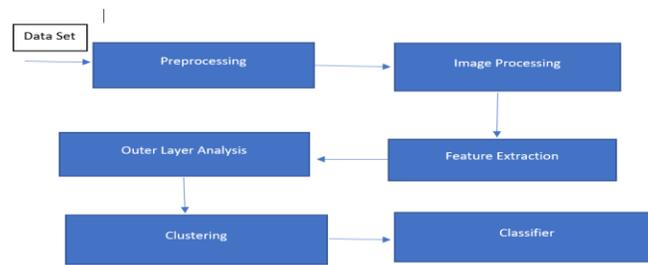


Figure 1. Flow of any Extraction of Emotions from Human Face or Eyes

Related Works

The [1] refers to various eye movements which is basically the strength levels of the eye movements which helps in the finding the voltage of the electrodes which are placed while recording the EOG signals which helps in recording whether the movements are in the either or directions which helps in recording the movements. The [2] gives us the deduction of the driver drowsiness while driving using the facial expression and eye muscle movements. The We assess the effects of different facial sub-regions on recognition accuracy and determine that combining the eye and mouth areas can result in the highest recognition accuracy. We also investigate the effects of different frame rates on the recognition results. The [3] gives the results as the multimodal emotions can be reduced by feature level and decision level using various techniques naming them as by obtaining from EEG signals and eye tracking data which is basically the data obtained when the eyes are exposed to high lights and bright lights and eyes gives the changes as contraction and retraction which helps in recording the size of the pupil and fusion strategy is applied to get accuracies of the techniques.

Feature Extraction

Feature Extraction is an integral part in any emotion recognition. Feature extraction is required in the process so there are few feature extraction for human face and human eyes so considering that there are many which are used in the earlier researches as proper algorithms which are dimensional analysis which consists of dimensional reduction and Discrete Wavelet Transform which usually gets acquired from the EOG signals. Features plays an important role in the classifying the signals and its classes. The frequency bandwidth of eyes varies from the 0.1 Hz to 15 Hz is selected for extracting the eye movements for positive stimulus, negative stimulus and neutral stimulus and the other feature extraction which can be used in case of eyes can be the principal component analysis which is basically the outer layer analysis which helps in extracting the features of the nature of the signals or the processes of the image processing because the technique which can be used is the eye tracking data which helps in the extracting the feature of pupil movement through image processing.

Discrete Wavelet Transform used as-

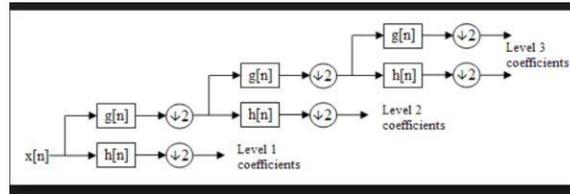


Figure 2: The Levels of Transformation

Discrete Wavelet Transform is a process in which the wavelets are discretely sampled and key advantage is the Fourier transform is a temporal resolution which captures both frequency as well as location information. Wavelets are used to denoise and filter the image and thus it helps in the image processing by selecting the wavelets and then decomposition and then detects the correct resolution and filter the gaussian noise and filter the image accordingly.

PCA- [6] In PCA we find the covariance of the data which are extracted from the data set. When we consider a case which has the red, green, blue are colors which are the components of each pixel present in the image which classifies the image in a proper way. Usually the red color have more wavelength and are more sensitive in case of the image sensors than the blue and green color and thus the three colors are correlated accordingly.

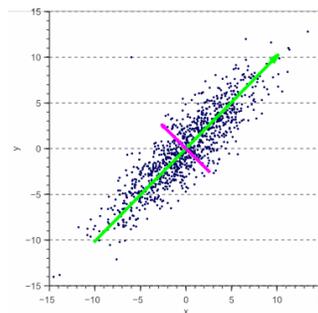


Figure 3: 2D Correlated data with eigenvectors.

The features x and y , in figure 3, are distinctly correlated. In fact, the covariance matrix is: $\text{Sum} = \text{cov}(x, y)$ -----Equation 1 //Calculates the covariance of the matrix

In few of the articles before it gives a clear picture of the correlation and the geometric representation of the covariance matrix and the covariance matrix can be decomposed as a series of operations which is the rotation and scaling and uncorrelated data is calculated by the eigen vector. Thus in figure 3 it is easily seen that the data D can be decorrelated with the rotation of the V which is eigen vectors along the reference axes:

$$D' = VD \text{-----Equation 2}$$

When we get the eigen vectors then we find the correlated then we find the total effect value considering the antecedents and consequents and eigen vector which helps finding the values which are further used for clustering.

Classification Algorithms:

The Classification is important part for emotion Recognition which helps in the training and testing of the data as a whole which helps in the finding out the accuracy of a particular technique and classification helps in the partwise accuracy also in which the data can be tested in a different parameters with different range. The classifier is used for training the data for different signals. The classifier can be the ANN, Support vector Machine, Fuzzy Machine which helps classifying the data when the human face or human eye is used. Classification is representing the data points distinctly and approximately used the mapping function. The classification can be used in two ways because we use two techniques not one technique which helps in the making the decision more prevalent by classifying the features.

Classification for Emotion Recognition can be used in two ways:

- Decision Level
- Feature Level

There are few classifier algorithms which are used in Emotion recognition that can be :

- Decision Tree
- Support Vector Machine
- Fuzzy Logic
- Artificial Neural Network

Decision Tree:

Decision Tree helps in building the classification models and regression models in the structure of a tree. It uses the if-then-else rules where we get a condition statements if this rule or decision does not satisfy the other decision is taken which is mutually exclusive when decision is taken. The rules are sequentially treated by the training data and the testing of the data is done after the data gets trained properly and the data is tested in a proper percentage gaps.

The construction of the tree is done by following recursion and top down approach. The attributes which are at the top are more responsible for the responsible for classification which data to be trained on what basis and helps in categorizing the data in that way possible.

Support Vector Machine- Support Vector Machine which is used in the emotion recognition through human eyes can be prevalent and which helps in the training and testing of the data helps in getting the results in the correct way possible. Support Vector Machine is the unsupervised learning technique which helps finding out the regression points and the classifying the data using training and testing methods. The classifier is used in the classifying the images and the classification is done in a correct way and also helps in many biological processes in which researches are going on and will be used in the further biological processes. The support vector machine is a very simple set to implemented on. SVM has an optimal plane which is the hyper plane which has two levels which helps in categorizing the data according to the levels of the frequency. Support Vector Machine tries to generalize the error using classification and regression and other outlier detection and helps accordingly.

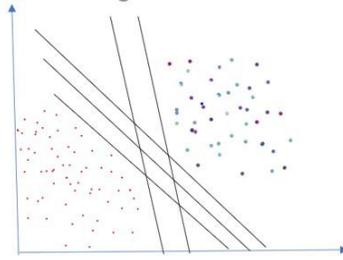


Figure 4: SVM Classification and Regression

Fuzzy Logic

Fuzzy Set Operation

A fuzzy operation creates a new set from one or several given sets. For example, given the sets A and B the intersection is a new fuzzy set with its own membership function. Let the set

$A = \{0.2, 0.3, 0.5, 0.2, 0.8\}$ $B = \{0, 0, 0.6, 0.8, 0.2\}$. **Union**

The function gives the union of the two fuzzy sets A and B with the membership functions. As for example, let there are two fuzzy set $A = \{0.2, 0.3, 0.5, 0.2, 0.8\}$ and $B = \{0, 0, 0.6, 0.8, 0.2\}$. The union of A and B is

$(A \cup B) = \{0.2, 0.3, 0.6, 0.8, 0.8\}$.

OR operation in Boolean Algebra is equals to the union operations.

Intersection

The function gives the intersection of the two fuzzy sets A and B with the membership functions. As for example, let there are two fuzzy set $A = \{0.2, 0.3, 0.5, 0.2, 0.8\}$ and $B = \{0, 0, 0.6, 0.8, 0.2\}$. The union of A and B is $(A \cup B) = \{0.2, 0.3, 0.6, 0.8, 0.8\}$.

AND operation in Boolean Algebra is equals to the intersection operations.

The minimum values of two set will be the intersection of the set. As for example, the intersection of two set A and B is $(A \cap B) = \{0, 0, 0.5, 0.2, 0.2\}$.

Complement

The complement means negative. So here negative of a membership function which is the fuzzy set is called complement. In Boolean Algebra, it is basically called NOT operation. The complement of A is $A^c = 1 - A$ which is $\{0.8, 0.7, 0.5, 0.8, 0.2\}$.

Proposal

General overview

The recognition of the emotions are done by take only the part of the face which is the eyes which the two techniques are mainly focused which are **EOG**(Electrooculography) and by recording the pupillary reflex which is the contraction and retraction of the pupil.

Techniques

A.EOG

Going to the details that **EOG**(electrooculography) is a technique where we try to record the eye movements by placing some electrodes in the face more specifically the forehead and the area around the eyes where the eyes movements can be placed and the area is recorded for the detection of various expression in the face which helps in the detection of the emotions. EOG describes the measuring of the cornea-retinal standing potential that exists in all the portions of the human eye which may be in the front or at the back. The resulting signal is called the electrooculogram. Primary applications in ophthalmological diagnosis and in recording eye movements.

EOG [9] does the movement of the cranial bones which further helps in the detecting the voltages of the electrodes which being placed in the areas near the eyes which helps in detecting the movement of the eyes which has bones in the face which helps in detecting positive and negative voltage which detecting the eyes movements which in turns helps in turn triggers the movement of the pupil which helps in contraction and retraction of the pupil of the eye which usually if subjected to illumination it shows the changes and helps in recording of emotions which helps in getting the accuracies of the both techniques. The eyes moves in a circle in its socket by using of the six muscles. These six muscles consists of medial and lateral recti. These muscles leads to horizontal movements. The other respective muscles are the superior as well as inferior recti which leads to vertical eye movements. The remaining other two muscles are oblique in nature and are focused for eye rotation around the primary axis of sight and vertical movements of eyes. The refelection of the signals is dependent on the movements of the eyes which may be in any direction.

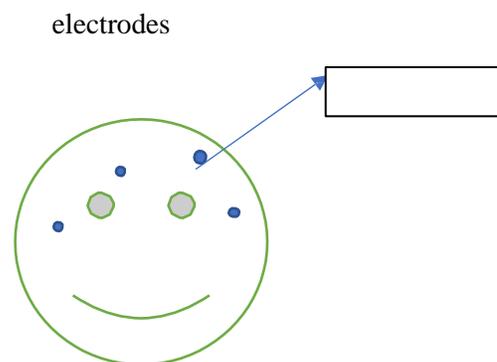


Figure 5: The electrodes placed when recording the eye movement

B.Pupillary Reflex

Going to the details of another technique which can be detection of **pupil movement** inside our eyes. The pupil of the eye is a very sensitive organ of the eye which reacts to any illumination which may be

any videos or any moving objects or any static object which shows two types of reaction that may be the pupil will become larger or will become smaller in size which concludes to be retraction and contraction of the pupil and the movement of the pupil is recorded.



Figure 6: Emotions reflects in eyes

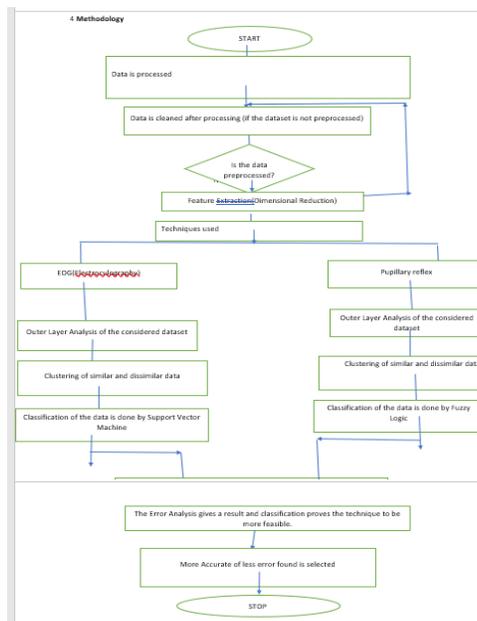


Figure 7: Flowchart of the Proposed System

EOG-The technique for getting the movements of eyes which may be the upward and downward movement which will help in the recording of the eye movements. One of the base paper(EOG) attached helps in deriving the EOG signals which is derived from the particular eye movements. According to the planning to get the existing and not deriving any dataset and helps in the proceedings in the project workflow as mentioned in Figure 7.

Pupillary reflex- The pupil [6] gets contracted and retracted when eyes are exposed to any videos or any moving objects which I want to expose the eyes to bright and shabby pics or any various moods or genre of films or videos are shown and the recording of the eye are taken which helps in getting the signals of the eyes of right eye and left eye which will give us a recording of a eyes and where we can apply few algorithms as mentioned in Figure 7.

Conclusion

The survey concludes that emotions can be derived from the human faces and human eyes .The emotions like fear, anger, sad, happy are the diverse emotions which are recorded by the various techniques using outlier analysis, feature extraction, clustering. The emotion recognition and various classifier like SVM, ANN, Fuzzy Logic, Decision tree to train and test the data and find the accuracies of various techniques. The aim is to find which is the accurate method of finding out the emotions from a human beings in which situation the person is in through only eyes and by which technique it is more feasible to deduce. So we are trying to find the accuracies of the detection of emotions which techniques gives a better result to use for commercial purpose.

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