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Face Expression Recognition System: A Survey

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Abstract: Face Detection of a Human by a Man-made intelligence has got the attention of many researchers and scientists alike. When a computer or a robot could be made to detect a human's face through either their in-built cameras or any other optical input devices why not also make those camera device determine the expression of that human too? It has become a possibility with the current rise in technology and various other algorithms. To simply put human face involves various facial muscle movements which constitutes to a collective term called Facial Expression. There are particular areas which can be referred to as Critical Points on face whose disposition in a specific pattern can make an individual's expression, depending on the type of mood or circumstance he/she's in. There are 6 basic expressions Happy, Sad, Disgust, Anger, Fear and Surprise. Well this paper focuses on determining these expressions which will be explained in the following parts.

I. Introduction:

Alongside verbal communication, non-verbal communication also plays an important role in conveying an information to the recipient. There are various filed of scope for Non-verbal communication, starting with body language and one major give-away informer is the face. Yes, the facial expressions are the outcome of internal feelings that are quite not appropriate to express in certain situations. A system that is built to detect and determine the Facial Expression automatically just by an interaction of the subject with the system can be called Automatic Facial Expression Recognition System, AFERS. There are 3 major steps involved in this system:

1> To detect a face of an individual.

2> To extract the facial features like eyes, nose and mouth of that face.

3> To classify these detected expressions into Happy or Sad or Anger or Disgust or Surprise or Fear.

Now, many proposed methods are used to detect the face and determine the expression of that subject. One popular method used to detect a face is through skin color detection and segmentation [2]. While facial features are extracted using Active Appearance Model AAM [2]. This paper also uses the above proposed methods for detection and extraction. Chuan-Yu Chang, Jeng-Shiun Tsai, Chi-Jane Wang, and Pau-Choo Chung implemented a method where they extracted 14 feature points on face [1] along with Physiological signals involving skin conductivity, finger temperature, heart rate from subjects while this paper intends to reduce the feature points and still identify the facial expression without taking into consideration the physiological signals. Few Particular Facial Expressions contain rich information about an individual's emotion. Isolated facial expression detection is quite hard to find not that it's rare but usually a facial expression involves movement of the head maybe rapid or slow. Thus static and dynamic readings are taken into consideration by separating a rigid motion (involves either body movements or just head or both body and head movements) from non-rigid movements (deformed facial expressions) [3]. [4] Suggests and implements the use of Local Binary Pattern (LBP) and Center-symmetric Local Binary Pattern (CSLBP) to detect a facial expression where a neutral expression is stored in the database and it will be hard to recognize an expression if it's any other than a neutral expression. Thus they would use LBP and CSLBP to extract local binary features of the image and then use Euclidian Distance, Histogram Intersection, chi-square distance to recognize the face. They evaluate the performance on Japanese Female Face Expression (JAFFE) database. [5] Used the method of comparing the ancient and modern chinese physiognomy to obtain a baseline for modeling a facial feature. Lastly, predefined shapes built using constrained local models are fit on an image and support Vector Machine architecture is used to detect Face expressions [6].

II. Literature Summary:

This Section consists of contents that are relatable and referred to the current project and consists of only those sections that proved helpful by providing the necessary thoughts and hints to carry out the project. The below are ideas of interest that are being included in this survey as they are published by the respective authors.

[1] - Among various sensible emotional reactions, facial expressions usually happen with the changes in distances between the facial features (feature points) while emotion is excited. While emotions are excited the physiological reactions and their corresponding physiological signals are hard to control, in a way they are partly involuntary. Here, a novel approach is proposed to recognize four emotions (love, joy,

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surprise and fear) by facial expression and their signals. Although there might not be any identical factors between an expression and physiological emotion this paper makes an effort at finding a similarity between the two and determine what the actual expression is.

PROPOSED METHOD: Before a Facial Expression can be determined through varius points on face called the feature points, the face region has to be detected first and then the corresponding features can be extracted correspondingly. After the respective face features to be extracted are identified they are subjected to training and testing of a classifier for an expression detection. Following are the steps take to achieve the result.

1) Face Detection: An adaptive color space switching method will be used to detect and plot the face regions automatically on the video frames.

2) Feature Points: Before the contrasting features on face can be extracted, fourteen feature points in eyebrows, eyes and lips in the face region will be defined. Three points are taken into consideration in the eye region that includes the uppermost, the innermost and the lowest corner points for each eye. Two points on eyebrows that includes the center and the innermost corner points of each eyebrow. And as for the lips, there are four points, the upper, the lower, and two outermost corner points of the lip region.

3) Feature Distances: Twelve points out of fourteen extracted feature points is measured using Euclidean distance between them to determine the expression on the face.

[2] – This paper used, Active Appearance Model i.e. AAM method to extract eh face features. Finally, the expressions are recognized as Happy, Sad, Anger, Fear, Disgust, and Surprise, initially by using simple Euclidean Distance method and then by training the Artificial Neuro-Fuzzy Inference System (ANFIS).

PROPOSED METHOD: 1) Skin Color Detection – One of the good feature to be considered in detecting a human face is detecting skin color. Since color will allow faster processing and is highly robust to variations in geometry of face pattern, skin color has proven to be a useful and robust cue for face detection, tracking and localization. **2) Lighting Compensation -** Many times there are large variations in the real colors of skin in an image, since the skin color is often affected by light in the image. So to make color correction in color images, lighting compensation algorithm is used. **3) Expression Recognition using Euclidean Distance method -** In this method, the database consists of training data sets and testing data sets of images. For one particular subject, the training and testing data sets consist of images of different expressions like Neutral, Happy, Sad, Anger, Fear, Disgust, and Surprise. Using AAM method, the points on facial features are located for all these images and stored in the form of data file. The data file consists of the relative x-y co-ordinates of those located points. When any test image is given as an input, the system finds the Euclidean Distance between the points on the test image and the points on each training image.

[3] - In this paper work, the initial steps towards separating rigid head motions from that of non-rigid head motions based on optical flow, caused by facial expressions is proposed. This paper suggests that after the separation procedure, both, head movements and facial expressions can be used as a basis for user's emotion recognition and feature dispositions. Facial movements are often confounded by superimposed motions corresponding to the respective expressions. A general approach is to stabilize the appearance of the face and further process the residual non-rigid spatio-temporal changes as an indication for changes in facial expressions.

PROPOSED METHOD: Based on the estimated optical flow fields, localizing and identifying the rigid and non-rigid face motions are constructed. Every input will be transformed into tuned maps for comparison with the set of motion patterns on multiple scales. The result obtained from matching templates will be used to conclude which part of the optical flow field will be caused by rigid motions and which changes caused in the optical flow field reflect non-rigid motions. The assumption made is that rigid head motions are captured by templates matching procedure with the inputs on larger scales, whereas non-rigid motions primarily occurred at smaller scales and they are contrastive to the surrounding patterns.

[4] – According to this paper work basically there are two types of face representations for face expression analysis. One is, holistic template based methods and the other is Geometric feature - based method. In a holistic system, the whole face image is processed to obtain a template which can be a pixel image or a feature vector. In a geometric feature-based system, the feature vector is obtained by extracting shape and location of facial components (including mouth, eyes, brows, nose, etc.) The feature-based techniques are expensive than template based techniques on the basis of computation but are very robust to variations to scale, size, head orientation, and location of the facial features. Local Binary Pattern summarizes local structures of images efficiently by comparing each pixel with its neighboring pixels. Local Binary Pattern is preferred because of its computational simplicity. It effectively tolerates the illumination changes.

PROPOSED METHOD: The use of the LBP has been increasingly used in various applications. In the LBP technique, all the pixels of image are labeled by LBP operator by thresholding the 3X3 neighborhood of each pixel with the center value. The result obtained is known as LBP code. The LBP operator produces very long histograms and thus in the case of a region descriptor, it is very difficult to use. To

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overcome this problem a new idea has been introduced i.e. CS-LBP which produces very small and compact binary patterns. In this technique, the pairs which are center symmetric are only compared. Euclidean Distance measures the summation of difference among the paired values of the feature set. After taking the square root of the summation the closest distance measure is taken as the final result for that particular image.

[5] – The solution proposed by the authors of this paper combines the data sets derived from the ancient physiognomy and the modern physiognomy to infer the corresponding relation between the personality and facial feature of an individual and to model the foundation to determine the shape and face feature. They compute the histogram of an individual's image by searching for the threshold values in that image and to create a binary image in an adaptive way**.**

PROPOSED METHOD: Authors proposed a new method to calculate the personality according to the facial feature obtained through physiognomy from the ancient times till now. Hence they summarize the classification of facial features based on the physiognomy. They cumulated the histogram data of each image and tried to find the better threshold value by using Otsu's methodology which is considered to be a kind of adaptive method. Thus by following this method the authors were able to generate a quality binary image. The boundary of each facial feature in the image is identified by referring to the connected components. There were different classifications made while adopting this method. **1) Face-shape Classification Standard –** Round Face, Nobla Face, Oval Face, Long Face, Diamond Face, Equilateral Triangle Face, Square Face. **2) Eyebrow-shape Classification Standard –** Upward, Beyond the baseline, On the baseline, Inside the baseline. **3) Eye-shape Classification Standard –** Big eyes, Small eyes. **4) Nose-shape Classification Standard -** The length of nose is measured based on the 1/3 of the total length of the nose all the way from hairline to chin. If the length of nose is bigger than benchmark value, it's considered to be a Big Nose. Whereas the nose is said to be Small if it measures lesser than the benchmark value. The height of the nose is then determined based on 1/2 of the nose length. If the size of the height measures bigger than the benchmark value, then it's a High Nose. Whereas the nose is said to be Low if it measures lesser then the benchmark value. The nose is then divided into seven categories based on width and height of the nose. The categories are: Short Nose, Seg Nose, Greek Nose, Straight Nose, Bag Nose, Fault Nose and Hawk Nose. **5) Mouth-shape Classification Standard –** Big Mouth, Small Mouth.

[6] – This paper work is on Facial Recognition Systems. It can be used in various present day applications, such as video surveillance, e-learning and robotic human machine interfaces. Feature Extraction and Classification methods used to train the system are the two main components that can affect the performance of the entire system. Active Appearance Model which is a powerful statistical method for modeling and registering deformable objects is implemented. This model is so powerful indeed that it can detect a deformed image, here a human face, closer to human representation of a human face. Support Vector Machines, SVMs, are used as they have the capacity to solve non-linear problems with relatively reduced number of samples and high dimension representation of features.

PROPOSED METHOD – There are 2 approaches the authors decided on:

1) The Generative Approach - The internal and external stimuli interaction has a minimization-type problem and the generative approach solves the problem. Constraints in the face model determines the Internal Part and the external part is represented by the facial features that are extracted from the actual image**.**

2) The Discriminative Approach - The discriminative approach makes use of Constrained Local Models (CLMs). The philosophical approach in Active Appearance Model is used in case of Constrained Local Model as well. The process involves two parts, (i) Model Building/Training and (ii) Model Searching/Fitting. The characteristic of CLMs are such that they decide by how the shape of non-rigid objects deform based on a Point Distribution Model (PDM). Local Detectors will determine the PDM. Matching a model to a test image consists of two stages: (i) Obtaining image features based on a local detector and (ii) Conducting a global optimization strategy that maximizes responses to PDM parameters.

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