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Ascertaining Human Emotions using Blue Eyes Technology

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***Abstract*—** Blue eyes technology aims to create computational machines which can sense and understand human feelings and emotions. It uses camera, microphone and various sensors to recognize human actions and emotions and aid disabled people. There are many researches in this area, still they have some limitations. In this paper we have proposed on architecture for blue eyes technology which can identify human emotions through facial features and sensors such as Galvanic skin response sensor, heart pulse sensor, temperature sensor. This paper explores various image processing techniques such as noise removal, segmentation, image enhancement. Supervised classification technique such as artificial neural network with back propagation is used to predict emotions. This research involves many areas like Machine learning, Image processing and IoT.

***Keywords*—**Human Computer Interaction, Facial Expression detection, Galvanic skin response sensor.

I. INTRODUCTION

Human Computer Interaction (HCI) is a vast research field that comprises of computer science and technology with human interaction. HCI incorporates multiple technologies like cognitive science, computer science and ergonomics etc., The blue eyes technology which will be discussed in this research paper is an application of human computer interaction. It is based on the facial expression identification, heart beat sensor, temperature sensor and has perceptual and sensory abilities. It helps to commutate the machines to behave and have sensory movements just like a human being. It also gives rise to the concept of brain human interaction.

Blue eyes technology recognizes the human emotion and sensory actions using few gadgets. It helps in recording the operators conscious and their brain involvement under their physiological condition to identify their action. The blue eyes technology can use the concept of image processing techniques such as image acquisition, image enhancement, image analysis and manipulations for facial expression identifications and sensory abilities to identify the human emotions. In this research paper we are trying explore the concept of blue eyes technology and the different techniques associated with this area such as machine learning, Iot, image processing, artificial intelligence etc.,. In this paper we are trying to explore the role of blue eyes technology to predict a person's present state such as whether he is in normal condition, anxiety, happy, sad or disgust.

The article is organized as follows, section I contains the introduction of blue eyes technology, section II includes architecture of emotion prediction system, Section III contains working of galvanic skin response (GSR), section IV explains Image feature extraction, Section V describes emotion prediction by Backpropogation algorithm, section VI explains the applications of blue eyes technology and Section VII concludes the research work.

II. ARCHITECTURE OF EMOTION PREDICTION STSTEM

Blue eye technology is completely dependent to identify human action and facial interaction. The computer gathers the information of the facial expression of human using some gadgets and sensors. This technology will help the doctors to check up their patients and predict the patient's health complications. This can be done by allowing the sensors to interact and understand the person's present position. We can achieve it by using temperature sensors, body movement sensors and pulse sensors.

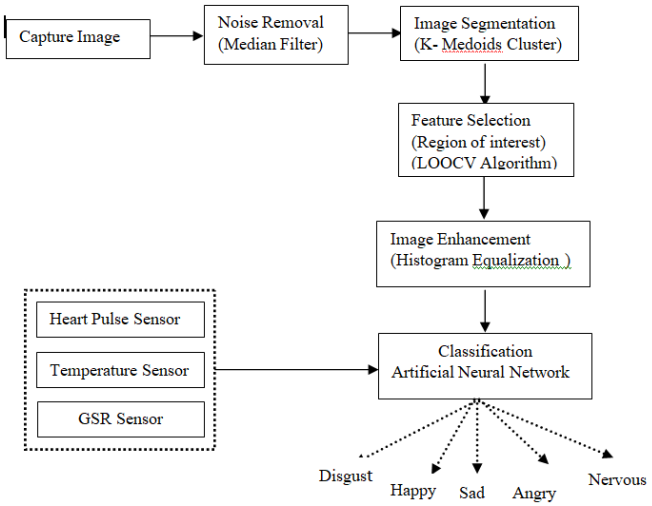

Figure 1: Architecture of Emotion Prediction System

Galvanic skin response (GSR) finds a person state by their sweat and skin moisture. GSR measures changes in sweat gland using changes in voltage. The electrodes in GSR have to be measure the changes, and need to transmit that information to the recording device. For measuring the pulse rate we can use the pulse sensor amped which is a plug and play type of device by which we know whether the person is suffering from anxiety. Heart beat sensor helps to assess the heart pulse rate. The heart beat for a normal person is 78 beats per minute. Heart beat sensor results digital signal as its output. Both sensor output and facial expressions are given as input to the classifier to predict the emotions of a person.

III. WORKING OF GSR

Galvanic Skin Response (GSR) is used to compute the continuous variations of the electrical characteristics of the skin caused due to changes in sweating in human body. Sweating is controlled by Autonomic Nervous System (ANS). The sweat gland activity increases especially when the sympathetic branch (SNS) of the ANS is induced heavily, which in turn amplifies the skin conductance and vice versa. In this way, electrical phenomenon of the skin will be active because of the human Sympathetic system responses. Such system is directly involved in the emotional behavioral regulation in human body.

The electrical skin response signal is extremely simple to record. Two electrodes need to be placed between index and middle finger of the hand, which generates a variation of a low-tension applied current in between those two electrodes. The principal behind GSR is, if sweating in human body increases, conductance of GSR also increases. The GSR sensor supplies a very less constant voltage between the electrodes. This circuit records the skin electrical phenomenon and its variation by applying Ohm's law.

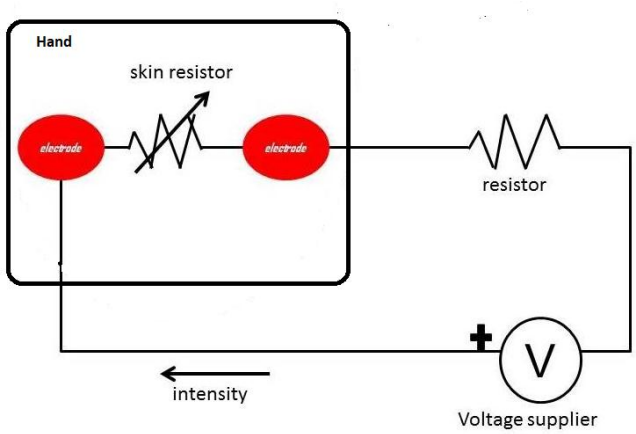

Figure 2: GSR Architecture

In figure 2, Keeping the voltage (V) as constant, the skin conductance is calculated by measuring the current flowing through the electrodes. With this setup, any fluctuation in current flow is because of changes in the electrical characteristics of the skin.

IV. FACIAL FEATURE TRACKING

Identification of facial expressions serves as a element of natural human machine interfaces. To identify facial expressions image processing techniques can be used. This section deals with feature extraction from the captured image.

a) Image preprocessing:

Image pre-processing is a technique to obtain a superior quality image by removing irrelevant parts from the images.

Resizing of the input images can be performed with the Gaussian filter which also gives the smoothness to the images. Normalization acts as a preprocessing method through which illumination can be reduced and disparity of the face images can be minimised with the median filter and to achieve an improved face image.

b) Noise removal

During image acquisition i.e., digitization and transmission noise can get into the digital image. Most of the real time scenarios, imaging sensors can be affected by environmental conditions or interferences, because of that noise are added to an image during transmission.

Let $a(x_i, y_i)$ is the actual image, $\eta(x_i, y_i)$ is the noise and $r(x_i, y_i)$ is the resultant pixel.

$$r(x_i, y_i) = a(x_i, y_i) + \eta(x_i, y_i)$$

If we can estimate the noise, we can restore the image. Median filtering may be a nonlinear technique to take away noise from images. It is extremely effective in

removing noise and protecting the edges. It is highly efficient technique to remove 'salt and pepper' sort of noise. The median filter traverses every pixel of the image, and transforms each pixel by the median of its nearest pixels. A pixel along with its neighbours is known as "window", which slides through all the pixels of the entire image.

The median of a window is calculated by arranging all the pixels belong to a window and substituting the pixel being considered with the median pixel.

c) Image Segmentation:

Image segmentation is a technique used to partition an image into many slices, where each slice has similar features. It is a critical state in image processing.

Clustering is an unsupervised learning method to group similar objects based on the principle the inter class similarity should be minimum and within the class similarity will be maximum. The similarity function is based on the distance between the pixels in the image usually Euclidian distance or Manhattan distance.

The Euclidian distance is measured using the formula,

$$d(i,j)=\sqrt{(|x_{i_1}-x_{j_1}|^2+|x_{i_2}-x_{j_2}|^2+...+|x_{i_p}-x_{j_p}|^2)}$$

K-Medoids is an unsupervised clustering method based on partitions where each cluster is denoted by one of the pixels, which work as follows.

- Partition the pixels into k-nonempty subsets.
- Compute the seed point of the cluster. Seeds / Medoids are the centrally located pixel in that cluster.
- Allocate each pixel to the cluster whose seed close to it.
- Repeat the steps until no new assignment.
- Each cluster identifies an object in the facial image.

d) Feature Selection:

The concept of forward feature choice algorithm is to assess all feature subsets that include just one input attribute.

In other words, to locate the best individual feature, m, find the Leave-One-Out Cross Validation (LOOCV) error of the subsets, $\{A_1\}$, $\{A_2\}$... $\{A_m\}$, where m is the input dimensionality.

Find all the 1-attribute LOOCVs and evaluate them, then capture the best 2 features and evaluate their LOOCV error, and repeat the same procedure until m features have been computed.

(1) Collect a training data set.
(2) Divide it into K partitions
(3) For each partition (p = 0, 1, ..., K-1)

- Let OuterTrainingset(p) = all partitions except p.
- Let OuterTestset(p) = the p'th partition
- Let Inner Training(p) = randomly selected 70% of the OuterTraining set(p).
- Let InnerTest(p) = left over 30% of the OuterTrainingset(p).
- For q = 0, 1, ..., m
  - Find for the best feature set with q components, fs_{pq}. Using leave-one-out on InnerTraining(p)
  - Let $InnerTestScore_{pq}$ = Root Mean Square score of fs_{pq} on InnerTest(p).

  End loop of (q).
- Select fs_{pq} with the top inner test score.
- Let OuterScore p = Root Mean Square score of the selected feature set on OuterTestset(p)

End loop.

4) Return mean OuterScore.

e) Image Enhancement:

The image enhancement technique is to make the digital picture more appealing to our eyes, (i.e.) making the images smooth or sharp. It helps to process the image so that the resultant image is more appropriate than the original image for a specific application.

The histogram of an image represents the frequency of pixels in an image. It shows the distribution of gray levels in the image which is extremely useful in image processing. Histogram finds a metamorphosis s=T(r) to be applied to every pixel of the input image f(x,y) such that a uniform distribution of gray levels in the entire range results for the output image g(x,y). Distributing the frequencies is a best way to improve dark or washed out images.

The discrete approximation of the transformation function for Histogram Equalization is given by

$$O_k=T(I_k) = \sum_{i=0 \text{ to } k} Pr(I_i) = \sum_{i=0 \text{ to } k} n_i / n$$

I_k - input intensity
O_k - processed intensity
k - Intensity range(e.g 0.0 – 1.0)
n_i - the frequency of intensity i
n - summation of all frequencies

V. CLASSIFICATION BY BACKPROPOGATION

Sensor input and the extracted facial features are given as input to the classification algorithm to predict human emotions. The backpropagation classification performs learning on a multilayer feed-forward neural network. It identifies weights for each connections between the nodes to predict the category of tuples iteratively. A feed-forward neural network with multiple layers has one input layer, one or more hidden layers, and one output layer.

Each layer can have multiple units. The input values to the neural network are the attributes of every training tuple. These attributes values are multiplied by a weight and sent from input layer to the next layer of "neuron like" units, known as a hidden layer. The outputs of the hidden layer units can be input to another hidden layer, and so on and finally it reaches the output layer.

Back propagation learns from the training tuple by comparing the network's calculated value for every tuple with the actual known target value ie., class labels such as anger, disgust, aversion, happy, sad, anxiety etc., For each training tuples, the weights are changed so as to decrease the mean squared error between the network's prediction and the actual target value. These modifications are propagated "backwards" direction from the output layer to first layer which is input layer through intermediate layers.
Algorithm:

- for each training tuple T in Database {
  - for each input layer node k {
    - $O_k = I_k$
    - for k = nodes in all layer except input layer
      $I_k = \Sigma w_{ik}O_i + \theta_k$
      $O_k = 1/ (1+e)^{-I_k}$
    - for k = 1,2,…. nodes in output
      $Err_k = O_k(1 - O_k)(T_k - O_k)$

    // Backpropogation
    - for k = 1,2,….all the nodes
      $Err_k = O_k(1 - O_k) \Sigma_k Err_k w_k$
    - for each w_{ik} in network
      $\Delta w_{ik} = (l)Err_k O_i$
      $w_{ik} = w_{ik} + \Delta w_{ik}$
    - for each bias θ_k in network
      $\Delta \theta_k = (l)Err_k$;
      $\theta_k = \theta_k + \Delta \theta_k$;

}}

Once the classifier is trained the unknown status of the person will be predicted from the features and sensor information.

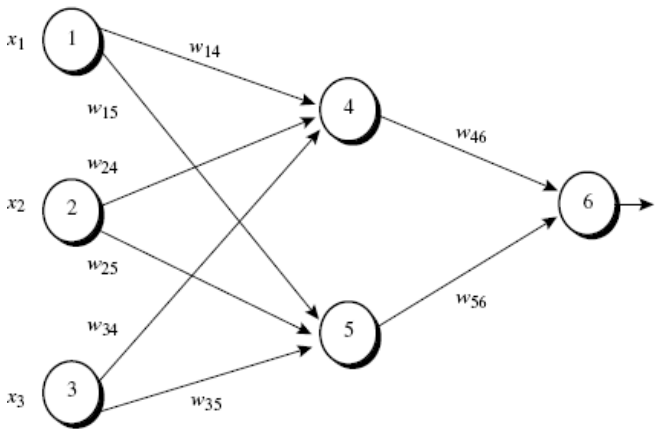

Figure 3: Artificial Neural Network

VI. APPLICATIONS OF BLUE EYES TECHNOLOGY

1. Aids disabled people.
2. Used to monitor critical patients to provide medical assistance.
3. Based on emotions in smart home system, music can be played.
4. Can be used in automatic car driving.
5. Can be used in power control station and flight monitoring.
6. In supermarket, based on the prediction of human temper, marketing of products can be done.
7. It can be used in security system.

VII. CONCLUSION

Resent researches reveals understanding the human emotions play a vital role in social networking. This paper gives an approach of creating Human Computer Interaction that has perceptual and sensory capability like human beings. The idea presented in this paper predicts human emotions such as sad, disgust, happy, tensed, etc., along with their blood pressure and temperature to suggest whether they need medical assistance.

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