INTEGRATION OF FACE EMOTION DETECTION AND TACTILE RECOGNITION TO MONITOR USER BEHAVIOR WHILE PLAYING GAME

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ABSTRACT: The popularity of games has grown exponentially in the last years. As the games has created several issues to the children, to overcome those issues they needed to be monitored. In this project we are integrating both facial emotion detection and hardware based tactile monitoring system to detect user's behavior. In our framework we have taken frame from live streaming and processed it using Principal Component Analysis (PCA) and Segmentation Based Fractal Texture Analysis (SFTA) as feature extraction and for classification Artificial Neural Network (ANN). Finally based on the observed behavior of user alerts were given to the parent.

IndexTerms – *Artificial Neural Network or ANN, Principal Component Analysis or PCA, Segmentation Based Fractal Texture Analysis or SFTA, Viola Jones Algorithm.*

I. INTRODUCTION

Most of the games were created for adults but, they are being played by the children. This physically and mentally affects the children. Hence this framework is proposed to protect the children form those issues. The human face plays a prodigious role for automatic recognition of emotion in the field of identification of human emotion and the interaction between human and computer for some real application like driver state surveillance, personalized learning, health monitoring etc. Most reported facial emotion recognition systems, however, are not fully considered subject-independent dynamic features, so they are not robust enough for real life recognition tasks with subject (human face) variation, head movement and illumination change. The emotions are derived from the arm gesture for various applications like music retrieval [1]. In this project we have tried to design an automated framework for emotion detection using facial expression using MATLAB. For human-computer interaction facial expression makes a platform for non-verbal communication. The emotions are effectively changeable happenings that are evoked as a result of impelling force. So, in real life application, detection of emotion is very challenging task. Our project mainly contains two portions. One is face emotion recognition and another one is tactile recognition. In Face emotion recognition, we have utilized viola jones method for face detection and for face recognition we have utilized Principal Component Analysis (PCA) because it gives 98.5% accurate recognition rate [2]. For feature extraction we have utilized Segmentation Based Fractal Texture Analysis (SFTA). We have used Neural Networks as a classifier. In tactile recognition, we have utilized the tactile sensor.

II. BACKGROUND WORK

A lot of work has been done in the area of face emotion recognition and feature extraction. The analysis on the face recognition is carried out in [3]. For a real time applications like traffic sign recognition Speeded-Up Robust Features has an accuracy rate of about 96% [4]. The PCA is the suitable method for Eigen faces and provides more accuracy in the classification [2].

For tactile recognition the main objective is to capture the hand gesture. Hand gesture recognition is an important communication path between the human and machine [5]. The use of tactile information is an essential one for object recognition. For the object recognition SURF takes smaller time as compared to CNN where in terms of accuracy CNN possess 91.67% [6] and both of them uses Support Vector Machine (SVM) as a classifier [4,6]. The SVM and RBFNN as a classifier possess 91% of recognition rate for emotion [7].

III. PROPOSED WORK

In the proposed system, we use a simple application as a game and when it gets opened user behavior is continuously monitored by the webcam and it is analyzed by the image processing for the presence of abnormalities and in case of any abnormal behavior is detected, then automatic notification is communicated to the parents through e mail/ mobile message. The basic outline of our proposed work is given as the following:

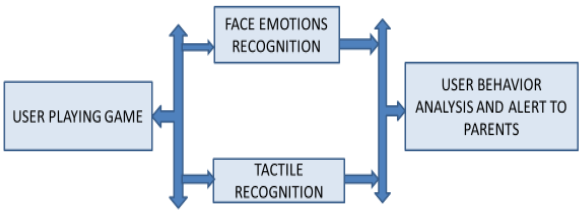


figure1**:** Outline of proposed work

The hardware used for the work are camera and pc with core i3 7th Generation with 4GB is used and the front-end software is MATLAB R2014 image processing tool.

The upcoming sections are organized as below. The face emotion recognition and tactile recognition are described in section IV and V respectively. The Results are discussed in section VI. Finally, the conclusion and future work is discussed in the section VII.

IV. FACE EMOTION RECOGNITION

The face expression recognition is an easy task whereas emotion recognition is a difficult one. Because emotions are derived from the actions, gestures, face expressions and verbal expression. The emotion plays an important role in determining the behavior of the user while playing game. Various modules are used for the face emotion recognition. They are listed as follows.

4.1) Image acquisition
4.2) Divided into frames
4.3) Face detection
4.4) Face recognition
4.5) Feature extraction
4.6) Classifier

4.1 Image acquisition

Image acquisition is the first and foremost step in an image processing because, without an image no processing is possible. It is the process of retrieving an image from a source. Our framework consists of PC attached with camera, controlled by the MATLAB software. The camera will capture the different human face emotions and based on the algorithm, MATLAB will extract the facial emotions. Initially, the input is acquired in the form of video. It is further processed to obtain the images.

4.2 Divided into frames

Frames can be obtained from a video obtained from the acquisition process through the camera and converted into images. To convert a video frame into an image, the MATLAB function 'frame2im' is used. The obtained image from the process is then applied for other processing techniques.

4.3 Face detection

Face detection is the first step for face recognition and it is a part of object detection. They can be used in many applications like security, bio-metrics, entertainment, law enforcement, etc. Many real time applications are using face detection. Facebook is also using face detection algorithm to detect faces in images. There are many methods to detect the faces. The appearance-based method uses set of training face images to detect the faces. It rely on techniques from machine learning and statistical analysis to find the characteristics of face images. In 2001, Paul Viola and Michael Jones proposed a face detection algorithm which is called as Viola Jones Algorithm. We have used Viola Jones method which is a standard detection technique used for both face detection and object detection. In this technique the detection is 15 times faster than any previous approach [8]. The viola jones method has four phases and they are given as follows:

4.3.1 Integral image
4.3.2 Adaboost
4.3.3 Cascading
4.3.4 Haar features

The viola jones algorithm examines 19*19 sub-window which uses set of two adjacent rectangles as shown in fig.2. The Let I and P denote an image and a pattern, both of the same size N × N. The feature associated with pattern P of image I is defined by,

$$\sum_{1\le i\le N}\sum_{1\le j\le N} I(i,j)1_{P(i,j) \text{ is white}} - \sum_{1\le i\le N}\sum_{1\le j\le N} I(i,j)1_{P(i,j) \text{ is black}}.$$

The integral pictures are used for the quicker feature analysis and they are simple to understand. Adaboost is used to form strong classifiers from the linear combination of the weak classifiers. Cascading is used to identify the face from an image.

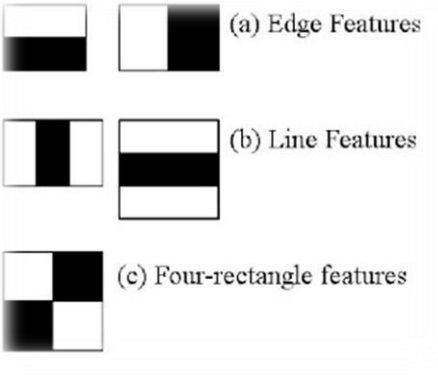


figure 2: Haar features

4.4 Face recognition

For face recognition we have used Principal Component Analysis algorithm which uses Eigen Faces by calculating the Euclidean distance. This method is very simple and better than Linear Discriminant Analysis [3]. In this PCA algorithm the input images and data base images are given as an input and the mean of the input image is calculated to find the covariance matrix from which the Eigen value and Eigen vector are obtained. Then it is compared with the data base and perfect match is given as an output.

The sample code for calculating Euclidean distance from neutral image is given as

```
meanNutral = mean(S(CentralIm,Out1)',2);
for Dat2Project = 1:numTestImage
   TestImage = Projected_Test(Dat2Project,:);

   Eucl_Dist(Dat2Project) = sqrt((TestImage'-meanNutral)'*(TestImage' ...
      -meanNutral));
     end
```

4.5 Feature extraction

In our frame work we have used Segmention-based Fractal Texture Analysis algorithmis is an effective feature extraction algorithm that performs fractal analysis of image texture [9]. The SFTA algorithm has two steps. First step involves conversion of image into binary images. Second step involves the extraction of properties from the binary images.

Table 1 Table of symbols

Symbol	***Definition***
I	Grayscale image.
Ib	Binary image.
Δ	Border image.
Nl	Grey level range.
T	Set of threshold values.
Nt	Number of thresholds.
D	Fractal dimension.
*D*0	Haussdorf fractal dimension.
_ Box	size in the box counting Algorithm.
*V*SFTA	SFTA Feature vector.

SFTA Algorithm is given as the following

1: $T \leftarrow$ MultiLevelOtsu(I,nt)
2: $TA \leftarrow \{\{ti, ti+1\} : ti, ti+1 \in T, i \in [1..|T| - 1]\}$
3: $TB \leftarrow \{\{ti, nl\} : ti \in T, i \in [1..|T|]\}$
4: $i \leftarrow 0$
5: for $\{\{t\_, tu\} : \{t\_, tu\} \in TA \cup TB\}$ do
6: $Ib \leftarrow$ TwoThresholdSegmentation(I, $t\_$, tu)
7: $\Delta(x, y) \leftarrow$ FindBorders(Ib)
8: VSFTA[i] $\leftarrow$ BoxCounting(Δ)
9: VSFTA[i + 1] $\leftarrow$ MeanGrayLevel(I, Ib)
10: VSFTA[i + 2] $\leftarrow$ PixelCount(Ib)
11: $i \leftarrow i + 3$
12: end for
13: return VSFTA

Further the extracted information are used to identify the emotion by using a perfect classifier.

4.6 Classifier

Classifier usually consists of database which is very important that contains predefined sample data of the subject under considerations. Several classifiers are available and some of them are Decision Tree, Support Vector Machine (SVM) and Artificial Neural Networks (ANN). In our frame work we have used Neural Networks which is similar to human Nervous system [10]. The Neural Network provides more accuracy than Support Vector Machine [7]. The classifier is pre-trained with the database and then only the classifier is used to perform the comparison of an input image features with the database.

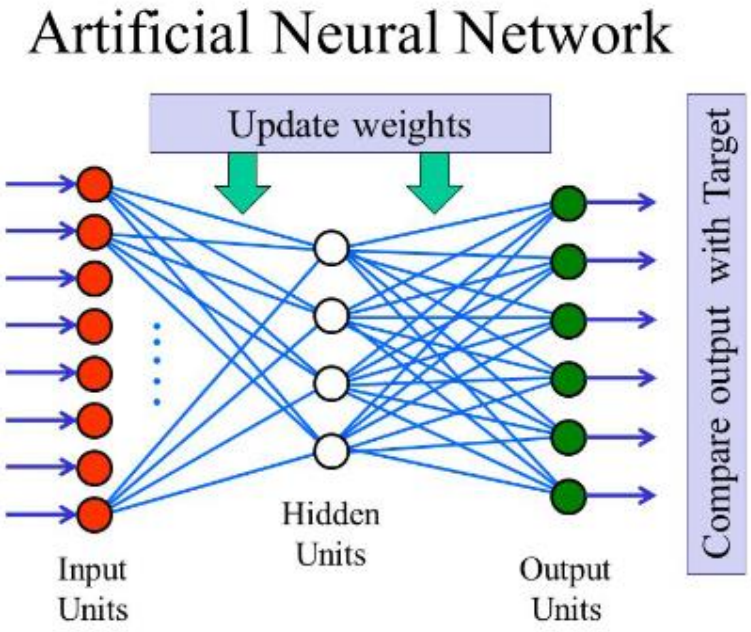


figure 4: ANN

V. TACTILE RECOGNITION

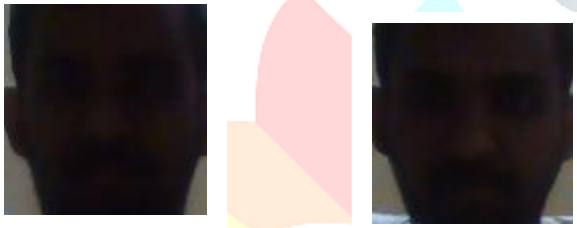
The issues that involved in the games cannot be prevented by using the emotion of the user alone. In some cases, the user may try to do some actions which could physically not safe to them. To avoid this, the motion of the hands must be monitored. Tactile sensors are used to measure the properties of an object to which it is being attached. For this we have used low cost MEMS sensor based tactile recognition. In our frame work we have used wearable MEMS tactile sensor. The MEMS sensors provide large area of coverage and is used in robotics especially in hands in order to detect geometry, texture, slip, etc. [11]. From the pressure image the amount of force being given by the user can be calculated. That information is fed into the classifier to identify the user behavior.

figure 5: hand wearing tactile sensor

VI. RESULTS AND DISCUSSIONS

In face emotion recognition part, we have taken four kind of expressions like happy, sad, angry and neutral in the database. Once the game application is opened the camera starts capturing the video live. The images obtained from the conversion of videos into images is taken as an input and the face detection, recognition and feature extractions are done on the input image. The obtained information from an input image is compared with the database by the use of trained classifier. Figure 6 shows the trained set of images. Figure 7 shows that the sad emotion is detected from an image. The amount of force calculated from the pressure image is compared with the gravitational force. If it exceeds, the classifier classifies that the user is in abnormal state. The abnormal behavior is observed in both emotion recognition and tactile recognition. Hence the alert is given to the parents through sms/ email. After certain period of alert, if the user stays in an abnormal behavior the game application is closed for 5 minutes. So that the user can come back into normal.

figure 6: Trained set of images



Input image Output image- Sad

figure 7: face emotion recognition

VII. CONCLUSION AND FUTURE WORK

In this paper an emotion recognition and tactile recognition based automatic system is presented. This system helps in safe guarding the children from misbehavior. The viola jones detection method is fast which supports this system in detecting the real time images. PCA as a face recognition method and SFTA as a feature extractor gives simplicity to the algorithm and along with classifier ANN the system provides good accuracy.
In future this system can be implemented in mobile which could use mobile camera for acquisition and MEMS present in the mobile for tactile recognition.

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REFERENCES

[1] Denis Amelynck, Marc Leman, Leon Van Noorden, Maarten Grachten (April-June 2012).Toward E-Motion Based Music Retrieval a Study of Affective Gesture Recognition. IEEE Transactions on Affective Computing, vol. 3, no. 2
[2] Divya Mangala B.S and Prajwala N.B. April 3-5, 2018. Facial Expression Recognition by Calculating Euclidean Distance for Eigen Faces using PCA. IEEE Transactions on Affective Computing, vol. 3, no. 2.
[3] Udit jain, kshreyansh choudhary, shubham gupta, M. Jasmine . 2018. Analysis of face detection and recognition algorithms using viola jones algorithm with PCA and LDA. International conference on trends in electronics and informatics.
[4] Nizar Akbar Arifin,Budhi Irawan, Casi Setianingsih. 2017. Traffic sign recognition application using speeded-up robust features (SURF) &support vector machine (SVM) based on android . IEEE Asia Pacific Conference on wireless and mobile.
[5] Jagdish Lal Raheja, Karen Das, Ankit Chaudhary. December 2011. Fingertip Detection: A Fast Method with Natural Hand. International Journal of Embedded Systems and Computer Engineering, vol 3, no.2.
[6] Juan M. Gandarias, Jesus M. Gomez-de-Gabriel, Alfonso Garcia-Cerezo. 2017. Human and object recognition with a High-Resolution tactile sensor, IEEE.
[7]] Bavkar S. S., Rangole, J. S., & Deshmukh, V. U. 2015. Geometric Approach for Human Emotion Recognition using Facial Expression. International Journal of Computer Applications, 118(14).
[8] Mehul K Dabhi1, Bhavna K Pancholi2. April 2016. Face Detection System Based on Viola - Jones Algorithm. International Journal of Science and Research (IJSR), Volume 5 Issue 4
[9] Costa, A. F., Humpire-Mamani, G., &Traina, A. J. M. August-2012. An efficient algorithm for fractal analysis of textures. In Graphics, Patterns and Images. IEEE
[10] Manish Mishra, Monika Srivastava. 2014. A view of artifical neural network. IEEE International Conference on Advances in engineering & technology research (ICAETR).
[11] Thomas V. Papakostas, Julian Lima and Mark Lowe. 2002. A large area force sensor for smart skin applications.IEEE.