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Thermal Imaging for Facial Expression – Fatigue Detection

VS. Elanthendral[1], R.K.Rekha[2], M. Rameshkumar[3]
CSE Department, Veltech Multitech Dr.Rangarajan Dr.Sakunthala Engineering College Chennai, Tamil Nadu

Abstract—Facial expressions play significant roles in our daily communication. Recognizing these expressions has extensive applications, such as human-computer interface, multimedia, and security. However, as the basis of expression recognition, the exploration of the underline functional facial features is still an open problem. Studies in psychology show that facial features of expressions are located around mouth, nose, and eyes, and their locations are essential for explaining and categorizing facial expressions. Moreover, expressions can be forcedly categorized into six popular "basic expressions": anger, disgust, fear, happiness, sadness and surprise. We develop a non-intrusive system for monitoring fatigue by tracking eyelids with a single web camera. Each of these basic expressions can be further decomposed into a set of several related action units (AUs).
Keywords— Facial expressions, Expression recognition, Action units, Non-intrusive, Disgust

I. INTRODUCTION

Many studies say that with help of the facial expression affective state, cognitive activity, intention, personality, and psychopathology of a person can be found. Facial expression is occurred due to the muscle movement beneath the skin in the human face. The emotional status of the human is transfer into facial expression. The changes in face convey information in one-to-one communication. Sometimes human go in for voluntarily facial expression. Those voluntary expressions are differing from the involuntary facial expression. The involuntary expressions are by reason of musle follow a subcortical route in the brain. The characteristic change in between the voluntary and involuntary facial expression varies. Those variations cannot be found easily. Facial detection plays an important role in the deception detection and physical status of human. Deception detection is used in the mock-crime scenario.

Manual analysis of deception outcome is depending on the hand of the expert. The accuracy will not be up to the level, report on average. The other technique is a polygraph examination. The polygraph technique use sensors to notify the human expression. Accuracy percentage of the polygraph examination is up to 90% but the polygraph examination need human cooperation and it is long process. The result outcome may take several hours.Thermal imaging process of facial expression is accurate and it does not need any cooperation from human side. The result of the process is quick. Thermal imaging work based on the heat radiated from the face according to their facial expression. Thermal imaging can be used to detect both instantaneous and sustained stress conditions. Since both these condition bring the changes in the periorbital blood flow.

Change in the blood flow brings changes in the heat delivered by the human face. So those heat changes can be easily detected and processed by using the thermal imaging process and the result is given out on hand.In this paper, we use thermal facial analysis to explore the physical status of the human. Physical status in the sense human's mind and body condition. The novelty of this paper is robust methodology to get information about the human physical status and to learn human mind. The proposed system in this paper gives the way for the feature extraction of the work. Our work has wide application in the medicine industries for patient health monitoring.

A. Thermal Face Imaging

The facial image in a combination many complex patterns consisting of hair, forehead, eyebrow, eyes, nose, ears, cheeks, mouth, lips, philtrum, teeth, skin, and chin. Some of the added features in the human face are expression, appearance, adornments, beard, moustache etc. To distinguish a person face region place an important role, and human brain has a special region called as the fusiform face area (FFA), if we got damaged it is difficult to identify the face even our close related family can't recognise our face. To identify the individual uniquely in biometric identification the patterns of the particular regions are used such as eye and other parts. For face recognition system there are any methods one of the methods is thermal face recognition which takes thermal face as an input. In the earlier description, the thermal images concept will be made clearer. Due the body heat pattern of the human being the thermal images are created.

Thermal Infra-Red (IR) imagery doesn't care of the ambient lighting conditions. Because the thermal IR sensors in the camera capture only the heat radiation emitted by the object. According to their temperature and characteristics different objects emit

different range of Infra-red energy. The human being has quite same rang of temperature all over their body. It does not vary too much between body and face it provides a consistent thermal signature. The temperature of the human body varies between 35.5°C to 37.5°C. superficial blood vessels under the skin of the human face are used for deriving the primary thermal pattern of the face. Each person has unique vein and tissue structure for their face. Hence the IR image of the face is also unique.This system consist of thermal camera connected with the computer loaded with the MATLAB software and an application using the further thermal image processing

B. Thermal Camera

A thermal camera is used in this project. The thermal camera model is Thermo Vision A-20M, FLIR system product. It is capable of gauging temperature ranging from -200C to 9000C, and also features a perfect resolution of 320x240 pixels. It has 50/60 Hz of refreshing rate. It has many number of connectivity choice and IEEE-1394 Digital output is one of the feature, a fast image and data transfer are promoted by it. At the same time for installing network of multiple camera, Ethernet connection has to be made.

C. Computer and appliance

Once the image is taken by the thermal camera the image is sent to the computer or laptop loaded with the MATLAB software for processing the image. Using the MATLAB software the face is extracted. Once the image is extracted it is sent to application using.

D. Wavelet Transform

In maths, a square-integrable(real- or complex-valued) is represented by a wavelet series a certain orthonormal is a function using this a series generated by a wavelet. Nowadays, wavelet transformation is one of the most popular methods for the image processing process. This block provides mathematical definition of an orthonormal wavelet and of the integral wavelet transform.

The integral wavelet transform is the integral transform defined as

$$[W_\psi f](a,b) = \frac{1}{\sqrt{|a|}} \int_{-\infty}^{\infty} \overline{\psi\left(\frac{x-b}{a}\right)} f(x)dx$$

The wavelet coefficients c_{jk} are then given by

$$c_{jk} = [W_\psi f]\left(2^{-j}, k2^{-j}\right)$$

Here, $a = 2^{-j}$ is called the binary dilation or dyadic dilation, and $b = k2^{-j}$ is the binary or dyadic position.

II. RELATED WORK

Since the facial expression has wide range application in various industries. So many researches were going on in facial detection for several decades. Numerous of techniques were proposed for facial expression detection. Face shape mapping based facial expressing detection method maps the shape of the face at the time of the emotion. By tracking and analyzing changes in the shapes, mapping point's variation and by comparing previous collected data base about expression the expression or status is resulted accordingly[1].

Research by Pavlidis et al. concluded that the thermal eye signals from the liar subjects have a steeper ascend match up with the responses from the non-deceptive subjects [2]. The person was classified as liar if the eye signals were closer to the eye signals of the fake control person. To explore the better feature performance in the classification of deception pavlidie had question and answer segments as input feature for using the product of the slope of the "eyes" curves to the classifier assuming bimodal distribution of the slop products and baseline obtain the threshold and to get 84% of the differentiation rate.

Other studies about the thermal imaging were used for automatic gender classification based on face images. This method absorbs using of local binary pattern histogram with discriminative classifiers show the accurate result in the classification gender [3].In this paper, we are proposing that using the thermal imaging, as thermal facial image as an input we can able find the physical status of a person. Without touching or without the co-operation of the person want to tested we can result the status of a person. This framework is able to automatically track gestures and expressions of both the subject and the interviewer, extract normalized meaningful synchrony features and learn classification models for deception recognition. To validate these

proposed synchrony features, extensive experiments have to be conducted on a database of 50 video samples, and shown that these features are very effective at detecting deceptions.

III. ARCHITECTURE DESIGN

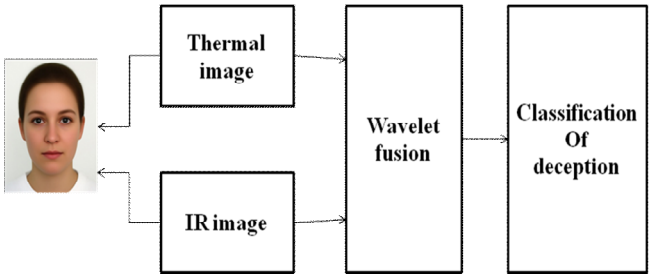

Fig 1.classification of deception

We investigate how degree of interactional synchrony can signal whether trust is present, absent, increasing or declining. We propose an automated, data-driven and unobtrusive framework for deception detection and analysis in interrogation interviews from visual cues only. Our framework consists of the face tracking, the gesture detection, the expression recognition, and the synchrony estimation. This framework is able to automatically track gestures and expressions of both the subject and the interviewer, extract normalized meaningful synchrony features and learn classification models for deception recognition. To validate these proposed synchrony features, extensive experiments have to be conducted on a database of 50 video samples, and shown that these features are very effective at detecting deceptions.

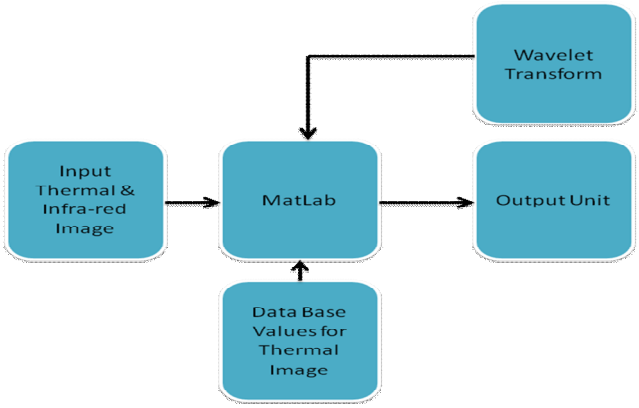

Fig 2.Detection of fatigueness

Image acquisition in image processing can be broadly defined as the action of retrieving an image from some source, usually a hardware-based source, so it can be passed through whatever processes need to occur afterward. Performing image acquisition in image processing is always the first step in the workflow sequence because, without an image, no processing is possible. The image that is acquired is completely unprocessed and is the result of whatever hardware was used to generate it, which can be very important in some fields to have a consistent baseline from which to work. One of the ultimate goals of this process is to have a source of input that operates within such controlled and measured guidelines that the same image can, if necessary, be nearly perfectly reproduced under the same conditions so anomalous factors are easier to locate and eliminate.

Image filtering allows you to apply various effects on photos. The type of image filtering described here uses a 2D filter similar to the one included in Paint Shop Pro as User Defined Filter and in Photoshop as Custom Filter. The trick of image filtering is that you have a 2D filter matrix, and the 2D image. Then, for every pixel of the image, take the sum of products. Each product is the colour value of the current pixel or a neighbour of it, with the corresponding value of the filter matrix. The centre of the filter matrix has to be multiplied with the current pixel, the other elements of the filter matrix with corresponding neighbour pixels. This operation where you take the sum of products of elements from two 2D functions, where you let one of the two functions move over every element of the other function, is called Convolution or Correlation. The difference between

Convolution and Correlation is that for Convolution you have to mirror the filter matrix, but usually it's symmetrical anyway so there's no difference.

A. Algorithm Details

1) *AES (Asymmetric Encryption Standard):* This algorithm is flexible in supporting any combination of data and key size of 128, 192, and 256 bits. However, AES merely allows a 128 bit data length that can be divided into four basic operation blocks. These blocks operate on array of bytes and organized as a 4×4 matrix that is called the state. For full encryption, the data is passed through Nr rounds (Nr = 10, 12, 14) . These rounds are governed by the following transformations

a) Byte Substitution: This is a non linear byte Substitution, using a substation table (s-box), which is constructed by multiplicative inverse and affine transformation.

b) Shifting the rows: This is a simple byte transposition, the bytes in the last three rows of the state are cyclically shifted; the offset of the left shift varies from one to three bytes.

c) Mixing of columns: Is equivalent to a matrix multiplication of columns of the states. Each column vector is multiplied by a fixed matrix. It should be noted that the bytes are treated as polynomials rather than numbers.

d) Adding round key: Is a simple XOR between the working state and the round key. This transformation is its own inverse.

IV. CONCLUSION

In this paper an approach is used as wavelet transform is used to detect the type of expression whether it is angry, happy or disgust or fatigue. Finally, the fatigueness of the person is detected and it is intimated that the person is fatigue.

V. ACKNOWLEDGMENT

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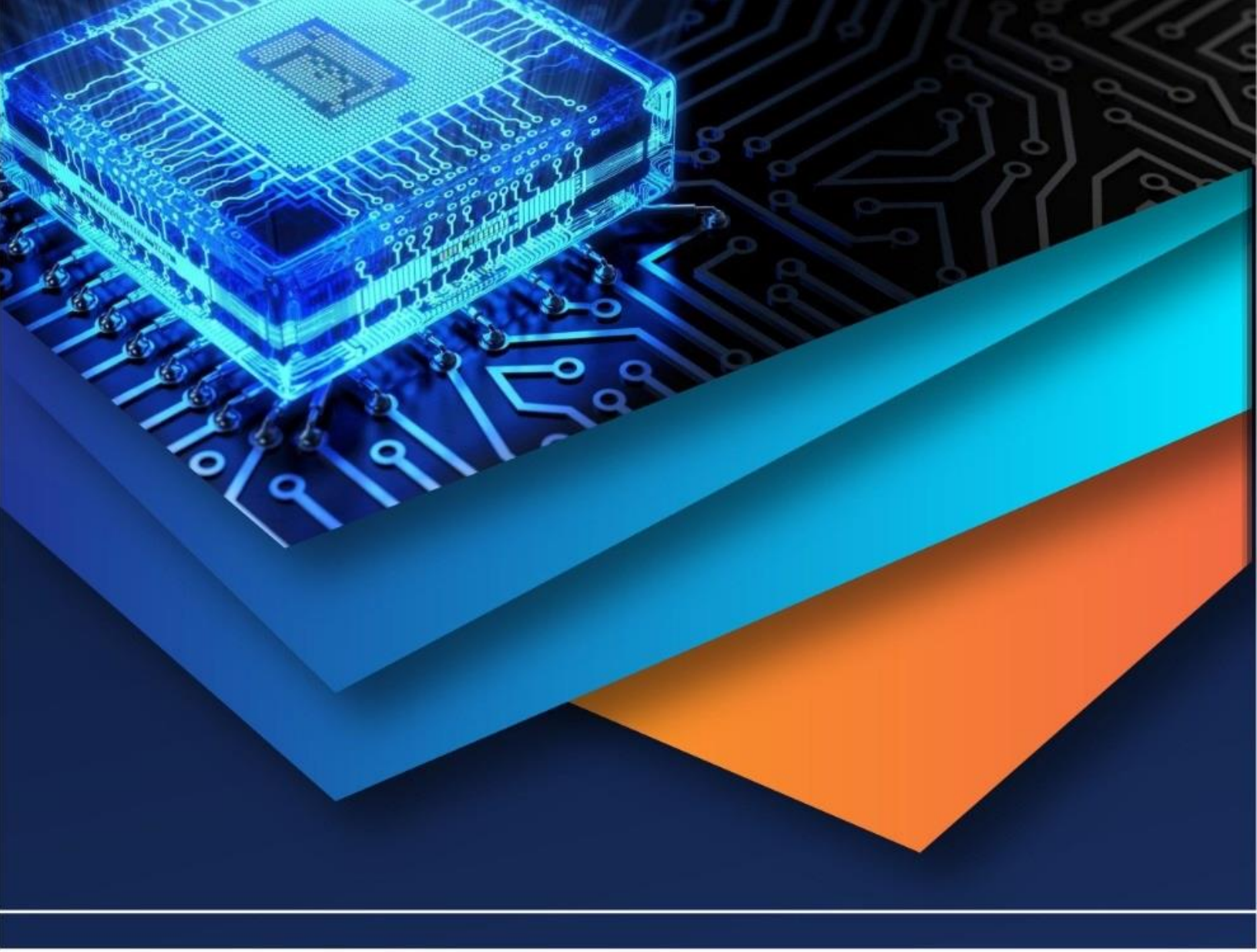

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