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Hidden Markov Model to Detect Anxiety in Human Face

Anupma Soni[1], Rahul Verma[2]

[1]M.Tech Research Scholar, CCEM, Raipur, Chhattisgarh, India

[2]Assistant Professor, CCEM, Raipur, Chhattisgarh, India

Abstract: ***In this paper we propose a human emotion recognition system based on Hidden markov model. Detection of anxiety from video is a sub area of the computer vision or human vision problem. It is particular interest of the wide variety of application. In our proposed method uses Hidden markov model to detect anxiety, here anxiety is uses as state and detected heart rate and blush response which are used as evidence variable. Visually recognize feeling of anxiety in humans, use video magnification to revel physical expression or emotions cues which is normally imperceptible to the naked eyes.***

Keywords: Hidden markov model, Video Magnification, HSV color space, Anxiety, Eulerian video magnification, spatio-temporal analysis

1. Introduction

If someone presented with anxiety, embarrassment filled situation then the mind state of a person's is excited. He feels hot due to blood rushing to the face and ears. Heart rate is become quicken and stronger. These all situation is invisible to normal outside observation will never known the difference. The computer vision system only sees the pick of the mental iceberg and changes physiological all due to emotional changes, which is commonly invisible.

A great challenge appears in a recent research topic to develop human vision system and computer vision system to automatically recognize all facial emotions [1]. To develop a system that is automatic detect the face, analyze and interprets the facial expression or emotions in a video clip or scene to accomplishment of this task is quite arduous. To develop this system there are generate several problems, for example first detection of a face from image and segment the face, after that extraction of the facial emotion or expression and at last classification of the emotion and recognition.

In this paper, we proposed the method that perform recognizing the particular facial emotion i.e. anxiety by using hidden markov model. Application of this proposed method is to improving the monitoring system in medical field, by analysis and rendering the patient face.

Basically our aim to extract the temporal variation in human emotion from video clip, which are hard to see with the necked eye. In our method uses Hidden markov model with anxiety as state and sensing heart rate using Eulerian video magnification and apply blush detection to revel blushing level as emitted evidence variable.

2. Methods

To perform our method the first step is loaded video clip, after that measure the heart rate by video magnification process and detect the blush and converted into feature to accomplish an HMM classifier to elicit the deception from video.

2.1. Detection of Heart Rate

For detecting heart rate of an object from the video clip is become quite challenge and various method are explored. In our implementation use video magnification to revel the heart rate. To magnifying the video apply eulerian video magnification method. To extract the temporal variations from videos that are tough or impossible and cannot be see with the naked eye. In Video Magnification method, first we takes input as a standard video sequence, and then apply spatial decomposition, followed by temporal filtering to the frames, after that the resulting signals is amplified to extract the subtle information. By using this method, the flow of blood we are able to visualize as it fills the face and can amplify to elicit the small variation in object. So from this method we are able to revel the heart rate from input video which is face based on the temporal variation of the skin color that is normally invisible to the human eye.

Eulerian magnification method [2]used for our implementation, in this approach avoid the taking average of whole region of interest (ROI) by capturing whole time varying signal from individual fixed pixel in face area. From these time varying signals, signal peaks are then calculated and are used in a pulse onset detection process to extract the heart rate. Basically in this approach combine the special and temporal processing to reveal the small temporal change in video. The method is illustrated in Figure 4. First we decompose the video into different frequency band by the use of special filter. In special filtering process all frames of video are pass through the spatially low pass filter and then downsample them for computational efficiency. In general, however we perform a full Gaussian pyramid, which remove high frequency variation.

2.2. Blush Detection

The blush detection is performed by looking the general changes in magnitude of color peaks over a time scale. To

obtain the signal form color trace we performed experiment, couple of different approaches. The blush of skin tone can be calculated by the percentage change from the baseline to get a dimensionless measure which is suitable for particular with varying physical characteristic, for example such as skin tone. The defining factor of our algorithm was the color space in which the blush response is sensed. There are numbers of color space each having its own pros and cons while work on skin color domain. In our algorithm lighting is an important factor, the RGB color space is simple and common method but it is unreliable for application due lack of distinct intensity and luminance measurement.

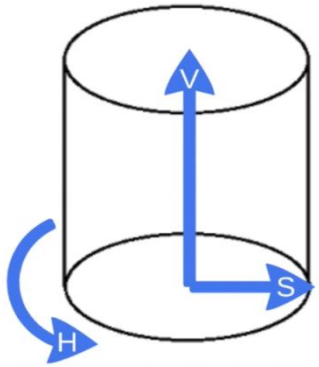

Figure 1: HSV color space

In this method lighting is an important factor; instead of RGB color space we used HSV color space in Fig.1. in this color space color are manipulated by their hue, saturation, value. The HSV color space has been proposed in [3] because it is more related to human color perception. In HSV color space is based on polar coordinates, not Cartesian coordinates. Where hue shows the quantity that distinguishes the colors, what color is perceived? It given as an angle from 0 to 360 degrees in a color wheel. Saturation represents the color purity and intensity of color strong to weak. The color having same hue but lower saturation value, that appear faded. Value is used to measure the brightness of color, where as color are dark or light basically define strength of colors. For detecting blush in skin tone that might be corresponding to color changed, first we extract out reddish colors from hue values that is in the range of 0 to 18 and 350 to 360 degrees. Filtering the other colors and the change in saturation value with respect to time was then calculated. Shows the graphical form of HSV color space Fig.2.So, it is confirmed that this color space is indeed similar to the physiological changes that take place during the blushing.

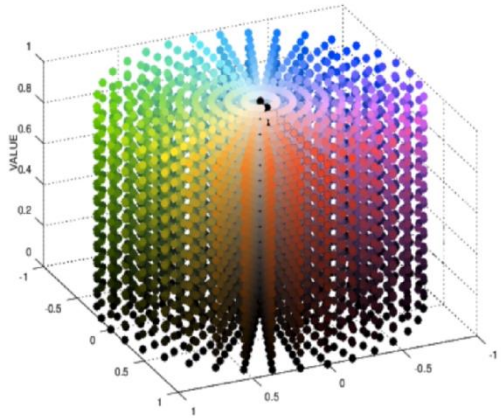

Figure 2: Illustration of hue, saturation and value in HSV color space

2.3. Hidden Markov Model

In our method, we proposed system that performs facial emotion anxiety recognition by using Hidden Markov Model. We use HMM with anxiety as a state or detected heart rate and blush response which emitted evidence variable. Basically HMM perform two processes (a) An unobservable Markov chain with a numbers of state, state transition probability matrix and probability distribution of initial state (b) set of probability density function with each state.

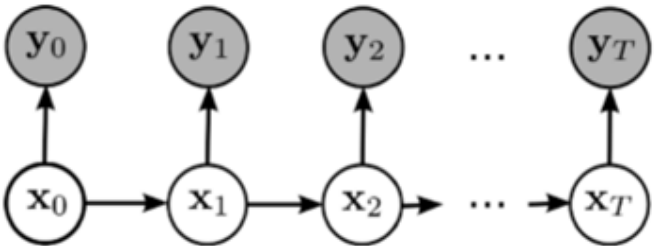

Figure 3: Sequence of Markov Model with hidden state

We chose HMM as a classifier, rather then linear classifier such as SVM or neural network because of its temporal property. After number of experiment we find that HMM to be more useful and suitable for our application.

In our algorithms hidden state is true level of human emotion that is deception and anxiety, after the detection of heart rate and blush response are evidence variable. Basically sequence of Markov model with hidden state are hmm. HMM is comprised of a hidden sequence of each time and emit certain variables. Markov chain is used to analyses the decision problems in which the occurrence of particular event depends on the occurrence of event which is immediately prior to the current event. Hidden markov model is a way of analysis the current movement of some variable to forecast its future movement.

3. Proposed Methodology

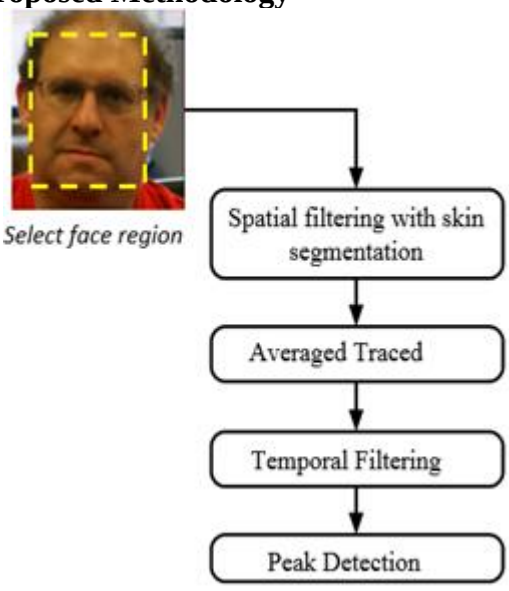

Figure 4: Detection of Heart Rate

Developing a robust algorithm for detecting the deception and anxiety of the object from the video clip to be quit challenging

While concealing truth cannot be detected through necked eye but these telling signals it can be measured by video magnification process. Particular the heart beat and the blood pumped in the face causes the capillaries close to the skin surface and swell or contract periodically.

At that time the face become slightly redder and paler. If someone blushes the baseline redness of the face are solely increase. By analysis this color variation over time useful information can be revel such as object's heart rate or small movement can be determine.

Apply standard video as input and filtering the video of a human face allow frequency signal to be traced and converted beats per minute illustrated in figure 4. When filtering at low frequency, the blushing response can be detected by using Hue Saturation Value (HSV) color space. The blushing manifests at low frequency variation in the saturation magnitude of red- based color.

To explain the relation between video magnification and temporal processing , we consider the one dimensional signal for translational motion of pixel value. Let I(x,t) is image intensity, here $\beta(t)$ is a displacement function. here I(x,0)=f(x)

The goal of video magnification is to synthesize the signal

$$\hat{I}(x, t) = f(x + (1 + a)\beta(t))$$

Here a is amplification factor.
In video magnification process take standard video clip as input and apply special low pass filter the frame of the video and down sample in general, we compute Gaussian pyramid that is followed by temporal filtering to the frames and then the resulting signal is amplified to revel the hidden information. The signal is converted to frequency space by fast Fourier transform FFT to detect the heart rate. The heart rate is calculated from the average of time between peaks.

$$HR = 60/\Delta t_{avg}$$

By using those technique to record heart rate and blush response trace over time, then take output to perform hidden markov model. Manipulate the data on the HMM probability are used to produce the evolution of the anxiety state over time.

Figure 5: Representation frames form videos demonstrating in our technique.

4. Experiment Results

The result were generated by using MATLAB code on a computer with a 4 GB RAM. The computation time per video was taken a few minutes. The video size is approx 640×480 at approx 45 frames per second on a standard laptop. We take four standard video at input and apply the algorithm on it. To process an input video by video magnification and blush detection method, first select a temporal bandpass filter, amplification factor, select the special cutoff frequency. For color amplification of blood flow a narrow passband are used because it produce more noise free result. For each video, passed each sequence of frame through an ideal bandpass filter for color amplification, so they have passband with sharp cut off, low pass IIR filter can be used for color amplification.

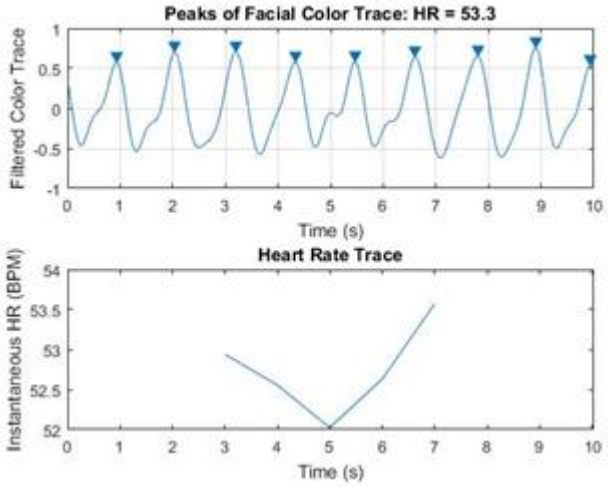

Figure 6: Test subject Heart rate

After the heart rate analyzes the frequency of peaks in the color trace signal, the blush response is captured by several trading change in magnitude of these color trace over a larger time scale.

The heart rate and blush response are infer the information about the subject state of deception given the physical cues, we select to design and train a hidden markov model. The HMM is a temporal probabilistic model which is used to forecast the evolution of the state at each point in time.

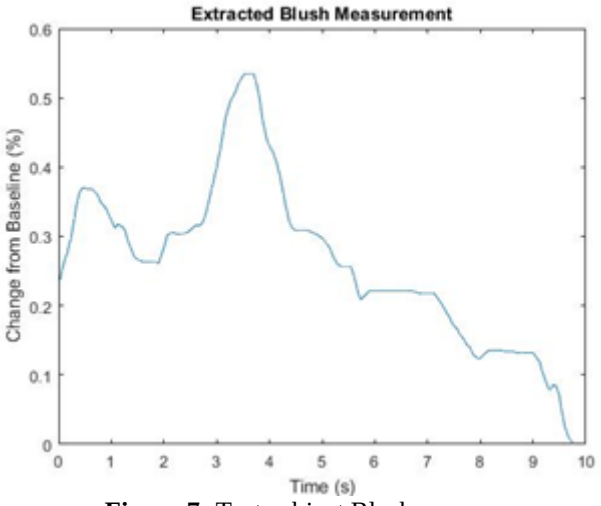

Figure 7: Test subject Blush response

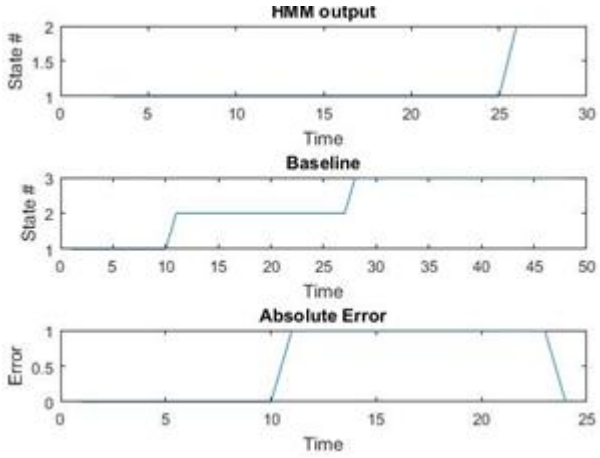

Figure 8: Test subject HMM output

5. Conclusion

The proposed work shows the robust performance for the given test video clip. Clearly, my proposed work detection of anxiety from human face is help to detect deception, anxiety such human emotions from videos. In this project we were able to see a peak behind the mask that it the human face. We believe that our algorithm such as a HMM have realistic transition probabilities. We anticipate that if we gather a larger quantity and variety of data, our result will have been more positively reflected.

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