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# Markov Model Based Human Face Reddishness and Heart Rate Measurement Framework

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***Abstract*: In this paper we propose a human emotion recognition system using Hidden Markov Model. Detection of heart rate and emotion of the face is quiet a challenging tasks. In this paper, we proposed the technique that perform recognize the specific facial emotion i.e. anxiety by utilizing Hidden Markov Model. Utilization of this proposed technique is to enhancing the monitoring framework in medical field, by analysis and rendering the patient face. The proposed HMM models performs well with the video as it processes the spatial and temporal regions of videos. The outcome of the project is the heart rate and reddishness scale. The more is the reddishness of face the more is changes that the person is speaking lie.**

***Keywords:* Heart Rate Measurement, Machine Learning, Video Processing, Region of Interest, HMM.**

## I. INTRODUCTION

If someone present with anxiety, embarrassment filled situation then the mind condition of a person's is excited. He feels hot because of blood rushing to the face and ears. Heart rate is moved toward becoming quicken and stronger. These all situation is invisible to typical outside observation will never know the distinction. The computer vision framework just observes the pick of the mental iceberg and changes physiological all because of emotional changes, which is invisible.

An incredible test appears in a recent research subject to create human vision framework and computer vision framework to consequently recognize all facial emotion [1].

To build up a framework that is programmed to recognize the face, examine and interprets the facial expression or emotions in a video clip or scene to accomplishment of this errand is very difficult. To build up this framework there are generate a few issues, for example first detection of a face from image and portion the face, after that extraction of the facial emotion or expression and finally characterization of the emotion and recognition.

In this paper, we proposed the technique that perform recognize the specific facial emotion i.e. anxiety by utilizing hidden markov model. Utilization of this proposed technique is to enhancing the monitoring framework in medical field, by analysis and rendering the patient face.

Fundamentally our aim to extract the temporal variation in human emotion from video clip, which are difficult to see with the necked eye. In our strategy utilizes Hidden markov model with anxiety as state and sensing heart rate utilizing Eulerian video magnification and apply blush detection to delight blushing level as emitted evidence variable.

## II. TECHNIQUES

To perform our technique the initial step is loaded video clip, after that measure the heart rate by video magnification process and distinguish the blush and converted into feature to accomplish an HMM classifier to evoke the deception from video.

### *A. Detection of Heart Rate*

For recognizing heart rate of an object from the video clip is progressed toward becoming very test and different technique are investigated. In our implementation utilize video magnification to delight the heart rate. To magnifying the video apply eulerian video magnification strategy. To extract the temporal variations from videos that are extreme or impossible and can't be see with the naked eye. In Video Magnification strategy, first we accepts input as a standard video sequence, and afterward apply spatial decomposition, followed by temporal filtering to the frames, after that the subsequent signals is enhanced to extract the subtle data. By utilizing this technique, the stream of blood we can envision as it fills the face and can enhance to evoke the little variation in object. So from this technique we can able to revel the heart rate from input video which is face dependent on the temporal variation of the skin color that is ordinarily invisible to the human eye.

Eulerian magnification strategy [2] used for our usage, in this methodology avoid the taking average of entire region of interest (ROI) by capturing entire time varying sign from individual settled pixel in face area. From these time differing signals, signal peaks are then calculated and are utilized in a pulse onset detection procedure to extract the heart rate. Essentially in this methodology join the special furthermore, temporal processing to reveal the little temporal change in video. First we decompose the video into various frequency band by the utilization of special filter. In special filtering process all frames of video are pass through the spatially low pass filter and after that down sample them for computational efficiency. In general, however we perform a full Gaussian pyramid, which remove high frequency variation.

### *B. Blush Detection*

The blush detection is performed by looking the general changes in magnitude of color peaks over a period scale. To acquire the signal from color trace we performed experiment, couple of various methodologies. The blush of skin tone can be figured by the percentage change from the baseline to get a dimensionless measure which is appropriate for specific with differing physical characteristic, for instance, such as, skin tone. The characterizing variable of our algorithm was the color space in which the blush reaction is sensed. There are quantities of color space each having its very own pros and cons while work on skin color domain. In our algorithm lighting is an imperative factor, the RGB color space is simple and normal technique however it is unreliable for application due absence of distinct intensity and luminance estimation.

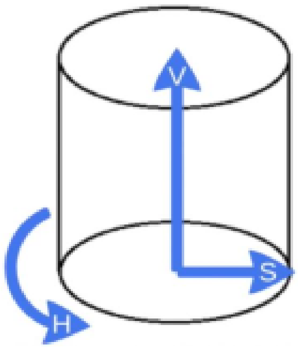


**Fig. 1: HSV color space**

In this strategy lighting is an essential factor; rather than RGB color space we utilized HSV color space in Fig.1. In this color space color are controlled by their hue, saturation, value. The HSV color space has been proposed in [3] in light of the fact that it is more identified with human color perception. In HSV color space depends on polar coordinates, not Cartesian coordinates. Where hue demonstrates the amount that recognizes the colors, what color is seen? It given as an angle from 0 to 360 degrees in a color wheel. Saturation speaks to the color purity and intensity of color strong to weak. The color having same hue yet bring down saturation value, that appears faded. Value is utilized to measure the brightness of color, whereas color are dark or light essentially characterize quality of colors. For distinguishing blush in skin tone that may be comparing 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 as for time was then calculated. Demonstrates the graphical type of HSV color space Fig.2. So, it is affirmed that this color space is indeed similar to the physiological changes that happen amid the blushing. [4]

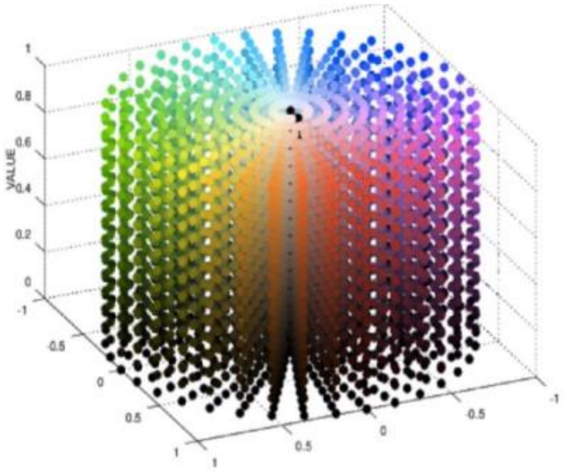

**Fig. 2: Illustration of hue, saturation and value in HSV color space.**

### *C. Hidden Markov Model*

In our strategy, we proposed framework that performs facial emotion anxiety recognition by utilizing Hidden Markov Model. We utilize HMM with anxiety as a state or detected heart rate and blush response which emitted variable. Fundamentally HMM perform two procedures (a) An unobservable Markov chain with a quantities of state, state transition probability matrix and probability distribution of beginning state (b) set of probability density function with each state.

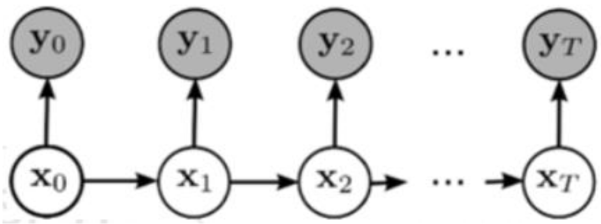


**Fig. 3: Sequence of Markov Model with hidden state**

We picked HMM as a classifier, rather than linear classifier, for example, SVM or neural network in light of its temporal property. After number of experiment we observe that HMM to be more valuable and appropriate for our application.

In our algorithms hidden state is genuine level of human emotion that is deception and anxiety, after the detection of heart rate and blush reaction are proof variable. Essentially sequence of Markov model with hidden state are hmm. HMM is involved a hidden sequence of each time and emit certain factors. Markov chain is utilized to investigations the decision problems in which the occurrence of specific event relies upon the occurrence of event which is promptly preceding the recent development. Hidden markov model is a method for analysis the present development of some factor to forecast its future development.

## III. LITERATURE SURVEY

In this section we presents existing work done in the field of heart rate measurement.

Juan et al. [5], in this paper author tackled the illumination variation challenge, we propose an illumination robust framework using joint blind source separation (JBSS) and ensemble empirical mode decomposition (EEMD) to effectively evaluate HR from webcam videos. The framework takes the hypotheses that both facial ROI and background ROI have similar illumination variations.

Yu SUN et al. [6], Presents photoplethysmography (PPG), non-invasive optical technique for detecting microvascular blood volume changes in tissues. Its ease of use, low cost and convenience make it an attractive area of research in the biomedical and clinical communities. Nevertheless, its single spot monitoring and the need to apply a PPG sensor directly to the skin limit its practicality in situations such as perfusion mapping and healing assessments or when free movement is required.

Verkruysse et al. [7], measured plethysmographic signals remotely (> 1m) using ambient light and a simple consumer level digital camera in movie mode. Heart and respiration rates could be quantified up to several harmonics. Although the green channel featuring the strongest plethysmographic signal, corresponding to an absorption peak by (oxy-) hemoglobin, the red and blue channels also contained plethysmographic information.

Feng et al. [8], proposes an adaptive bandpass filter to remove residual motion artifacts of RIPPG. It combine ROI selection on the subject's cheeks with speeded-up robust features points tracking to improve the RIPPG signal quality. Experimental results show that the proposed RIPPG can obtain greatly improved performance in accessing heart rates in moving subjects, compared with the state-of-the-art facial video-based RIPPG methods.

Wang et al. [9], proposes a method to improve the SNR of the state-of-the-art rPPG technique from 3.34 to 6.76 dB, with instantaneous reference pulse rate from 55% to 80% correct. ANOVA with post hoc comparison shows that the improvement on motion robustness is significant. The rPPG method developed in this study has a performance that is very close to that of the contact-based sensor under realistic situations, while its computational efficiency allows real-time processing on an off-the-shelf computer.

## IV. METHODOLOGY

This section presents the proposed methodology in detail. Implementing such a system which detects person's heart rate and redness of face is quite a challenging task. The truth can be grabbed using some video processing algorithm by simply analyzing the person face. The person face turns red when he/she is uncomfortable while answering specific question. This type of behavior can be detected by our framework.

Proposed system contain various modules for heart rate and reddening of face measurement:

**1. Heart Rate Measurement**

a. Spatial Filtering

b. Averaged Tracing

c. Temporal Filtering

d. Peak Detection

**2. Redding of Face Measurement**

a. RGB Components Extraction

b. Transformation into HSV space

c. Median Filtering

The proposed system architecture shown in fig. 4 and 5.

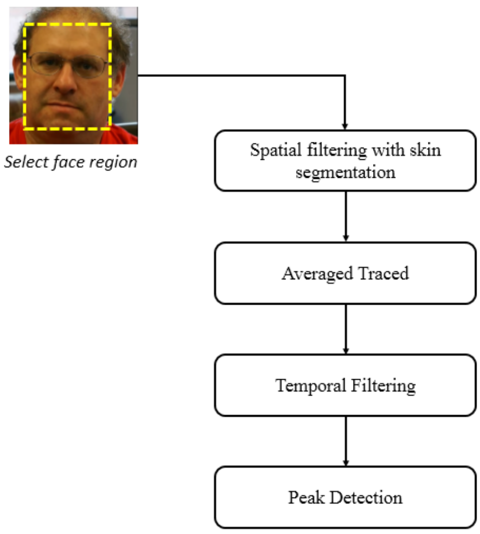


**Fig. 4: Heart Rate detection framework**

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**Select Face Region:**

Some of the video frames may contains noises which need to be removed so that our algorithm correctly recognizes the face. Firstly, the face regions are selected using MATLAB face selection feature. By select face region only, we generally eliminate the non-facial region.

**Spatial Filtering:**

The frames are then further filtered spatially by blurring and down sampling the video sequence in a Gaussian pyramid, which removed high frequency variations. After this is completed, the face is further segmented into "skin" vs. "not skin" based on color. This was done in a basic manner by selecting pixels with a red channel intensity higher than the grayscale luminance, with the premise that this simple metric represents candidate reddish pixels that are not too dark.

**Averaged Trace:**

Finally, the green color channel is averaged over each frame, and this trace is selected to be used in the next parts of the process. Green is used over the red and blue channels as it has been shown to contain the strongest waveform.

**Temporal Filtering:**

To temporally filter the signal such that only frequencies in the range of valid human heart rates are considered, the signal is converted to frequency space by taking a FFT. All frequencies outside a specified heart rate range are suppressed. This heart range can be given by the user the finer the window, the more accurate the heart rate measurement will be.

**Peak Detection:**

Peak analysis is used to local maximums along the curve, under the constraint that they are spaced at least a minimum time span apart. This time span is determined by the upper limit of the heart rate range. Finally, the heart rate is calculated from the average time between peaks:

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

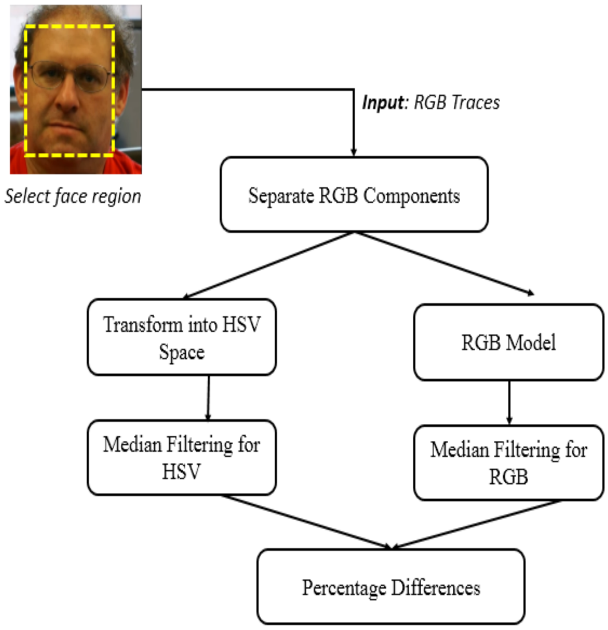


**Fig. 5: Redness of face detection framework**

The blush response is captured by looking at the general trending changes in magnitude of these color peaks over a larger time scale. In order to obtain this signal from the normalized color trace. The blushing response metric was calculated as the percent change from the baseline to obtain a dimensionless metric suitable for individuals with varying physical characteristics, such as skin tone.

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Our method analyzed the HSV color space, where colors are separated by their hue, saturation, and value. The HSV color space is similar to the way humans perceive color. Hue represents color, given as an angle from 0 to 360 degrees around a color wheel.

For detecting color changed that might be corresponding to a blush, we separated out reddish colors with hue values in the range of 0 to 18 and 350 to 360 degrees. Filtering out the other colors, the change in saturation over time was then measured.

## V. EXPERIMENT RESULTS

The experiments are performed in MATLAB using video and image processing tools. 4 GB of RAM is required while performing experiments. Four different types of video are taken as input. Two face and two child sleeping videos are captured to measure heart rate and reddishness of face. The two baby video are of size 1.75 MB and 5.85 MB. While face video size are 1.56 MB and 2.91 MB.

The output obtained by the hidden markov model are presented in fig. 6 and 7.

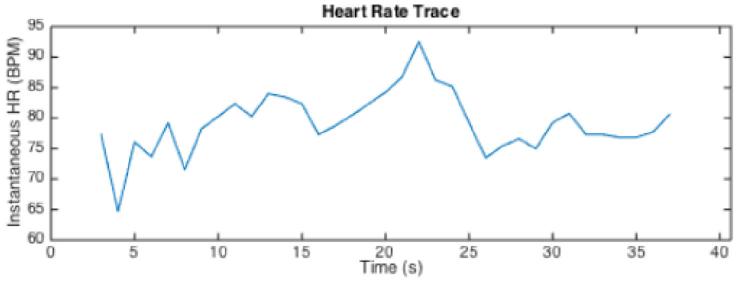


**Fig. 6: Shows the heart rate trace of baby video**

Fig. 6. Shows the heart rate of baby. The heart rate are measured while the baby is at rest position. The video magnification technique is quite useful in close analysis of any object. The heart rate with respect to different times are shows in the graph. For example the heart rate at time 5 is around 75-80 BPM while at time 20-25 sec the heart rate goes up from 80 to 92 BPM.

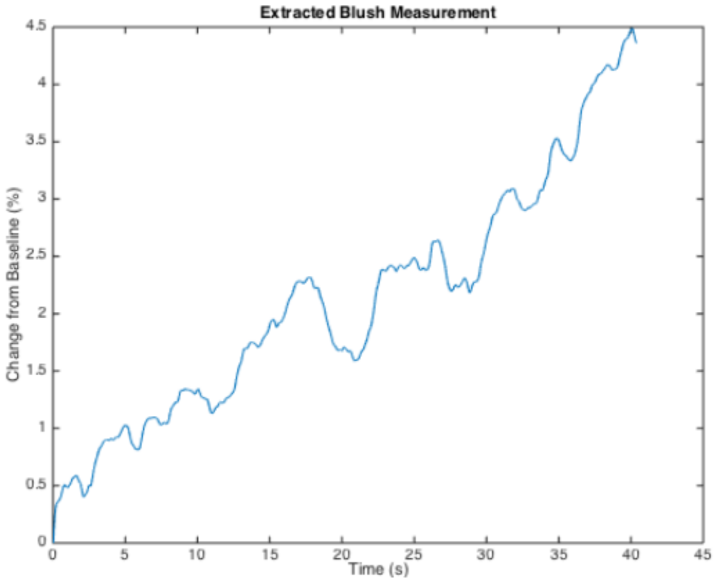


**Fig. 7: Shows the reddishness of face with respect to time**

Fig. 7. Shows the reddishness of face of person. This is helpful in investigation by police. The sets of questions are prepared and asked to the suspected person. Proposed algorithm keeps on measuring the reddishness of person with specific question. Suppose, at time 10 the reddishness of person face is around 1.5 while at time 40 it becomes 3.5. There is increase in the facial color of the person.

## VI. CONCLUSION

In this paper we proposed a robust and efficient framework which measures the human heart rate and reddishness of face using HMM algorithm. The proposed system can able to detect deception and anxiety from the videos. The heart rate detection algorithm can be used by big hospitals where without disturbing patient heart rate are measured. While the reddishness detection system can be used by investigation agency who interrogates the criminals.

The proposed HMM models performs well with the video as it processes the spatial and temporal regions of videos. The outcome of the project is the heart rate and reddishness scale. The more is the reddishness of face the more is changes that the person is speaking lie. The heart rate of baby is measured low at time 0 to 15 and 25 to 40 while high at 15 to 25. The reddishness of person face is increasing as the time passes. But in time duration 20 to 25 we observed decrease in reddishness.

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