**Introduction:**

Heart rate can say a lot about a person’s health.

While most conventional methods for heart rate measurement require contact with the subject, these are not always applicable.

Currently the ways available to measure heart rate are handheld devices (electrocardiograph machine) which measure the pulse but these are very expensive and it requires expertise to use. Now a days placing your finger on the camera of a phone will also estimate your heart rate, but the disadvantage of all these methods is that we need to have physical contact with the device while measuring the heart rate.

The science behind is every time your heart beats, more blood is pumped into your face. This slight increase in blood volume causes more light to be absorbed, and hence less light is reflected from your face. Using image processing techniques, we can detect these changes which are invisible to the human eye. These spatio-temporal variations are amplified and analyzed to derive the heart beat based on certain algorithm and formula.

Hence the solution we are proposing to this problem is as follows, we are providing an android app which lets users capture their video and get their heart rate instantaneously. This lets the user measure the heart rate without having any experience or knowledge about the process to measure heart rate and it is cost effective. Catering to the phenomenon of people using smartphone camera as the most popular smartphone feature, we can address this problem.

Here a non-invasive method for pulse detection is implemented and the results analysed.

Different signals from the color of the forehead at different lighting conditions—including the green channel, the hue channel and different ICA and PCA components—are inspected, and their resulted heart rates are weighted together according to the significance of their FFT peaks.

**Concepts involved:**

**RGB :**

RGB is a very commonly used color representation model, having

three parameters—R (red), G (green), and B (blue)—each of them with

a value in range [0.0, 1.0]. It is an additive color model, which means

that the resulting color is the one where the parameters are mixed .

For example, black is represented by the triplet (0, 0, 0), blue by (0, 0, 1)

and white by (1, 1, 1). The RGB color model is used throughout this project.

**HSV**:

HSV (hue, saturation, and value) is a color model that represents an RGB color in a cylindrical coordinate system , to make the representation more intuitive. The hue parameter is the angular dimension and represents the color with red at 0◦, green at 120◦ and blue at 240◦.Saturation, ranging from zero to one, states how saturated the color is.

Finally, value describes the brightness in a 0–1 range.

**Component Analysis:**

When dealing with camera footage used for heart rate estimation, motion and illumination artifacts are substantial obstacles. To overcome these, blind source separation (BSS) can be used to separate the PPG signal from other signals influencing the color change of the skin. Two of the most commonly used methods to do this are independent component analysis (ICA) and principal component analysis(PCA). ICA decomposes mixtures of source signals into components that are, if not completely independent, as independent as possible

.PCA, on the other hand, identifies the principal components by using an orthogonal matrix composed by the eigenvectors of the original variables’ covariance matrix.

**Method**:

The system consists of three main steps—ROI (Region Of Interest) detection, signal processing, and heart rate estimation—where each main step is divided into a handful of smaller steps.

**1) ROI Selection**

We use OpenCV for detecting and tracking the face from the video which now has a box around the persons face. After this we select the Region of Interest (ROI) which is the forehead.This area is found by detecting the eyes of a person and then selecting the area above the eye .we then obtain RGB(Red-Green-Blue) and HSV(Hue-Saturation-Value) signals of the data.

**2) Signal Processing**

The RGB values of the pixels inside the ROI were spatially averaged, excluding the 5 percent highest and lowest values, which resulted in three raw signals, x1(t), x2(t) and x3(t) for each time frame, t. From the raw RGB signals, the HSV values were calculated producing three more raw signals, x4(t), x5(t) and x6(t).

Considering that only small color changes are of interest, the signalwere detrended to eliminate larger fluctuations caused mainly by an alternation of illumination. This was done by subtracting a 30-frame(one second) moving average from the signals resulting in six new signals, x’1(t) …. x’6(t) . where t is the current frame and N is the total number of frames in the video sequence. To remove high-frequency noise and to make the signals clearer, the detrended signals were smoothed using a five-frame moving average.

One of the biggest problems with remote pulse detection on moving subjects is artifacts caused by motion, which make it difficult to recover the PPG signal from the raw signal. Many different approaches have been tested by others to overcome this and no method is optimal and outperforms the other methods in all scenarios. Hence, the method in this idea is to use multiple signals and weight the heart rate measurements from these together. Because of this, 12 further signals were calculated using ICA and PCA on the detrended and smoothed color channels. Altogether, 14 signals were used:

a) The green channel of RGB (x2’)

b) The hue channel of HSV (x4’)

c) All three components generated using ICA on RGB.

d) All three components generated using ICA on HSV.

e) All three components generated using PCA on RGB.

g) All three components generated using PCA on HSV.

The green channel of RGB and the hue channel of HSV were selected because it has been shown before that these are good signals for PPG extraction. For ICA, the JADE algorithm was used, which has been proven to be a suitable method for this purpose

**3) Heartrate Estimation**

After the signals had been extracted, heart rates for all of them had to be measured and weighted together. To get the heart rate corresponding to a particular signal, FFT was used. Since the heart rate might vary over time, causing the pulse to get spread out in the power spectrum, a moving window was used. The window was 10 seconds long and shifted forward with one second. Each signal was zero-padded to a length of 450 frames, to get a frequency resolution of 4 bpm .The resolution was chosen because it was high enough for the wanted accuracy, but not so large that it required too much zero-padding. To make the values for the different signals’ frequency domains comparable, each signal was normalized before the FFT was calculated. For each 10-second window, the FFT was calculated for all 14 signals.Signals with an FFT containing a significant peak in the frequency range corresponding to a possible heart rate were desirable. This range was defined as 1–2.5 Hz, corresponding to 60–150 bpm. If the highest value of the FFT was outside this range, the measurement was rejected (by receiving a score of zero) and did not contribute to the final result.

When evaluating a result where the peak is in the correct range, two factors are especially important for the significance of it: how big the peak is and its size compared to other peaks. If a peak with a high value is found, one cannot be confident of the result if an almost as high peak is found 20 bpm away. The score, s, of a heart rate measurement was because of this calculated

When all heart rates and their corresponding scores had been calculated for all 10-second windows, the final estimate of the average heart rate, p ̄, could be calculated. Three different methods were used for this,where one utilized all measurements in each time window, and two of them only used the measure with the highest score in each window.For the last two, one of them used the weighted average and the other one the non-weighted.

**Applications:**

1) Amusement Parks - For safety of people who need to be checked for heartrate and BP for certain specific rides which can be potentially dangerous for their health

2) Gyms - Gym trainers can keep a check on their trainee’s after workouts every day to check for any abnormalities.

3) Remote diagnosis - Patients who can’t go to doctors in cases of emergency can measure their vitals and get an immediate response from doctors thus saving a lot of lives.

4) Patients – BP patients can calculate the Blood Pressure (obtained from heartrate) easily and can be notified when risk of a heart attack increases.