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Non-Contact Pulse Monitoring using Eulerian Approach

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Abstract: In the so perfect world of stillness, the objects around us are like a perfect model. A baby sleeping in her cradle may look very still, a house's roof which looks so straight but in reality they have slight deviations from their perfect stillness and straightness. There are observations where we can see subtle deviations produced due to the environment in and around us, while it is invisible to our naked eye making it unable to reveal this information in real time. In the proposed procedure, the Eulerian approach is used to reveal subtle motion with respect to time of an object which cannot be noticed through our naked eye, like a pulse due to the pumping of heart. Here we follow an algorithm where every pixel is monitored for variations and then it exaggerates those differences. The differences include color as well as the motion with respect to the phase position.

Keywords: pulse; monitoring; eulerian; image processing; magnification; non-contact.

I. INTRODUCTION

The vital signs are important in both home and hospital situations for regular and non-invasive measurements because of their basic role in the prognosis of health conditions and monitoring it. The measurements include pulse rate variability(PRV),pulse rate(PR), breathing rate. Usually, vital signs are measured by using various equipment such as electrocardiogram probes, pulse oximeters, chest straps, blood pressure monitoring cuffs. Equipment like theseare usually contact sensors, and not well suited for all environments.

Eulerian approach for Video Magnification is an up-growing method capable of revealing unnoticed motions that were impossible to distinguish with the naked eye. It essentially monitors the variations in each pixel and then exaggerates them. As the heart pumps the blood, the arteries contacts and expands which in turn changes our skin color. The change to bright red colored blood during the pump action of heart is very subtle and human eye, no matter with how much consideration stares at the wrist or someone else's face, it would be very hard to detect thecolor change. Let's take a computer, however, thereeven the tiniest fluctuations per-pixel (between pink and slightly-redder-pink, say) are easily detectable.

At the time of observing the pulse rate of a personnel (Figure 1), the proposed method detects the pixels that are subtly change and exaggerates them by changing the reddish blood color as violet. Apart from measuring the blood stream the same can also reveal the minute movements of eye muscles, the oscillation of the buildings caused by wind, or the vibrations in objects caused by sound waves which is hidden to our naked eye. The proposed work could be made compatible to the smartphones and wearables in order to make use of it in real time. It could be ultimately helpful for Doctors, Government lie detections agents and even for our daily needs.

Video magnification can quickly and cheaply produce visualizations that can aid the cause. It is a non-contact based pulse monitoring system which is fast, reliable and uses lesser cost heads. It can be readily available and is much user friendly and can be used in various other domains and different from the intended defined use.

II. RELATED WORKS

The proposed work in [1] focused on the change on the body movements and the movement of head due to breathing. It monitored the motion for the same and produced the results based on them. The approach was limited to the motions which was caused by the continuous breathing. If a person consciously chooses not to have any observable body motion or causes extra motion, then the approach isn't efficient and produces erroneous results.

In [2] the concluded work was based on the change of color due to the blood flow and the redness hue due to hemoglobin. It follows the same algorithm as the one proposed in this paper but it is restricted with the color change and does not take the motion into any consideration.

The recommended work in [3]was done with the blind source separation and automated face tracking methodology. It had smaller focused bounds and lacked highlighted motion magnification of the subject in the video.

The suggested work of [7] was the use of Phase Disturbance, the work uses a quadrature pair of various

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filters and vary the local phase providing the subject with motion. It had high processing time and restricted implementation, the high resource usage made it less cost efficient.

III.METHODS

The proposed algorithm, we take the pixels are having transitional motion in the subject video. The value of the pixel at given position be $V(x, t)$ where x is the position at the given time t . Let $\delta(t)$ be the function for the displacement due to temporal variation. Then we can say,

Eq1:

$$V(x, t) = f(x + \delta(t))$$

And,

Eq2:

$$V(x, 0) = f(x)$$

So, the equation after the α amplification factor, which is nothing but an offset value to multiply the exaggerated location or the color value.

Eq3:

$$V'(x, t) = f(x + (1 + \alpha)\delta(t))$$

The proposed work here processes the video of the subject and produces results. The following are the steps followed by the proposed algorithm.

- The video of the subject is made using a high quality video capturing device, and is being fed into the machine.
- The algorithm then analyses the video and extracts certain details, such as the height, width, fps and so on.
- The algorithm takes the pixels one at a time (Figure 3)and changes the same with temporal shifts (Figure 2) from one color code to its higher color shade. For instance, it changes the pink color to purple instead of slightly reddish-pink color.

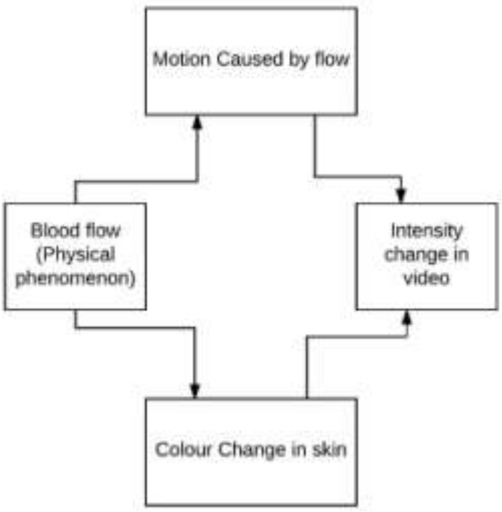

Figure 1: We can see two phenomena due to blood flow.

- The motion with the phase position of the object is also exaggerated. Let's say, instead of changing 10 pixels it changes 50 pixels, making the motion look magnified.

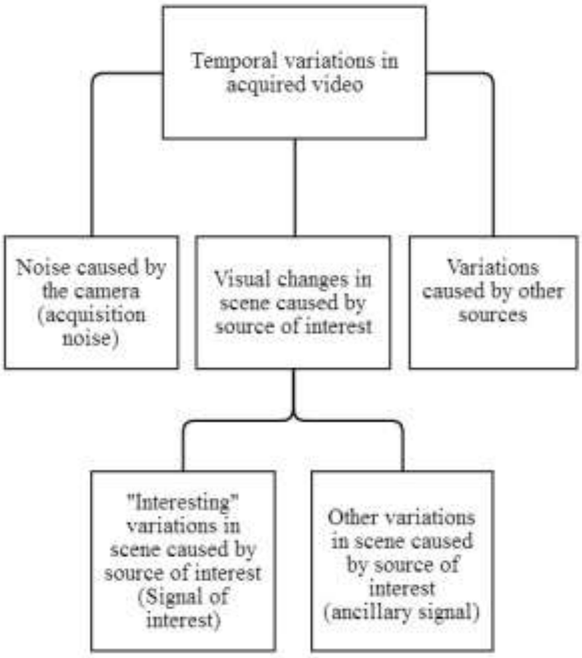

Figure 2: Various Temporal Variations in a video.

IV.RESULTS

The results were produced using MATLAB with a quad core processor and 4GB RAM. This video took few minutes for its computation. To construct the video pyramids, we used a separable binomial filter of size five. It does the processing entirely on the core CPU, it can take a minimum of 640x480 video with 45 fps and work smoothly on a standard desktop or laptop system.

The resultant video showed color change (Figure 4) due to the blood flow, in a video which was not even recorded for the intended use. Thus, showing us that the algorithm can be used for pre-recorded videos as well.

Figure 3: Each Individual pixel is selected for further manipulation and exaggeration. Courtesy: Warner Bros Pictures.

The proposed work can be implemented with less expenses which can do rapid processing and produce nearly exact

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outputs when compared to the normal on-body sensors. It can perform like multitasking by monitoring more than one personnel at given time which is more powerful to person movement (when supported with sufficient processing power). The method can work with the longer range of 1 to 5 meters.

Figure 4: The Source and Result video screenshots showing the color change due to pumping of blood.Courtesy: Warner Bros Pictures.

V. CONCLUSION AND FUTURE ENHANCEMENTS

It is an eulerian approach which analyses pixels bounded by a focused area which can be used only for small changes in the region. After detecting the minute alternations in pixels this method exaggerates the motion change of the pixels in a manner which is enormously visible to our naked eye. It erratically produces an output with the low signal-to-noise.

In futureproposed work could be made endorsed to the smartphones and wearables in order to make use of it in real time. With required resources this dream can be made true and ultimately helpful for Doctors, Government lie detections agents and even for our daily needs.

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