Are You Burning Fat?

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Abstract. Obesity is the major contributor of several diseases and results in higher healthcare cost to our society. Diet and exercise can improve fitness level and hence better health. But, people need an easy way of knowing if they are in their fat-burning zone during exercise. In addition, the measuring device needs to be non-invasive and ubiquitous. In this project we devised a technique of detecting the right heart zone and we believe this can be achieved at no-cost by using the "always-available" mobile phone. We used the camera and flash in NexusOne mobile phone for capturing the color intensity of finger pulse during heartbeats. In addition, we are able to extract the respiratory pattern from the heartbeats. From this, we are trying to find the anaerobic threshold of person using the variation in Inhalation and Exhalation during exercise. With this we will be able to find the heart rate zone at which a person stops burning his fat and starts burning his carbohydrates. To our knowledge there is no research reported on the analysis of burning fat based on the measurements from a mobile device.

Keywords: Mobile phone, Respiratory patterns, Anaerobic Threshold.

1 Introduction

Over the past 20 years, there has been a startling increase in the amount of obese in America. Statistically, almost 3 out of every 10 adults are obese as of 2009 (26.7% of America's population). This is up from 2007 which showed a percentage of 25.6. Obesity is a medical condition that is easy to recognize, however, there are no treatments for obesity. Between 16 and 33 percent of children are obese currently. Soon enough, there will be an overwhelming of Americans (adults and children) who will be obese in 20-30 years [1]. Among these are our children and the next generation of Americans. These numbers will continue to increase until something drastic is changed in their lifestyle. A common and natural treatment of obesity is exercise. Many obese people looking to lose weight try exercise, however not many obese people actually lose a significant amount of weight after lengthy periods of exercise. Aerobic Exercise is a traditional way of burning fat. Aerobic exercise is not meant to be intense. During aerobic exercise, a person reaches their anaerobic threshold. A person's anaerobic threshold is the threshold when they stop burning an efficient amount of fat and they start to burn carbohydrates. When people exercise, they naturally pass this threshold, and from that moment forward, they are not burning a significant amount of fat [2]. There is a corresponding heart

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rate to a person's anaerobic threshold, if this heart rate is not surpassed then the person will burn the fat that they are looking to burn from their exercise. If a person could know their anaerobic threshold, then they could burn fat rapidly over a few weeks and months instead of years. It is always beneficial to know the heart rate corresponding to the anaerobic threshold during exercise. A person's anaerobic threshold changes constantly based on the fitness level; this is why it needs to be continuously monitored if one wants to continue to burn fat (also not carbohydrates) and achieve their weight-loss goal. The world's society looks at smart phones as if a necessity in our time. This is one of the advantages a smart phone contains; its abundance in our world and the heavy use of it in our society. This is why the smart phone is a special no-cost-device compared to special-purpose devices made by vendors. In particular, there is one tool that the smart phone has to offer that makes it useful to many researchers; this is the camera of a smart phone. The heart is the main organ of the human body which is in charge of pumping blood to all of the limbs of the body. When the finger is placed under a close light fixture, it is possible to analyze a person's blood flow to the finger. Figure 1 shows the locations where pulse can be found on human body.

Fig. 1. Where pulse can be found on human body

The finger glows bright red under heavy light fixture. Analyzing the finger-image under this light fixture, a person can see when the heart is pumping blood into the finger through the arteries. When observed, a person can see the finger blinking periodically. This is because of the heart pumping blood into the finger and then returning the blood back towards the heart to refill it with oxygen from the lungs and then to pump it to another limb in the body. When the finger-image is blinking, this also represents the beats of the heart pumping blood to the limbs of the body.

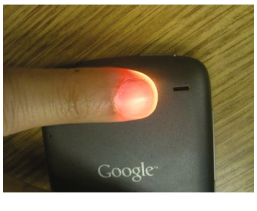

Fig. 2. Measurement being taken with finger on the camera lens

When the finger is placed on the camera 2 and flash, a video of the finger is being taken. This allows us to analyze the finger more clearly.

2 Methodology

A smart phone is used to analyze the respiratory pattern of a person during exercise. When a smart phone camera along with a flash is placed on the finger of a person, it will be able to capture the blood flow i.e., the variation of color intensity of blood in the finger. This process is similar to the Photoplethysmography(PPG) technique [3] without using the wavelength of light for analysis. Using the intensity variations, we are able to capture the pulse from the finger. This model works on a principle that, every heart beat pertains to a rush of blood in the blood vessels, even in the capillaries at the finger-tips. Whenever the capillaries are rich in blood during a systolic pulse, more light is getting absorbed by the blood, leading to low reflective index and darker frame intensities. Likewise, during a diastolic pulse, most of the light gets reflected leading to bright frames. This change in intensity of light which can pass through the finger creates an alternative pattern of waves similar to a pulse. Figure 3 shows the pulse wave obatined through video by placing the finger on the camera lens.

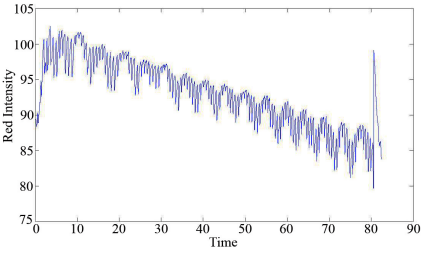

Fig. 3. Pulse waves obtained from finger

Figure 4 shows the analyzed area in a video frame. Initially the video frames were split into four quadrants and only the first quadrant was considered for analysis, since we observed most of the changes and fluctuations are predominant in that region. Every pixel information on each frame was split into individual Red(R), Blue(B) and Green(G) components. For accuracy of plots, we considered only the Rc in video frames. The average intensity of pixels for every frame was calculated as its frame intensity.

Breathing pattern can be obtained from the pulse waveform [4]. The derivation of breathing pattern requires filtering of pulse wave. In the derivation of respiratory pattern, we passed the camera feed from the subject's finger through a 10th order running median averaging filter implemented as a smoothing function. Figure 5 shows the working of respiratory pattern detection from finger pulse. The inhalation and exhalation patterns are split from a breath basing on the peak and time stamp of a breath wave. Figure 6 shows how the Inhalation and Exhalation patterns are divided from a breath wave. Research is in

Fig. 4. Area under analysis

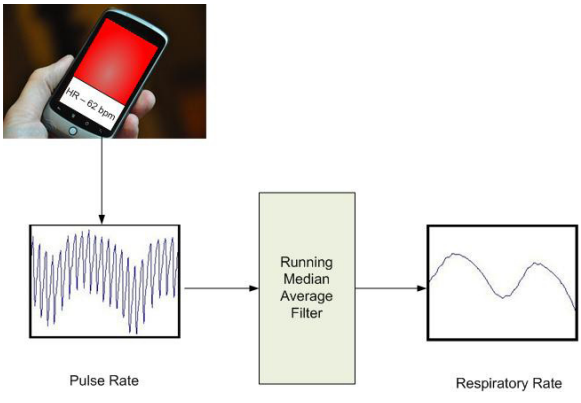

Fig. 5. Model of respiratory pattern with mobile phone

progress to analyze the anaerobic threshold of a person basing on the Inhalation and Exhalation variation. Once we are able to find the Exercise Intensity from the variation in Inhalation and Exhalation pattern [5] we will be able to find the anaerobic threshold of a person [6]. We are calculating the area of Inhalation and

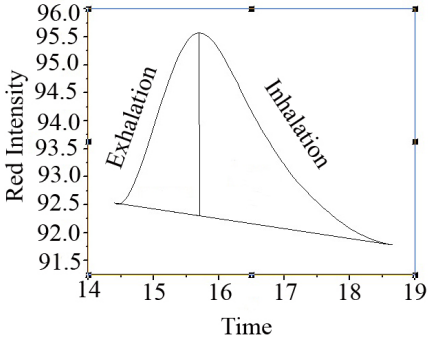

Fig. 6. Inhalation and Exhalation from a breath wave

Exhalation for analyzing the variation between them. Video frames are collected from different people of different age, fitness are being analyzed.

3 Results

Respiratory patterns of a person were calculated at different situations. Figure 7 shows the respiratory pattern during deep breathing. We can observe that all the breaths are similar during deep breathing. Figure 8 shows the respiratory pattern of a person during exercise at a heart rate of 144bpm. In Figure 9 we can clearly observe that the person is gasping for air, as there is a short exhalation and long inhalation immediately.

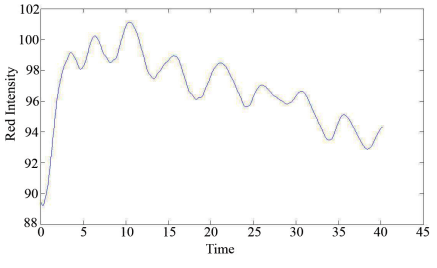

Fig. 7. Respiratory pattern of deep breathing

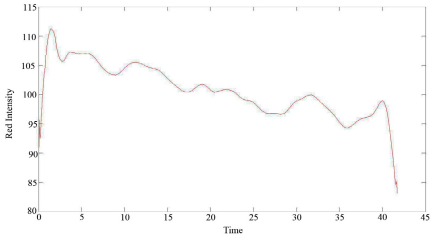

Fig. 8. Respiratory pattern during excercise

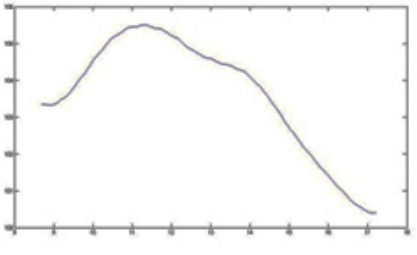

Fig. 9. Inhalation and Exhalation while gasping for air

4 Future Work

We are analyzing the Inhalation and Exhalation pattern of people during exercise which could help in deriving the anaerobic threshold of a person. Different categories of people of age, fitness are being considered for analysis. With the variations in Inhalation and Exhalation patterns we will be able to derive a formula for calculating the anaerobic threshold in terms of heart rate

5 Conclusion

The analysis pattern explained in the paper could lead to an efficient technique which could help us in finding the anaerobic threshold of a person. This could be of high benefit for the obese people who are trying to burn their fat but could not due to lack of awareness of exercise pattern. This application will be available for free to everyone and easily accessible by all categories of people.

References

1. http://www.cdc.gov/obesity/data/trends.html
2. http://www.rice.edu/jenky/sports/anaerobic.threshold.html
3. Allen, J.: Photoplethysmography and its application in clinicalphysiological measurement. Physiol. Meas. 28, R1–R39 (2007)
4. Johansson, A., Stromberg, T.: The respiratory Induced variation of the photo plethysmogram. J. Clin. Monit. 16, 575–581 (2000)
5. Park, S.H., Jang, D.G., Son, D.H., Zhu, W., Hahn, M.S.: A biofeedback-based breathing induction system. In: 3rd International Conference on Bioinformatics and Biomedical Engineering, pp. 1–4 (2009)
6. Rapoport, B.I.: Metabolic factors limiting performance in marathon runners. PLoS Computational Biol. 6(10), e1000960 (2010)