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A Non-Contact Respiratory Monitoring System using Advanced Nasal Mandible Tracking Algorithm Along with ROI

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Abstract*: Increasing demand on public healthcare services due to the aging population has become a major problem in developed and underdeveloped countries. In parallel with the advances in ubiquitous computing technologies, extensive research is being carried out in using sensor networks and automated healthcare systems for home and hospital care environments. A problem with airflow measurement is that some patients may not feel comfortable with the sensor. The collector can also affect respiratory activity by increasing dead space. The existing method worked well when the subject breathed through the nose (not mouth) and the mouth remained closed. The Non-Contact Respiratory Monitoring System with advanced nasal-mandible tracking algorithm along with ROI. In this work the Inspiration, Expiration, Respiratory rate and Pulse rate values are calculated. The existing mean value 2.4 and 78.1 and the proposed value is 9.7 and 81.3.
***Keywords:* ROI, Respiratory rate, Pulse Rate, Nasal cavity, Wireless mensuration.**

I. INTRODUCTION

Monitoring of breathing function has applications among others in polygraph, sleep studies, sport training, early detection of sudden infant death syndrome in neonates, and patient monitoring.

Various contact measurement methods have been developed for estimating the breathing rate of a subject. George B. Moody, et al. developed a contact modality in which numerous Electrocardiogram (ECG) electrodes and sensors are attached to the subject [1]. The principle of operation is based on the fact that the heart rate is typically modulated by breathing, a phenomenon known as sinus arrhythmia [2]. Therefore, a signal corresponding to the heart function contains breath information, which is filtered out using band-pass filters.

As an improvement over the ECG method, the BioMatt method [3] was developed in Finland by a group of researchers who were studying sleep disorders. BioMatt performs measurements of vital signs, such as breathing and cardiac activity without electrodes. Initially, BioMatt could not distinguish motion that was due to breathing versus cardiac activity or body movement. Later, Larson developed a signal processing technique to separate out the components of the BioMatt signal [4].

Photo plethy smography (PPG) is a variant method of the ECG, developed to measure blood volume changes in living tissues by absorption or scattering of near-infrared radiation. This modality consists of an infrared Light Emitting Diode (LED) and a photodiode which can be clamped to the ear lobes, thumbs, or toes. It is advantageous in that it is portable, compact, and needs very little maintenance. The measurement of blood volume changes by PPG depends on stronger absorption of near-infrared light by blood when compared to other superficial tissues [5]. The amount of backscattered light corresponds to the variation of the blood volume. As in ECG, the breath waveform is separated from the cardiac signal through various methods that have been developed [6], [7]. However, using heart function as a basis for acquiring the breathing waveform is unreliable since sinus arrhythmia is not present in all individuals. Control of cardiac activity by breathing depends on the age and medications administered to subjects.

Other contact modalities are capable of measuring directly the breathing signal. An example of such modality is the abdominal strain gauge transducer [8] that is strapped around the subject's chest and measures the change in thoracic or abdominal circumference while breathing. Another example is a thermistor measuring nasal air temperature variation as an indication of breathing [9].

II. BREATHING FUNCTION

Respiration in a man involves three well defined stages [6]. The first stage called breathing comprises of inspiration, which is the process of taking oxygenated air into the lungs and expiration, which is discharging out air rich in carbon dioxide. The second stage

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involves the transport of the oxygen to the cells of the body using the heart and the vascular system. The third stage is called cellular respiration where oxygen is used in the process of generating energy for physiological activities.

In our study, we are interested in monitoring breathing using infrared imaging. The breathing cycle consists of inspiration, expiration, and post-expiratory pause. During quiet breathing, inspiration begins due to negative pressure created inside the chest cavity by the contraction of the diaphragm. Expiration is a passive process where the air flow occurs due to the elastic recoil property of the lungs. The post-expiratory pause is caused when there is equalization of the pressures inside the lungs and the atmosphere.

Breathing cycle is defined as the time interval between the beginning of inspiration and the end of post-expiratory pause. During quiet breathing, the breathing rate may vary from 12-20 breaths/min and after physical activity, 30-40 breaths/min in healthy individuals. Figures 1(a) and 1(b) show typical duration of the three phases during quiet breathing and after physical activity respectively.

During quiet breathing, the duration of post-expiratory pause is comparable to that of inspiration and expiration. After a person undergoes physical exertion, the post-expiratory duration reduces considerably and in some cases, this phase may even cease to exist.

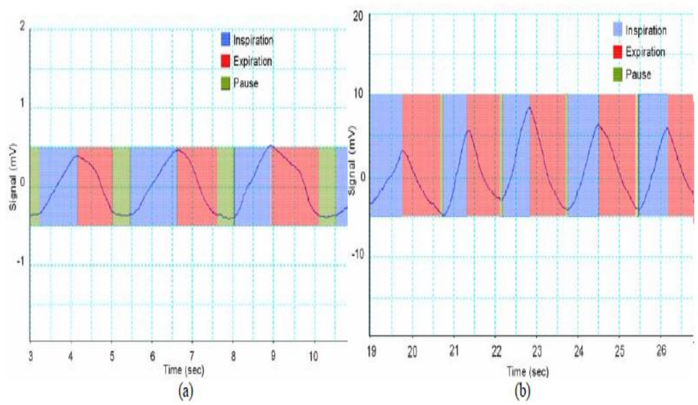

Fig. 1 Output from a piezo-respiratory belt transducer showing the three breathing phases during (a) quiet breathing and (b) after exercise [1]

III.TRACKING THE REGION OF INTEREST (ROI)

We define as the Region of Interest (ROI) *R* the region in the background, where there is possible presence of respiratory airflow. It is in this small image region that our statistical algorithm is applied. The ROI is characterized by its size, shape, and position. Over time the size and shape of ROI remain the same but its position changes to cope with the subject's motion (tracking).

For simplicity, *R* was chosen to be a rectangular region. Typically, subjects are breathing through the nasal cavity, which results in a downward airflow profile. Breathing through the mouth is less prevalent and results in horizontal airflow profile. In our data set we observed downward airflow profiles (Figure 1.2(a)) in eight (8) video clips and horizontal profile (Figure 1.2(b)) in one (1) video clip. Hence, we chose a rectangular region *R* arranged in a longitudinal fashion to closely match the prevalent downward profile of airflow.

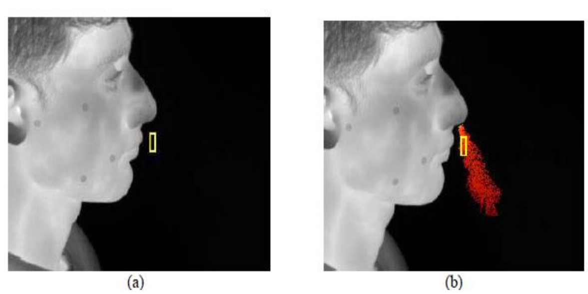

Fig. 2 Visualization of breath during (a) non-expiration and (b) expiration. The ROI is anchored just under the subject's nose tip[2]

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IV. NON-CONTACT SENSING TECHNOLOGIES

Current medical techniques for monitoring heart rate, respiration rate and other phenomena use electrodes attached to the body. These methods are impractical for patients recovering from surgery or the elderly who are encouraged and in many cases required to maintain an active lifestyle. A number of techniques for non-contact sensing technologies are presented.

A capacitive sensor for detecting heartbeat rate without direct contact with the skin is investigated by [3]. Precordial movements change the capacitance between patch electrodes embedded in a person's clothing and modulate the frequency of a Colpitts oscillator. Heartbeat and respiration data can be obtained by demodulating the oscillating signal. In addition, heartbeat signals are extracted from the demodulated signal and a band pass filter is used to separate the harmonics of heartbeat frequency.

A non-invasive pneumatic sensor is presented by Watanabe *et al.* [4] and is placed under the bed mattress to measure human vital functions. The small movements attributable to a person's vital signs are measured as changes in pressure using a pressure sensor having an almost flat frequency response from 0.1 to 5 kHz and a sensitivity of 56 mV/Pa. Using the newly developed system, heartbeat, respiration, apnea, snoring and body movements are measured.

Non-contact sensors and wireless sensor networks have also been used for surveillance systems, a form of activity-level measurement, within the home, office, and other indoor environments. Passive infrared motion sensors (PIR sensors) are ideal because they do not require any signal or devices on the object or person to be tracked and they can function in dark environments as well. [5] Analyse the performance and the applicability of the PIR sensors for security systems and propose a region-based human tracking algorithm in a real environment.

V. METHODOLOGY

This research work is to compress the color images. It is based upon GUI (graphical user interface) in MATLAB. It is an effort to further grasp the fundamentals of MATLAB and validate it as a powerful application tool. There are basically different files. Each of them consists of m-file and figure file. These are the programmable files containing the information about the images. The work is to implement Non-Contact Respiratory Monitoring System Using Thermal Image Processing with the help of new algorithm. The Measurement of physiological information is the primary and most important task for our proposed system.

The proposed steps are given below:

Step 1: Set the camera and apparatus .

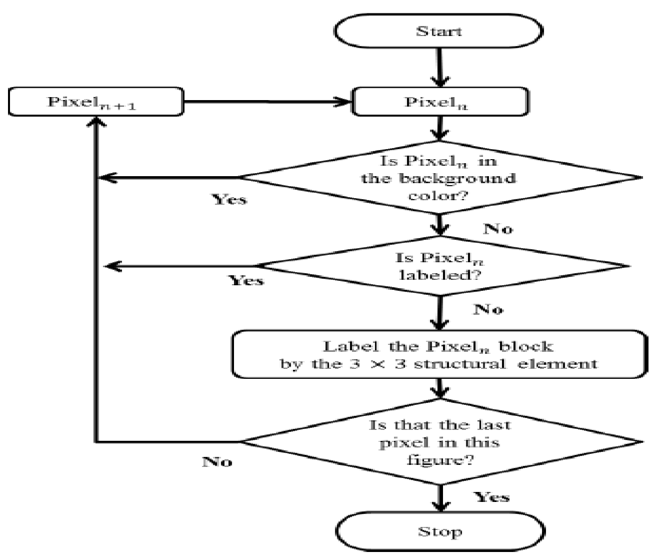
Step 2: Apply the pre-processing for image reading .

Step 3: Apply the algorithm for RMS.

Step 4 : Apply morphological operators for noise removal .

Step 5: Get the parameters respiration rate and other parameters.

The processing flow of connected component labelling.



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VI.RESULT

In the research work the different snap shorts are displayed with different respiration wave signals and Camera. These snap shorts are given below:

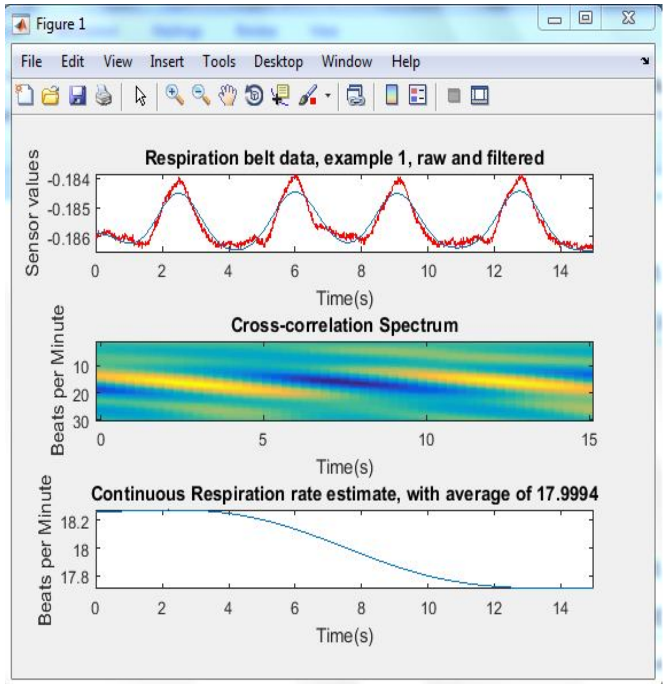

Fig. 3 Respiration belt data with average 17.9994

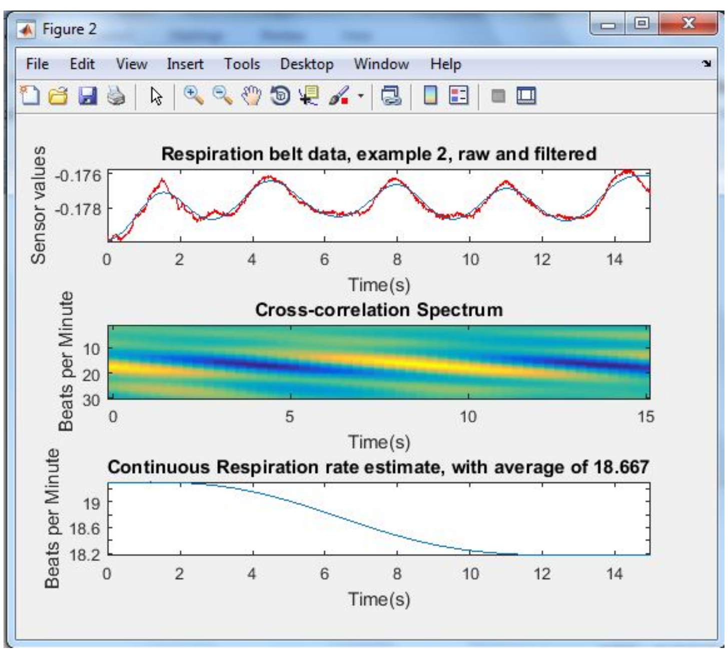

Fig.4 Respiration belt data with average 18.667

The figure 3 and the figure 4 is the processing of respiration belt with different average. It displays the cross correlation spectrum and continuous respiration rate estimation.

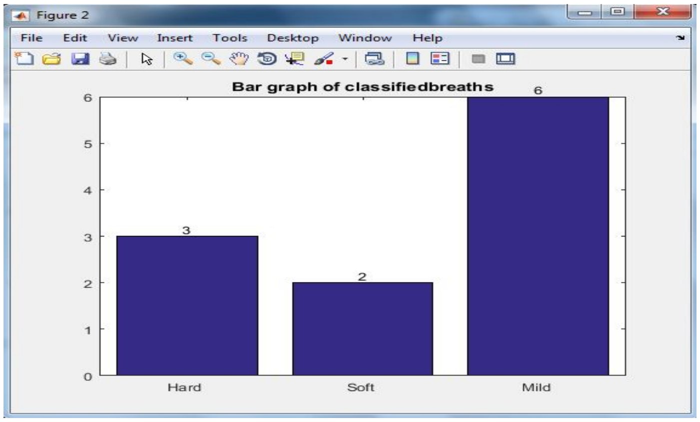

Fig. 5 Bar Classification of breath on 1.wav signal

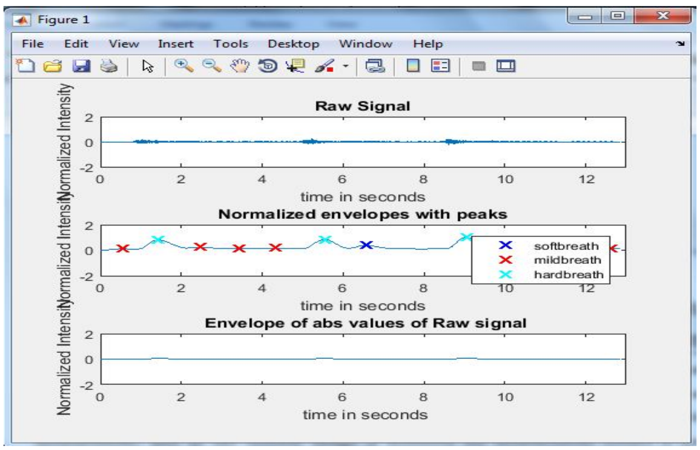

Fig. 6 Wav breath signal processing

The figure 5 and the figure 6 displays the 1.wav signal processing with soft, mild and hard breath. It displays the different wave signals that is displayed in the figure.

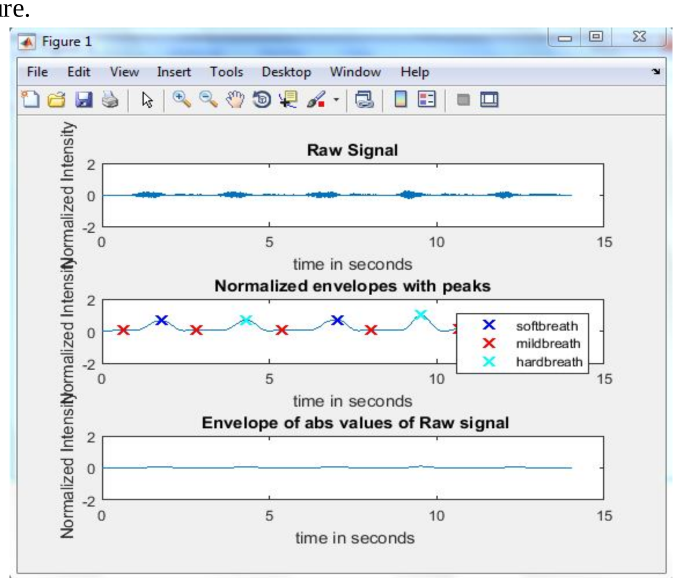

Fig. 7 wav breathe signal processing

Proposed work

Breath in the hold respiration pattern				
Sample number	Thermal image processing			Photoplethysomgraphy
	Inspiration (Times)	Experation (times)	Respiratory rate (breaths/min)	Pulse rate (bpm)
1	6	6	6	78
2	6	6	6	75
3	6	6	6	74
4	6	6	6	78
5	6	6	6	75
6	6	6	6	86
7	20	20	20	85
8	6	6	6	90
9	20	20	20	86
10	15	15	15	86
Mean	9.7	9.7	9.7	81.3

VII. CONCLUSION

In this respiration watching system, we have a tendency to specialise in thermal imaging process, build this technique ready to settle for the movement of a subject matter among a precise vary and distance. and therefore the most significant half is that the system has the feature of wireless mensuration, and because the thermal image is quiet the mensuration results is a lot of obvious, and a lot of correct regarding metabolic process undulation. Besides, we have a tendency to divide respiration into 3 patterns for information aggregation throughout the experiment. they're traditional metabolic process pattern and deep metabolic process pattern and hold metabolic process pattern. The results of the experiment works with success. The undulation clearly discovered the metabolic process standing. In distinction, since the system is wireless mensuration, it's plenty of noise that require to be excluded. particularly owing to the state of once motion, subject's skin surface sweat glands the warmth and as a consequence, the temperature of every skin surface block is comparatively unstable. there's scenario that causes difficulties in measurements, that's the pattern of the speedy respiration. In my opinion, the rationale there's such scenario is that the frequency is just too high and therefore the sample rate is tiny, inflicting the signal is commonly

considered noise. All and every one, the system is sort of appropriate for respiration undulation detection. In this work the Inspiration, Experation, Respiratory rate and Pulse rate values are calculated. The existing mean value 2.4 and 78.1 and the proposed value is 9.7 and 81.3.

VIII. FUTURE WORK

In the future the respiration system is extended with the help of microchip and the signal processing with the help of different operators and algorithms. It is further classified with the help of real time database.

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