Non-Contact Heart Rate Measurement Using UWB Antenna

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Abstract: Presently the beat rate of the heart is measured with the help of these devices such as ECG, Pulse oximetery etc, that uses electrodes which are in straight towards the body. In healthcare and medical applications, infants at risk, sudden infant syndrome or burn victims in which the electrodes are employed to compute cardiopulmonary signal becomes impossible, In such situations the contactless monitoring plays a vital role. The use of an UWB antenna plays as a noninvasive monitoring system for the cardiopulmonary activity of the human being, since the little movements are observed because of the microwave sensitivity. Thus by receiving the signal which is reflected from antenna, then it is processed to find the rate of the heart. From the processed signal, the rate of the heart is computed with the help of the algorithm called Peak Detection. The rate of the heart is computed by finding the variation of the adjacent peaks after determining the peaks present in the processed signal.

Index Terms: Contactless, ECG (Electro Cardio Graph), Heart rate, Non Invasive, UWB(Ultra Wide Band)

1. INTRODUCTION

The need for Non invasive and contactless measurement of physiological functions is constantly increased and moreover such technology is helpful for monitoring the conditions of the hospitalized patients [1] [2] [3] . Generally, a belt named as a piezoelectric is covered in the region of the patient's body and the breath is monitored. This equipment gives artifacts but the activity of the heart is calculated using Electrocardiography (ECG) or by pulse oxiometry.In the case of pulse oxiometry a clip-type probe is fixed on the patient's finger. The beating of the heart causes the blood to pump through the body and it is squeezed into the capillaries so that its volume gets increased. The volume of heart rate gets decreased which affects the level of red or infrared light that is passed into the tissue. Although the fluctuation is quite small and this is determined by pulse oxiometer. In the case of Electro cardio gram, the body electrodes are placed which monitors the rate of the heart. These equipments can cause discomfort and also it creates a problem in the case of injured patients or infants for longer-term, and for frequent measurements. Moreover, these devices need a straight contact of the sensor with the body. The patient's body posses small exposure risk as well as less consumption of power and high compatibility with the peripheral equipments which are the features encountered by the antenna. Thus, UWB patch antenna plays a vital role in the measurement of heart rate. In real time, Radar systems permits accuracy in the subject through mess, with low power consumption, relatively low multipath and EM interference, and the capability to monitor the health of multiple subjects [4]. Thus for measuring the cardio activity, a novel design of UWB patch antenna is used. Thus UWB antenna finds to be useful in gadget to calculate the biological data [5] [6]. When signals pass through antennas or low level of signal over an extensive range of frequency band, less power is needed because it suffers from less interference. Here the paper presents about the rate measurement of the heart in terms of microwave system [7]. Here a continuous wave is applied towards the person's chest and the signal reflected is analyzed and the signals are recorded from the automatic actions of the chest (expansion and contraction) and further signal processing is done with the help of peak detection [8] [9] [10] [11].

2 METHODOLOGY

Firstly UWB antenna is designed with the calculated parameter values as shown in Fig 1.

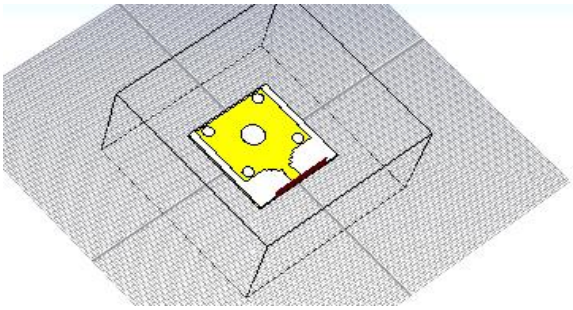

Fig 1: *Proposed antenna design*

For simulation, the heart phantom is created as shown in Fig 2 and thus proposed antenna is excited against the phantom thus created.

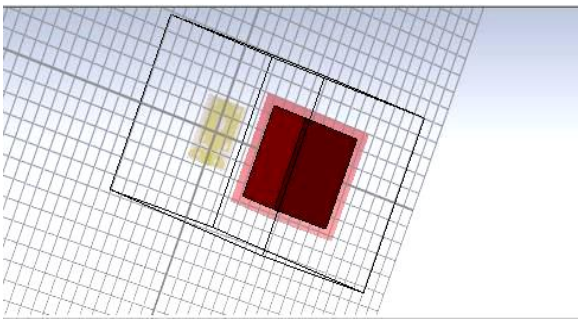

Fig 2: *Phantom design*

The signal is passed from the UWB antenna to the person's chest and the signal that gets reflected back are due to the result of reflex activities of the chest, These signals are further processed to get the rate of the heart of the patient by using the peak detection analysis which is shown in fig 3.

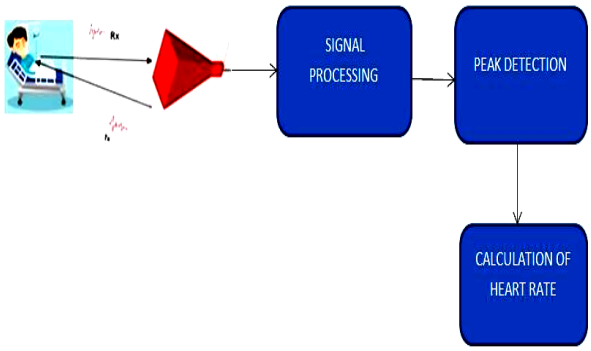

Fig 3: *Block diagram – Non-invasive detection of cardio activity*

3 SIMULATION AND MODELING MATLAB

The network analyzer is used to obtained proposed antenna output, the increased and reduced signals are obtained. Conventionally, vital signs can be detected by applying FFT on the slowly varying time samples. Here the FFT of the increased and reduced signals are taken and the pulses train is generated by applying convolution method and it is noticed that the peaks in the signal shows at same intervals. In Fig 4 and Fig 5 expansion phase and contraction simulated signal output are displayed

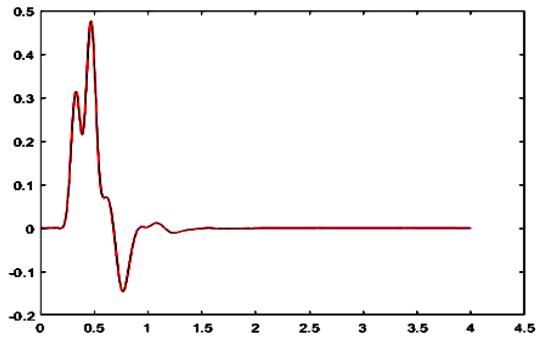

Fig 4*: Expansion signal output*

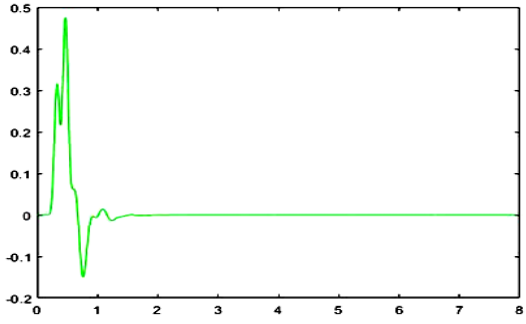

Fig 5: *Contraction signal output*

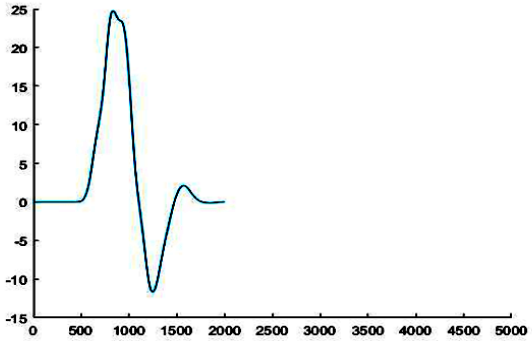

Fig 6: *Convolved signal output*

Both increase and decrease combine to form a cycle called cardiac cycle. Hence both the signals are convolved which resembles simply cardiac cycle. After performing convolution of both signals, the resultant output is obtained as figure 6. From single convolved output we cannot find the rate of the heart because it requires a train of pulses to calculate it. So single convolved output is repeated for some samples to produce train of samples.

4 EXPERIMENTAL RESULTS

After the convolution of the signals of antenna output, the peak is detected and then maximum peaks are thus obtained from the train of samples as shown in the Fig 7. From the peak detected output, the distinction between the maximum peaks are calculated and then this value divided by 60 (per minute) gives the rate of the heart of target object. Heart rate (bpm) =60/ (diff between peaks (in sec)) Here the difference is obtained as 0.8691 (approx.) and it is obtained as 70 per minute for the considered samples.

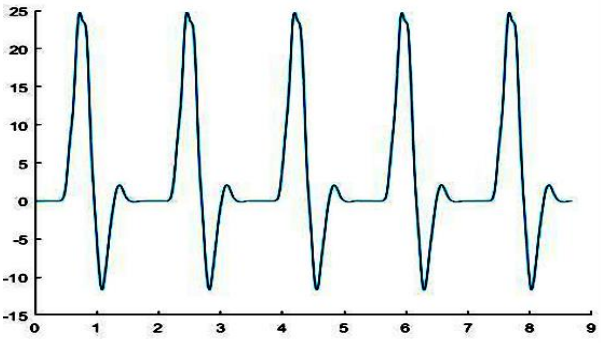

Fig 7: *Train of samples*

5 CONCLUSION

This paper involves just observing the cardio activity which is addressed by UWB microstrip patch antenna. The peak detection methodology is employed as signal elaboration technique to unravel this downside. To achieve this the antenna signals are obtained from the heart activities like expanding and contracting actions which are performed on convolution, the algorithm named peak detection is applied for detecting the maximum peaks of the convolved signal, thus the distance between two consecutive maximum peaks are determined. The results of UWB radar are encouraged in the

activity of heart. The performance of the projected method is varied from the other methods discussed above and it is used to acquire the rate of the heart using UWB antenna signals.

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