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An UWB Radar Signal Processing Platform for Real-Time Human breathing Feature Extraction

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Abstract

Background/Objectives: To evacuate trapped victims in complex environment with the help of UWB to detect the victim whether injured or not even before evacuation. **Methods/Statistical Analysis:** UWB system was used for sensing the breathing activity. In this process, the primary issue is the definition of design constraints about the signal processing waveform to transmit, correctly for the concerned algorithms for retrieving the breathing frequency and waveform precisely even in worst environment noise. **Findings:** The observation made from this study showed that more bitwise linear characteristic produced by the captured radar breathing signals than sinusoidal characteristics. **Applications/ Improvements:** The proposed system helps to find the status of the victim whether dead or alive; healthy or injured.

Keywords: Biomedical Measurement, Bio Medical Signal Processing, Four Segment Linear Waveform, Piece Wise Linear Approximation, UWB Radar Tranceivers

1. Introduction

Ultra-wideband (UWB) radar is having large bandwidth, results it produces high-resolution material. Further, UWB radar based on impulse concept has low power radiation[1] which is suitable to work in remote medical and human monitoring system. The breathing rate provides vital information regarding sleep stage classification as shown in Figure 1. The current methods to determine the breathing rates are Fourier and discrete wavelet transforms[2]. The breathing rates resolutions are improved by Weiner-filter-based post signal processing method and more information held in the breathing signals could help in clinical diagnosis[3].

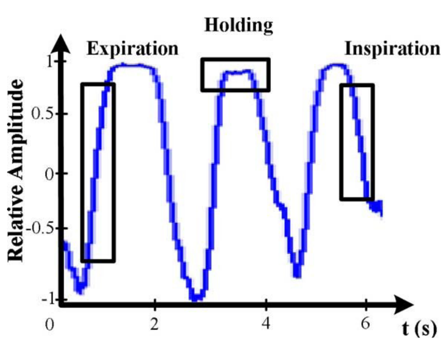

Figure 1. Radar-captured human respiratory signal.

The usage of UWB radar for detecting the breathing rate in this study is shown in Figure 2. Further, in this study, MRCW breathing model was designed to have several features like inspiration speeds, expiration speeds, breathing intensity and breathe holding ratio[4], that help to provide information and encourage the clinical diagnosis. Therefore, database could be managed successfully by respiratory monitoring system due to decrease in storage capacity and required transmission power[5].

The breathing feature extraction algorithm is massive and the digital signal processing system is used to overcome and reduce hardware complexity. Therefore, this study proposes a new breathing model with respect to body movement. Design and implementation of the proposed breathing model is able to capture the breathing signal.

2. Mechanism of UWB Radar

The mechanism of UWB radar holds the unique features is described in this section. The high precission (multi path resolution capacity) in he UWB radar chip helps to image the organs of human body. Further, UWB radar

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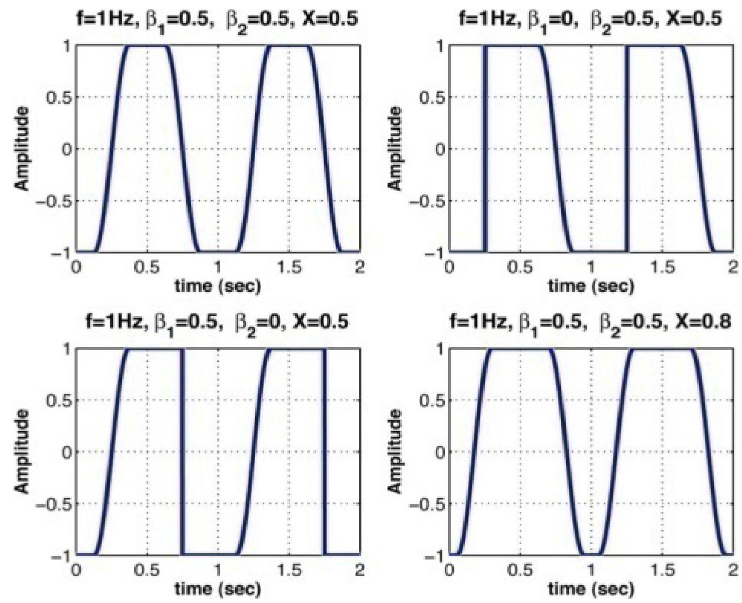

Figure 2. MRCW Waveform.

chip in the UWB radar is used to capture the human breathing signals in the remote area through a wireless communciation using 65nm CMOS technology[6]. Measurement results of UWB radar CMOS transceiver is presented in Table 1. The tunable frequency is from 1 to 18 GHz for UWB radar chip.

Table 1. Summary of USB radar receiver

Implementation	Technology	65 nm CMOS
	Die area	1.3 mm*1.4mm
	Digital signal voltage	1.0 V
	Analog supply voltage	1.0 V
	Reference clock frequency	10 MHz
Core UWB channel information	Center Frequency	1-18 GHz
	10 dB Bandwidth	12.7 GHz
System Performance	Fine-Range Bin Resolution	0.94 mm
	Radar Range	15 m
	Max Integration time	1.5 µs
	SNR Improvement	48 dB
Power	Total Power Consumption	76 mW

3. Proposed Breathing Model

A previous study on MRCW waveform reported that the curve fits for specific biological signals including breathing signal is in the form of sinusoidal.

Figure 3 represents the FSLW waveform variation. A linear regression algorithm is framed for FSLW waveform breathing model (Figure 3). The framed algorithm is having sufficient number of linear segments and specific numbers of segment transition.

The informative results obtained using FSLW waveform variation in clinical diagonis, which is more precises to take a decision than rate of respiration observed from the conditions of lungs in the human body. Thus, the results of the proposed breathing model (FSLW waveform variation) in this study exhibits more linear signs than sinusoidal signs.

Figure 4 shows the UWB radar CMOS architecture. UWB radar CMOS architecture is having very large bandwidth, used to analysis the echo signals as a function of target distance. From Figure 4, the signals can be trapped using the modified algorithm. The proposed algorithm is based on the modification of algorithm of MRCW model.

Figure 5 shows the Architecture of radar signal processing platform. It consists of CPUs based on RISC generates larger bandwidth signals and those signals are received by RSSI. Amplifier and filter in FSLW breathing model is used to compare the performance and complexity[7].

Figure 6 shows the flowchart for the iterative algorithm. The high efficiency ARM cortex M4 is used in Ultra wide band radar signal processing.

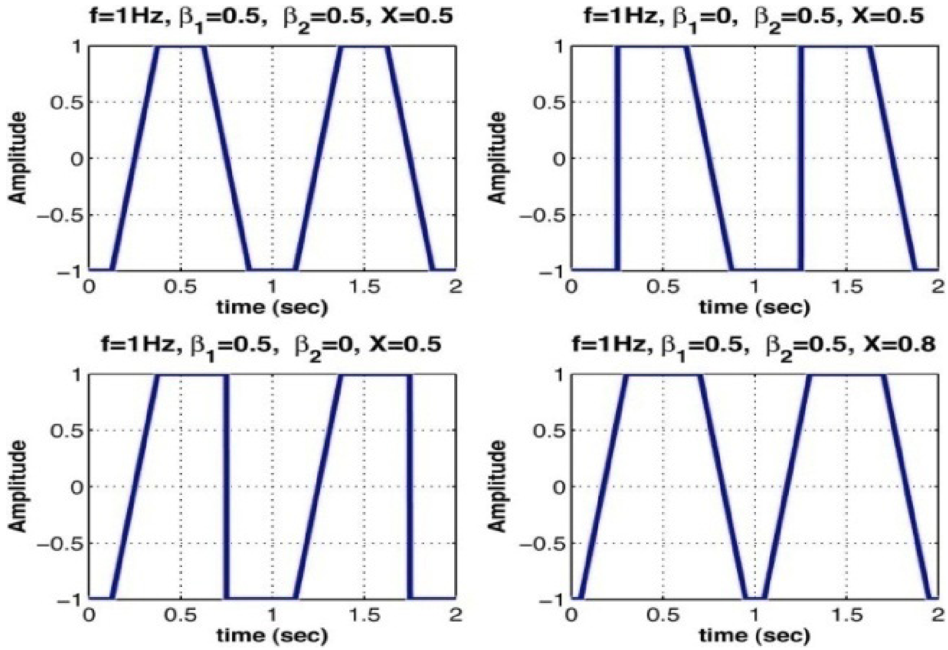

Figure 3. FSLW waveform variation.

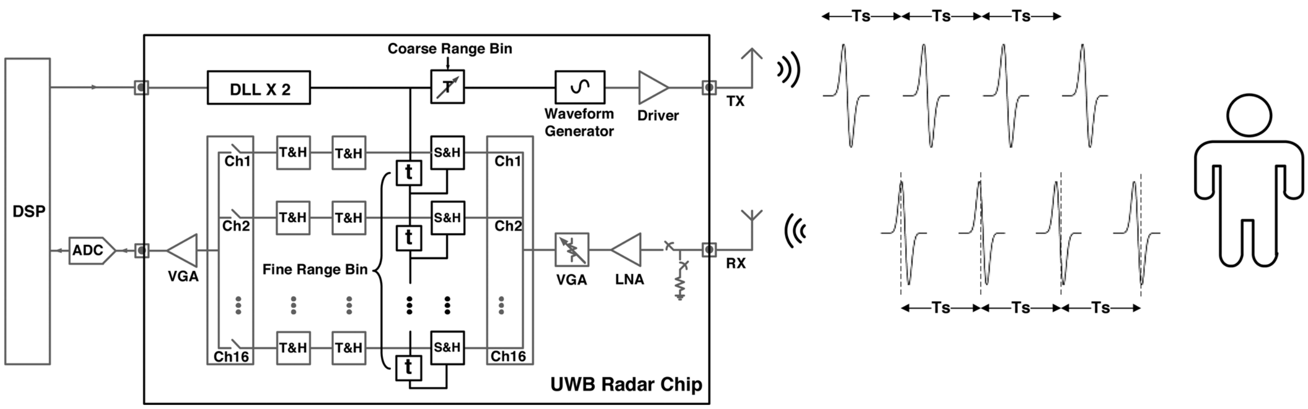

Figure 4. UWB radar CMOS architecture.

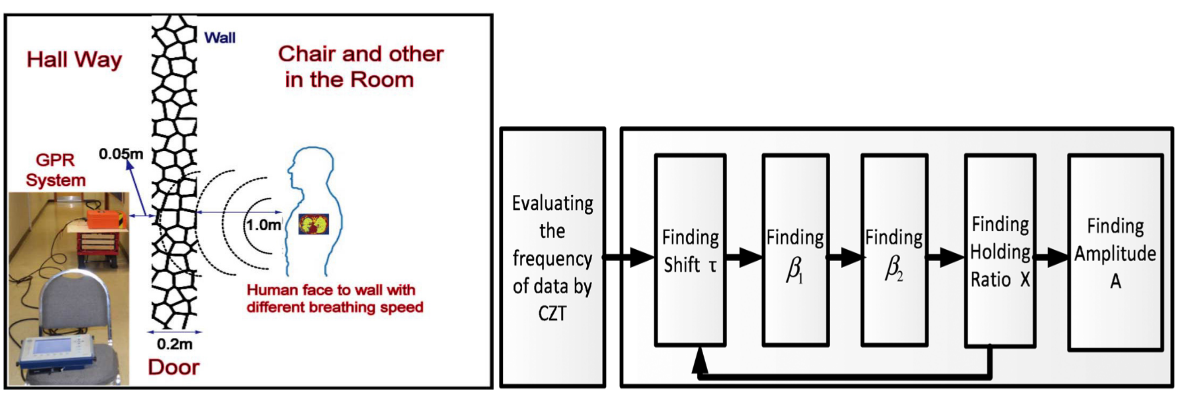

Figure 5. Architecture of radar signal processing platform Exiperimental set up.

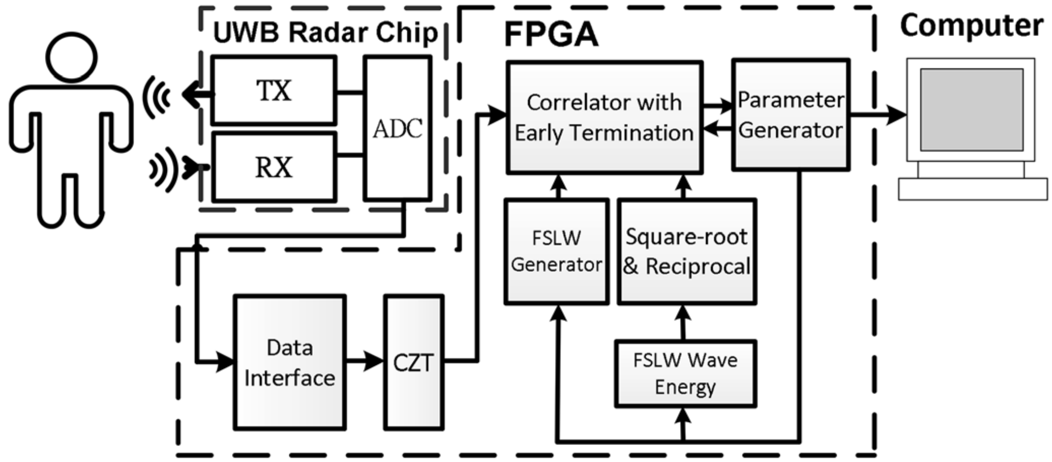

Figure 6. Flowchart for iterative algorithm.

4. Conclusions

This study proposed a model to detect and extract trapped victims in complex environment using UWB radar. This system is helping to identify the injured victims for safe retrieval by observing their respiratory system and heart beat without direct contact of skin. It can also be extended not only to critical issues specific to the disaster environment but also in health and safety sectors. The observation made from this study showed that radar-captured breathing signals produce linear signs than sinusoidal signs.

5. References

1. Li J, Zeng Z, Sun J, Li F. Through wall detection of human being's movement by UWB radar. IEEE Geoscience and Remote Sensing Letters. 2012; 9(6):1079-83.
2. Lazaro A, Girbau D, Villarino R, Ramos A. Vital signs monitoring using Impulse based UWB radar signals. Manchester: Proceeding of 41st European Microwave Conference. 2011; p. 135-38.
3. Liu LB, Liu Z, Barrowes B. Through-wall bio-radioactive with UWB impulse radar observation, simulation and signal extraction. IEEE Journal of Selected Topics Apple Earth Observe. 2011; 4(4):791-98.
4. Hsieh CH, Shen YH, Chiu YF, Chu TS, Huang YH. Human respiratory feature extraction on an UWB radar signal processing platform. Beijing: Proceeding of International Symposium on Circuits Systems, (ISCAS). 2013; p. 1079-82.
5. Immoreev I, Tao T-H. UWB radar for patient monitoring. IEEE Aerospace Electronic System Magazine. 2008; 23(11):11-18.
6. Leib M, Menzel W, Schleicher B, Hermann S. Vital signs monitoring with a UWB radar based on a correlation receiver. Barcelona, Spain: Proceedings of 4th European Conference of the Antennas Propagation (EuCAP). 2010; p. 1-5.
7. Kandar D, Sur SN, Bhaskar D, Guchhait A, Bera R, Sarkar CK. An Approach to Converge Communication and Radar Technologies for Intelligent Transportation System. Indian Journal of Science and Technology. 2010 Apr; 3(4):417-21.