A Short-Range Radar System to Detect Chest Movements of a Still Person

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Abstract

This project presents an FMCW radar system using off-the-shelf components controlled by a micro-computer. This device can be used as an experimental platform to test various ideas in vital signs detection research. The design expands on the MIT radar project to use as a non-contact solution to detect chest movements of a still person. As a backup system for comparison against the MIT device, an alternative independent radar system, Xethru, was used to study additional ways to detect vital signs

Introduction

The current design is a compact, computer-based, low-cost, low-power, short-range frequency modulated continuous wave (FMCW) sensing system. The design architecture enables the detection of subtle displacements such as the breathing and heart rate of a human being and displays the biometric information in real-time.

The device is based on high directivity PCB Yagi-Uda antenna, continuous ramp signal generation and synchronous modulation for linear sweeps, rapid transition analog filtration, and real-time digital signal processing. The raw analog data is acquired from a radar sub-system and delivered to a single board computer (SBC) for low latency audio-based analysis. The XeThru device used is a single chip radar subsystem that measures breathing patterns of a still person. It is used to show an example of a similar product on the market.

Methods and Materials

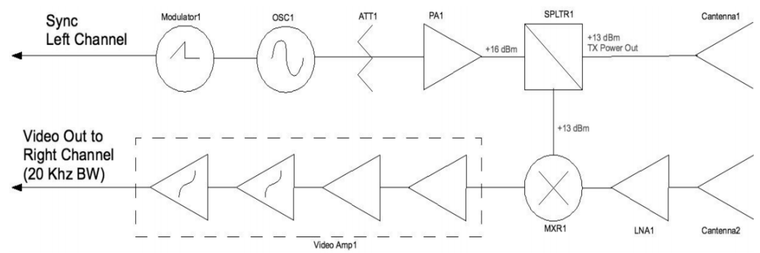

Figure 1 – RF Block Diagram

Circuit Design: Utilizing a Voltage Controlled Oscillator (VCO) to support the FMCW system allows the transmitting antenna to continuously propagate waves with varying frequencies and the receiving antenna will continuously receive waves. The FMCW radar system is used to detect a moving target by analyzing the altered frequency of the returned signal.

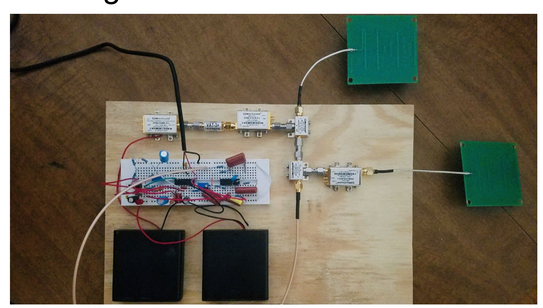

Figure 2 – Hardware Components

Digital Signal Processing: the DSP implementation utilizes the forward Fast Fourier Transform (FFT) algorithm to compute and plot incoming signal data from the antennas using C#. This software is controlled by a LattePanda micro-computer and touch display to allow portability by the user.

Results/Discussion

The result is an efficient and compact portable device able to acquire and plot accurate biometric data in real-time for chest movements of a still person.

Figure 3 – Chest Movement Results

The XeThru device has similar output data to that of the goal for this project.

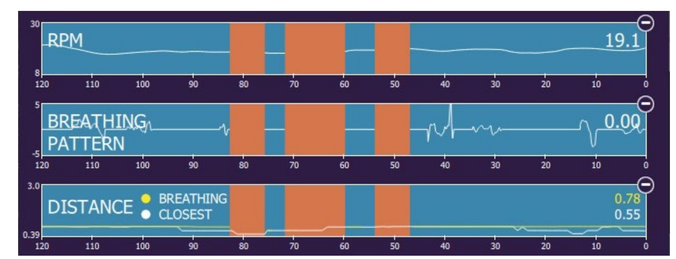

Figure 4 – Xethru Breathing Results

Conclusion

The solution to non-contact vital sign detection is a rapidly developing field of research. In this project we were able to achieve two low-cost, low-power alternatives for detecting chest movement of a still person. These experimental radar platforms will help to pursue research on vital signs detection at NIU.