Targeted Problem Statement:

Decreasing processing time in biometrics extraction from raw radar data while keeping signal integrity over the air.

Research Questions:

1. How can radar-extracted biometric data be compressed and encrypted for secure transfer and storage?
2. How can alternative transform methods (Fourier or otherwise) be tested against each other and implemented to increase computation speed?

Extended Literature Review:

Source 1 - Time Frequency Analysis of Wavelet and Fourier Transform (Jarlton Wirsing) [November 18th, 2020]

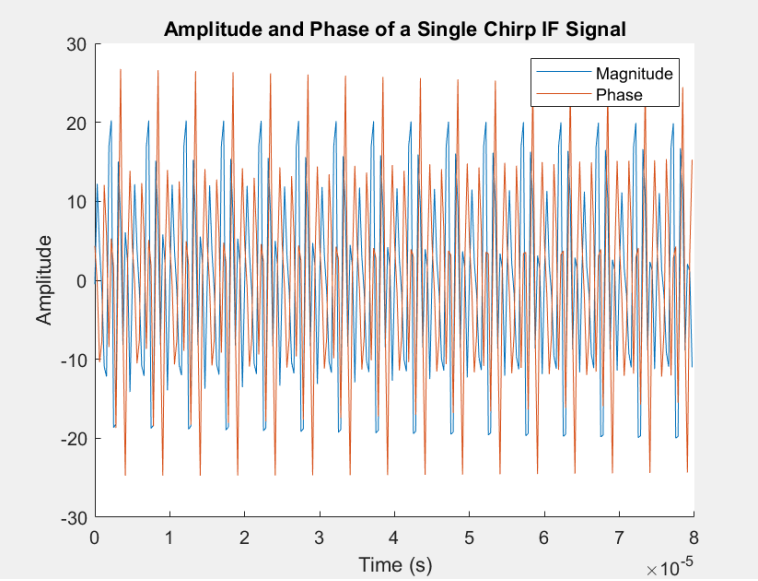
This source details the fundamentals of the wavelet transform as an alternative transform method to the Fourier and the Fast Fourier Transform for signal processing and decomposition. The Fourier transform is limited to a global scale, and the lack of ability to account for local features. In response to this, the windowed Fourier transform was created, which applies a window function of a short period to a signal and applies the transform only to that window. This, in turn, is limited by local features that are larger or shorter than the applied window function and the lack of time resolution scaling between high and low frequencies.

The wavelet transform scales in time and frequency, and because of this, beats out the limitations of the Fourier transform in these areas. The wavelet transform scales the bandwidth of the applied filter inversely to the frequency, allowing it to better account for signals of differing frequency. Many biometric signals are less consistent than ideal, like heart rate. Heart and respiratory rates are non-constant and can vary in frequency based on circumstance and other component signal pollution. Considering the wavelet transform for signal decomposition could allow for a more accurate assessment of biometric data. The wavelet transform does have an implementation in MATLAB, so there could be tests done to verify the accuracy and speed of the wavelet transform in comparison to different Fourier transform methods for biometric data acquisition.

Source 2 - Compression and Encryption of ECG Signal Using Wavelet and Chaotically Huffman Code in Telemedicine Application (Mahsa Raeiatibanadbooki, Saeed Rahati Quchani, MmohammadMahdi KhalilZade, Kambiz Bahaadinbeigy) [January 16th, 2016]

This source develops encryption and wavelet compression methods to secure, transmit, and store ECG data for physicians' access. Many of the signal processing methods are similar to those of Source 1 in the previous literature review, such as noise removal and phase restriction, but it is significant to reference a source that compression and encrypts biometric data with minimal losses across larger distances than necessary for the current project, especially considering the use of wavelet transform for reasons discussed in Source 1.

High-Level Proposed Approach / Experimental Design

- Currently working on processing simulated chirp data
- After a base algorithm that can properly decompose the signal is developed, further testing to optimize processing speed and accuracy based on signal decomposition methods can be conducted
    - Separate tests on Fourier vs. Wavelet transforms
    - Potential use of Quantum Fast Fourier Transform (QFFT)
- Data will need to be encrypted/transmitted/stored, so testing on best encryption and compression methods to ensure security and persistence of necessary features will need to be done
- Original chirp signal:
- 

- 1-D FFT

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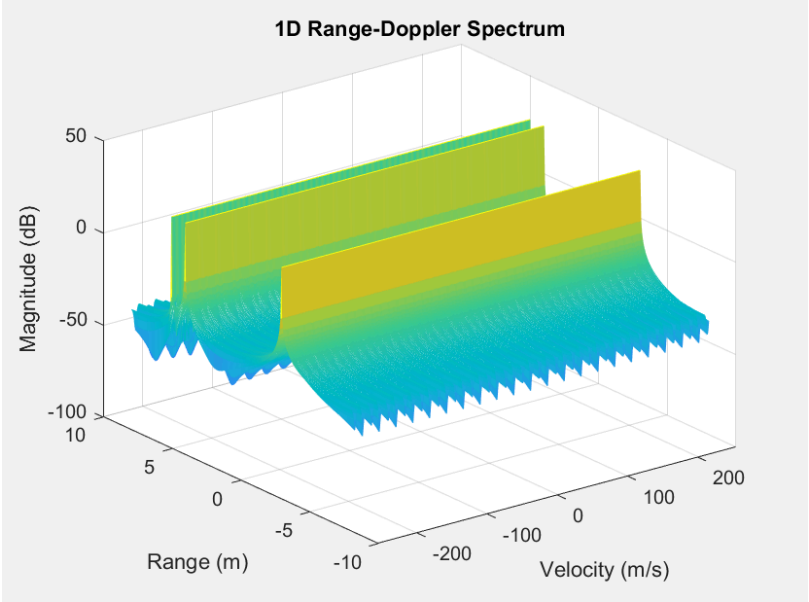

- 2-D FFT (windowed)

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