Refined Problem Statement:

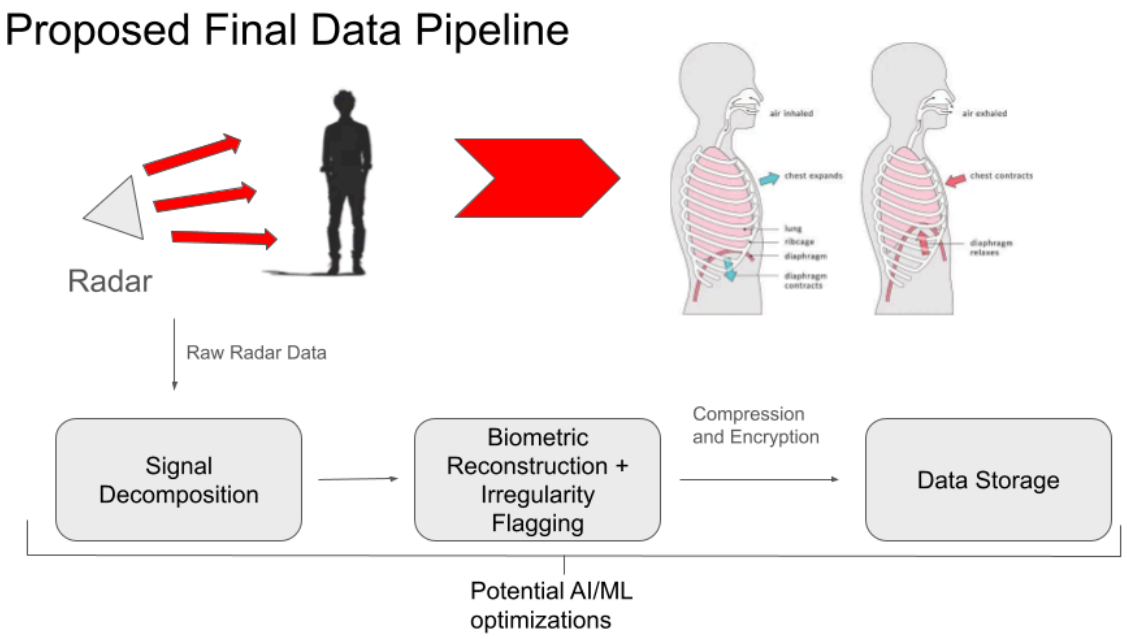
This project aims to develop an accurate and optimal algorithm to extract and store biometric data from a Frequency Modulated Continuous Wave radar within an easily-used device for data privacy and early irregularity detection.

Extended Literature Review:

A Low-Complexity Compressed Sensing Reconstruction Method for Heart Signal Biometric Reconstruction (Jian Xiao, Fang Hu, Qiang Shao, Sizhuo Li) [December 3th, 2019]

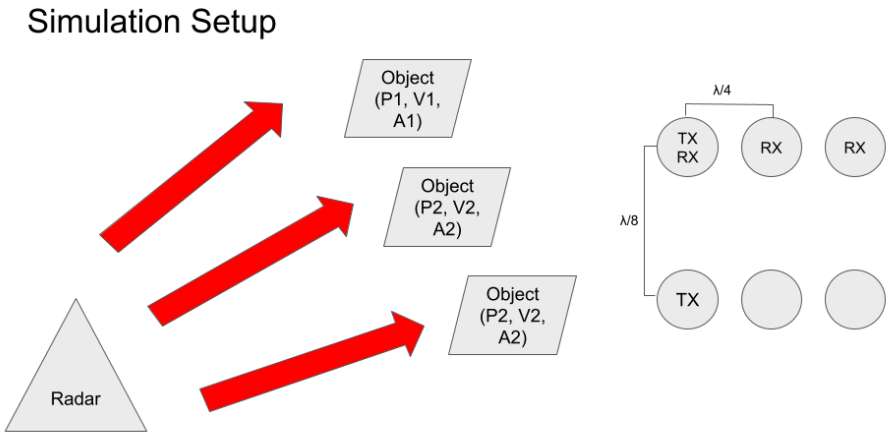
Key Details from this source:

- Tests the utilization of compressed sensing, a signal processing pipeline in which the data sensing and data compression are done simultaneously
- Can help avoid wasting computational resources and increase power efficiency, great for small and wearable devices
- Potentially could cause issues for external and excess processing algorithms applied to the data post collection/compression
- ECG Signal recognition rates at ~95%



- The radar will measure the displacement of the chest as the radar subject breathes
- Raw radar data will be ran through a signal decomposition algorithm to separate the noisy radar data into its components
- The component signals will be used to reconstruct the heart rate of the subject, as well as a baseline “healthy” rate for future use in irregularity detection
- The raw data will be encrypted and compressed for storage and use elsewhere

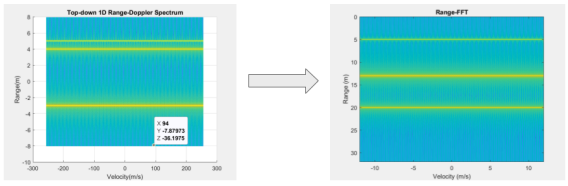
Experimental Design



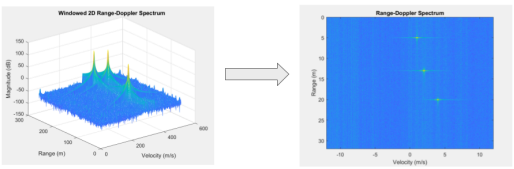
- Simulated radar has 3 subjects with individual position, velocity, and angle-of-attack data
- The radar has a configurable antenna array where the number or RX and TX antennas, as well as the distance between the antennas, can be adjusted

Output

Fixes Relating to Understanding and Physical Constraints

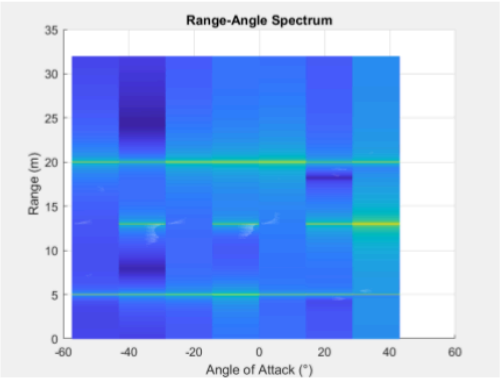


Fixes Relating to Understanding and Physical Constraints

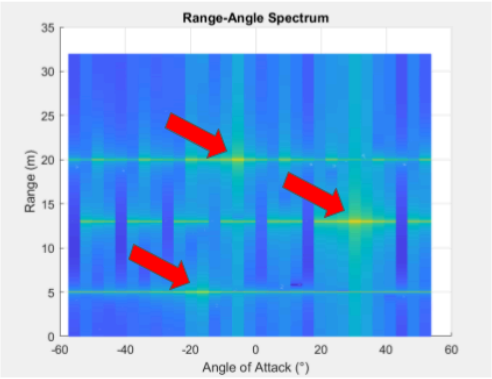


- Fixed range constraint and axes issues

Concerns with Angle of Attack Estimation



8-Channel Output



16-Channel Output

- Changing antenna array will affect radar resolution for angle-of-attack
- Current issue with viable range and flipped-sign output 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

Future Work

- Base alg.
    - CFAR
    - SNR Optimization
- Computation Speed Optimization
    - Test transforms
    - QFT?
- Testing for best encryption/storage methods
- Neural Net. Implementation?
- Physical Design Constraints

References

Rao, S. (n.d.). *Introduction to mmwave Sensing: FMCW Radars*. Texas Instruments. https://www.ti.com/content/dam/videos/external-videos/en-us/2/3816841626001/5415203482001.mp4/subassets/mmwaveSensing-FMCW-offlineviewing_0.pdf

Xiao, J., Hu, F., Shao, Q., & Li, S. (2019, December 3). *A low-complexity compressed sensing reconstruction method for heart signal biometric recognition*. MDPI. https://www.mdpi.com/1424-8220/19/23/5330