

DEVELOPMENT OF
HEART RATE
DETECTION
ALGORITHM FOR
DOPPLER
ULTRASOUND
RECORDINGS

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BACKGROUND/GOAL REVIEW

- Developing a MATLAB-based system for detecting the heart rate
- An existing methods for detecting average heart rate in audio Files:
 - Autocorrelation [Fetal HR Detection]
- Despite this, there is not a current viable system for clearly defining the location of each cardiac cycle
 - Especially in Doppler audio recordings

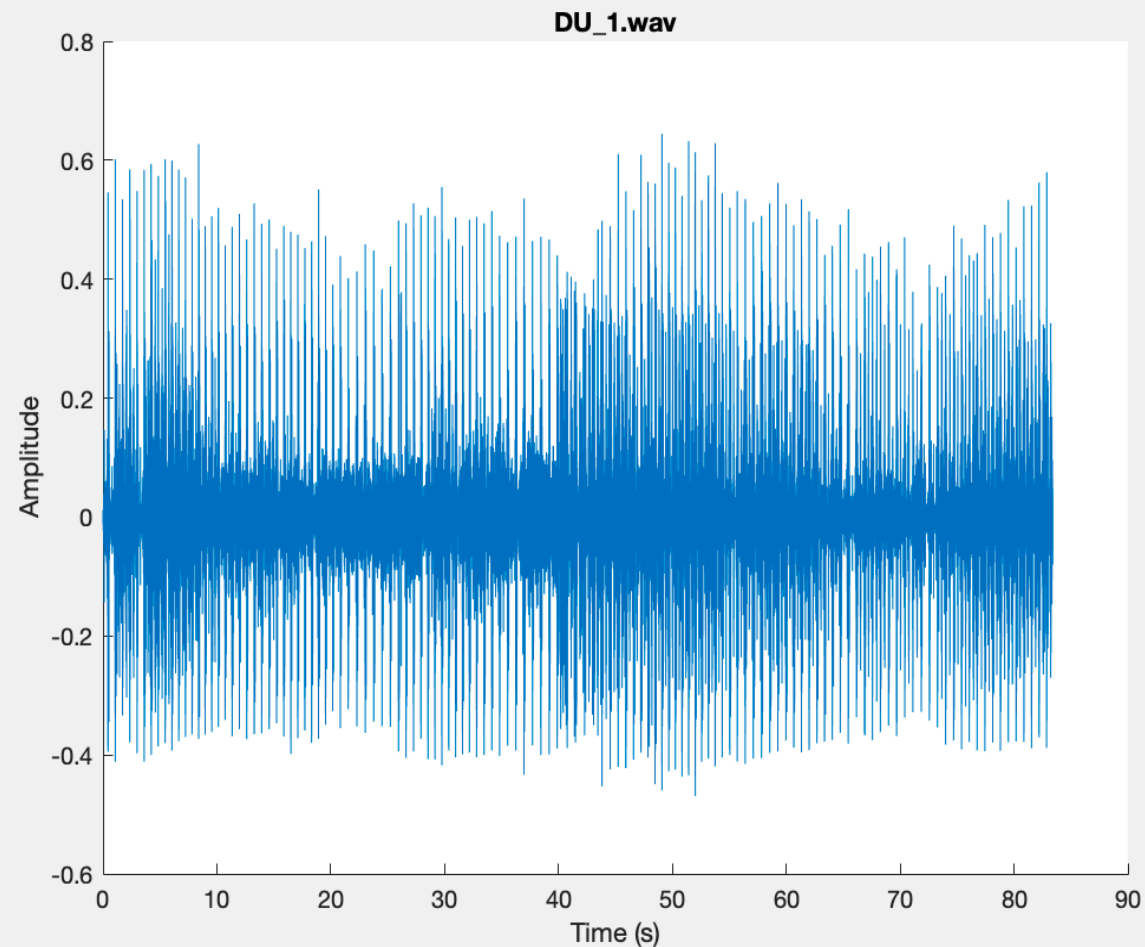


Figure 1. Sample of a Doppler Audio Recording

METHOD

- Filtration Design
 - Butterworth (Effective at Low Order)
 - Finite Impulse Response (Intermediate)
 - Chebyshev (High Order)
- Cut off Frequency
 - 60 – 180 beats per minute (BPM)
- FindPeaks Function
 - Identifies the max extrema point
 - Peak = Heartbeat
 - MinPeakDistance defines period
- Evaluate heartrate through computational formula
 - Output location of heartbeats

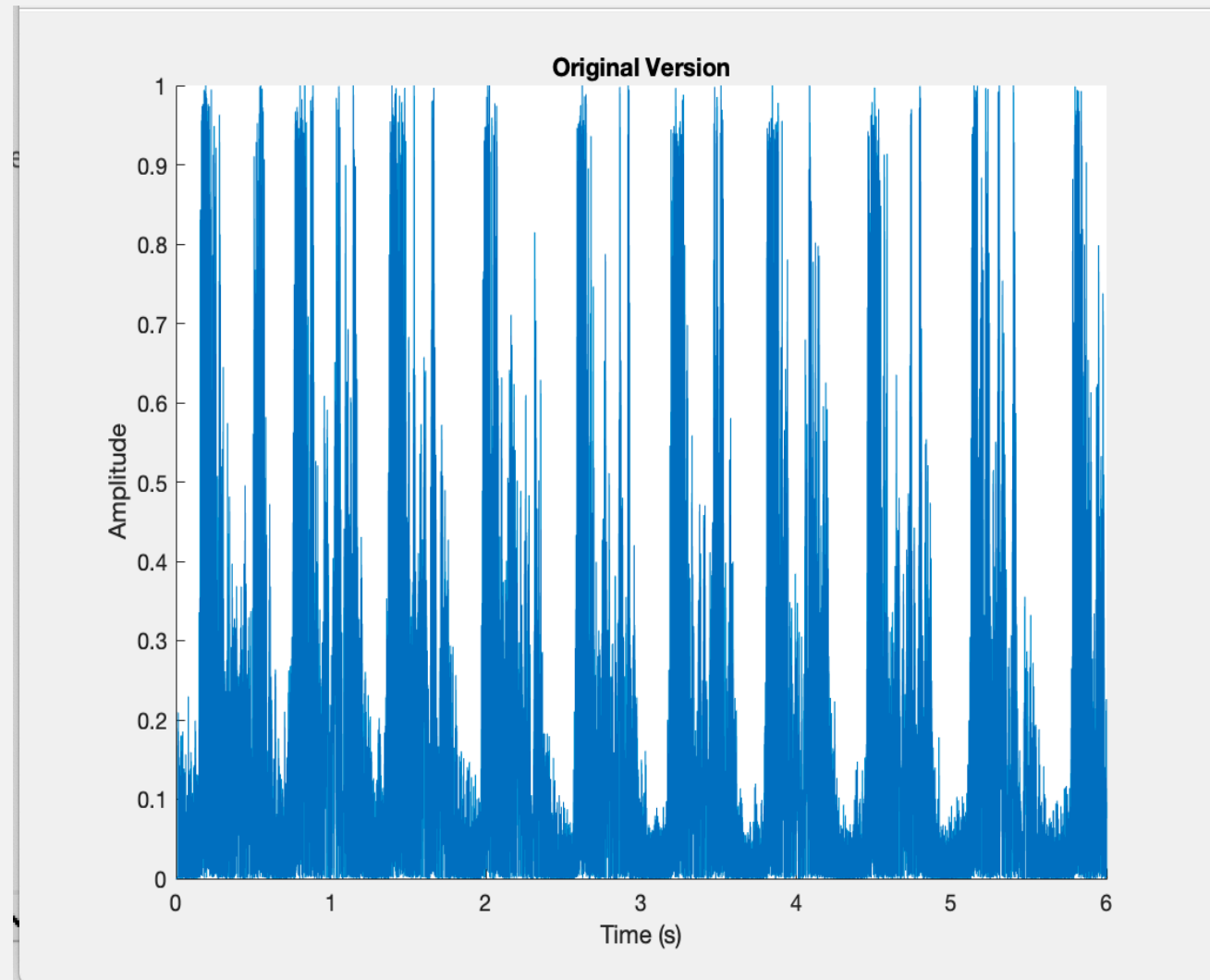


Figure 1. Unfiltered output version

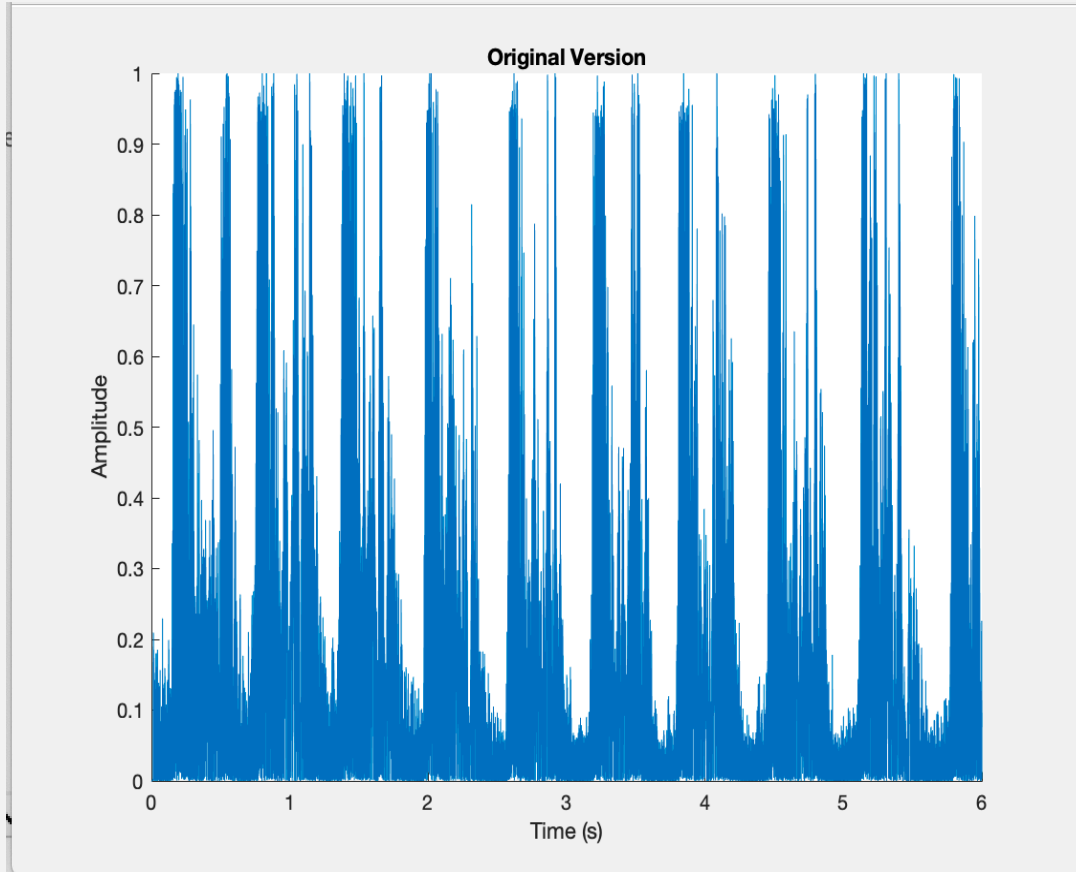


Figure 2. Unfiltered signal

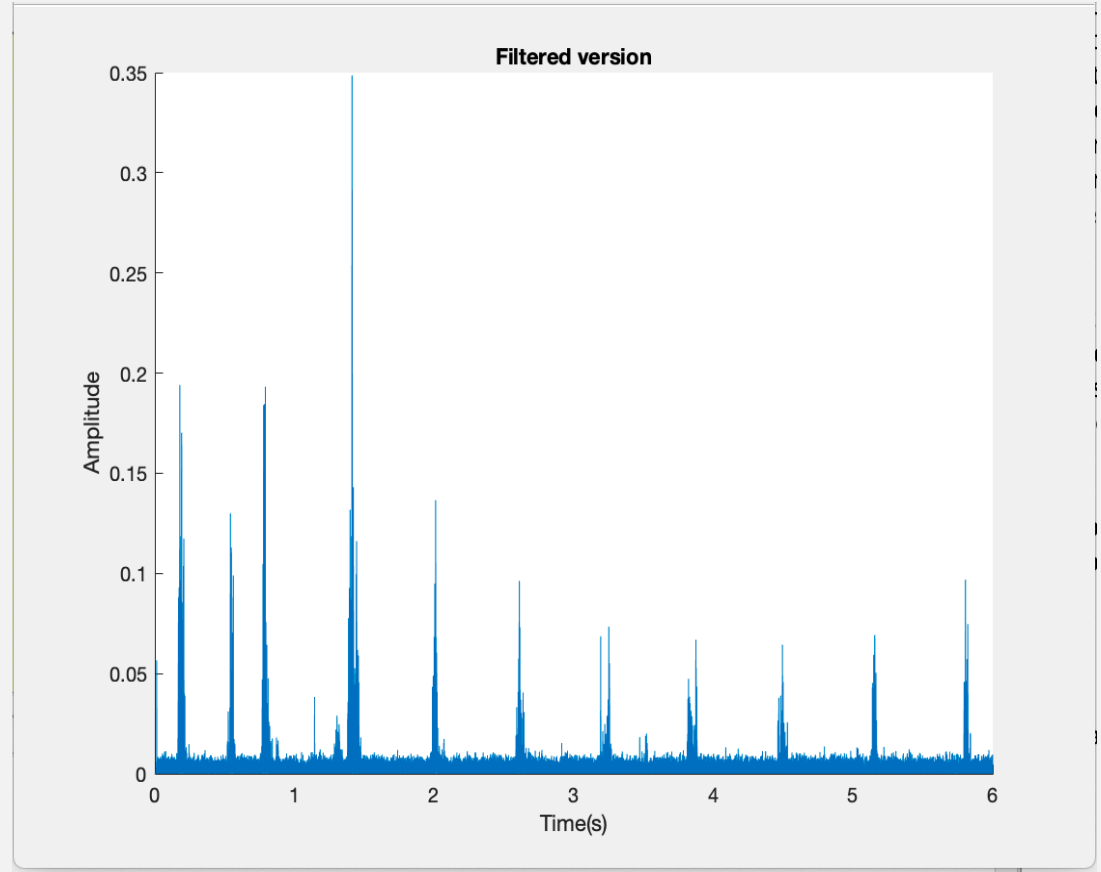


Figure 3. Filtered signal

RESULTS

- Every heartbeat (aka peak) detected, it is marked with an “x”
 - Adjustable parameters define the period of FindPeaks
 - $\text{MinPeakDistance} = \text{Period}$
- Other Output:

Number of Beats in Audio File: 73 beats
Beat Interval: 91.2 beats per minute

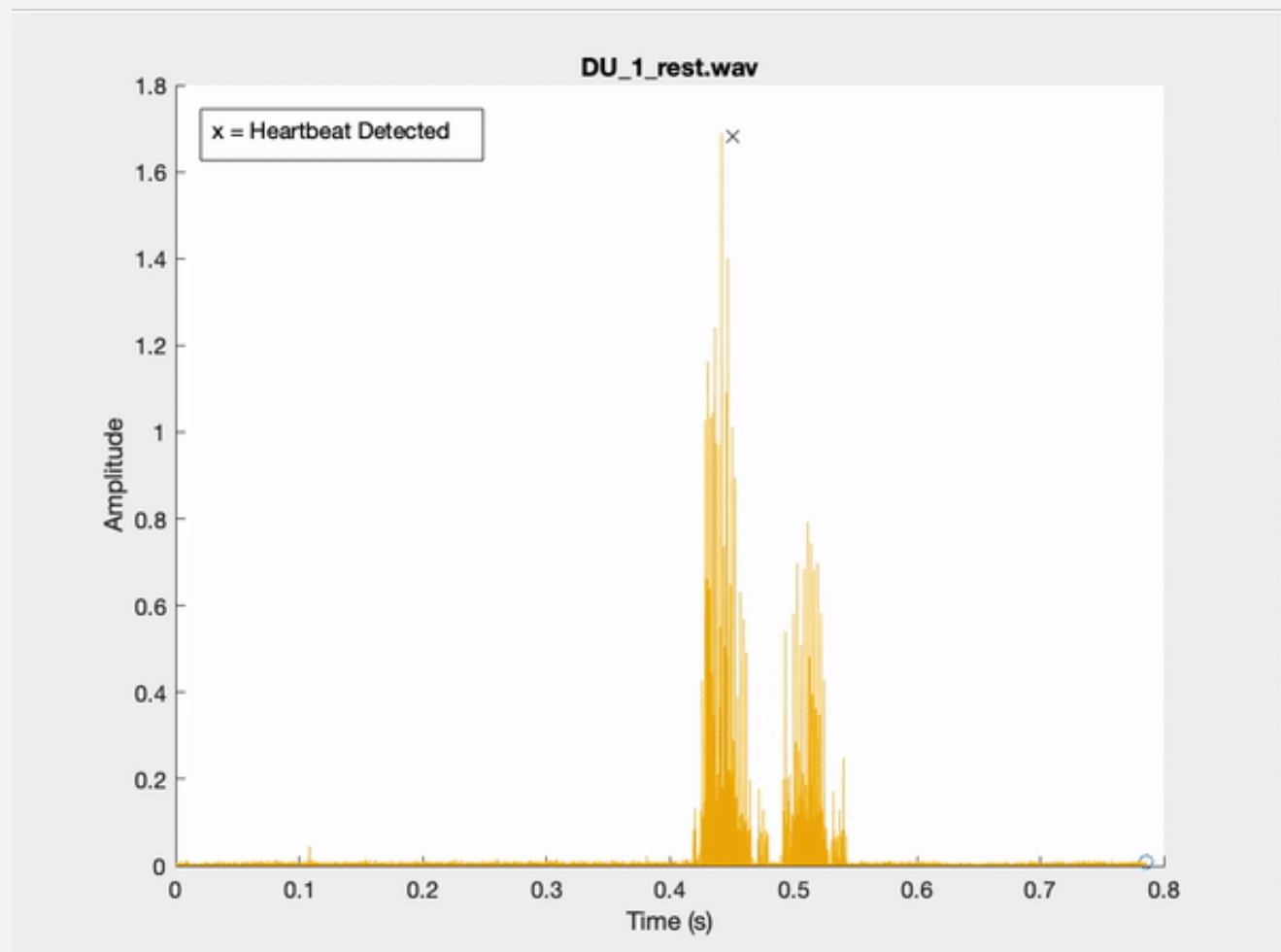


Figure 4. HRD Algorithm Output

CURRENT OBJECTIVES

- Automating the HRD system
 - Avoids manual adjustment of parameters
 - Reduce processing rate
 - Increase sample size for evaluation

REFERENCES

- Divon MY, Torres FP, Yeh SY, Paul RH. Autocorrelation techniques in fetal monitoring. *Am J Obstet Gynecol.* 1985 Jan 1;151(1):2-6. doi: 10.1016/0002-9378(85)90413-2. PMID: 3966502.
- Pierleoni, Paola & Palma, Lorenzo & Belli, Alberto & Pieri, Massimo & Maurizi, Lorenzo & Pellegrini, Marco & Marroni, Alessandro. (2019). An EMD-Based Algorithm for Emboli Detection in Echo Doppler Audio Signals. *Electronics.* 8. 824. 10.3390/electronics8080824.