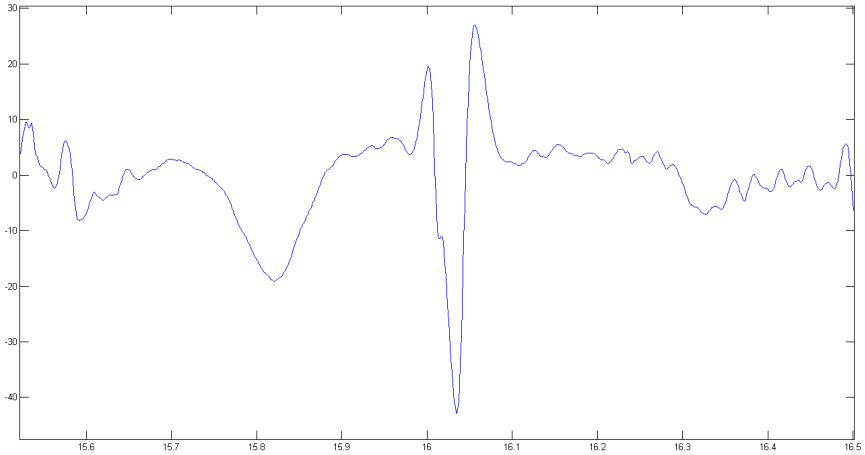
CSM229S: ECG Annotations for applications in fetal AR detection



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with Professor Fabien Scalzo
UCLA, Spring 2013

Project Overview

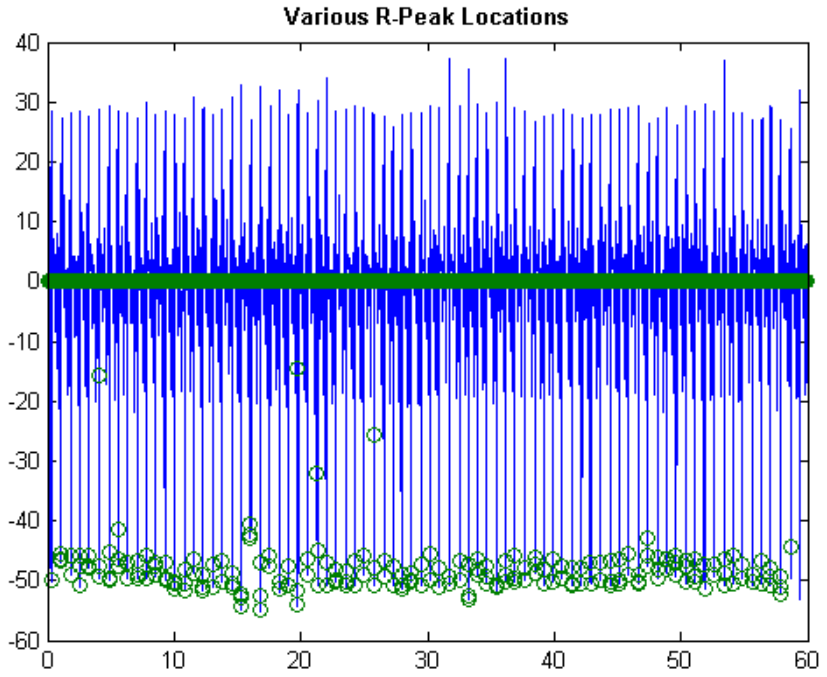
- Goals:
  - extract insighful ECG signal info
  - apply signal processing techniques to look at time-dependeant behavior of beats
  - use rules to make determinations about sources of deviations

- Methods:
  - ECG peak detection
  - signal/beat segmentation (non-stationary signals)
  - ponytonic pulse removal



Basic Efforts

- Tools
  - signal annotator and plotting
  - signal splicer and filters
- Simple peak detection
  - nqrsdetect from NSDL Toolbox
  - multiple mature algorithms
- Simple beat segmentation
  - midpoint of R-R interval
  - stored in a data structure





So what's the problem?

- *After segmentation, left with unequal segments of a "beat"*
  - hard to compare even if normalized
  - frqz spectrum hard to interpret
- *Full normalization requires deep understanding of sources of "noise" or signal distortion*
  - determine which pulses should most likely be "mixed" out (analogy to RF signal processing techniques)



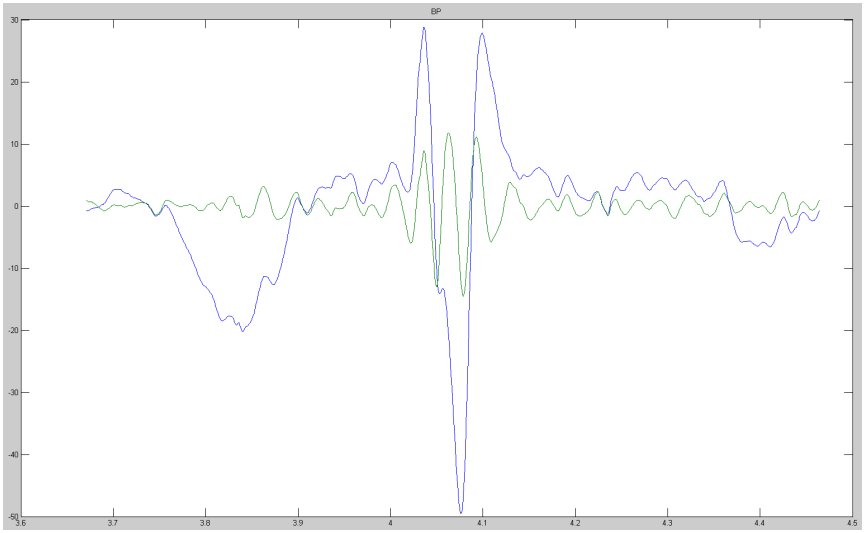
Necessary Methods

- *After segmentation, left with unequal segments of a "beat"*
  - hard to compare even if normalized
  - frqz spectrum hard to interpret
  - implement time-domain alignment to synthz a full beat
- *Full normalization requires deep understanding of sources of "noise" or signal distortion*
  - determine which pulses should most likely be "mixed" out (analogy to RF signal processing techniques)
  - employ polytonic pulse recognition



Literature -- Envelope Detection

- Choi (Kyung Hee University) : Development of ECG beat segmentation method by combining lowpass filter and irregular R–R interval checkup strategy
  - R-R peak detection
  - filtering methods to find wave-envelope
  - compared QRS envelopes in MIT-BIH AR databse
  - I have reproduced similar results using various frequency filters, the PR-QT intervals detectable using simple thresholding



Raw wave-envelope
(BPF 20-780Hz)

OK, but so what?

- QRS envelope is useful to detect AR of maternal ECG, but is not particularly useful in fetal AR detection
  - require a sort of pulse clustering to determine the "average" or most-likely maternal ECG signal from a stream of data
  - this is NOT a QRS envelope!

- Interesting relevance: audio engineering
  - signal stiching and insertion (e.g. crossfading)
  - dsp techniques employed in time-domain for alignment clustering



Literature -- Audio Engineering/DSP

- Jason Filos (Imperial College) thesis: Time-Domain Alignment of Non-Stationary Signals
  - midpoint interval segmentation (same results as me)
  - time-domain alignment of snippet into original (very applicable)
  - feature-vector comparision model (possibly applicable)
  - My method must map clusters of similar signals onto a larger "full" beat signal (rather than onto an known orignal signal)
  - The "average" deviation* from the clustered signal determines "noise" and distortion signal
  - Can examine this data over time to determine fetal envelope

*Deviation determined by rules



Progress

• Parsing	parser.m
• Feature extraction	extractor.m NSDL(nqrsdetect)
• Tools	
– annotating	plotPOS
– filtering	filter_function
– splicing	segment_by_edge generate_edges_from_locs
• R-R segmentation	segmentor.m
• Envelope detection	using HPF,LFP,BPF
• Full-beat synthesis	mapper.m
• "Averaging" and "Noise" extraction	--> next-step
• Fetal feature detection	--> goal



References

Immediate motivators:

- *Filos -- Time-Domain Alignment for Audio Engineering
- Zhang -- Multi-channel video display system with image stitching

Background:

- Hu, Xu, Scalzo -- Morphological Clustering
- Scalzo -- Peak designation, ICP detection
- Narayana -- Wavelet based QRS detection
- Belkheiri -- ECG beats using a radial basis function
- *Choi -- QRS Envelope with Filtering
- Marre -- Mapping a neural population
- Neagoe -- Neuro-Fuzzy ECG for disease diagnosis
- Gatos -- Greek Polytonic OCR with character class reduction
- Frau -- ECG Clustering using computer-aided Holter analysis

*referenced here directly

