ADAPTIVE MULTI TRACE CARVING BASED ON DYNAMIC PROGRAMMING

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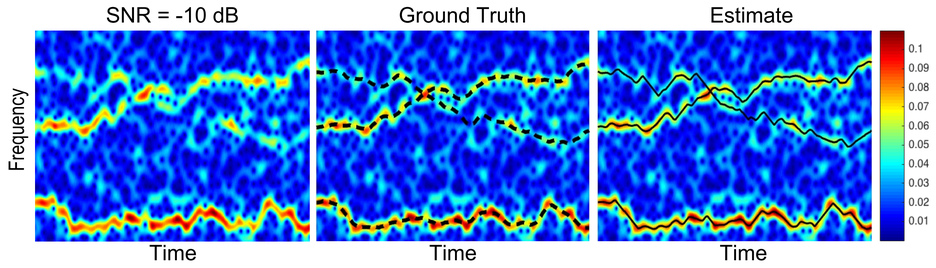
Robust Frequency Estimation and Tracking

- Freq. Estimation/Tracking in very noisy environment has many applications: *Physiological Measurement, Radar/Sonar Signal Proc., Multimedia Forensic, etc.*
- Existing art may be vulnerable in low SNR, inefficient in real-time, case sensitive due to large training requirement, or simply time consuming.
- AMTC can track multiple signal frequencies in a very low SNR environment in real time.



Trace Tracking Algorithm

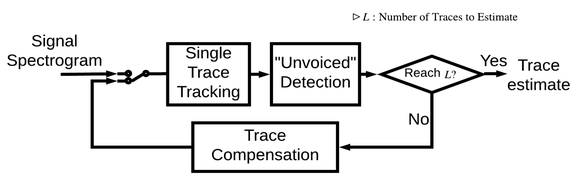
Single Trace Tracking by Dynamic Programming

- Problem: search a freq. trace which has the maximum trace energy while regularized by the freq. temporal dynamic (Markov Chain)

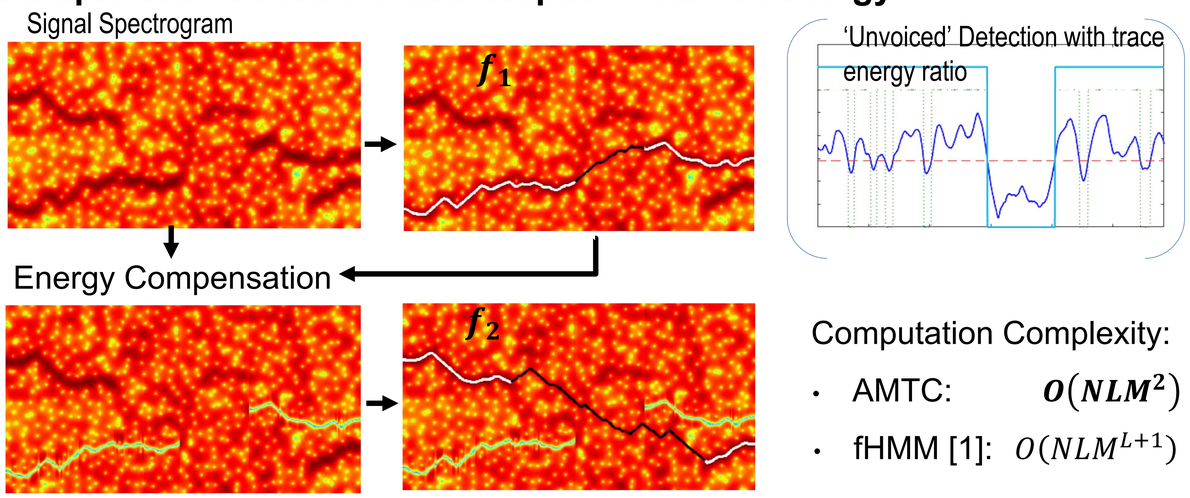
$$\boldsymbol{f} = \underset{\boldsymbol{f}}{\operatorname{argmax}}\, E(\boldsymbol{f}) + \lambda P(\boldsymbol{f}), \qquad \lambda > 0$$

Freq. trace energy *Trace dynamic constraint*

- Optimal solution: achieved by dynamic programming.



Multiple Trace: iterative and adaptive search strategy

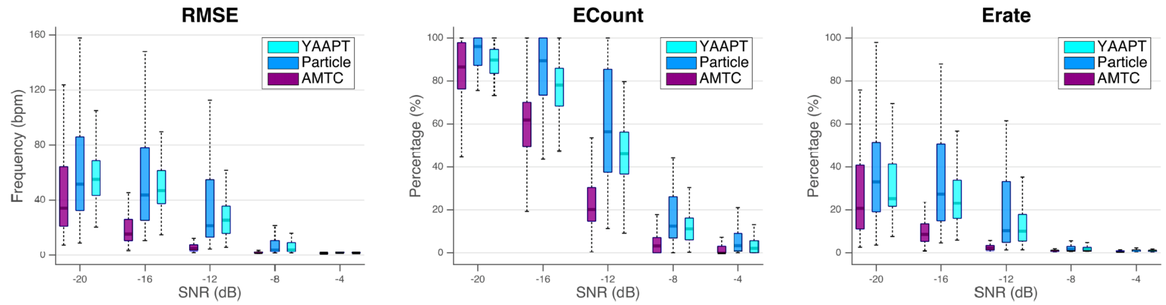


Computation Complexity:

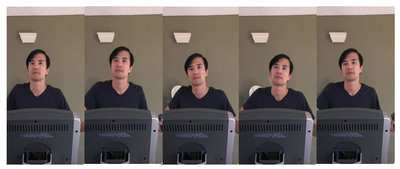
- AMTC: $O(NLM^2)$
- fHMM [1]: $O(NLM^{L+1})$

Experimental Results

- Simulation Result, Prior Art (YAAPT and Particle Filter) and AMTC

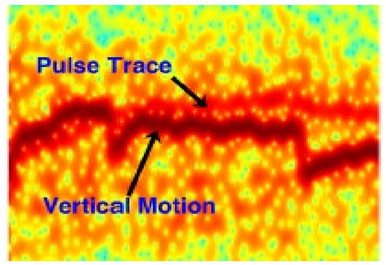


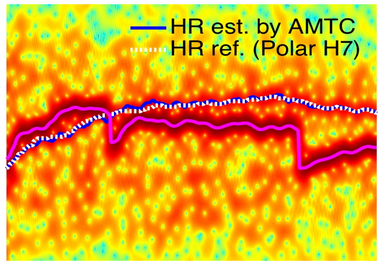
- Fitness Heart Rate from Face Video (photoplethysmography)



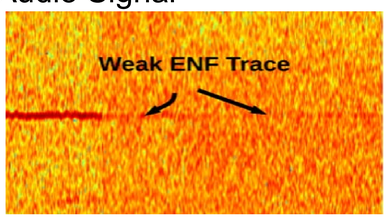
IPhone 6s, Elliptical Machine

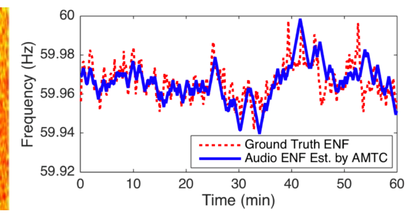
Ref.: Polar H7 Chest Belt





- Power Grid Signature from Audio Signal
  - 03:03am to 04:03am PT, Oct. 31st, 2012, San Diego, CA.
  - Nominal Electrical Network Freq.: 60Hz
  - Olympus WS-700M, 44.1kHz

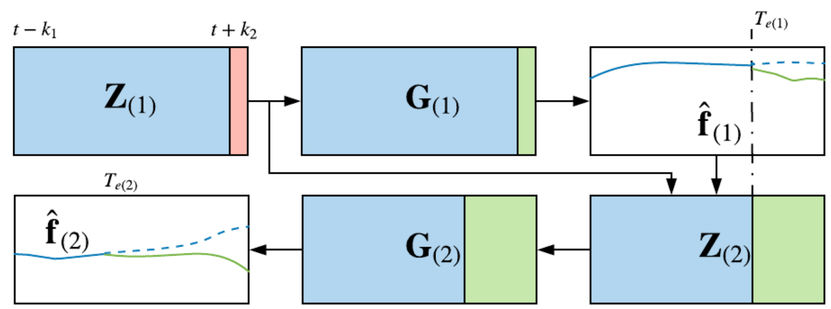




Pseudo Real-time Implementation

Online AMTC: Efficient pseudo real-time implementation $O(N(k_1+k_2)LM^2)$

Scan for online AMTC demo:



: innovation frame $\mathbf{Z}_{(1)}(t+k_2)$
: unchanged from previous iteration
: updated in current iteration