

**MMI505/606**  
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*Assignment 4: Tempo Tracking. You will Implement a tempo estimator in MATLAB using the algorithm proposed by Scheirer (1998).*

1. Create a simple click track at 60 BPM (i.e., one click per second) in MATLAB or Audacity. You will use this for testing as you create the tempo-tracker. Each “click” should be comprised of twenty samples of decaying white noise at  $F_s = 8$  kHz. Your click track should contain a total of eight clicks.
2. Use the MATLAB ELLIP command to create Schierer’s six filterbank filters. Each filter should be a sixth-order elliptic filter with 3 dB of passband ripple and 40 dB of stopband attenuation. Use cutoff frequencies of 200, 400, 800, 1600, and 3200 Hz. List the coefficients used for each filter.
3. Plot the log-magnitude response of each filter.
3. Continue implementing the next few parts of Figure 3 from the JASA article (the envelope extractor, differentiator, and half-wave rectifier). Print the time-domain envelope and the output of the differentiator for the lowest frequency band of the filtered click track. This should closely match the output shown in Figure 5.
4. Create a bank of at least 200 comb filters for each frequency subband. The delay times should be set so that the comb filters will resonate at click inputs between 50 BPM and 180 BPM. Use the following difference equation for the combs:

$$y_t = (1 - \alpha)x_t + \alpha y_{t-T}$$

where  $\alpha$  is the half-life decay coefficient and  $T$  is the comb delay in samples. Set  $\alpha = 0.5^{t/T}$  ( $t = 1.5$ – $2.0$  sec) as described in the article (note that this value is different for each comb filter), and explain why this is done.

5. Implement the remaining architecture of Figure 3. Finally, run the original input click track through your entire system, and plot Comb Energy vs. Tempo. What is the tempo of the click track? Does it match what you expected?