Homework 3

Biomedical Signal Processing

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Problem1

Design a Wiener filter to remove the artifacts in the ECG signal in the file ecg_hfn.dat. (See also the file ecg_hfn.m.) The equation of the desired filter is given in Equation 3.101. The required model PSDs may be obtained as follows:

Create a piece-wise linear model of the desired version of the signal by concatenating linear segments to provide P, QRS, and T waves with amplitudes, durations, and intervals similar to those in the given noisy ECG signal. Compute the PSD of the model signal.

Compare the results with the results of the lowpass filter.

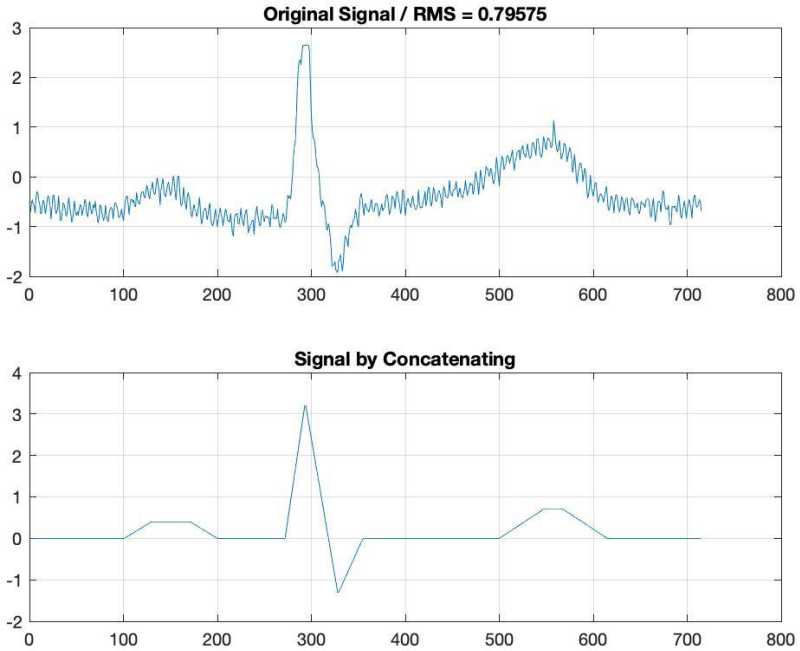
Method

1.手動繪製ECG波形作為預期理想訊號(desire signal): 使用linspace()函數

2. 使用講義Weiner Hopf 公式得到濾波參數

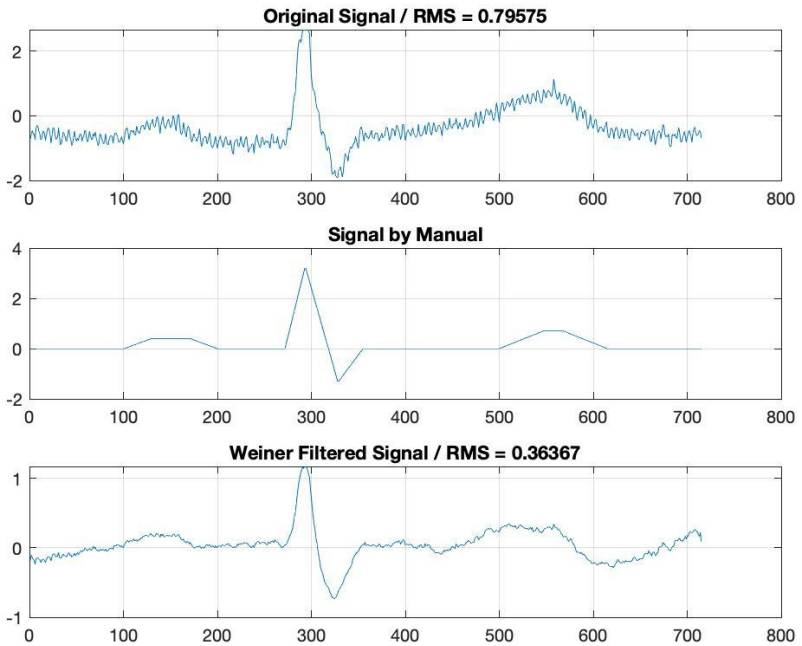
3. 套用至原波形:

filter(b,1,xn)=conv(b,xn)



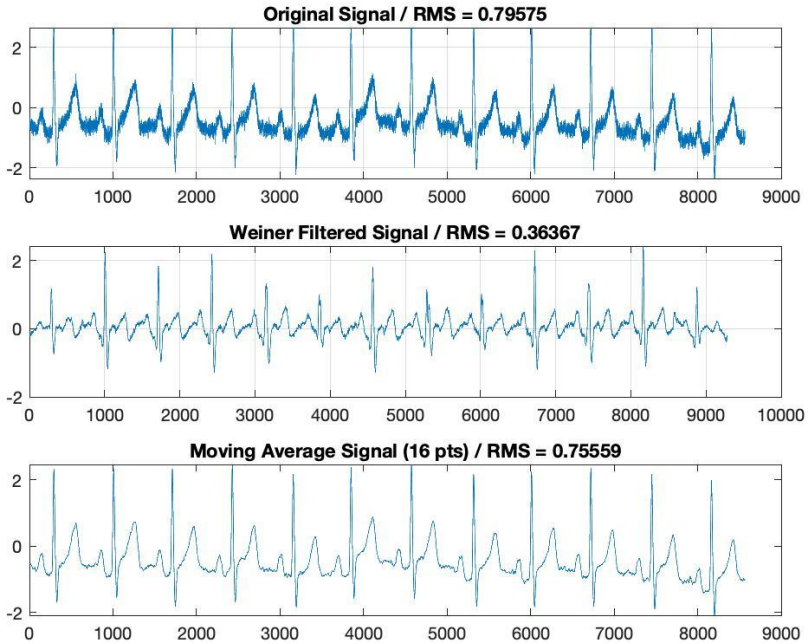
Result

濾波後圖形RMS有明顯下降。



Discussion

以moving average 做為lowpass filter濾波之效果能夠小程度的降低RMS，但效果不如Weiner Filter



Problem2

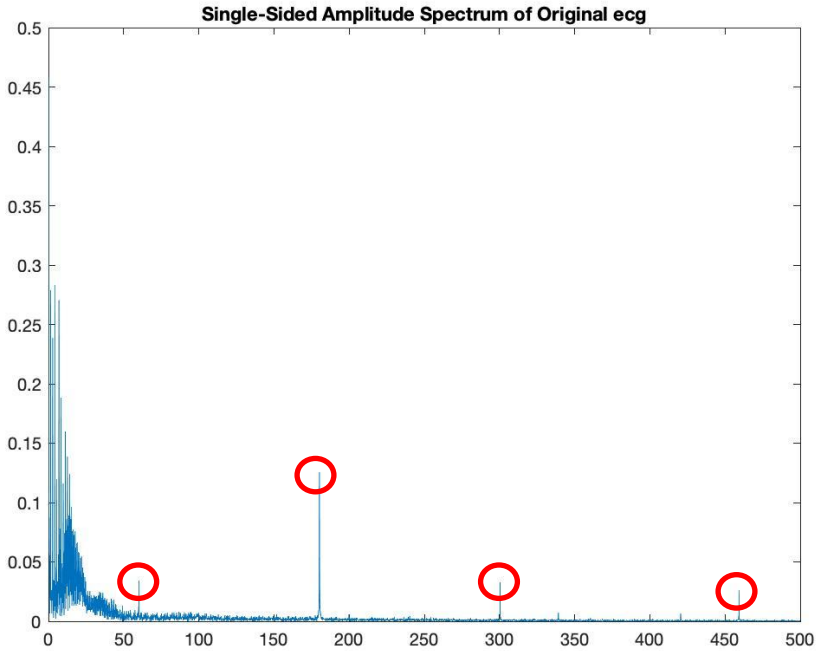
Design a Wiener filter to remove the artifacts in the ECG signal in the file ecg_hfn.dat. (See also the file ecg_hfn.m.) The equation of the desired filter is given in Equation 3.101. The required model PSDs may be obtained as follows:

Create a piece-wise linear model of the desired version of the signal by concatenating linear segments to provide P, QRS, and T waves with amplitudes, durations, and intervals similar to those in the given noisy ECG signal. Compute the PSD of the model signal.

Redo the above exp by using the ECG filtered by the Comb filter as the template.
Also Compare the results with the results of the lowpass filter.

Method-Comb

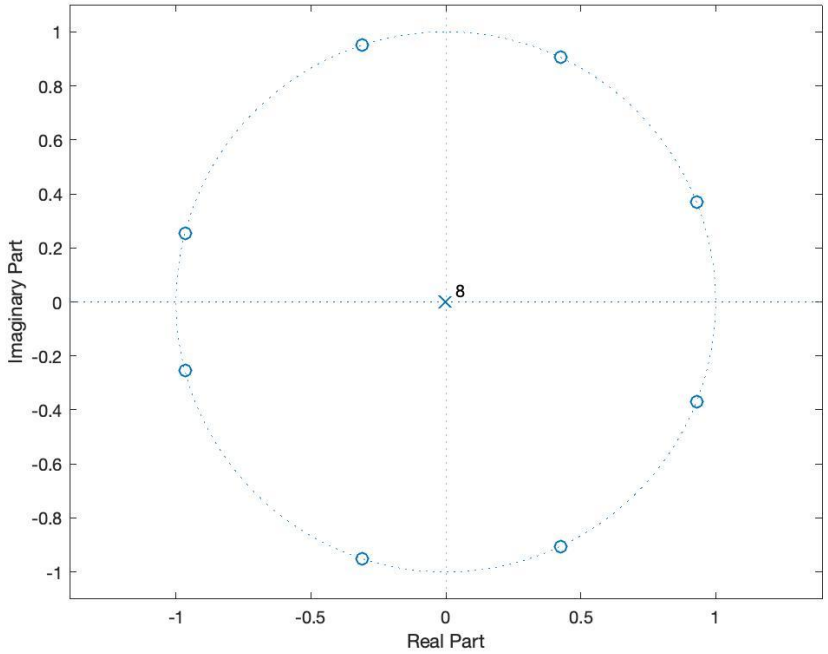
對原訊號做fft，可以發現存在四個明顯頻率，約為:60、180、300與459Hz，因此利用Comb Filter將這四個頻率濾掉。



Method-Comb

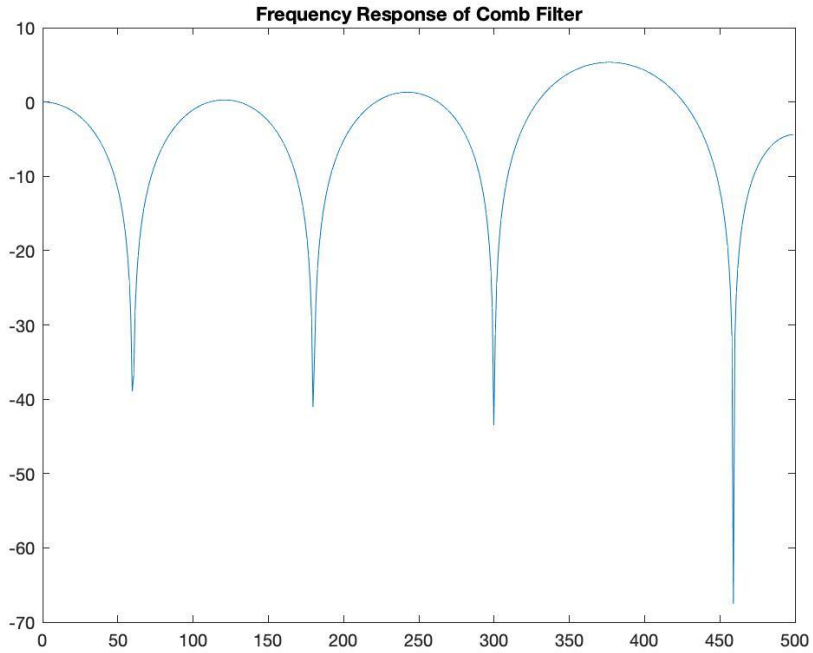
一個頻率可以計算出一對Zeros，總共有八個Zero，顯示於右圖zplane。利用conv計算兩兩多項式的相乘，最後再標準化。

再重複之前Weiner Filter手法。



Method-Comb

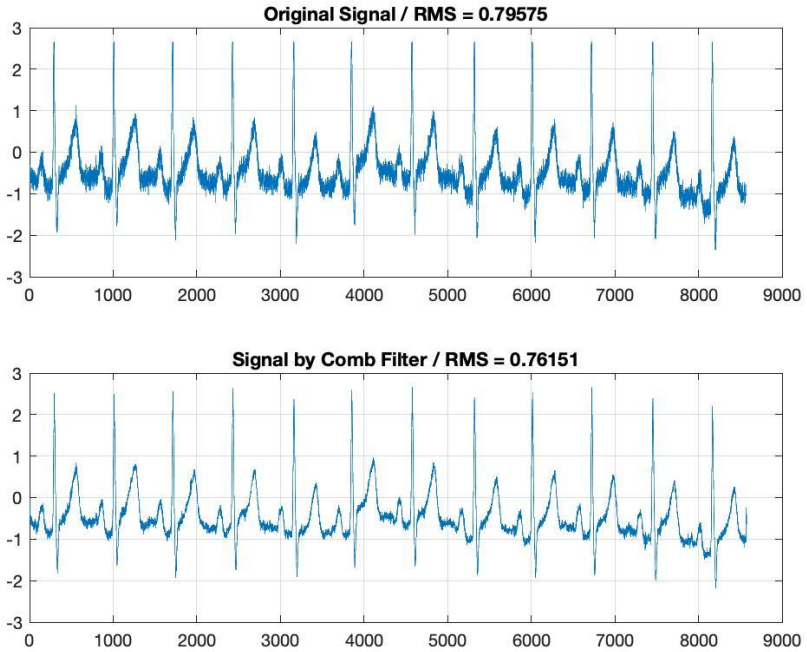
圖為Comb Filter之頻率響應圖。可以發現在頻率60、180、300與459Hz有陷波作用。



Result

套用過Comb Filter之訊號，RMS有些微下降。

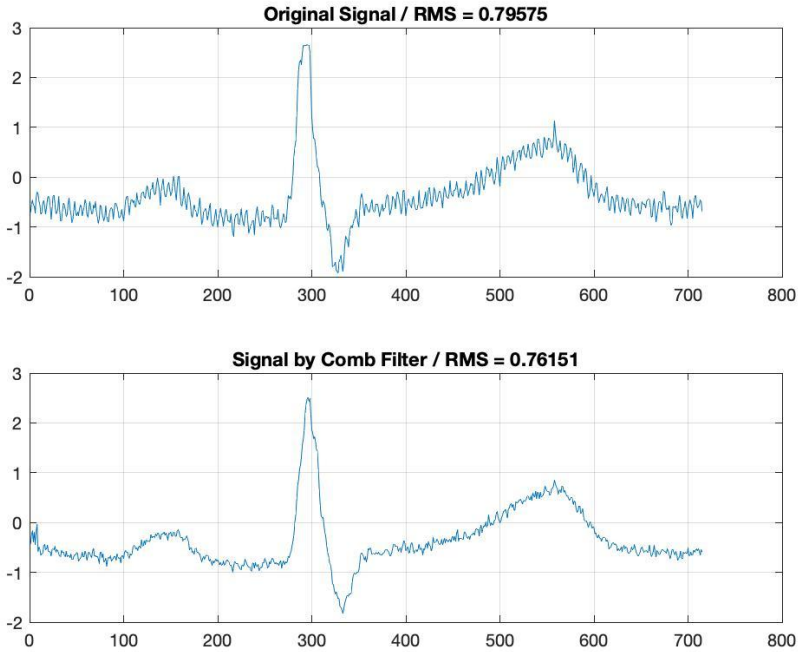
圖：整段訊號



Result

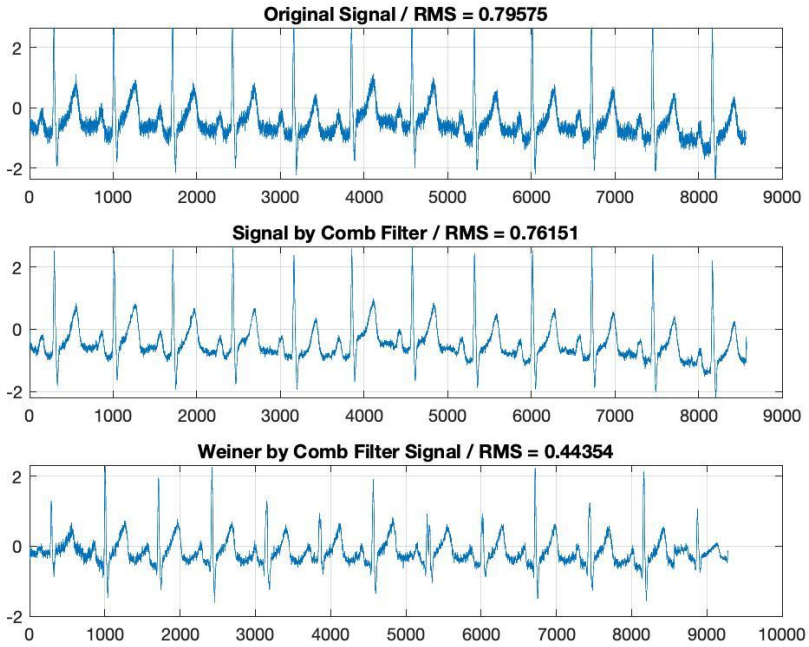
套用過Comb Filter之訊號，RMS有些微下降。

圖：單一週期訊號



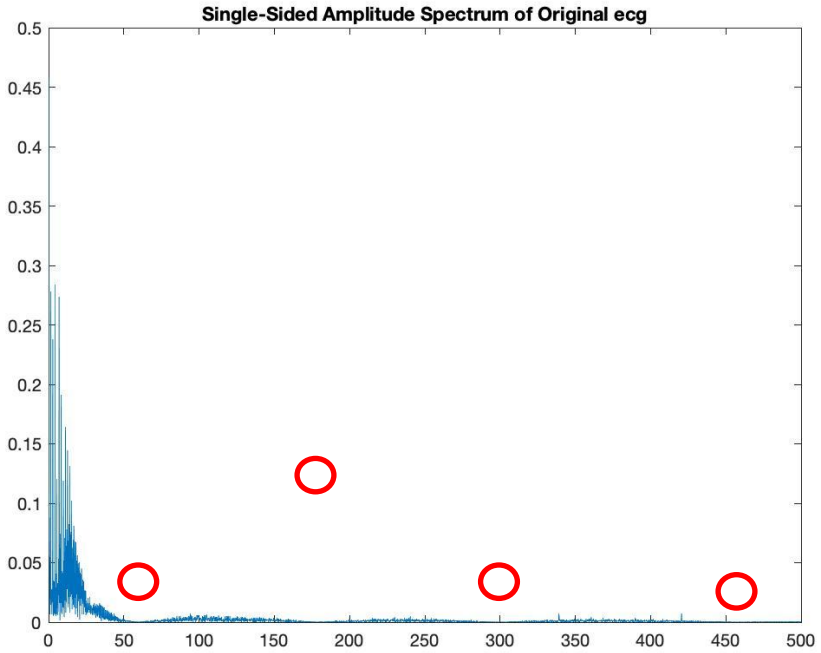
Result

以Comb Filter之結果作為模版，經Weiner Filter後結果圖如，計算出RMS會發現有明顯下降。



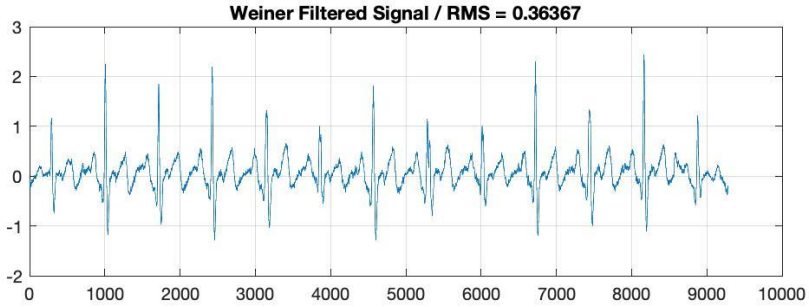
Discussion

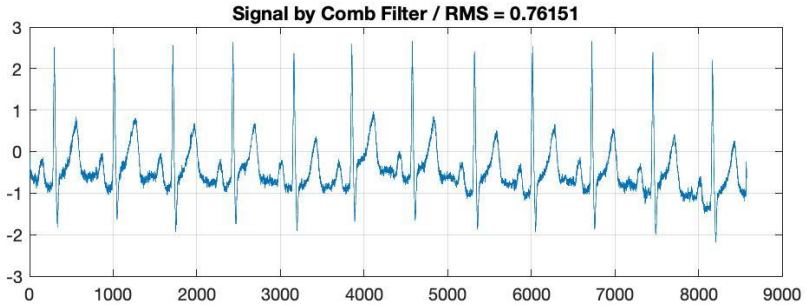
對濾波後的訊號做fft, 可以發現原本ecg訊號出現的四個明顯頻率已經消去。



Discussion

但RMS仍比前面Ideal Weiner Filter大，可見Ideal Weiner Filter有較好的去雜訊效果。





Thanks!