

Wiener Filter

1 Questions

1. What are the design criteria of the Wiener filter?
2. Explain the term formant frequency!
3. What is the frequency domain solution of the Wiener filter for orthogonal signals?
What does the magnitude frequency response look like for the two extreme cases when the observed signal contains the desired or undesired signal only?
4. Explain the noise estimation scheme based on Voice-Activity-Detection (VAD)!
5. Explain the noise estimation scheme based on Minima Tracking! Which influence do the parameters β , Δ_{inc} , and Δ_{dec} have?
6. Why is a maximum operator introduced into the filter characteristic?
7. What is musical noise?
8. What is overestimation and why is it used?
9. What is the advantage of an adaptive overestimation?

2 Answers

1. Optimal separation of wanted and unwanted signal. Knowledge of statistical properties up to second order.
2. Formants are the characteristic resonance frequencies of speech sounds created by the vocal tract.
3. $H_{\text{opt}}(e^{j\Omega}) = 1 - \frac{S_{bb}(e^{j\Omega})}{S_{yy}(e^{j\Omega})}$,
only desired: $H_{\text{opt}}(e^{j\Omega}) \rightarrow 1$, only undesired: $H_{\text{opt}}(e^{j\Omega}) \rightarrow 0$
4. In speech pauses the noise estimate is updated using the parameter β . During speech activity no update is performed. β controls how much the estimate fluctuates and how much of the current spectrum is estimated as noise. The scheme depends on the robustness of the VAD. The VAD has potentially a high complexity but it prevents an unwanted rise of the estimate during speech phases.
5. Smoothing of the input PSD and increasing or decreasing the noise estimate in the direction of the PSD. β determines the extent of the smoothing. Δ_{inc} and Δ_{dec} are the step sizes of the adaptation.
6. The maximum operator is applied because in speech pauses the estimated noise power spectral density can become bigger than the estimate of the power spectral density of the microphone signal. Thus, the filter coefficients would become negative and the signal would be amplified. To prevent this, the maximum operator is applied. Additionally, the attenuation of the filter can be arbitrarily limited as desired.
7. Musical noise is a fast changing tonal sound which is created by the "opening" and "closing" of the Wiener Filter.
8. The noise estimate is artificially increased by a fixed or adaptive factor. Overestimating the noise can reduce musical noise.
9. Better speech quality (quality of desired signal) can be achieved.