

## Questions A

### ***A1. How can the short-time PSD of the background noise be estimated?***

- Which are the two noise estimation schemes presented in the lecture?
- Propose another scheme to estimate noise!

### ***A2. Frequency-domain solution of the Wiener Filter***

- The frequency-domain solution for orthogonal signals is: ...
- Describe the magnitude frequency response in your own words for the two extrema: only noise; only speech.

### ***A3. Explain the method of minimum tracking for noise estimation.***

- Describe the method in your own words!
- Which influence do the parameters  $\beta$ ,  $\Delta_{\text{inc}}$  and  $\Delta_{\text{dec}}$  have?

### ***A4. What is musical noise?***

- What is musical noise and what is its origin?

## Answers B

### ***B1. What are the design criteria of the Wiener Filter?***

- Compare slides 6 and 10; optimal separation of wanted and unwanted signals; knowledge of statistical properties up to second order of both signals.

### ***B2. Explain the term formant frequency.***

- Formants are the characteristic resonance frequencies of speech sounds created by the vocal tract.

### ***B3. Explain the noise estimation scheme based on voice activity detection.***

- In speech pauses, the filter is updated using the parameter  $\beta$ , while speech activity, no adaptation is performed.
- $\beta$  controls how much the noise estimate fluctuates and how much of the actual spectrum is estimated as noise
- This scheme depends on the robustness of the voice activity detection (VAD) which has higher complexity, but the noise estimate does not rise while speech activity.

### ***B4. What is overestimation?***

- The noise estimate is augmented subsequently. Overestimation is applied in order to reduce musical noise.
- Fixed and adaptive overestimation: See slides 20, 21.

## Questions B

### ***B1. What are the design criteria of the Wiener Filter?***

- Enumerate the criteria that were presented in the lecture.

### ***B2. Explain the term formant frequency.***

- In the context of speech modeling, what is the meaning of a formant frequency?

### ***B3. Explain the noise estimation scheme based on voice activity detection.***

- Describe the scheme in your own words.
- Which influence has the parameter  $\beta$  ?
- What advantages and what drawbacks are there compared to the method of minimum tracking for noise estimation?

### ***B4. What is overestimation?***

- Why is an overestimation factor applied to the noise estimate?
- Illustrate the presented schemes in your own words.

## Answers A

### **A1. How can the short-time PSD of the background noise be estimated?**

- By means of a) tracking of minima, or b) voice activity detection.
- E.g., methods based on multiple microphones, minimum statistics, speech presence probability (SPP)

### **A2. Frequency-domain solution of the Wiener Filter**

- The frequency-domain solution is:  $H_{\text{opt}}(e^{j\Omega}) = 1 - \frac{S_{bb}(\Omega)}{S_{yy}(\Omega)}$ .
- Only noise:  $H_{\text{opt}}(e^{j\Omega}) \rightarrow 0$ , only speech:  $H_{\text{opt}}(e^{j\Omega}) \rightarrow 1$ .

### **A3. Explain the method of minimum tracking for noise estimation.**

- See lecture slide 18: Smoothing of the PSD; increasing or decreasing the noise estimate in the direction of the smoothed PSD.
- $\beta$  determines the extent of the smoothing;  $\Delta_{\text{inc}}$  and  $\Delta_{\text{dec}}$  are the step sizes for the adaption.

### **A4. What is musical noise?**

- Musical noise is a fast changing tonal sound which is created by the “opening” and “closing” of the Wiener Filter.