PERCEPTUALLY BASED SPEECH ENHANCEMENT USING THE WEIGHTED $\beta$-SA ESTIMATOR

ERIC PLOURDE AND BENOIT CHAMPAGNE
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING, MCGILL UNIVERSITY, MONTREAL, CANADA

INTRODUCTION

Problem:

We propose the W$\beta$-SA estimator where:

Using (2) in (1), we get the W$\beta$-SA estimator:

This work:

We propose the W$\beta$-SA estimator where:

Table 1. $C(\hat{X}_k, \hat{X}_k)$ in previous publications.

<table>
<thead>
<tr>
<th>Estimator</th>
<th>$C(\hat{X}_k, \hat{X}_k)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE STSA (Ephraim et al., 1984)</td>
<td>$(\hat{X}_k - \hat{X}_p)^2$</td>
</tr>
<tr>
<td>LSA (Ephraim et al., 1985)</td>
<td>$(\log(\hat{X}_k) - \log(\hat{X}_p))^2$</td>
</tr>
<tr>
<td>WE (Loizou, 2005)</td>
<td>$(\hat{X}_k - \hat{X}_p)^2$</td>
</tr>
<tr>
<td>$\beta$-SA (You et al., 2005)</td>
<td>$(\hat{X}_k - \hat{X}_p)^2$</td>
</tr>
</tbody>
</table>

We propose the W$\beta$-SA estimator where:

Choice of $\beta$:

• Loudness is thought to be more perceptually relevant than sound intensity.

• Model perceived loudness $\rightarrow \beta = 1/3$.

Choice of $p$:

• In Loizou, 2005: Since smaller $X_k$ will not mask noise remaining in the estimator, obtain a more accurate estimation for smaller $X_k$.

• Here: Since there is less speech energy at high frequencies, further improve the estimation of small $X_k$ at high frequencies $\rightarrow p = p_k$.

END OF EIGHTEENLY RELEVANT PARAMETER VALUES

RESULTS

Objective evaluation

Table 2. SNR$_{eq}$ values for several estimators with white and cockpit noises (0 dB).

<table>
<thead>
<tr>
<th>Estimator</th>
<th>White Cockpit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MMSE STSA</td>
<td>0.47 -0.57</td>
</tr>
<tr>
<td>LSA</td>
<td>2.06 0.35</td>
</tr>
<tr>
<td>WE (q = -1)</td>
<td>2.97 0.79</td>
</tr>
<tr>
<td>W$\beta$-SA</td>
<td>$\beta = 1$, $p = p_k$ 3.28 0.90</td>
</tr>
<tr>
<td></td>
<td>$\beta = 1/3$, $p = p_k$ 3.35 0.83</td>
</tr>
<tr>
<td></td>
<td>$\beta = 1/3$, $p = p_k$ 3.62 0.94</td>
</tr>
</tbody>
</table>

Subjective evaluation

Fig. 2. MUSHRA values for several estimators with white and cockpit noises (0 dB).

CONCLUSION

W$\beta$-SA estimator with chosen $\beta$ and $p$ achieves better overall performance both in terms of objective (gain of 0.65 dB for white noise) and subjective (best MUSHRA results) measures.