Direction Preserving Wind Noise Reduction of B-Format Signals
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1. Introduction
- Soundfield microphones can be used to capture 3D audio via first-order Ambisonics (B-format)
- Wind noise in outdoor recordings degrades the sound quality and speech intelligibility

Tasks:
- Enhance desired signal and reduce wind noise
- Preserve spatial distribution of all sound-field components

2. Problem Formulation

3. Proposed Method

Motivation
- PMWF: tradeoff parameter $\mu$ controls desired-signal distortion and noise reduction

Present Work
- Derive dipole-to-omnidirectional power ratio (PR)
  - Use PR for B-format to B-format wind noise reduction
  - $PR = \frac{g_0^2}{g_d^2} \phi_{\text{dip}} \phi_{\text{omni}}$
    - $g_0, g_d$ omnidirectional and dipole gains from B-format encoding
    - $\phi_{\text{omni}}$ omnidirectional power
    - $\phi_{\text{dip}}$ dipole power
  - "Windiness" $\hat{PR} = \min\{\{PR - 1\}/8, 0\}, 1$
  - Proposed trade-off parameter $\mu = 1 + \rho \hat{PR}$

4. Performance Evaluation

Simulation Setup
- 10 wind noise recordings with AMBEO VR mic
- 2 different English speech files (plane-wave encoding)
- 4 different speech directions (DOAs), 0 dB SNR

Processing
- Short-time Fourier transform domain processing
- Recursive estimation of signal statistics, oracle DOA
- Max. noise reduction: 20 dB

Performance Measures
- Noise reduction (NR), signal-to-distortion ratio (SDR)
- Spatial preservation of noise (similarity noise)
- PESQ improvement ($\Delta$PESQ)

Audio Examples
https://www.audiolabs-erlangen.de/resources/2021-ICASSP-BWNR

5. Conclusions
- NR, similarity noise and $\Delta$PESQ increase with $\rho$
- BP: + NR and SDR, - similarity noise and $\Delta$PESQ
- BP+PM: + SDR, + similarity noise, + NR and $\Delta$PESQ
- DP: + NR, similarity noise and $\Delta$PESQ, - SDR

References