CCI-MOBILE: ENVIRONMENT-SPECIFIC SPEECH ENHANCEMENT WITH COCHLEAR IMPLANT LISTENERS USING CONVOLUTIONAL NEURAL NETWORK

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S proposed system and

3 baseline systems

1. INTRODUCTION

Observation: Cochlear Implant (CI) recipients enjoy near-to-normal speech intelligibility (SI) in quiet conditions [1].

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3. METHODS cont.		4. RESULTS cont.
Standard CNN	Causal CNN	Intelligibility scores (Non-causal SE):
Convolutional Network (CNN)	-Causal Convolutional Network (CausalCNN) -	 Noisy Wiener-wt Wiener-as LogMMSE Some Source Vanilla-CNN SS-CNN Wiener-CNN Some Source A propose A propose
22 ×2500	22 ×2500	

Challenge: CI generally recipients experience reduced speech intelligibility in environmentally rich spaces [2].

Speech **OKANN-based** Enhancement (SE): considers local temporal-spectral speech signals Of structures and effectively dis-integrates the clean signal and noise from noisy input.

powerful network ensures a estimating model capable Of the nonlinear mapping between noisy and clean speech.

Proposed Consider **networks**:



Wiener-CNN o 0 0.9-0.9outperform other ntelligibility systems under car noise Outperform baseline algorithms. -5 dB 0 dB -10 dB 5 dB **Intelligibility scores (Causal SE):** Noisy Vanilla-CNN SS-CNN Wiener-CNN 3 proposed system systems Score Score Significantly improve Intelligibility .0 80 SE in CI features domain **Causal Wiener-CNN** (SE) algorithms -10 dB 0 dB 5 dB -10 dB 0 dB outperform others 5 dB Car 1 Car 2 **Paired Preference Test: Pairwise Preference Pairwise Preference Pairwise Preference Comparing 2 Enhancement Comparing 2 Enhancement Overall Listener Preference** methods; 10 dB SNR methods; 5 dB SNR 4 Conditions: (Noisy, V_CNN, W_CNN, SS_CNN)

Solutions: (i) vanilla CNN, (ii) spectralsubtraction style CNN (SS-CNN), (iii) Wiener-style CNN (Wiener-CNN).

2. METHODS

- Method #1: Speech Enhancement in a cochlear filter-bank space.
- Method #2: Leveraging the CNN to extract both stationary and non-stationary components of the environmental acoustics and speech



Causal CNN SE \longrightarrow CausalCNN $\rightarrow \otimes \rightarrow$

CNN Parameters:

- Training/Testing Sets: 3150/1575 utterances
- Convolutional Layer: 7
- ♦ Epochs: 300. Kernels: 65
- Activation Function: 'tanh', 'linear'

4. RESULTS

Test Corpora:

- Databases: UT-Drive (TIMIT sentences).
- ♦ <u>SNR:</u> -10, 0, and 5 dB.
- ♦ <u>Noise</u>: Speech shape, Car.
- Car Types: Mitsubishi Galant (2002) and

Nissan-Sentra (2008)



5. CONCLUSIONS

Proposed algorithms shown to successfully enhanced signals under noisy conditions for CI users.

Causal Wiener-CNN achieves the highest performance vs. all 3 methods.

Cl subjects preferred enhanced sentences

Fig.1. Basic block diagram of cochlear Implant signal processing pipeline.

All the star

ECM metric is used to calculate the objective speech intelligibility score

Subjective Study:

- Implant users:1 unilateral and 1 bilateral.
- Databases: 120 pairs (sentences) (pair of noisy and enhanced signal)
- ♦ SNR: 5 and 10 dB
- ♦ <u>Noise</u>: Speech shape

(98%) versus noisy sentences (2%). Cl subjects preferred Vanilla-CNN based enhanced signal vs. others for speech shaped noise (5 & 10dB SNR).

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