Piezoelectric Acoustic Sensing for Sitting Pose Classification

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Code

Motivation

- People now spend more time seated (e.g., teleconferencing), calling for **privacy-preserving sitting pose classification**.
- Existing approaches relies on **optical/pressure sensors**, but often occlusion/privacy sensitive, costly, and fragile.

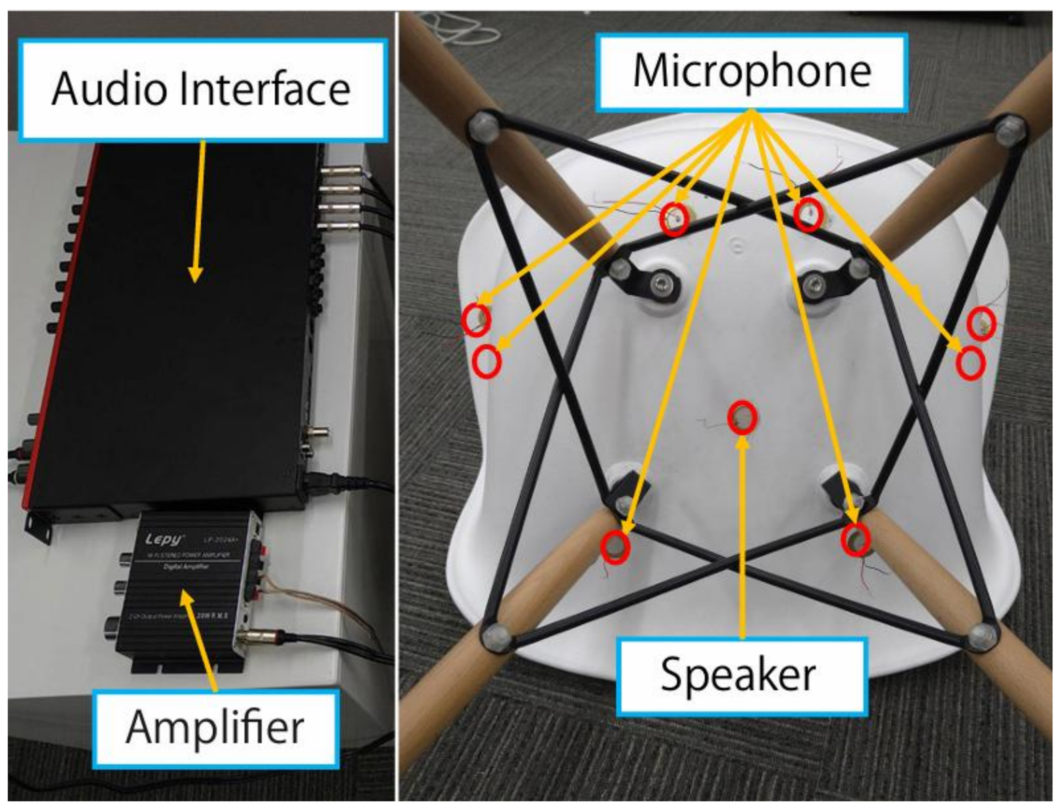
Goal: We explore sitting pose classification based on chair-mounted piezoelectric acoustic devices.

Key Contributions

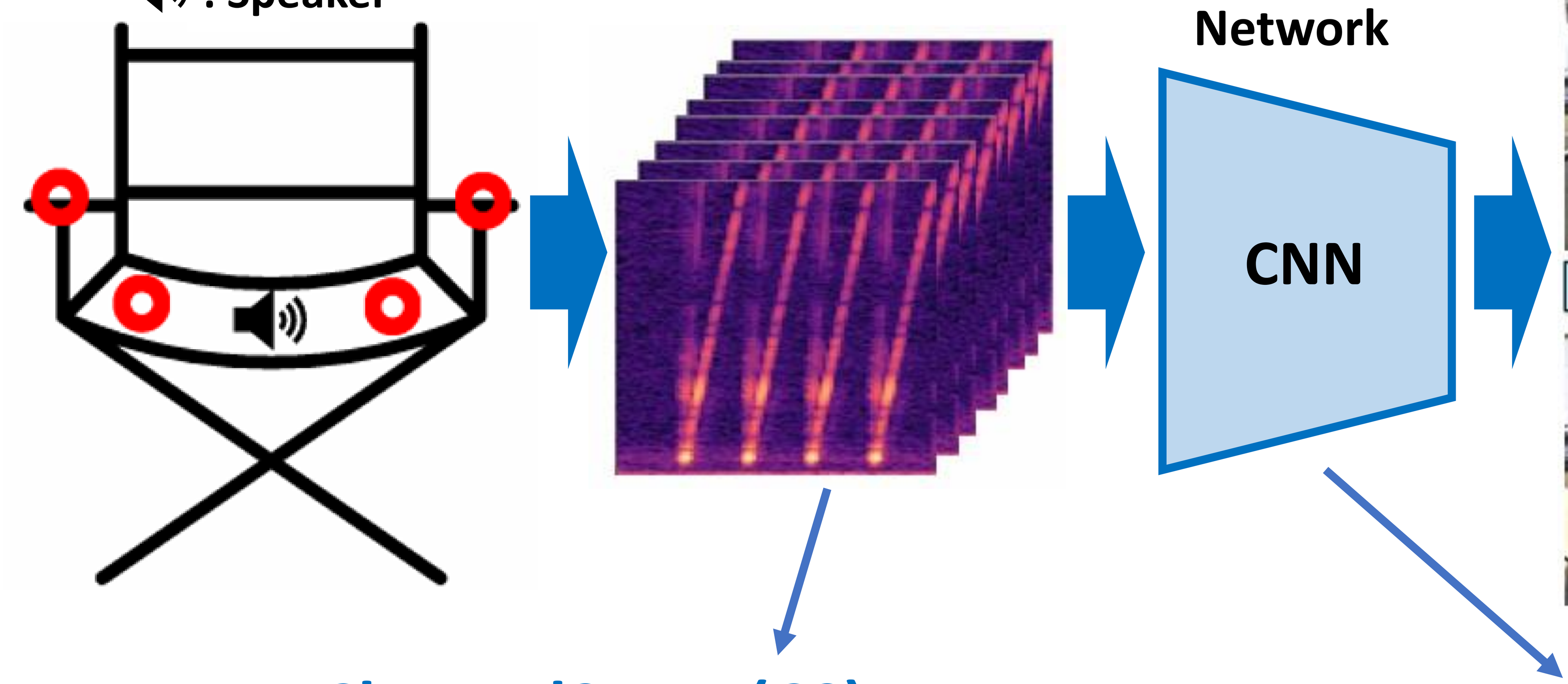
- We present **the first study** on sitting pose classification using **active acoustic sensing with piezoelectric devices**.
- We propose two tailored learning techniques:
  - **ChannelSwap (CS)**: a symmetry-based data augmentation that mirrors left/right poses.
  - **Symmetric Consistency Enhancement (SCE)**: a feature-level constraint that enforces consistency between original and mirrored samples, mitigating symmetry violations.

Equipment

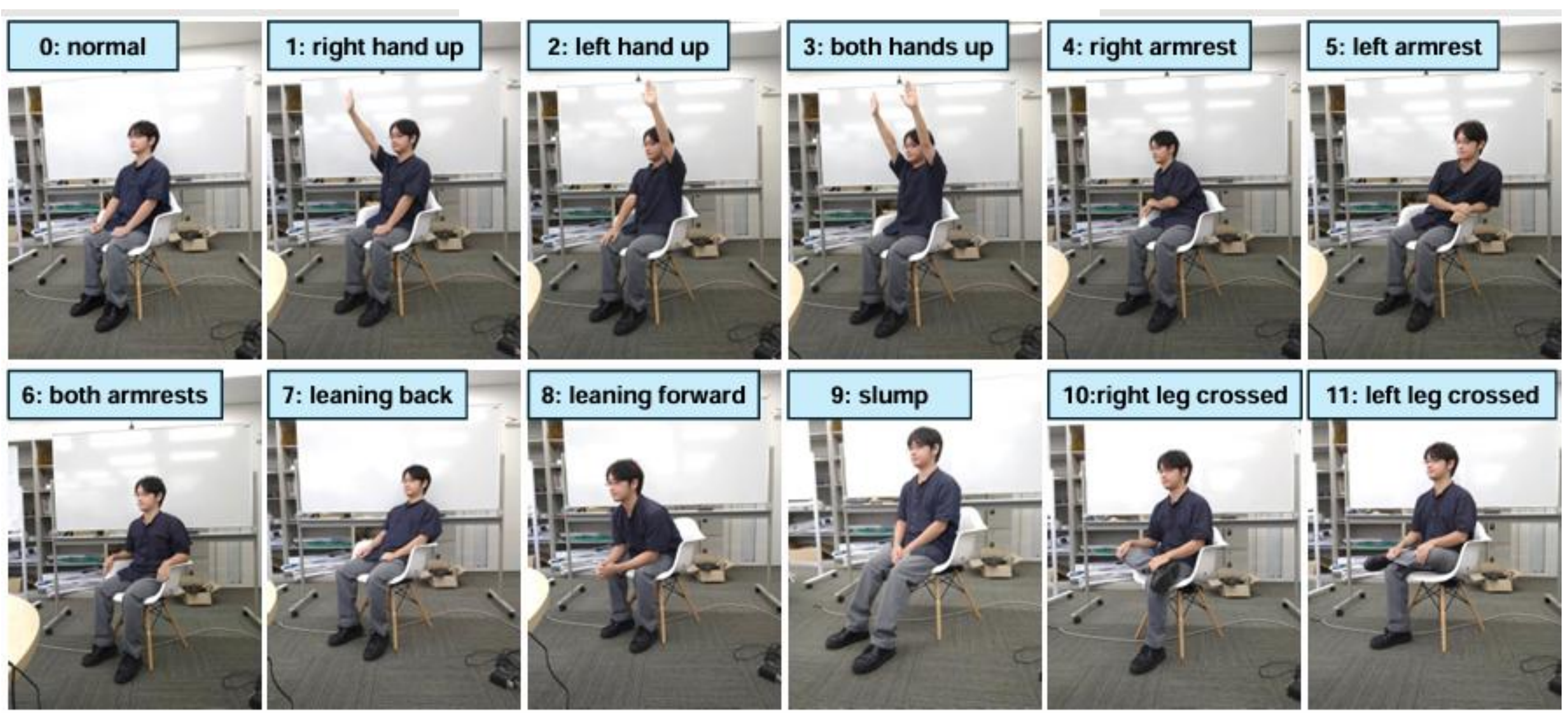
- One piezoelectric speaker and eight piezoelectric microphones are attached to the chair's backrest and seat edges.
- The speaker emits short chirp signals (~22 kHz, 0.1 s), and the microphones capture the acoustic responses transmitted through the chair and the seated body.



Method

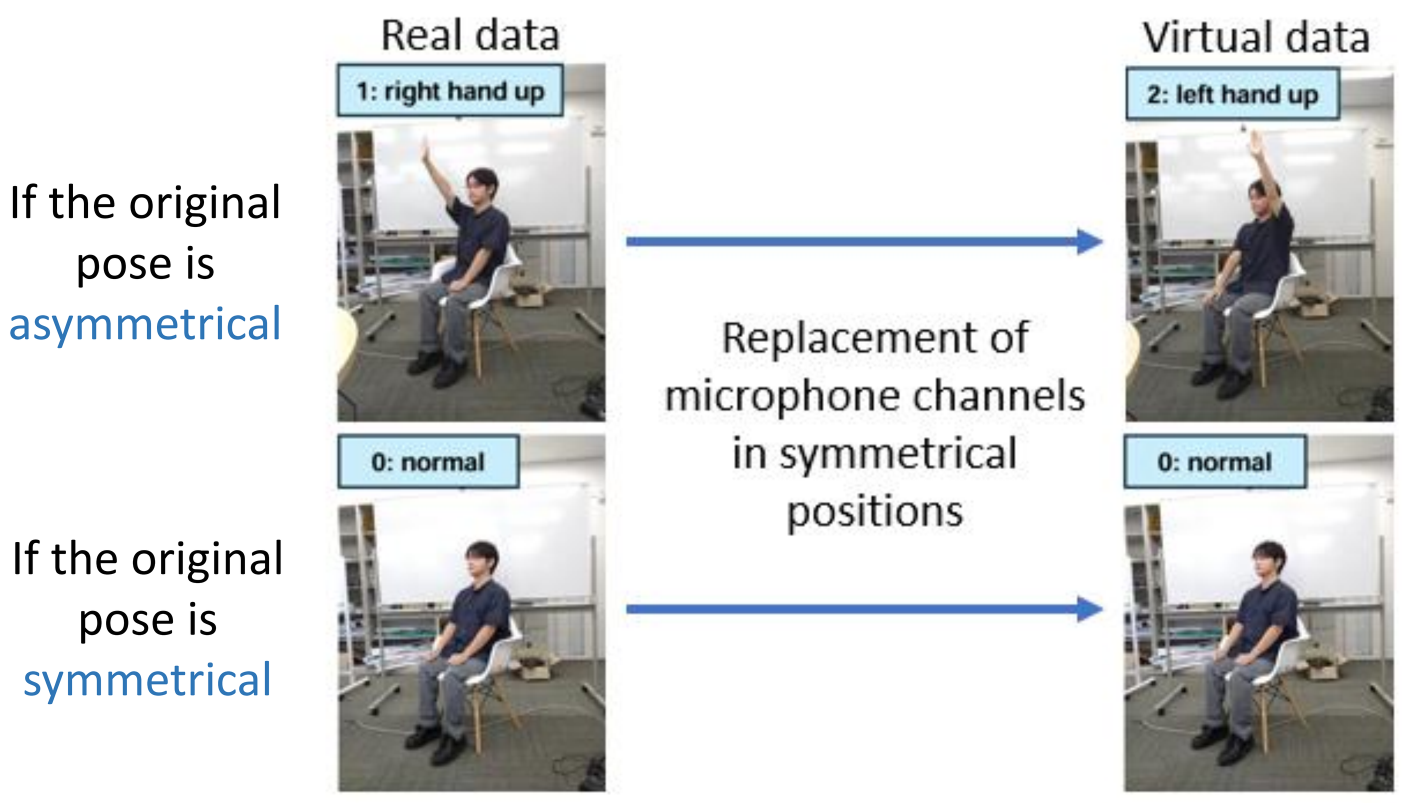


Classification Result



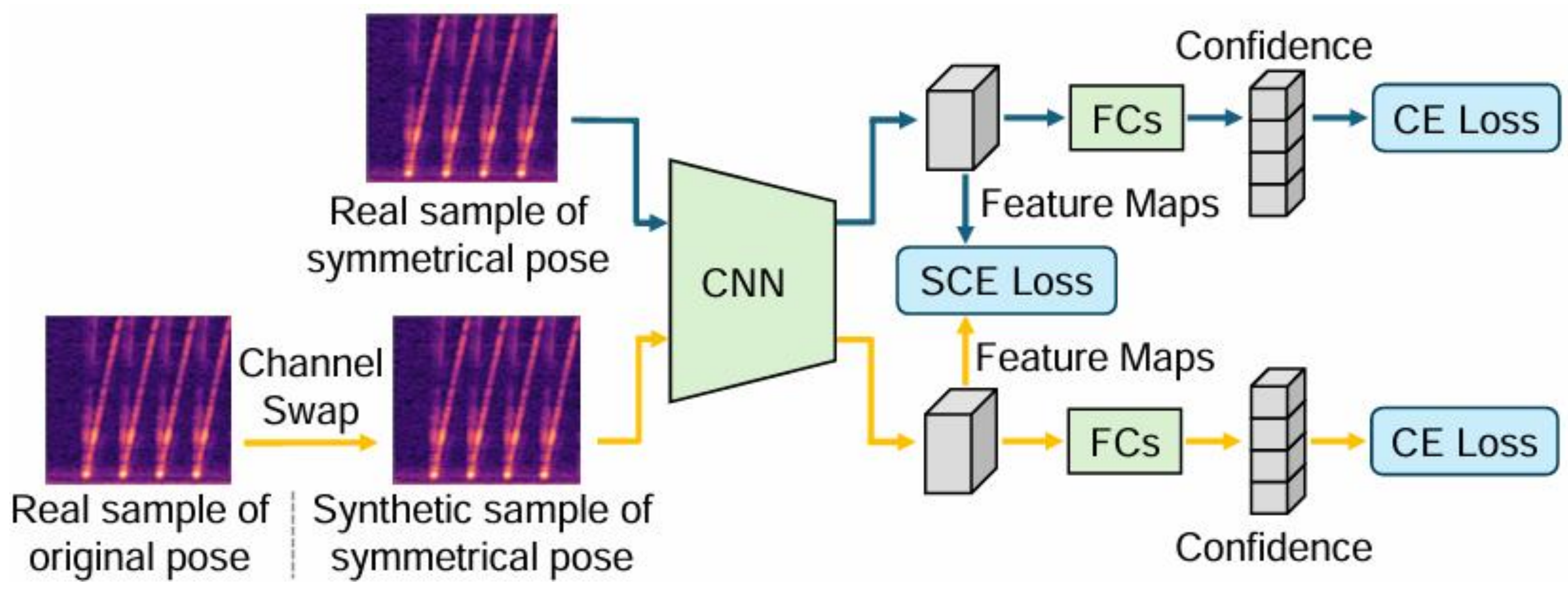
ChannelSwap (CS)

- A data augmentation technique that exploits the natural left-right symmetry of sitting poses.
- Swaps the left and right microphone channels, enabling data-efficient learning of symmetric poses.



Symmetric Consistency Enhancement (SCE)

- A learning framework that introduces an auxiliary loss to enforce feature-level consistency between left-right symmetric sample pairs.
- Complements ChannelSwap (CS) by improving robustness to real-world symmetry violations.



Results

Table 1: Comparative result

Method	Acc.(%) ↑
Base	48.1
Base+SpecAug **[1]**	47.5
Base+CS	47.8
Base+CS+SCE (Ours)	**51.4**

※ 11-fold cross-validation

Table 2: Sensitivity to chair materials

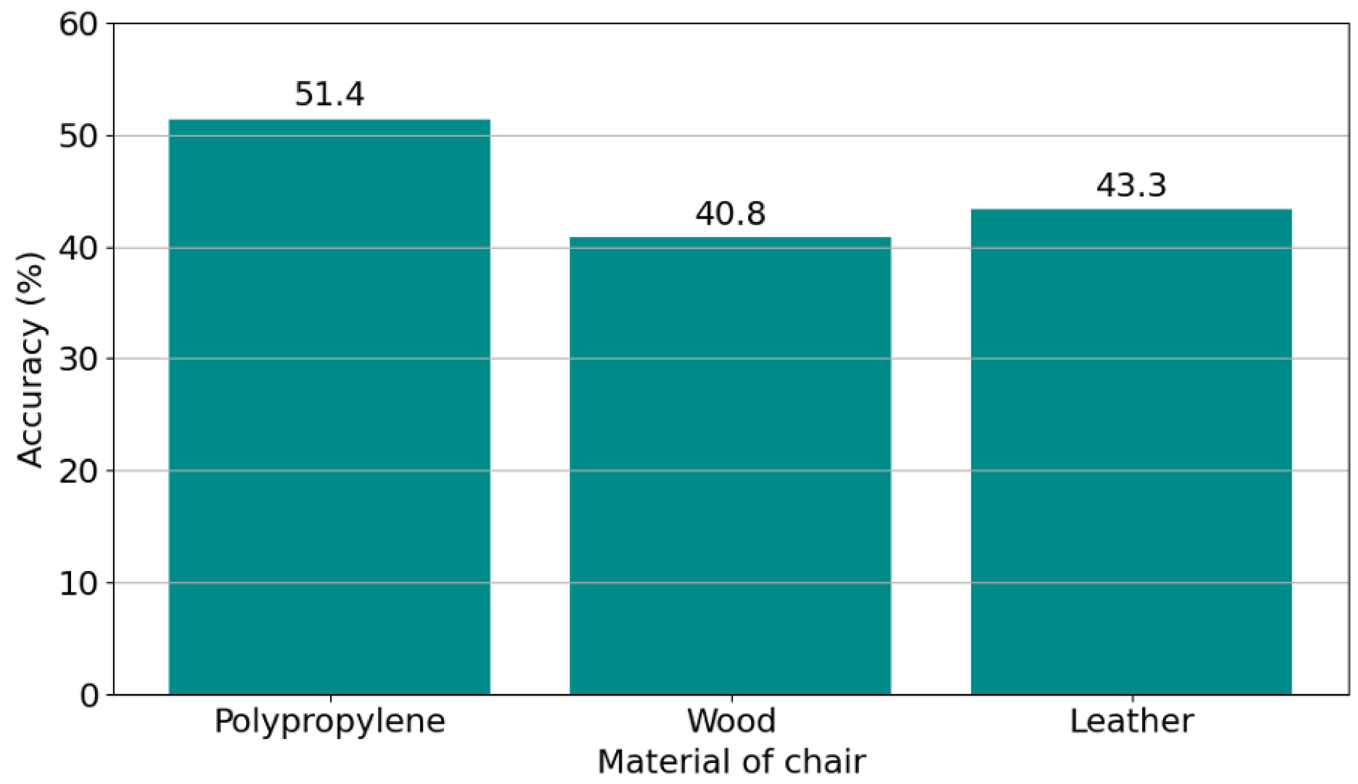
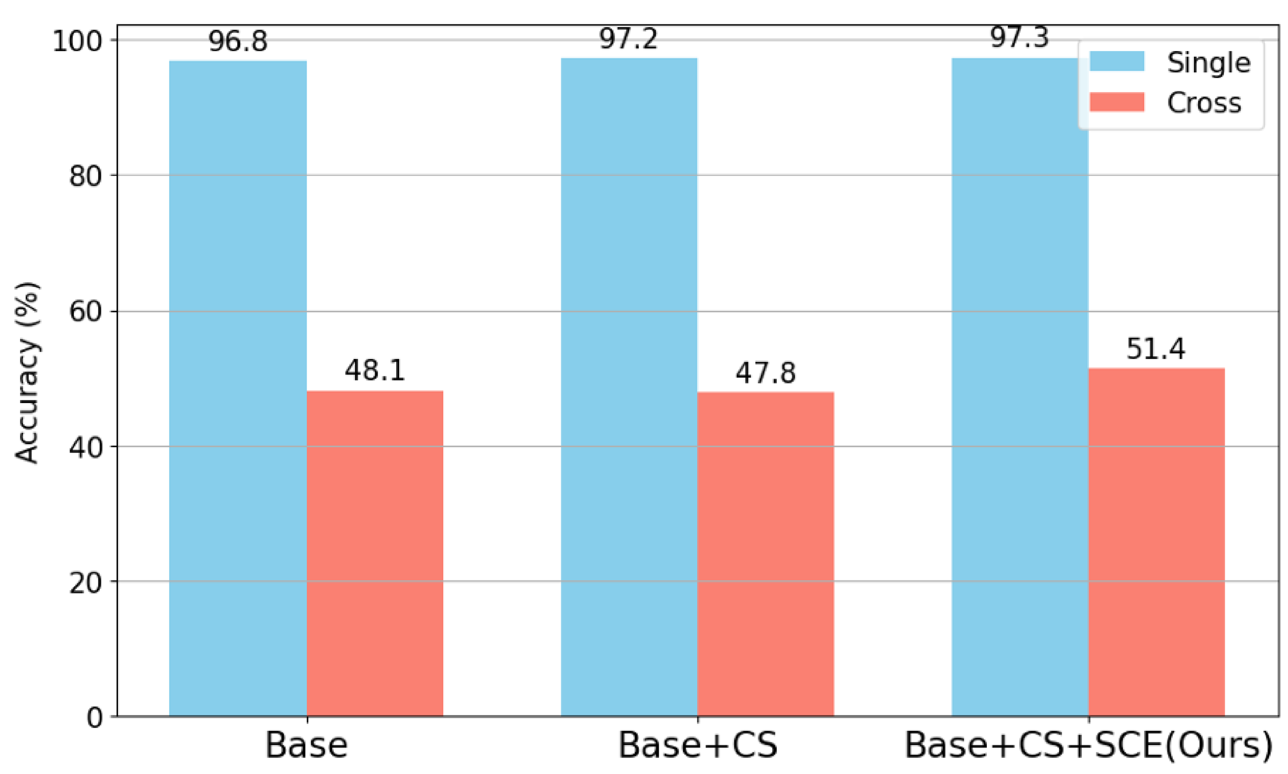


Table 3: Accuracy under the single-subject setup



[1] Daniel S. Park, et al. SpecAugment: A Simple Data Augmentation Method for Automatic Speech Recognition, In Proc INTERSPEECH, 2019