Voice Privacy - Leveraging Multi-Scale Blocks with ECAPA-TDNN SE-Res2NeXt Extension for Speaker Anonymization

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Prevention Network Dunkenfeld [3]

“You are not guilty because of your sexual desire, but you are responsible for your sexual behavior. There is help! Don’t become an offender!”

AnonymPrevent

- Video-calls anonymized in real-time.
- Callers are protected from their countries.
- The system may lead to more acceptance.

Own Research

Main ideas

- Add more low-level descriptors
- Apply other speech representations
- Extend x-vectors, e.g. ECAPA
- Use HiFI-GAN and StarGAN for conversion
- Fuse conversion and NSF

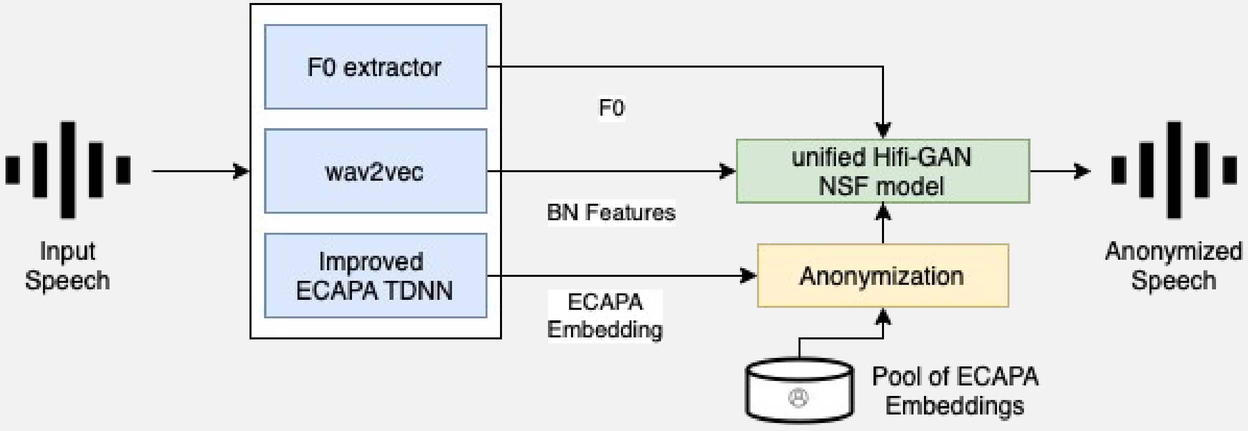


Figure 1: Adaptation of Baseline

Experiments in the SPSC Paper

- ECAPA vs. x-vectors
- Improved ECAPA-TDNN (SE-Res2NeXt)
- Extend 1d conv to 2d conv as input to ECAPA

Speaker Model: ECAPA-TDNN

- Enhanced version of the x-vector topology
- Introduces 1-dimensional TDNN-specific SE-blocks

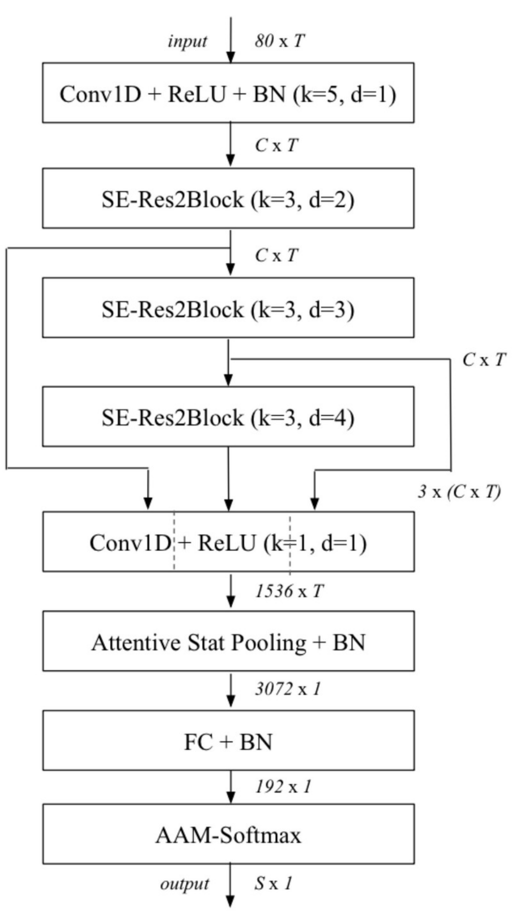


Figure 2: Network topology of the ECAPA-TDNN [1]

Extended ECAPA-TDNN

- Evaluate the effectiveness of the baseline model using
- Various CNN dimensions including scale and cardinality

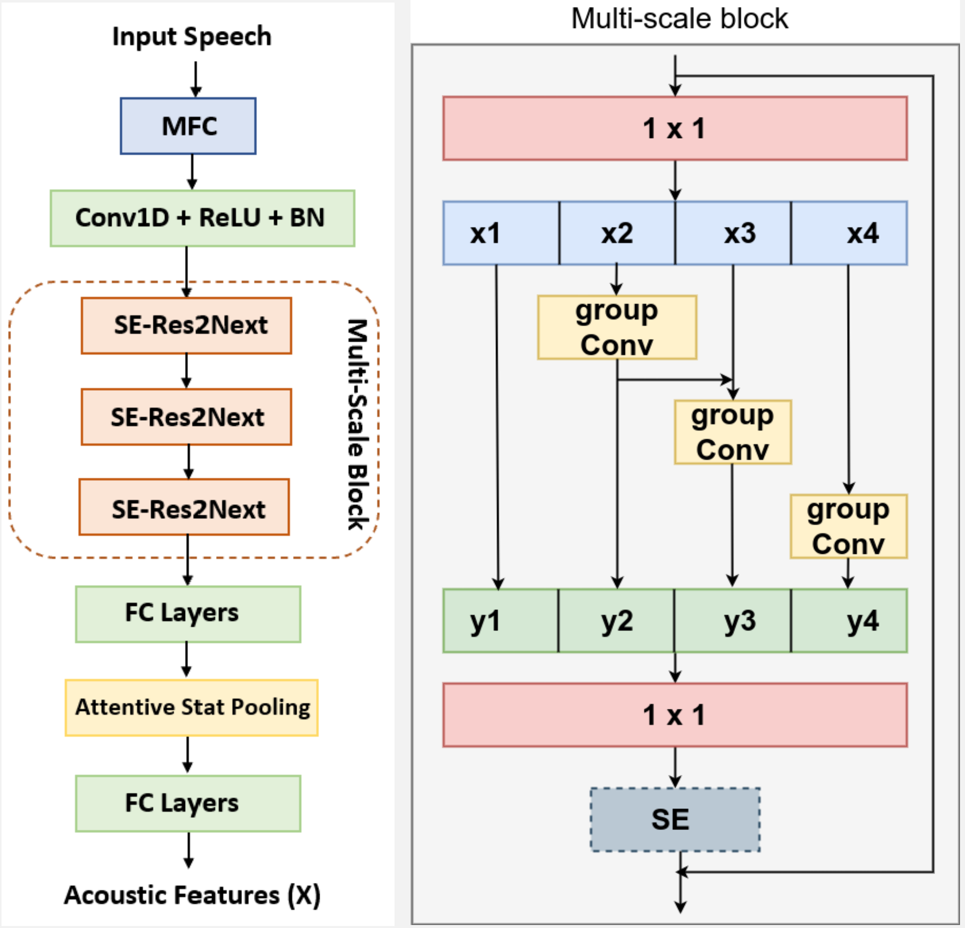


Figure 3: Extended ECAPA (SE-Res2NeXt architecture)

Training ECAPA Embedding Extractor

Dataset

- Evaluate on the development part of the VoxCeleb2 dataset with 5994 speakers as training data
- Use VoxCeleb1 test set as a validation set

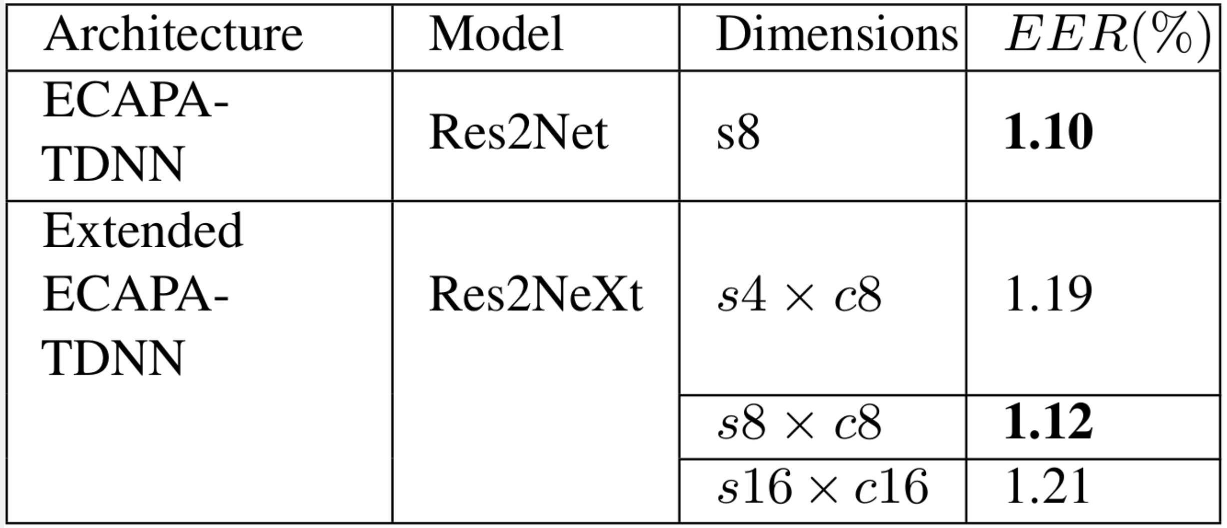
Training

- Standard Adam optimizer with cyclical learning rates ranging between 1e-8 and 1e-3
- AAM-softmax with a margin of 0.2 and softmax prescaling of 30 for 4 cycles

Results

- Evaluate the effectiveness of the baseline model using various CNN dimensions including scale and cardinality

Table 1: Top-1 test error (%) for the VoxCeleb dataset.



Architecture	Model	Dimensions	$EER(\%)$
ECAPA-TDNN	Res2Net	s8	**1.10**
Extended ECAPA-TDNN	Res2NeXt	$s4 \times c8$	1.19
		$s8 \times c8$	**1.12**
		$s16 \times c16$	1.21

ECAPA CNN-TDNN

- 2D convolutional stem for the ECAPA-TDNN speaker verification model
- Incorporating frequency translational invariance in the initial layers of the network

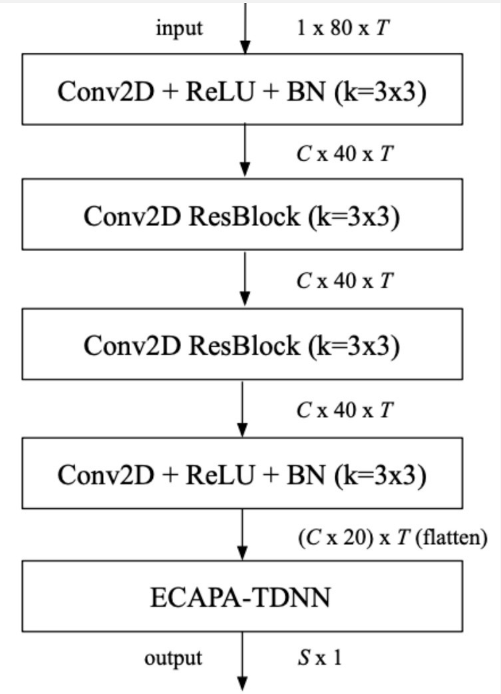
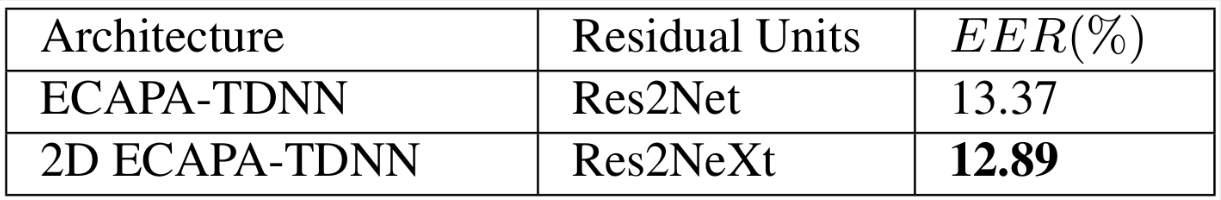


Figure 4: The 2D convolutional stem of the ECAPA CNN-TDNN architecture [2].

Preliminary Results

- Evaluate with small subset of the development part of the VoxCeleb2 dataset
- Using a 2D ECAPA-TDNN with Res2NeXt residual units improves the preliminary EER results by roughly 0.5% absolute

Table 2: Top-1 test error (%) for the VoxCeleb dataset.



Architecture	Residual Units	$EER(\%)$
ECAPA-TDNN	Res2Net	13.37
2D ECAPA-TDNN	Res2NeXt	**12.89**

Conclusion

- This study presents an extended ECAPA-TDNN and 2D ECAPA-TDNN with Res2XBlock integration for speaker verification
- Extending ECAPA-TDNN with 1-dimensional TDNN-specific SE-blocks does not improve by adding an extra dimension of cardinality
- changing to 2D ECAPA-TDNN we reach a relative improvement of roughly 0.5% absolute in EER over a strong baseline

Future Works

- We will keep evaluating the effectiveness of different types of residual units while integrating them with the 2D ECAPA-TDNN representation
- Using more data utilizing additional datasets and generating extra samples for each utterance by data augmentation

References

[1] B. Desplanques, J. Thienpondt, and K. Demuynck, “ECAPA-TDNN: Emphasized Channel Attention, Propagation and Aggregation in TDNN Based Speaker Verification,” in Proc. Interspeech 2020, 2020, pp. 3830–3834.

[2] J. Thienpondt, B. Desplanques, and K. Demuynck, “Integrating frequency translational invariance in TDNNs and frequency positional information in 2d ResNets to enhance speaker verification,” in Interspeech 2021. ISCA, aug 2021. [Online]. Available: https://doi.org/10.21437%2Finterspeech.2021-1570

[3] K. Beier, “The German Dunkelfeld Project:Proactive Strategies to Prevent Child Sexual Abuse and the Use of Child Abusive Images” Contributions from the 8th Annual International Forum 2014

THANK YOU

For Your Attention