Frame-level Emotional State Alignment Method for Speech Emotion Recognition

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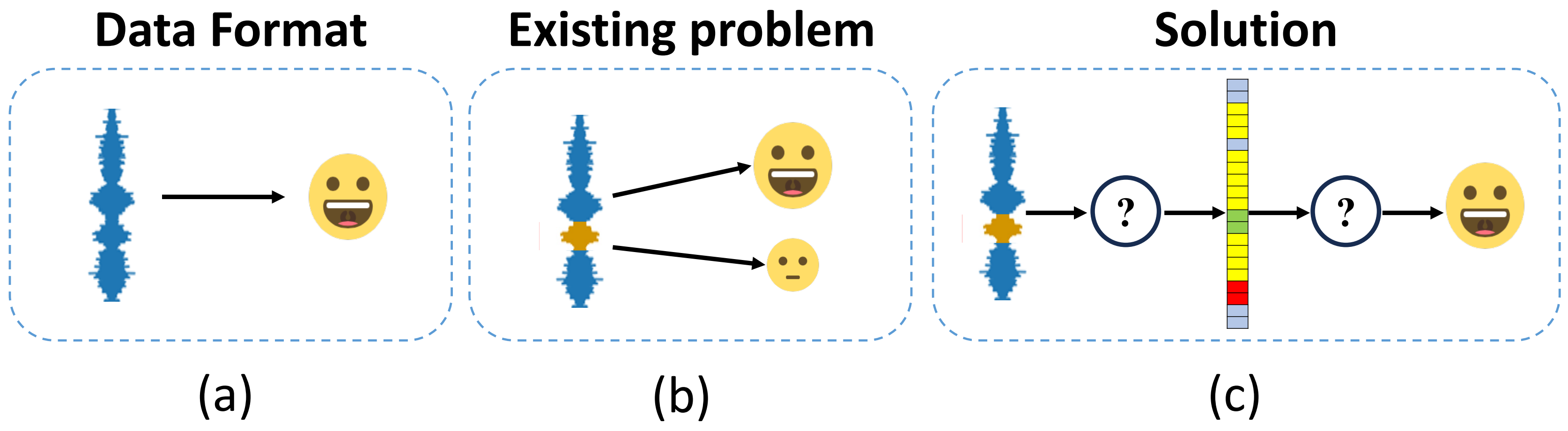
Background

Motivation: **Not all frames** in an audio have **emotional states consistent** with **utterance-level** emotional **label**.



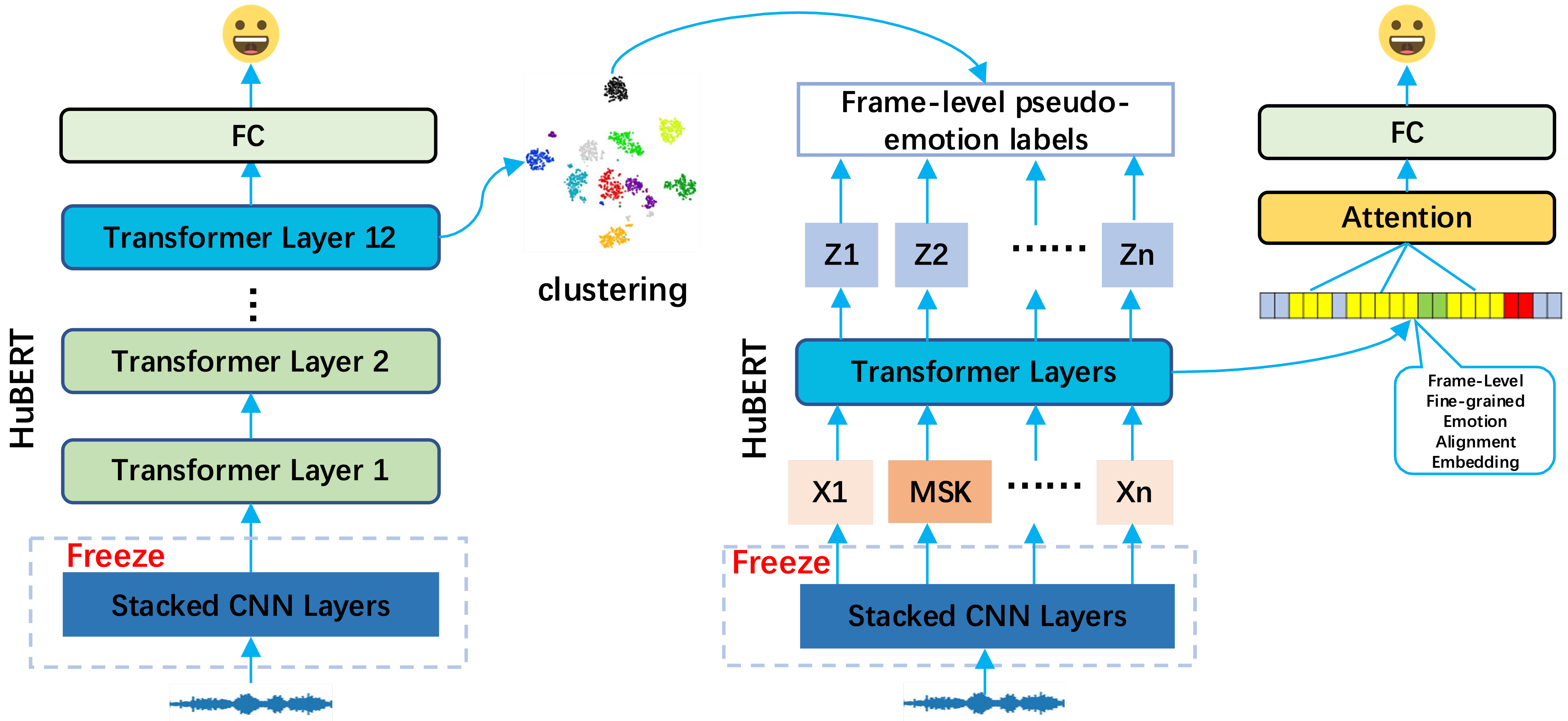
Contributions

□ Based on the previous research work, a frame-level **pseudo-emotional label generation** is proposed;

□ Proposing a method for **frame-level pseudo-emotion label and representation alignment** based on **masked language model**;

□ **Mapping frame-level** emotional alignment **representation**s and **utterance-level** emotional **labels** by **attention mechanisms** for SER, and **achieving remarkable performance**.

Methods



Phase 1. TAPT and cluster

Phase 2. Pre-training HuBERT for frame-level alignment

Phase 3. Fine-tuning CPT-HuBERT for SER

Phase 1:(Generate pseudo label for each frame)
□ Using task adaptive pretrain HuBERT with IEMOCAP.
□ Extracting the embedding of i-th transformer layer to generate pseudo emotion labels by K-means.

Phase 2:(Align pseudo label and representation)
□ Continuing pretraining HuBERT with frame-level pseudo-emotion labels to align frame-level pseudo label and representation of each frame.

Phase 3:(Realize SER)
□ Utilizing attention to map the frame-level emotion alignment representation and utterance-level label for SER.

Experiments and Results

Dataset:
- □ **IEMOCAP**, the number of samples is **5531**;
- □ **Leave-one-session-out** cross validation;
- □ Metrics are the **unweighted and weighted** accuracy.

Pretraining:
- □ **Masked language model (MLM)** for pretraining;
- □ **Mask 20%** representation along with time dimension;
- □ **Each fold of** CV requires pretraining a model.

Clustering:
- □ **K-means**;
- □ The number of clusters attempted is **50, 100, 150.**

Pooling:
- □ **Soft attention pooling；**
- □ **Average pooling.**

The ablation experiments of the numbers of cluster (Table 1):
- □ The best number of clusters for SER on IEMOCAP is **50**.
- □ The output of the **ninth** transformer layer in HuBERT-base for clustering is optimal.
- □ The **number** of clusters may **be related to** the **size** of the dataset.

The ablation experiments of the method of pooling (Table 1):
- □ Attention outperform average pooling in aligning frame-level representations and utterance-level labels;
- □ However, as the number of layers and clusters increases, the average pooling performance approaches and gradually surpasses the attention pooling.

Performance comparison with previous methods (Table 2):
- □ The proposed method **achieves optimal performance compared to other recent research results**.
- □ Meanwhile, the performance of method we proposed **approximates that of some multimodal methods**.

Table 1. The UA/WA (%) of ablation experiments of different poolings and different clusters of different transformer layers. BL means Baseline. The i-*th* layer represents extracting the embeddings from the i-*th* transformer layer to cluster.

Layers	Clusters	Average Pooling	Attention Pooling
BL [15]	-	74.3/-	-
TAPT	-	74.1/72.8	-
6-*th*	50	75.0/73.6	75.2/73.6
	100	74.8/73.3	75.1/73.5
	150	74.5/72.7	74.3/73.2
9-*th*	50	**75.1**/73.5	**75.7/74.7**
	100	75.0/**73.9**	75.3/74.0
	150	74.8/73.5	74.6/73.2
11-*th*	50	74.3/72.7	74.4/73.0
	100	74.0/72.8	74.2/72.7
	150	74.3/70.1	73.5/72.5

Table 2. Performance comparison of UA and WA with previous methods on IEMOCAP. The P-TAPT is baseline.

Type	Year	Methods	UA(%)	WA(%)
Audio	2023	P-TAPT [15]	74.3	-
	2023	SMW-CAT [20]	74.2	73.8
	2023	ShiftCNN [11]	74.8	72.8
	2023	SUPERB [13]	75.6	-
	-	**Ours**	**75.7**	**74.7**
Multi-modal	2023	MTG [21]	75.0	74.5
	2023	MSMSER [22]	76.4	75.2

Conclusions

□ **Proposing** an effective frame-level emotional state alignment **method** based on **MLM for SER** and achieving outstanding performance.

□ The performance **is strongly correlated with the representation** of the i-th **transformer** layer used **for clustering** and **the number of clusters**.

More Information

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Main References:

□ ***Exploring wav2vec2.0 fine-tuning for improved speech emotion recognition, Chen et al., ICASSP 2023.***

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