Focal Loss based Residual Convolutional Neural Network for Speech Emotion Recognition

Suraj Tripathi, Abhay Kumar, Abhiram Ramesh, Chirag Singh, Promod Yenigalla

Samsung R&D Institute India – Bangalore

SAMSUNG

Introduction

This paper proposes a Residual Convolutional Neural Network (ResNet) based on speech features and trained under Focal Loss to recognize emotion in speech.

Proposed Solution:

- Speech features such as Spectrogram and Mel-frequency Cepstral Coefficients (MFCCs) have been used to characterize emotion better than just plain text.
- Focal Loss has the ability to focus the training process more towards hard-examples and down-weight the loss assigned to well-classified examples, thus preventing the model from being overwhelmed by easily classifiable examples.
- Our best model achieved a 3.4% improvement in overall accuracy and a 2.8% improvement in class accuracy when compared to existing state-of-the-art methods on IEMOCAP dataset.

Methods

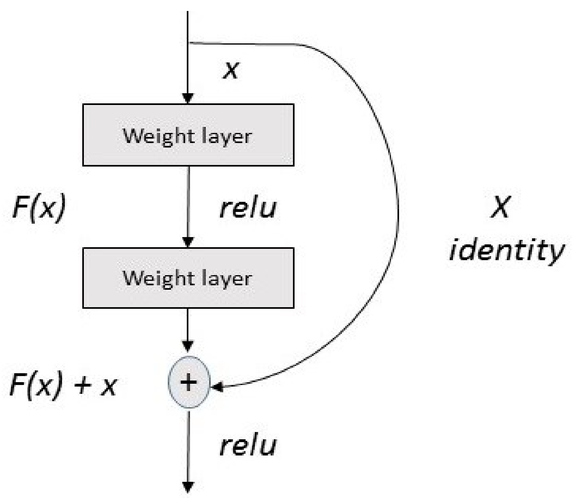


Fig. 1. Residual block

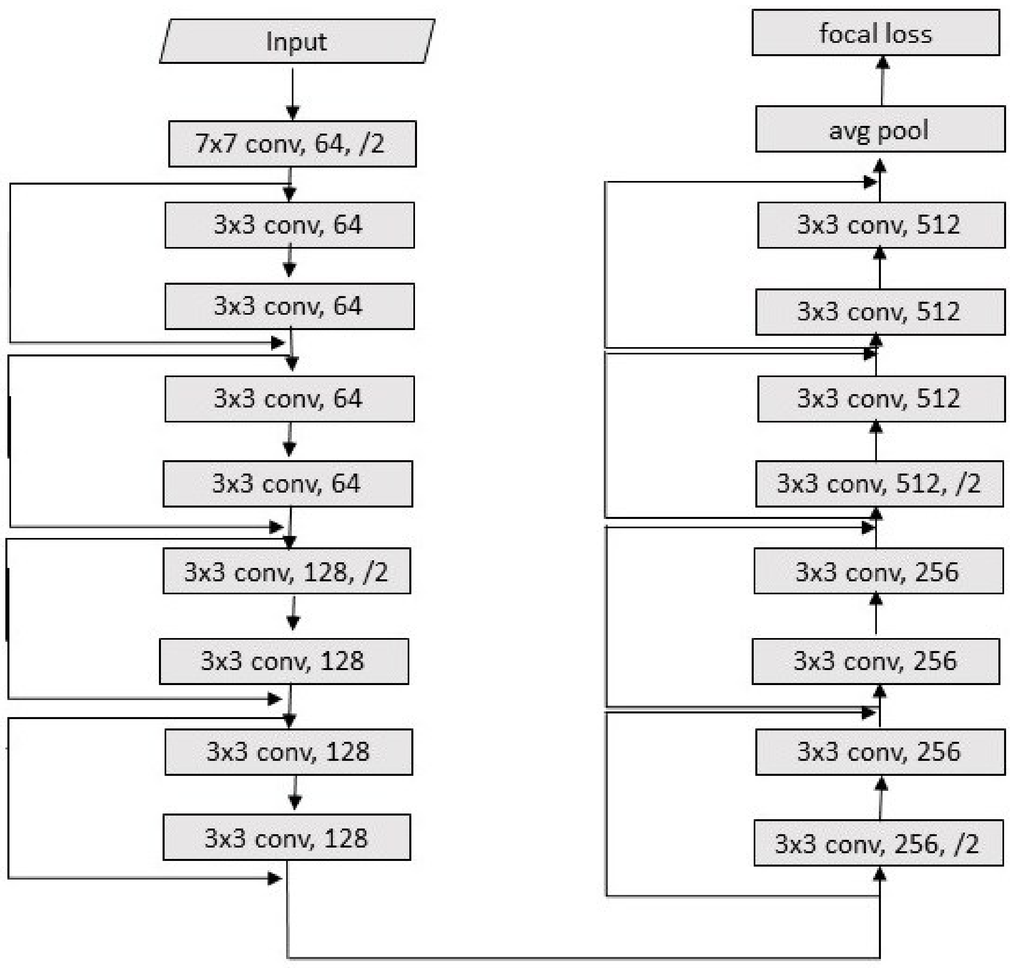
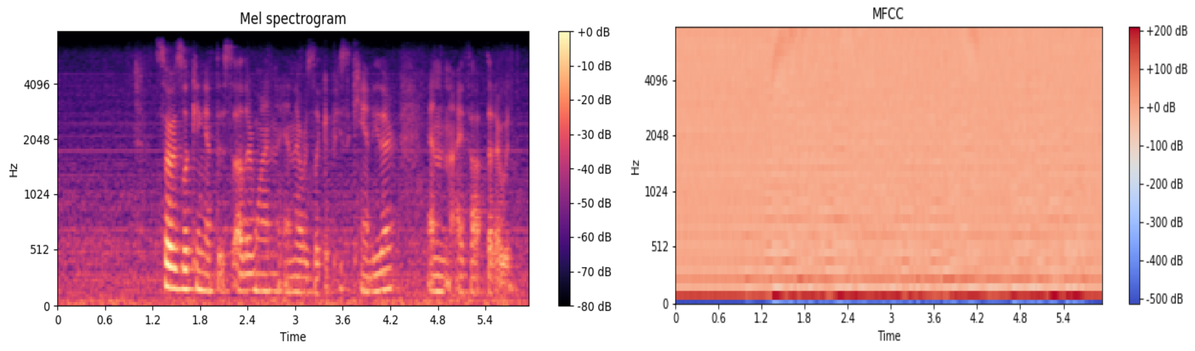


Fig. 2. Proposed model architecture

Focal loss is formulated as-

$$FL(p_t) = -(1 - p_t)^{\gamma} \log(p_t)$$

Speech Features



Results

Methods	Input	Overall Accuracy	Class Accuracy
Lee et al. [1]	Spectrogram	62.8	63.9
Satt et al. [2]	Spectrogram	68.8	59.4
Yenigalla [3]	Spectrogram	71.2	61.9
Proposed Model	Spectrogram	74.2	64.3
Proposed Model	MFCC	**74.6**	**66.7**

Table 1. Comparison of accuracies

Input Features	Loss functions settings	Overall Accuracy	Class Accuracy
Spectrogram	Softmax Loss	70.2	55.8
Spectrogram	Focal Loss	**74.2**	**64.3**
MFCC	Softmax Loss	70.7	56.9
MFCC	Focal Loss	**74.6**	**66.7**

Table 2. Ablation study of the effectiveness of Focal Loss

Conclusions

- The use of Spectrograms and MFCC provides low-level features, which when combined with ResNets has allowed us to extract very deep features boosting the model performance.
- Our best model (MFCC) outperforms the benchmark results by 3.4% and 2.8% for overall and class accuracies respectively.
- With the help of Focal Loss, we have significantly improved recognition of the rarer emotion classes (Anger, Sadness and Happiness) as shown in our confusion matrices.
- Focal Loss helps to scale the standard cross-entropy loss to down-weight loss corresponding to easily classifiable examples dynamically and focus more on hard examples to make the system perform better on hard examples as well.

References

1. *Lee, J., Tashev, I.: High-level feature representation using recurrent neural network for speech emotion recognition. In: INTERSPEECH (2015).*
2. *Satt, A., Rozenberg, S., Hoory, R.: Efficient Emotion Recognition from Speech Using Deep Learning on Spectrograms. In: INTERSPEECH, Stockholm (2017).*
3. *Yenigalla, P., Kumar, A., Tripathi, S., Kar, S., Vepa, J.: Speech Emotion Recognition using Spectrogram & Phoneme Embedding, In: Interspeech, 2018.*

SAMSUNG Research