TCN-Based Stress Classification Study Using Nose Thermography

1220398 Tatsuya Watanabe 【 Advanced Computer Engineering Laboratory 】

1 Introduction

In recent years, machine learning has been used in many systems such as image recognition, speech recognition, medical diagnosis. As one of the applications, convolutional neural network (CNN) was applied to estimate stress levels from thermal images, the classification accuracy of the three-level estimation was 56.3%[1]. In this study, stress classification based on thermal images was implemented by temporal convolutional network (TCN)[2]. The evaluation results of the five-fold cross-validation were given and analyzed.

2 Experiment

The ten subjects (18–24 years old, males) were recruited in our experiment. In the experiment, four kinds of stress tests (two stroop tests and two calculation tests) were conducted on each subject. During each test, the area around each subject's nasal cavity was recorded with a thermal camera as shown in Figure 1. The subject answered the questions of the stress level, i.e., high-stress, low-stress, or non stress, and then labeled it.

For stress classification using TCN model, 32 and 8 samples (4 samples per each subject) were used as training and testing data, respectively. To evaluate the learning accuracy of the TCN model, five-fold cross-validation by constructing five patterns of recombination of training and testing data was used. In this study, original thermal images were transformed into respiration variability spectrogram (RVS). To study the performance effect of the size of RVS, 220x220, 120x120, 60x60, and 28x28 pixels of RVSs were utilized for model training and testing respectively. The flowchart of stress test and classification is shown in Figure 1.

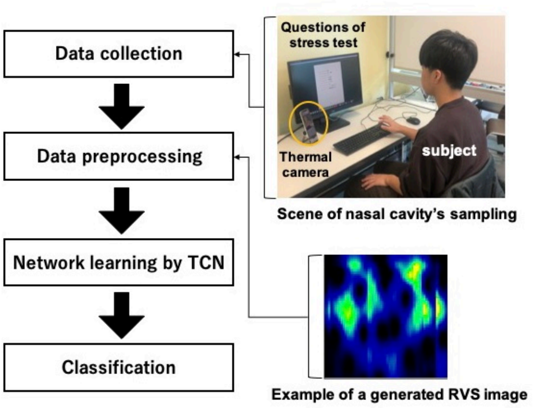

Figure 1 Stress test procedure.

3 Results

In our evaluation, the range of the time component in RVS image generation was changed in three patterns (10, 20, and 30 sec.) and the three results were averaged. Table 1 shows the classification accuracy of the RVS images, where the scores of five groups of training and testing data are given respectively. The best accuracy is 41.6% obtained by RVSs in the size of 60x60. The average accuracy of TCN is 37.75% for the whole experiment.

The average accuracy of this study is lower than [1], and the data quality and quantity are probably the main reason of that. Specifically, there is no significant features within RVSs derived from each stress level. And the learning accuracy of MNIST using TCN was over 90%, while the amount of training data in the stress classification was much smaller than that of MNIST[2].

4 Conclusion

In this study, we explored the application of TCN to the simple stress estimation even the expected results were not obtained. In the future, the TCN-based study should consider not only the amount of the learning data but also collect high quality data from real tasks.

References

[1] Y. Cho, et al., "DeepBreath: Deep Learning of Breathing Patterns for Automatic Stress Recognition using Low-Cost Thermal Imaging in Unconstrained Settings," ACII 2017, pp. 456–463, 2017.

[2] S. Bai, et al., "An Empirical Evaluation of Generic Convolutional and Recurrent Networks for Sequence Modeling," arXiv:1803.01271v2, 19 Apr. 2018.

Table 1 Classification accuracy along with RVS image size.

px × px	220 × 220	120 × 120	60 × 60	28 × 28
1st run	25%	42%	50%	38%
2nd run	38%	38%	38%	29%
3rd run	62%	38%	45%	33%
4th run	25%	25%	25%	25%
5th run	54%	33%	50%	42%
Average	40.8%	35.2%	41.6%	33.4%

Learning param.: Batch_size: 3, Dropout: 0.05, Epochs: 20, Learning_rate: 2e-3.
TCN hyperparam.: Layers: 8, Kernel_size: 7, Log-interval: 100, Hidden units: 25, seed: 1111.