

EEG based Emotion Recognition using Convolutional Neural Network

Charles Kim and Young He Lee

School of Electronic and Electrical Engineering, Kyungpook National University

E-mail: charles@ee.knu.ac.kr, younghe@ee.knu.ac.kr

Introduction:

Emotion is one of the most central and pervasive aspects of human experience. Normal people ‘feel’ and ‘express’ a wide range of emotions. While emotions deepen and enrich human experience, they also have profound effect on other cognitive functions such as decision-making, reasoning, language comprehension, etc[1].

In the field of machine learning, Convolutional Neural Network (CNN) is considered the state-of-the-art model in image recognition tasks. CNN have been shown successfully in many applications such as face recognition[2], object classification[3] and scene descriptions[4]. The main reasons of this success are 1) advances in learning algorithms for deep architectures and 2) large labeled data sets such as ImageNet[5]. ImageNet is a huge dataset of hierarchical labeled images for the ImageNet Challenge.

Methods:

In this paper, we aim at analyzing the ability of AlexNet[6] to classify topography images from EEG signals. The EEG signals are came from emotionally induced subjects. Our initial hypothesis was that well represented topography image improve the performance of CNN. Because, CNN is good at the image recognition problem. “AlexNet” is now a standard architecture known in the deep learning community and often used for benchmarking. It contains 5 convolutional layers, 3 of which are followed by max pooling layers, 2 fully connected layers, and 1 softmax layer. We used functions in the tensorflow tool to implement the “AlexNet”. Figure 1 shows the structure of “AlexNet”.

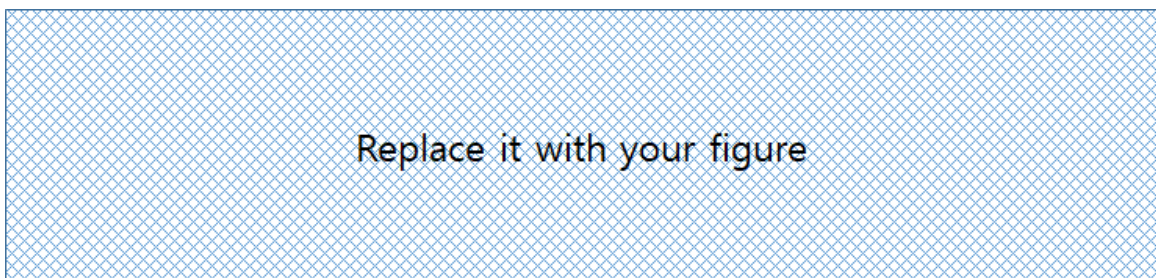


Fig 1. Structure of AlexNet[6]

Phase Locking Value (PLV) is adopted to extract EEG features. PLV is able to quantitatively measure the locking level on phase view of signal between two distant EEG electrodes[7]. There are two type of PLV computation methods. Depending on the applications, PLV across the total trials or Single-trial PLV is used feature[8]. In this study, we used Single-trial PLV (S-PLV) due to increase the number of sample size.

Results:

To compare the performance with other studies, we used the DEAP dataset which represents the benchmark for emotion classification research. The database was taken from [9] and included responses of 32 participants (seventeen males, fifteen females). Their mean age was 27.197 years (S.D.= 4.446). Generally, the results show that the state of the art classification accuracy of valence into 2 classes (high, low valence). The results of alpha frequency band (average training accuracy: $96.177 \pm 3.467\%$, average test accuracy: $95.444 \pm 2.905\%$) are better than the results of beta frequency band (average training accuracy: $94.037 \pm 4.558\%$, average test accuracy: $93.993 \pm 3.169\%$).

Discussion and Conclusions:

Discussion and conclusions.....

References

- [1] L. Pessoa, *The cognitive-emotional brain: From interactions to integration*: MIT press, 2013.
- [2] A. Jalali, R. Mallipeddi, and M. Lee, "Sensitive Deep Convolutional Neural Network for Face Recognition at Large Standoffs with Small Dataset," *Expert Systems with Applications*, 2017.
- [3] G. Huang, Z. Liu, K. Q. Weinberger, and L. van der Maaten, "Densely connected convolutional networks," *arXiv preprint arXiv:1608.06993*, 2016.
- [4] O. Vinyals, A. Toshev, S. Bengio, and D. Erhan, "Show and tell: A neural image caption generator," in *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 2015, pp. 3156-3164.
- [5] O. Russakovsky, J. Deng, H. Su, J. Krause, S. Satheesh, S. Ma, Z. Huang, A. Karpathy, A. Khosla, and M. Bernstein, "Imagenet large scale visual recognition challenge," *International Journal of Computer Vision*, vol. 115, pp. 211-252, 2015.
- [6] A. Krizhevsky, I. Sutskever, and G. E. Hinton, "Imagenet classification with deep convolutional neural networks," in *Advances in neural information processing systems*, 2012, pp. 1097-1105.
- [7] J.-P. Lachaux, E. Rodriguez, J. Martinerie, and F. J. Varela, "Measuring phase synchrony in brain signals," *Human brain mapping*, vol. 8, pp. 194-208, 1999.
- [8] J.-P. Lachaux, E. Rodriguez, M. Le Van Quyen, A. Lutz, J. Martinerie, and F. J. Varela, "Studying single-trials of phase synchronous activity in the brain," *International Journal of Bifurcation and Chaos*, vol. 10, pp. 2429-2439, 2000.
- [9] S. Koelstra, C. Muhl, M. Soleymani, J.-S. Lee, A. Yazdani, T. Ebrahimi, T. Pun, A. Nijholt, and I. Patras, "Deap: A database for emotion analysis; using physiological signals," *IEEE Transactions on Affective Computing*, vol. 3, pp. 18-31, 2012.