Machine Learning Approach to Recognition Human Mental State from EEG Signal

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Abstract

In this chapter, EEG signal analysis technique is examined for measuring mental stress of human being at different stages of attention. The goal of the current work is to identify discriminative EEG-based characteristics and suitable classification techniques that may classify brainwave patterns according to their intensity or frequency for the recognition of

mental states that is beneficial for human–machine interaction. In this research work, three different mental states are classified such as relaxation, neutrality and concentration using Emotiv headset with four EEG Sensors (TP9, AF7, AF8 and TP10). In order to train and test various techniques, a dataset is developed for comprising five individuals and one-minute sessions for each category of mental attention. We tested a variety of features selection algorithms from an initial pool of 2100 features and application of multiple classifiers such as Bayesian Networks, Support Vector Machines and Random Forests allowed us to narrow the feature set down to only 44 critical factors to achieve an overall accuracy 87%.

References

1. Bird, J.J., Anikó, E., Buckingham, C.D., Faria, D.R.: Mental emotional sentiment classification with an EEG-based brain-machine interface. In: The International Conference on Digital Image & Signal Processing (DISP'19). Oxford University, UK (2019)

Google Scholar

2. Kishan, P., Harit, S., Malcolm, D., Dvijesh, S.: Evaluating NeuroSky's single-channel EEG sensor for drowsiness detection. In: International Conference on Human-Computer Interaction (2017)

Google Scholar

3. Li, W., Jaramillo, C., Li, Y.: Development of mind control system for humanoid robot through a brain computer interface. In: International Conference on Intelligent System Design and Engineering Application, pp. 679–682. IEEE (2012)

Google Scholar

4. Ang, K.K., Guan, C., Chua, K.S.G., Ang, B.T., Kuah, C., Wang, C.: Clinical study of neurorehabilitation in stroke using EEG-based motor imagery brain computer interface with robotic feedback. In: Annual International Conference of the IEEE, pp. 5549–5552 (2010)

Google Scholar

5. Chowdhuri, S., Mal, D.: Concentration level detection for left/right brain dominance using electroencephalogram signal. Romanian J. Inf. Technol. Autom. Control **32**(3), 109–118 (2022)

Google Scholar

6. Rahman, M.M., Sarkar, A., Md Hossain, A., Md Hossain, S., Mohammad Ali, M.: Recognition of human emotions using EEG signals: a review. Comput. Biol. Med. **136**, 104696 (2021)

Article PubMed Google Scholar

7. Wang, Y., Yangming, S., Jing, D., Yingzi, L., Qi, W.: A CNN-based personalized system for attention detection in wayfinding tasks. Adv. Eng. Inform. **46**, 101180 (2020)

Article Google Scholar

8. Wang, D., Heng, L., Jiayu, C.: Detecting and measuring construction workers' vigilance through hybrid kinematic-EEG signals. Autom. Constr. **100**, 11–23 (2019)

Article Google Scholar

9. Arjun, R., Aniket, S., Mahesh, R.: Subject independent emotion recognition using EEG signals employing attention driven neural networks. Biomed. Signal Process. Control **75**, 103547 (2022)

Article Google Scholar

10. Cui, H., Aiping, L., Xu, Z., Xiang, C., Kongqiao, W., Xun, C.: EEG-based emotion recognition using an end-to-end regional-asymmetric convolutional neural network. Knowl.-Based Syst. **205**, 106243 (2020)

Article Google Scholar

11. Aziz, F.A., Ibrahim, S., Noor Akhmad, S., Yasue, M.: Classification of human concentration in EEG signals using Hilbert Huang transform. Int. J. Simul. Syst. Sci. Technol. **18**(1)

Google Scholar

12. Houssein, E.H., Hammad, A., Ali, A.A.: Human emotion recognition from EEG-based brain–computer interface using machine learning: a comprehensive review. Neural Comput. Appl. **34**(15), 12527–12557 (2022)

Article Google Scholar

13. Wagh, K.P., Vasanth, K.: Performance evaluation of multi-channel electroencephalogram signal (EEG) based time frequency analysis for human emotion recognition. Biomed. Signal Process. Control **78**, 103966 (2022)

Google Scholar

14. Gonzalez, H.A., Shahzad, M., Jerald, Y., Ibrahim, M.: BioCNN: a hardware inference engine for EEG-based emotion detection. IEEE Access **8**, 140896–140914 (2020)

Article Google Scholar

15. Tao, W., Chang, L., Rencheng, S., Juan, C., Yu, L., Xun, C.: EEG-based emotion recognition via channel-wise attention and self-attention. IEEE Trans. Affect. Comput. (2020)

Google Scholar

16. Jung, T.: Analysis and visualization of single-trial event-related potentials. Hum. Brain Mapp. **14**, 166–185 (2001)

Article CAS PubMed PubMed Central Google Scholar

17. Linas, R.R., Ribary, U.: A global characteristic of the 40 Hz response during sensory input. In: Induced Rhythms in the Brain, pp. 147–154. Birkhiauser, Berlin (1992)

Google Scholar

18. Lotte, F., Congedo, M., Lecuyer, A.: A review of classification algorithms for EEG based brain-computer interfaces. J. Neural Eng. **4**, R1–R13 (2007)

Article CAS PubMed Google Scholar

19. Makeig, S., Onton, J.: ERP features and EEG dynamics: an ICA perspective.

Google Scholar

20. Wang, S., Lee, B., Tse, G., Liu, H.: EEG signal processing-driven machine learning for cognitive task recognition. In: Artificial Intelligence Enabled Signal Processing based Models for Neural Information Processing, pp. 168–187 (2024). https://doi.org/10.1201/9781003479970-11

21. Pfurtscheller, G.: Functional topography during sensorimotor activation studied with event-related desynchronization mapping. J. Clin. Neurophysiol. **6**, 75–84 (1989)

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Ethics declarations

Conflict of Interests

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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