

Brain-Computer Interactive Portable and Interactive Applications

Oana Andreea Rusanu
Automation and Information
Technology Department
Transilvania University of Brasov
Brasov, Romania
oana.rusanu@student.unitbv.ro

ABSTRACT

During the last 50 years, human beings have wondered how it would feel to control anything around them just by using the power of mind. Even though this may be considered a science fiction application, the brain-computer interface proved to be a tremendously real biomedical engineering-based system.

Moreover, the achievements of this multidisciplinary research field have rapidly evolved during the last decades. Currently, the brain-computer interface helps people with neuromotor disabilities to control robotic devices by using only cognitive commands. Also, the patients who suffered a stroke benefit from the efficient rehabilitation of their motor functions if they are assisted by a brain-computer interface. Therefore, my PhD topic is about the development of portable applications aimed at both the assistance and the cognitive training of people with neuromotor disabilities as well as for providing an interactive learning environment for novice researchers.

To accomplish the five specific objectives of this research project, I implemented 25 versatile and completely functional applications. The first objective refers to integrating different hardware platforms (Arduino, Raspberry Pi, NI myRIO) and programming languages (Python, C) or software environments (LabVIEW, Matlab). The second objective is based on acquiring, processing and classifying the raw neuronal data to recognize the voluntary eye-blinks and the evoked biopotentials that are used as commands for all my original brain-computer interfaces. The third objective is related to controlling the mechatronics prototypes such as mobile robots, robotic hand or arm, miniature motorcycle, or juice vending machine. The fourth objective is aimed at communication by transferring text messages using Android smartphone and showing them to LEDs display systems. The fifth objective is focused on creating virtual simulations based on animating 3D models of robotic hand or wheelchair.

More than 200 students were involved during the experimentation of all the applications that I developed, tested, and improved. They agreed to get surprised about a new experience requiring them to use portable headsets with multiple sensors for electroencephalography (NeuroSky,

Emotiv Insight, GTEC Unicorn). Volunteer subjects have never used such brain-computer interface systems in the past. A time interval of about 5-10 minutes was necessary for them to get accustomed to the working principle. After that, they followed several tasks related to progressive difficulty levels – beginner, middle and advanced. The overall performance obtained by the students after experimenting with the proposed brain-computer interface applications was rated to 45% advanced and 55% medium.

The poster includes original YouTube videos for showing the scientific background, explaining technical working principles and watching live demonstrations of all the proposed brain-computer interface versatile devices. There are also presented the necessary stages for implementing the BCI systems starting from general idea and ending with the final commands to control external robotic devices and 3D virtual simulations.

As future research directions, I will focus on implementing novel artificial intelligence techniques, designing robust mechatronic systems, and improving the working principle of the software applications to be simpler to use.

CCS CONCEPTS

•Human-centered computing •Applied computing •Software and its engineering

KEYWORDS

BCI, EEG headset, eye-blink, virtual instrument, P300 speller

ACM Reference format:

FirstName Surname, FirstName Surname and FirstName Surname. 2018. Insert Your Title Here: Insert Subtitle Here. In *Proceedings of ACM Woodstock conference (WOODSTOCK'18)*. ACM, New York, NY, USA, 2 pages. <https://doi.org/10.1145/1234567890>

REFERENCES

- [1] Rusanu, O. (2024). A P300 Based Brain-Computer Interface LabVIEW Instrument for Controlling an Experimental Prototype of Juices Vending Machine Using the Unicorn EEG Headset. The 26th International Conference on Interactive Collaborative Learning (pg. 413 - 426). Madrid, Spain: Springer Cham.

- [2] Rusanu, O. A. (2024). A Brain-Computer Interface Application Based on P300 Evoked EEG Potentials for Enabling the Communication Between Users and Chat GPT. International Conference on Interactive Mobile Communication, Technologies and Learning. Thessaloniki, Grecia: Springer Cham.
- [3] Ruşanu, O. A. (2023). A LabVIEW Instrument Aimed for the Research on Brain-Computer Interface by Enabling the Acquisition, Processing, and the Neural Networks based Classification of the Raw EEG Signal Detected by the Embedded NeuroSky Biosensor. International Journal of Online and Biomedical Engineering (ijOE), 19(05), pp. 57-81. <https://doi.org/10.3991/ijoe.v19i05.37857>
- [4] Simon, C. B. (2021). Challenges and Opportunities for the Future of Brain-Computer Interface in Neurorehabilitation. *Frontiers in Neuroscience*.
- [5] Lazarou, I. N. (2018). EEG-Based Brain-Computer Interfaces for Communication and Rehabilitation of People with Motor Impairment: A Novel Approach of the 21st Century. *Frontiers in Human Neuroscience*, vol. 12.
- [6] Jayakody Arachchige, M. N. (2022). A hybrid EEG and head motion system for smart home control for disabled people. *Journal of Ambient Intelligence and Humanized Computing*, vol. 14, 4023-4038.