BRAINWAVE ANALYSIS

BCI with robot-assisted training for neurorehabilitation

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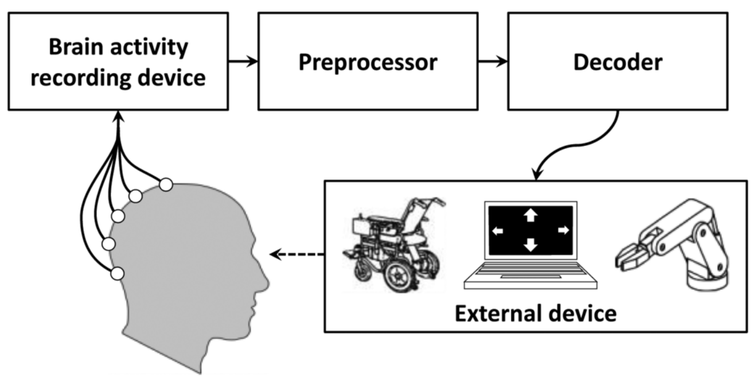
Introduction

Action observation, motor imagery, and imitation are represented in the same basic motor circuit as action execution – the mirror neuron system. That promoted an idea to use motor imagery as an auxiliary rehabilitative technique in patients after stroke who suffer from hemiparesis [1].

This project aims to improve patient's condition by using brain-computer interface (BCI).



The patient receives immediate feedback by seeing the outcome of his effort (movement of a robotic arm) and it allows him to modulate the state of activation of his brain more effectively. After a long-term exposure, it can induce neuroplastic changes in the brain [2].

Methodology

Measured raw EEG signal was decomposed using the power spectrum analysis into 6 frequency bands – Mu, SMR 1, SMR 2, Beta 1, Beta 2 and Alpha. BCI classifies based on mu rhythm which is a specific type of alpha rhythm localized in senzorimotor area with typical event-related desynchro-nization (ERD) occurring during movement or motor imagery [3].

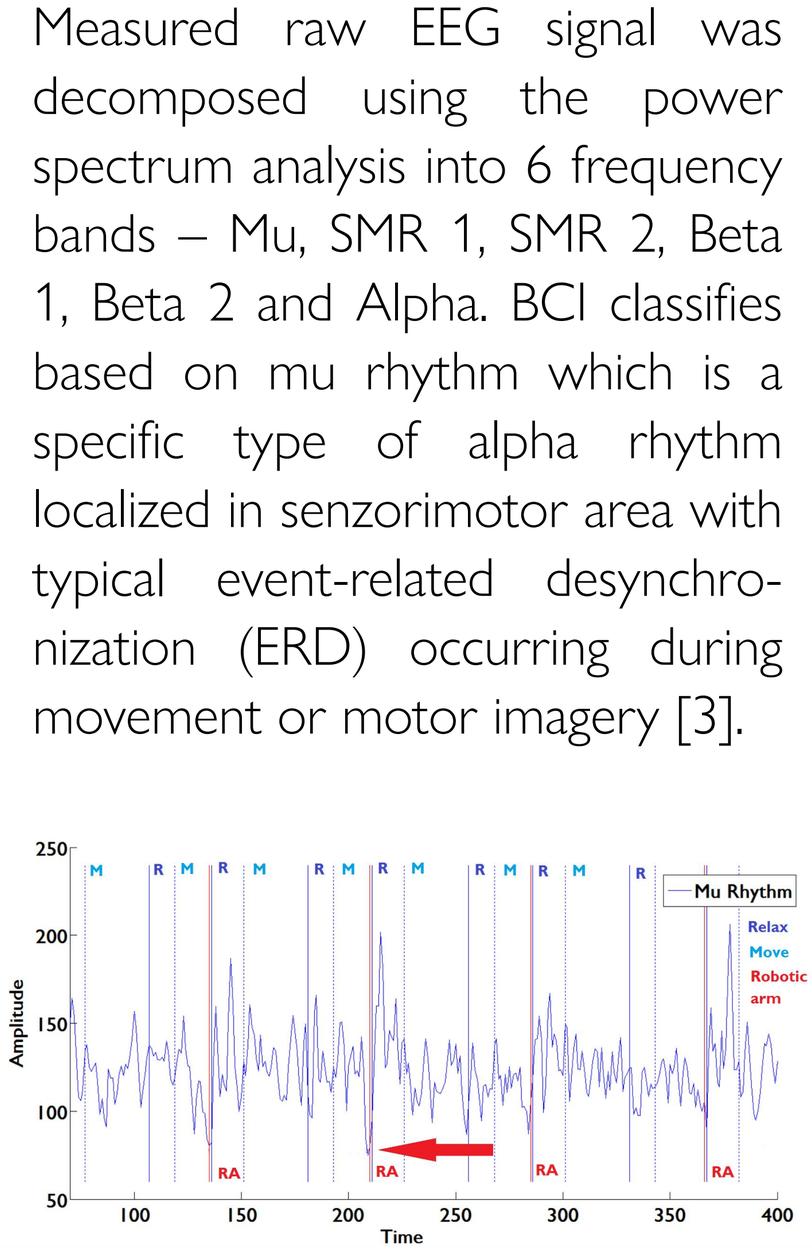


Figure 1: Desynchronization of mu rhythm during successful session followed by movement of a robotic arm.

References

[1] M. Lotze, L.G. Cohen. "Volition and imagery in neurorehabilitation." *Cognitive Behavioral Neurology*, vol. 19, pp. 135–140, 2006.

[2] B. Cimrová, I. Farkaš, & R. Rosipal. "Využitie rozhrania mozog-počítač pri neurorehabilitácii: prehľad aktuálneho výskumu." *Kognícia a umelý život*, vol. 14, 2014.

[3] Pfurtscheller, G., Neuper, C., & Mohl, W. (1994). Event-related desynchronization (ERD) during visual processing. *International Journal of Psychophysiology*, vol. 16, no. 2-3, pp. 147-153.

Results

The analysis has shown incorrect time synchronization in original script – mu rhythm has to exceed threshold 15% in all cases (Table 1).

SMR1	SMR2	Mu	Beta1	Beta2	Alpha
- 8.6%	- 4.7%	- 14.9%	- 8.1%	-5.2%	- 14.5%

Table 1: Average decrease of rhythms before movement of the robotic arm compared with relaxed state.

	SMR1	SMR2	Mu	Beta1	Beta2	Alpha
SMR1	1					
SMR2	0.509**	1				
Mu	0.367**	0.356**	1			
Beta1	0.431**	0.499**	0.341**	1		
Beta2	0.409**	0.541**	0.353**	0.690**	1	
Alpha	0.504**	0.331**	0.364**	0.372**	0.375**	1

Table 2: Correlation of rhythms from last training session. $p < 0.01$.

Conclusion

Strongest correlation was found between SMR 1 and SMR 2 rhythm and between Beta 1 and Beta 2 (Table 2).

Future objectives:

fix incorrect synchronization; understand changes occurring during the „move" condition and, on its basis, develop more complex model which will combine more rhythms together.

Acknowledgements

I would like to thank Roman Rosipal and Barbora Cimrová for their guidance and encouragement in carrying out this project work.

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