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Composing music with the "musical brain cap" based on the g.tec BCI

Short notice from Günter Edlinger, g.tec medical engineering GmbH, edlinger@gtec.at

The aim of this project -headed by the composer Prof. Miranda Reck from the University of Plymouth, UK -is to develop a "Brain-Computer Music Interface". The human brain is directly connected with musical devices such as automated piano and electronic musical instruments. Prof. Miranda Reck developed a device that composes musical pieces and plays them with expression on an automated piano based on information extracted from specific altered brain signals. The ultimate goal of this project is to develop both a recreational device for people with disabilities and a device for concert performance and composition [1,2].

The "g.tec BCI" [4] is used to extract special features found in the EEG for generating the music. Band power from different frequency bands control a generative system that composes music on the fly based on musical grammar. The complexity of the EEG signal, which is an indicator of the deviation of the actual signal from a sinusoidal curve, is extracted by the SIMULINK block "Hjorth" and used to control the interpretation (tempo) of the musical piece (the more complex the signal the faster the music, see Figure 1, [3]).

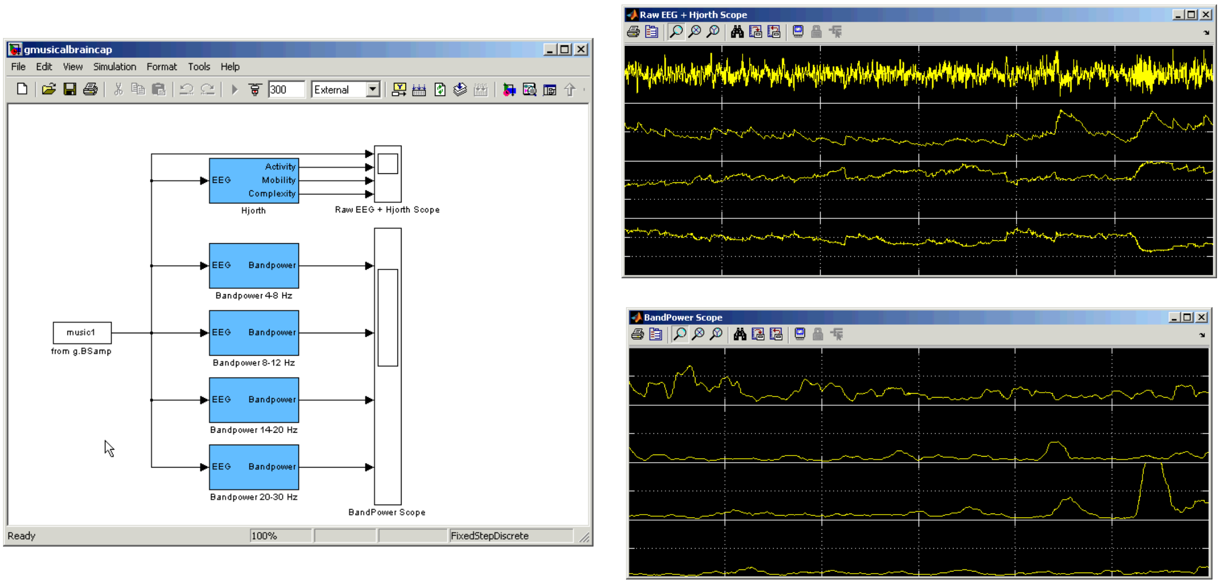

Figure 1: Top left: SIMULINK model for band power extraction and Hjorth's parameter estimation. The top right panel yields one raw EEG channel displayed for 30 seconds and 3 Hjorth parameters i) activity (resembles the variance of the mean power), ii) mobility (resembles the mean frequency) and iii) complexity of the EEG signal. The bottom right panel displays the band power computed in the 4 frequency bands theta, alpha, low beta and high beta.

The generative system composes sequences of short sections of music using musical grammars. Each section is generated by 1 rule selected from 4 grammatical rules. The selection is made according to the mental activity of the subject. For example, if the subject is in a state of deep relaxation (high power in the theta band, low power in all other bands), then rule 1 is selected, if the subject is in relaxed wakefulness (high power in the alpha band, low power in all other bands) then rule 2 is selected and so on (Figure 2).

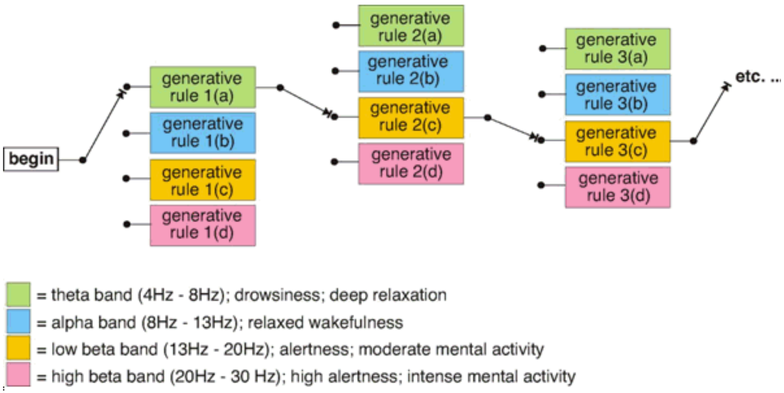

Figure 2: Selection of musical grammatical rules by based on the band power distribution in different frequency bands (with permission from Prof. Miranda Reck)

The output of the musical generative system is then connected via a MIDI interface to a mechanical piano that plays the actual composed musical piece (Figure 3).

Figure 3: EEG measurement setup and connection to the mechanical piano (with permission from Prof. Miranda Reck)

One of the next steps in the work of Prof. Miranda Reck is to develop methods to train subjects to achieve specific EEG patterns to play the BCMI-Piano system. Similar to the Brain-Computer Interface the subject learns to modify specific EEG patterns and subsequently learn to gain greater control of the piano.

References

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[2] Miranda, E. R., Roberts, S. and Stokes, M. (2004), "On Generating EEG for Controlling Musical Systems", *Biomedizinische Technik*, 49(1):75-76.
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[4] Guger, C., Schlögl, A., Neuper, C., Walterspacher, D., Strein, T., and Pfurtscheller, G., “Rapid prototyping of an EEG-based brain-computer interface (BCI),“ IEEE Trans. Rehab. Engng., vol. 9, pp. 49-58, 2001.