Proposal for EMBC 2019 Workshop

Type: 1 day

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Major BCI methodological approaches and design of BCI applications for communication, neurorehabilitation, neurological assessment, deep brain stimulation and functional mapping with EEG and ECoG.

Theme:

- *Therapeutic & Diagnostic Systems, Devices and Technologies, Clinical Engineering*
- *Biomedical Signal Processing*

Keywords: BCI, P300, SSVEP, motor imagery, neuroplasticity, DOC, coma, stroke, assessment, EEG, ECoG, functional brain mapping, DBS

Abstract

The Brain-Computer Interface (BCI) research area is a thriving and rapidly expanding field. BCIs have been developed during the last years for people with severe disabilities to improve their quality of life. However, BCI applications have recently been extended to different research areas, such as rapid functional mapping on the cortical level, virtual reality and rehabilitation & therapy after stroke. The workshop will discuss prerequisites to successfully perform both invasive and non-invasive BCI experiments, and discuss progress in relevant medical domains. Live demonstrations of BCI control will help attendees understand the technology.

Many studies over the past decade have shown that ECoG activity in the high gamma band is a reliable indicator of local task-related cortical activity, and could thus complement existing methods for functional mapping. Further highlights of the workshop are new approaches of semiautomatic mapping of the sensorimotor cortex using somatosensory evoked potentials and cortico-cortical evoked potentials for brain mapping in intraoperative scenarios. The workshop will also describe techniques for direct-brain stimulation in Parkinson patients to reduce tremor and to improve treatment opportunities.

Attendees will get insights into state-of-the-art hardware and software for BCI research enabling participants to run their own experiments. Advantages and disadvantages of dry and wet biosignal sensors will be discussed as well as differences between invasive and non-invasive BCI applications. Participants will be able to understand the most commonly used methodological approaches (auditory, visual, vibrotactile P300, SSVEP, motor imagery) underlying the design of BCIs and will have the opportunity to operate BCI based medical systems for neurorehabilitation, communication and consciousness assessment. The speakers of this workshop provide a competent mix between neurosurgery, neurology, scientific and technical expertise.

LIST of Speakers

A. Dean J. Krusienski PhD, Virginia Commonwealth University, Richmond, VA, djkrusienski@vcu.edu

Characterization and Decoding of Speech Processes from Intracranial Recordings

Dean J. Krusienski is a Professor of Biomedical Engineering at Virginia Commonwealth University. He received the B.S., M.S., and Ph.D. degrees in electrical engineering from The Pennsylvania State University, University Park, PA, in 1999, 2001, and 2004, respectively. He completed his postdoctoral research at the New York State Department of Health's Wadsworth Center Brain-Computer Interface (BCI) Laboratory in Albany, NY. His primary research focus is on the application of advanced signal processing and pattern recognition techniques to brain-computer interfaces, which allow individuals with severe neuromuscular disabilities to communicate and interact with their environments using their brainwaves. His research interests include decoding and translation of neural signals, digital signal and image processing, machine learning, evolutionary algorithms, artificial neural networks, and biomedical and musical applications. His research has been supported by the National Science Foundation (NSF), the National Institutes of Health (NIH), and the National Institute of Aerospace (NIA)/NASA.

B. José M. Azorín, PhD, Universidad Miguel Hernández de Elche, Spain jm.azorin@umh.es

Interacting with Robotic Exoskeletons by means of Brain-Computer Interfaces

Jose M. Azorin is the Director of the Brain-Machine Interface Systems Lab and Full Professor of the Systems Engineering and Automation Department at Miguel Hernández University of Elche (Spain). He holds a M.Sc in Computer Science from the University of Alicante (1997, Spain) and a Ph.D. in Robotics (Award for the Best Thesis of the Department) by the UMH (2003, Spain).

He has been a visiting professor at the University of Houston (USA) and at Imperial College London (United Kingdom). His current research interests are Brain-Machine Interfaces, Neuro-robotics and Rehabilitation Robotics. Over the last years, his research has been funded by prestigious grants from the European Union and Spanish government agencies. He has been the PI of more than 10 research projects, and his research has resulted in more than 150 technical papers and 3 patents. Currently, he is a Distinguished Lecturer of the IEEE Systems Council.

C. Christoph Guger, PhD, g.tec medical engineering GmbH, Austria guger@gtec.at

BCIs for stroke rehabilitation and assessment of patients with disorders of consciousness

Christoph Guger, PhD studied biomedical engineering at the University of Technology Graz and Johns Hopkins University in Baltimore, USA. Then he carried out research work at the Department of Medical Informatics (Prof. Pfurtscheller) at the University of Technology Graz and received his PhD degree in 1999. The topic of his PhD work was the design of an EEG-based brain-computer interface. This was the first real-time BCI system with continuous feedback. He also developed the real-time analysis with common spatial patterns which is still the fastest and most accurate approach for oscillatory BCIs and developed also a P300 BCI with very high accuracy and speed. He is co-founder of g.tec where he works since 1999. g.tec is active in more than 10 international research projects in the BCI domain and neurotechnology.

D. Nuri Firat Ince, PhD University of Houston, Texas, USA nfince@uh.edu

Intraoperative investigation of the functional utility of local field potentials in Parkinson's disease

Nuri Firat Ince, PhD is an associate professor and head of the Clinical Neural Engineering Lab, at the University of Houston, Texas, USA. After completing his PhD studies on EEG signal processing with adaptive wavelets in 2005, we worked as a post-doc associate at the University of Minnesota and explored the neural activity of non-human primates for brain machine

interfaces. His current work include a variety of basic and translational research in neural engineering and biomedical signal processing. Areas of special interest are: neural decoding for neuroprosthetics; machine learning for neuromarker discovery in epilepsy and movement disorders. Dr. Ince and his group contribute not only to algorithm development but also to the discovery of new methods for diagnosis and therapy that can be applied in clinical practice. In this scheme, the group works closely with clinicians and researchers from diverse fields such as neuroscience, neurosurgery and neurology.

E. Christoph Guger, PhD, g.tec medical engineering GmbH, Austria guger@gtec.at

High-gamma mapping and control of brain-computer interface technology

Christoph Guger, PhD studied biomedical engineering at the University of Technology Graz and Johns Hopkins University in Baltimore, USA. Then he carried out research work at the Department of Medical Informatics (Prof. Pfurtscheller) at the University of Technology Graz and received his PhD degree in 1999. The topic of his PhD work was the design of an EEG-based brain-computer interface. This was the first real-time BCI system with continuous feedback. He also developed the real-time analysis with common spatial patterns which is still the fastest and most accurate approach for oscillatory BCIs and developed also a P300 BCI with very high accuracy and speed. He is co-founder of g.tec where he works since 1999.

F. Tomek Rutkowski, PhD, BCI Lab, University of Tokyo, Japan, tomek@bci-lab.info

Multisensory BCIs in applications for robotics, VR/AR, art and dementia monitoring

Tomasz (Tomek) M Rutkowski is a researcher and educator born in Poland. He lives in Japan since 1998 and focuses his professional activity on computational neuroscience (neurotechnology), multi-sensory (multimedia) applications, artificial intelligence and intelligence augmentation. He developed an award winning tactile (haptic) brain-computer interface and he is also active in multi-sensory (auditory, visual, tactile, etc.) media design. Tomek contributed also to a design of a direct brain-music interface with Prof. Furukawa's team (Tokyo National University of Fine Arts and Music) and he has been involved in a research on brain correlates of creativity together with Prof. Okada (The University of Tokyo). Currently he is an AI research scientist at RIKEN AIP in Tokyo where his research has been focused on human intelligence augmentation (IA) for dementia prevention and a passive BCI development with support of deep learning techniques. For a full publication list please check http://tomek.bci-lab.info/publications/