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Large Scale EC Horizon 2020 research projects: ComaWare and recoveriX

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Introduction: The European Commission recently launched the latest Horizon 2020 research program. The dedicated SME instrument encourages for-profit European SMEs to put forward their most innovative ideas. The instrument aims to fill gaps in funding for high-risk innovation and close-to-market activities to give a strong boost to breakthrough innovation. Brain-computer interface technology has the power to induce a paradigm shift in certain technological and medical application areas. At the moment, g.tec is coordinating two of these projects:

(i) ComaWare – COMmunication and Assessment With Adaptive Realtime Environments [1]

Imagine being able to hear, feel, and think – but not see or move. You cannot communicate in any way, but can hear doctors and family members saying that you are comatose and cannot understand or make decisions. Recent work has shown that this nightmarish situation is a reality for thousands of people worldwide, who have been diagnosed as comatose but may in fact have some ability to understand. More recent work has shown that brain-computer interface (BCI) systems can help with re-assessment of these patients [2].

The system developed in ComaWare consists of active EEG electrodes, a biosignal amplifier, a real-time processing system running the BCI analysis and experimental paradigms, loudspeakers and tactile stimulators. The system is able to run three different paradigms: (i) auditory evoked potentials, (ii) vibrotactile stimulation (with 2 or 3 stimulators for assessment and also communication) and (iii) motor imagery. The signal analysis calculates evoked potentials with statistical analysis for paradigms (i)-(ii) and event-related desynchronization maps for (iii). Additionally, a classifier is trained on the data to obtain an objective classification accuracy. The system was already successfully used with patients in minimal consciousness state or vegetative state (n=15) and gave useful information if the patient can perform the experimental paradigms. A low classification accuracy shows that the patient is not able to perform the tasks; a high classification accuracy shows that the patient can do the tasks and that the patient understood the instruction how to perform the experiment.

The system is currently tested by 10 validation partners in 8 different countries. In addition to providing assessment and communication, our new mindBEAGLE prototype will also be able to provide outcome prediction based on evoked potential analysis and rehabilitation with functional electrical stimulation. In addition to creating a new mindBEAGLE system specialized for severely disabled persons without vision, we will also develop, pilot-test, and launch a novel business focused on providing support for patients, their carers and clinicians.

(ii) recoveriX - Motor Recovery with Paired Associative Stimulation [1].

Patients around the world need therapy to improve motor function. Motor disabilities may result from many causes, including traumatic brain injury (TBI), stroke, congenital conditions and some diseases. New research from G.TEC and others has shown that novel brain-computer interface (BCI) systems can substantially improve motor rehabilitation outcomes while reducing burdens on patients, therapists, and carers. Our new approach relies on paired stimulation (PS), which adds real-time EEG-based analyses of motor imagery to conventional therapy systems. The system consists of active EEG electrodes, a biosignal amplifier, a real-time analysis system running motor imagery BCI experiments and functional electrical stimulators with 2 channels for two muscle groups. Patients are trained for 30 minutes to attempt left or right hand movement with 120 repetitions. The BCI system is able to detect the movement attempt in real-time and triggers the functional electrical stimulation of the muscle of the corresponding arm/hand so that it is actually moving.

The system was already successfully tested with sub-acute and chronic patients, and every patient (n=8) achieved good BCI accuracies and motor function improvements. Functional improvement were assessed with a 9-hole PEG test.

Interesting is that the BCI accuracy is an important marker if patients are participating and that this parameter can be used to coach the patient. It is also important that all patients improved their BCI accuracy with the training and many achieved accuracies above 95% [example in 2]. More importantly the motor functions improved for all patients (even for chronic patients).

The system is currently validated with 10 validation partners in 6 countries. We will also develop, pilot-test, and launch new businesses called recoveriX-Gyms, where patients can train with our system.

References

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