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Multi-command on-line EEG Brain machine interface using steady state visual evoked potentials

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In the past few decades, neuroscientists are striving to meet the challenges presented by a novel paradigm in brain science, the direct Brain-Machine Interfaces (BMI), which rely on conscious self-control of one's brain states, instead of one's muscles, to control a machine or a computer. The requirements for such BMI systems are now becoming more rigorous – including higher reliability, faster real-time analysis and better quantitative classification of several brain activity patterns. One BMI paradigm which is able to satisfy many of these strict requirements is the Steady-State Visual Evoked Potential (SSVEP) approach in which selective attention to one of several reversing patterns evokes synchronized steady-state brain activity. We propose a multi-stage procedure for real time BMI with an implementation for 8 independent commands. Our EEG-based BMI system enables a user to navigate a small car on a screen in near-real time and to execute additional actions. Our approach offers several novel points, such as integrating moving patterns together with the controlled object to decrease fatigue and to minimize eye movements on the screen. Other new features are using online blind-source separation (BSS) for blink and muscle artifact rejection, improved signal feature selection and a fast classifier for multiple commands. The brain responses to SSVEP pattern reversal onset and the frequency response curve of the visual cortex were studied in detail to improve the design and efficiency of the BMI system.