EEG in Dual-Task Human-Machine Interaction: On the Feasibility of EEG based Support of Complex Human-Machine Interaction

Elsa Andrea Kirchner,*,# Su Kyoung Kim*,# and Manfred Fahle**,+

* Robotics Lab, University of Bremen, 28359 Bremen, Germany
# Robotics Innovation Center, German Research Center for Artificial Intelligence (DFKI), 28359 Bremen, Germany, Email: ekir@informatik.uni-bremen.de
** Brain Research Institute IV, University of Bremen, Bremen, Germany
+ The Henry Wellcome Laboratories for Vision Sciences, City University, London, U.K.

Usually, humans can deal with multiple tasks simultaneously. We show here that even under high cognitive workload in dual task conditions, the human electroencephalogram contains patterns faithfully representing well-defined cognitive states. This finding allows the detection of these brain states while a human performs complex human-machine interactions, such as teleoperating a robotic system, thus presenting the possibility of improving operator performance. We present the results of two experiments recording the human electroencephalogram. Subjects performed a demanding senso-motor task (Brio labyrinth). During the performance of the senso-motor (labyrinth) task, two types of visual stimuli occurred. One type of stimulus could be ignored while the other, quite similar type, required a motor response (that interfered with the labyrinth task). We recorded the EEG by means of a 64 channel system with active electrodes (Brain Products) and found significant and characteristic event related potentials at parietal electrode sites even without averaging, i.e. on single events. These activities were more strongly expressed under dual task than under simple task conditions while response behavior was identical. Our results indicate that even under high workload it is possible to detect certain cognitive states in the human electroencephalogram possibly improving human-machine interaction.