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## Is it time for passive Brain Computer Interfaces in UAV Operations ?

Unmanned Aerial Vehicles (UAVs, drones) are steadily rising in popularity for both military and civilian use, but as these systems become capable to operate for extended periods of time operator mental fatigue is growing into a serious issue [3,4,7].

Mental Fatigue affects a multitude of cognitive processes, that are critical to the safe operation of UAVs. Research has shown effects of mental fatigue on attention [6], cognitive flexibility [15], decision making [2], rule adaptation [12], planning [14] and situational awareness [13]. These problems are well studied in the domain of Aviation [11]. However, UAV operations are often characterized by long, monotonous and fatigue-inducing phases of surveillance, intermittently interrupted by unpredictable periods of high mental workload. This renders traditional methods of fatigue mitigation, such as crew-rest as not viable.

Passive Brain Computer Interfaces (pBCIs) are one of the most promising technologies that could ensure safety for prolonged UAV operations. EEG based pBCIs have been shown to reliably detect mental fatigue, as elicited by time-on-task (TOT). A recent meta-analysis of 21 studies, found that mental fatigue resulted in reliable increases of both alpha and theta activity [9]. Power features have been successfully used as biomarkers for single-trial fatigue classification [8,10].

Yet knowing about the state of an operator is only half of the solution, as the altered mental state needs to be accounted for within the operations. State-based adaptive automation (AA) and adaptive interfaces (AI) are promising tools to fulfill this duty. By taking over certain tasks for the operator or by changing the interaction between the operator and the control surfaces, AA and AI have been proven to be capable to accommodate the needs of operators' mental state [1,5]. Hence, we suggest that combining pBCIs with AI or AA offers a significant opportunity to support UAV operators in situations of prolonged use.

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