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Characterization with EEG and eye tracking of the impact of time-on-task on a UAV operator

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Abstract. Boredom, mind wandering and mental fatigue are common issues in operational UAV supervision control. They can lead to a lack of situational awareness. We propose to characterize them using physiological sensors in order to perform real time monitoring and apply countermeasures in later experiments.

1   Goals

Past research has shown that human factors account for an important number of unmanned aerial vehicle (UAV) accidents. For instance, according to the FAA, in U.S. military drones, the percentage of accidents due to human factors ranged from 21% to 67%, depending on the drone model. Therefore, detecting in real time the operator's mental state in such an operational context is interesting in order to correct it if necessary by interface countermeasures.

Other past studies have shown that boredom and mind wandering are important elements of operator performance. Operators are very rarely solicited by UAVs and only at irregular intervals, which means that they alternate between long, dull surveillance phases and high workload phases under strong temporal pressure (e.g. failures). All this leads to a lack of situational awareness during the active phases.

A long time spent on an attentional task generates mental fatigue, characterized by a degradation in performance (e.g. reaction time). During long periods of time, mind wandering also occurs, in which intrusive thoughts lead someone to not focus as much on their main task and process less environmental information. Both mental fatigue and mind wandering have been characterized with EEG and eye tracking in other contexts.

Our goal in this study is therefore to characterize the mental state induced by a long time spent on a monotonous UAV surveillance task, in order to later estimate this state in real time.

2 Experiment

Participants will use a multi-UAV simulation software in order to perform a monotonous drone surveillance task for two hours. They will have to watch only one UAV out of ten shown onscreen, and discriminate some notification blinks. They will have to react to some of these blinks with a short tracking task and to others with a decision related to going back to base for refueling. Such active phases will be very rare (fifteen 20-second phases during the whole experiment).

The participants' performance will be evaluated by their reaction time and accuracy to the blink alarms. The participants will also fill subjective surveys: the Karolinska Sleepiness Scale (before and after the experiment), Rating Scale Mental Effort, Boredom Proneness Scale, and questions about their engagement in the task and experience of non-task-related thoughts.

In addition to these behavioral and subjective metrics, we will use EEG and eye tracking measures in order to find the best indicators of mental fatigue and mind wandering. Eye tracking data will be combined with EEG data to extract eye fixation related potentials (EFRPs). For this experiment, processing will be done offline, but it should remain doable on line for future studies.