Research Internship: Online mental fatigue estimation for long endurance Unmanned Aerial Systems (UAS) operators

1 Context

This internship is part of the Concorde project (funded by ISAE-Supaero, Onera & ENAC) which aims to study human-machine interaction in the context of long endurance UAS (UAS: unmanned aerial systems) operations. More precisely, it is part of the PhD thesis of Marcel Hinss.

With the increased operational time of modern military and civilian drones and the increased popularity of such systems, a recent human factors challenge has emerged. Mental fatigue as a result of long and monotonous missions threatens the safety of UAS operations, as the deterioration of the mental state of the operators can result in an increased error proneness [1]. The goal of this internship is to support the development and testing of a closed loop (online) system, that detects and mitigates mental fatigue during long-endurance UAS missions [2]. We are developing an experimental protocol to study the decrease in vigilance during simulated UAS missions. Cardiac, cerebral (Electroencephalography, EEG) and eye-tracking data will be collected to estimate fatigue. This data is then fed into a machine learning and estimation pipeline, which will determine if the cockpit interface needs to adapt to the current state of the participant [3]. To simulate the UAS operations we use the Paparazzi Ground Control Station, developed at ENAC, [4] as well as other tasks such as the MATB-II [5].



(a) Partial experimental setup in the lab



(b) Paparazzi Ground Control Station [4] used to simulate UAS missions

2 Objective of the internship

There are several challenges associated with this experiment. Depending on the intern's competencies and the supervisors' needs, the internship's focus can be adapted to any challenge or combination of the following challenges. During the internship, the intern may also be required to aid with the writing of reports and publications, as well as associated work.

- Development of a robust online classifier for mental fatigue This is a critical element of the experiment, as training data cannot be collected in the same session as testing data. This will likely require the use of transfer learning methods, preferably using Riemannian Geometry [6, 7]. Due to the temporal nature of mental fatigue, Bayesian methods may also be of use [8].
- **Experimentation** Data collection involves not only setting up the experiment and ensuring that the participant is comfortable, but it also involves the development of procedures that assure that all components work together.
- **Signal processing and feature extraction** Linked to the challenge above is signal processing and feature extraction required for the EEG signal. The appropriate use of filters and feature extraction methods is vital to the success of the experiment [9].

3 Requirements

Main Requirements

- Bachelor or Master's degree in Neuroscience, Biomedical Engineering, Psychology, Ergonomics or Data Science
- Programming skills (Matlab, Python or C++)
- Scientific mindset and understanding

Additional, non-obligatory skills

- Machine learning skills
- Experience with experimentation
- Conversational English skills

4 Key information

Location : ISAE-SUPEARO (onsite), Toulouse Duration of the internship: 6 Months Supervisors : Marcel Hinss (ISAE-SUPEARO) marcel.hinss@isae-supaero.fr, Raphaëlle Roy (ISAE-SUPEARO) raphaelle.roy@isae-supaero.fr, Anke Brock (ENAC) anke.brock@enac.fr

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