Fully Funded 3-year PhD Position

Human-drone interaction: Taking into account the estimation of operator fatigue in the design of adaptive interactions for the control of long-endurance UAVs.

Context

During the operation of UAVs (unmanned aerial vehicles, drones) or UAV fleets, operators have to be able to supervise the UAV(s), the mission properties and regain control if necessary. Just as the operating parameters of UAVs are crucial for mission management, the mental state of the operator in charge of controlling or piloting these UAVs is crucial as well, since a failure at his level has major repercussions in terms of safety and performance. However, all too often this is overlooked. For several years now, the field of neuroergonomics has been studying the human operator through neurophysiological measurements. The development of tools based on automatic learning has brought a means of estimating the mental state online and thus allowed the development of interfaces that take into account this mental state (i.e. passive brain-computer interfaces). To date, studies in neuroergonomics and passive brain-computer interfaces in aeronautics have focused mainly on pilots (Verdière et al., 2018) and controllers (Arico et al., 2016). However, a few studies are beginning to focus on UAV operators (Roy et al., 2017, Senoussi et al., 2017, Drougard et al., 2017; Jahanpour et al., 2020; Roy et al., 2020). This thesis aims to develop this rapidly expanding field of study by focusing on the use of an estimate of the mental fatigue state of a UAV operator.

An adaptable system monitors the user's activity and context, and tries to adapt to the needs and preferences of the users (Greenberg & Witten, 1985). This implies flexibility of the system, but also taking into account the user's experience and state. These systems have, for example, been tested in the context of driving, where they have been shown to be particularly useful in routine situations (Lavie & Meyer, 2010).
Human-Drone Interaction is an area of Human-Computer Interaction that has steadily been growing over the past years (Cauchard et al., 2021) and is at the center of this thesis.
This thesis aims at modeling, designing and experimenting novel interfaces able to achieve an efficient adaptation between the drone operator's state and the mission context. It will take advantage of the work previously carried out at ISAE-supaero and ENAC on fatigue estimation

(Jahanpour et al., 2020) and HMI for UAVs using Paparazzi UAV (Garcia et al., 2019, Hattenberger et al., 2014).

Content and Outline

This thesis is situated at the interface of Human-Computer Interaction and neuroergonomics. It will thus adopt methods and technologies from both fields.
For Human-Computer Interaction, this thesis will put into practice the participatory design method, an iterative design approach that involves target users (drone operators) in the design process (Beaudouin-Lafon & Mackay, 2009). The technologies to be studied will include adaptive interfaces, but also multimodality. The thesis is also part of the emerging area of Human-Drone interaction.
On the neuroergonomics side, the methods employed will be the experimental approach with subjective, behavioural and physiological measures, as well as signal processing and machine learning tools.

The main challenges to be addressed in this thesis include :
- Designing, modeling and implementing interfaces and interactions which are adaptable to the mental state of the operators;
- Study and evaluation of these interfaces in the context of UAV piloting;

In addition to the thesis main work, the PhD fellow will have to assist the supervisors in writing the deliverables for the funding agency, the French DGA.

Outline

- First year: literature review, familiarisation with the state of the art (adaptive interfaces and mental state estimation) and the tools developed in the lab (e.g., the drone environment Paparazzi UAV http://wiki.paparazziuav.org/wiki/Main_Page)
- Second year: development of the adaptive interface based on the previous developments of the project and on the physiological markers identified as relevant. Running a first user study / experimental campaign. Analyzing the results and implementing modifications for a second run.
- Third year: Final adaptive interface prototype delivery, thesis writing and defense.

PhD Candidate’s Profile

- Master or engineering diploma in Human-Computer Interaction, Computer Science, Biomedical Engineering or Cognitive Science;
- Strong programming skills (C++/Qt5);
- Knowledge in Human-Computer Interaction;
- Basic knowledge in Matlab or Python for signal processing;
- Autonomous, hard-working, problem-solver;

- Interested in neuroscience and cognitive science;
- English proficiency would be a plus.

Additional Information

- Salary: This PhD thesis is financially supported by the French DGA (Directorate General of Armaments). The monthly gross salary is 2048€. There is no teaching obligation, but if the candidate is interested optional paid teaching is possible.
- Duration: 36 months (from Oct. 2021 to Sept. 2024)
- Supervisors:
  - ENAC : Anke Brock, anke.brock@enac.fr, www.ankebrock.com
  - ISAE : Raphaëlle Roy, raphaelle.roy@isae-supaero.fr, https://personnel.isae-supaero.fr/raphaelle-n-roy-211/
- Collaborators: ENAC: Jérémie Garcia, Jean-Paul Imbert & collaborators from the ENAC drone systems team, ONERA: Bruno Berberian
- Working environment: https://www.isae-supaero.fr/en, https://www.enac.fr/en
- Application procedure: Formal applications should include a detailed CV, a motivation letter, at least one reference letter, and transcripts of degrees. Samples of published research by the candidate will be a plus.

Références

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