

Multilevel models for intensive longitudinal data: modelling mental workload of unmanned aerial vehicle pilots

Mario Miguel Ojeda¹, Angélica Reyes²

¹mojeda@uv.mx, Facultad de Estadística e Informática, Universidad Veracruzana.

²mreyes@ac.upc.edu, Department of Computer Architecture, BarcelonaTech.

The use of unmanned aerial vehicles (UAVs) is expected to increase exponentially in the next few years. Operators will be required to perform more informationally-dense and cognitively-demanding tasks. The primary objective of this work is to investigate models for monitoring and predicting mental workload of pilots in command of UAVs. After a review of multilevel models, we characterize the particular process of modelling in intensive longitudinal data. In order to show the modelling process we use objective workload measures such as a non-invasive method based on EEG sensors that record electrical activity of the brain. Also, we use subjective workload measures such as the Instantaneous Self-Assessment used by Eurocontrol [1] and the NASA TLX. The considered tasks are: (a) functional check prior and post to flight of UAV components and software, (b) Information processing, (c) pilot-operator communication. Each task was weighted in a scale of 1 to 3, being 3 the highest level of complexity according to the required information to do the task and the complexity of information processing that the pilot does. These variables are influenced by the level of automation of the Mission (Automatic/ Manual flight) and Pilot Experience. The subjective workload ratings and the objective measures are used to create a database for the modelling process. The multilevel models that we adapt would enable systems to use workload levels to distribute tasks optimally in addition to identifying levels of workload, for example a very high workload could lead to a serious breakdown in performance but a very low workload can produce boredom. We demonstrate the performance of objective workload measures to produce objective signals that can substitute the Self-Assessment subjective workload measures.

Keywords: Cognitive workload assessment, UAV pilots, Random coefficient models, Hierarchical linear models.