Towards Multimodal Monitoring of Cognitive Workload for the Development of Personalized Flight Simulator Training Applications

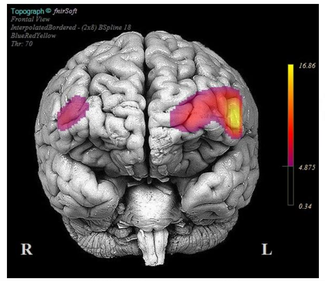
Murat Perit Çakır
Modelling & Simulation R&D Center, Middle East Technical University, Ankara, Turkey

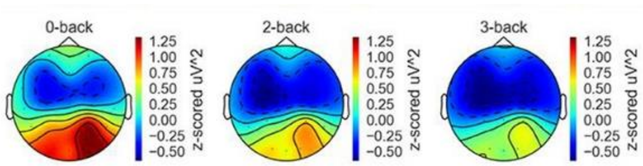
Introduction

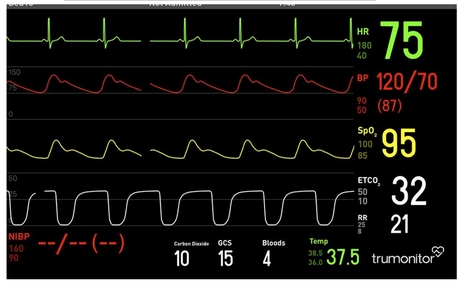
- Neurophysiological sensor designs with wireless/wearable miniaturize battery powered systems enable their use in ecological settings (McKendrick et al., 2018).
- The field of neuroergonomics emerge through this motivation to employ neuroimaging tools in the field, in real-world settings (Parasumaran & Rizzo, 2008).
- Existing studies showed great promise for decoding pilot/operator mental states (e.g. mental workload, drowsiness) inside training simulators (Gateau et al., 2018, İsbilir et al., 2019).
- EEG, fNIRS studies have shown that the signals are responsive to mental workload changes due to task episodes, mishaps, accidents, secondary tasks (Borghini et al., 2017;Dehais et al., 2020).

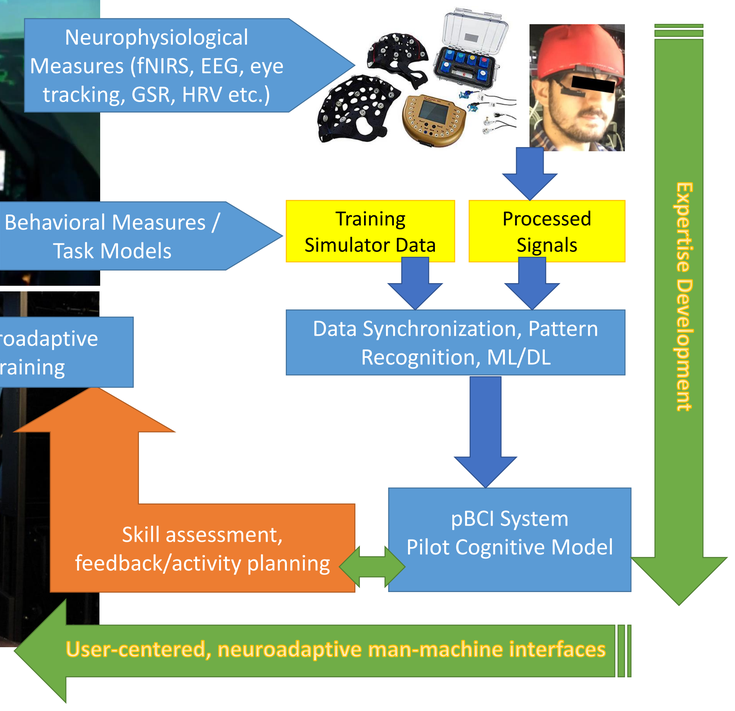
Challenges Ahead

- Most approaches are based on offline anaylsis – a need for real-time pBCI approaches.
- Single modality is often inadequate, especially in the complex field settings triangulations among modalities are required:
  - Development of sound multimodal analysis techniques over sensors that monior different physiological phenomena at different spatial/temporal scales.
  - Meaningful integration and interpretation of multimodal streams remains a challenge.
- Individiual differences – the need to calibrate, adjust the measure to personalize observations, training regiments limit the wide applicability of BCI applications.
- Translation of pBCI enhanced training into the real world (e.g. pBCI in real flight conditions).
- Improving the signal quality and long-duration wearability/comfort of the sensors sustained use scenarios in real-life applications.









References

Borghini, G., Aricò, P., Di Flumeri, G., & Babiloni, F. (2017). Industrial neuroscience in aviation: evaluation of mental states in aviation personnel (Vol. 18). Springer.

Dehais, F., Lafont, A., Roy, R., & Fairclough, S. (2020). A Neuroergonomics Approach to Mental Workload, Engagement and Human Performance. Frontiers in Neuroscience, 14, 268.

Gateau, T., Ayaz, H., & Dehais, F. (2018). In silico vs. over the clouds: on-the-fly mental state estimation of aircraft pilots, using a functional near infrared spectroscopy based passive-BCI. Frontiers in human neuroscience, 12, 187.

İşbilir, E., Çakır, M. P., Acartürk, C., & Tekerek, A. Ş. (2019). Towards a multimodal model of cognitive workload through synchronous optical brain imaging and eye tracking measures. Frontiers in human neuroscience, 13, 375.

McKendrick, R., Parasuraman, R., Murtza, R., Formwalt, A., Baccus, W., Paczynski, M., & Ayaz, H. (2016). Into the wild: neuroergonomic differentiation of hand-held and augmented reality wearable displays during outdoor navigation with functional near infrared spectroscopy. Frontiers in human neuroscience, 10, 216.

Parasuraman, R., and Rizzo, M. (2008). Neuroergonomics: The Brain at Work. Oxford: Oxford University Press.