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Study of a pilot's heart rate throughout his training

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Content

In aviation, the physiological monitoring of pilots can be useful to estimate the pilot's mental and physical state and to help understand their performance. So far, most of this physiological monitoring takes place inside labs or flight simulators, as some physiological sensors are still rather unwieldy in a plane or uncomfortable for the pilot, or are still expensive, such as EEG or fNIRS. However, the humble cardiac monitoring now offers good quality yet cheap sensors for athletes, which makes it a good fit for the general aviation domain, where pilots have a limited budget. Although physical activity impacts heart rate, this activity is limited inside a cockpit and the metabolic heart rate could be subtracted for better results 1.

We have had the opportunity of logging a student pilot's physiological data throughout his initial PPL training (which is not over yet). During all his flights, he wore a Garmin D2 watch, which synchronizes the heart rate with the GPS position, speed and altitude.

We are currently conducting a first data analysis by segmenting all his flights by flight phase. We expect, as in [2], to find the highest heart rate responses during take-off, followed by landing, due to the increase in both mental workload and stress that occurs in these flight phases. Preliminary results indicate the highest heart rate during take-off, but no noticeable increase during landing.

We will also study the evolution in heart rates throughout his training, similarly to [3], who studied heart rate variability (LF/HF ratio) evolution during standardized maneuvers in different lessons of a flight training during simulated and real flights. We also plan on identifying flights or flight phases that are significant for a student pilot (first flight, first landing, first solo, first navigation, examination) and studying if the heart rate significantly differs from standard flights. Preliminary results show a strong difference between non-solo flights and the first solo flight. Finally, we will also mention a few anecdotes that generated significant heart rate behavior.

This study aims at giving some indication as to whether the flight instruction can maintain a constant mental workload and stress level throughout the student pilot's training. For later works, it would be interesting to derive from this study a metric measuring the efficiency of the training, to compare real-flights-only trainings to trainings including simulated flights, and to compute performance metrics to compare with the pilot's heart rate [4].

1 Brouwer, Anne-Marie, et al. "Improving real-life estimates of emotion based on heart rate: a perspective on taking metabolic heart rate into account." *Frontiers in human neuroscience* (2018).

[2] Causse, Mickaël, et al. "An analysis of mental workload and psychological stress in pilots during actual flight using heart rate and subjective measurements." (2012).

[3] Regula, Marek, et al. "Study of heart rate as the main stress indicator in aircraft pilots." *Proceedings of Mechatronika 2014. IEEE*, 2014.

[4] Faaland, Olivier, et al. "Évaluation du stress et de la performance du pilote d'aviation générale au cours d'un vol dans un environnement peu familier". 2011.

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