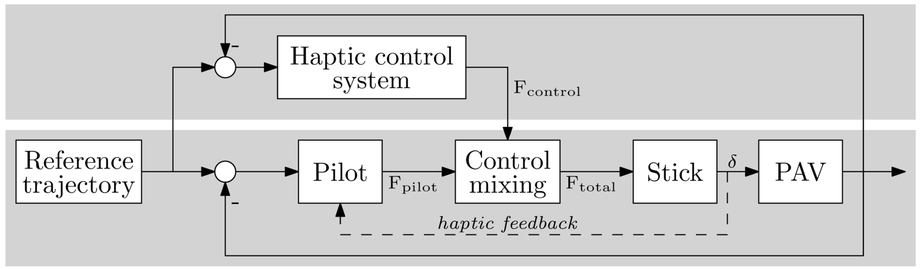
Haptics and Human Factors research for Personal Aerial Vehicles

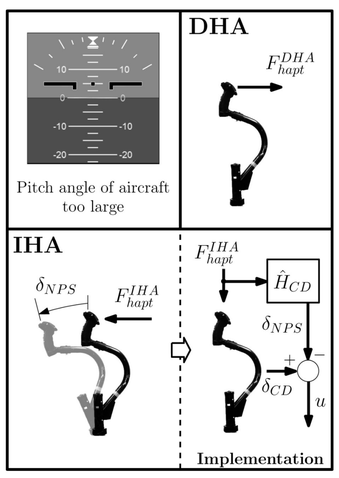
Max Planck Institute for Biological Cybernetics

Max-Planck-Institut
für biologische Kybernetik

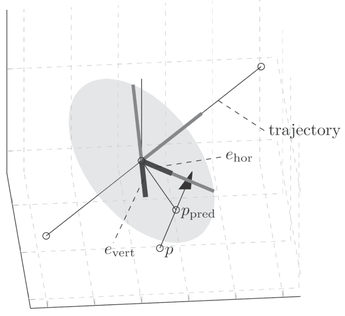
Haptics research

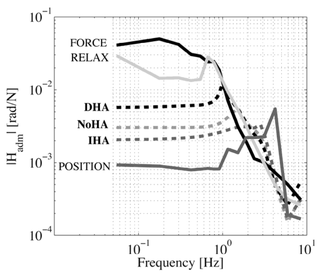
Haptic shared control systems allow pilots to continuously share control authority with an automatic control system through force interactions on a control stick. By combining such a system with a HITS display, a pilot can be guided along the flight trajectory.

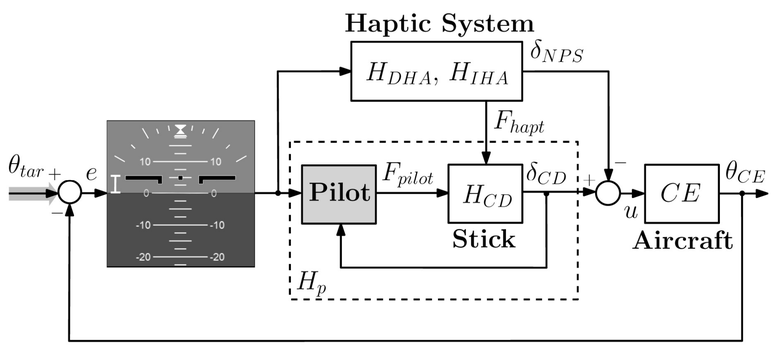




Analytical designs of haptic aids require adequate knowledge about changes in pilot behaviour. We use system identification techniques to determine how pilots adapt their visual response and the biomechanical properties of their arm (admittance) to haptic aids.

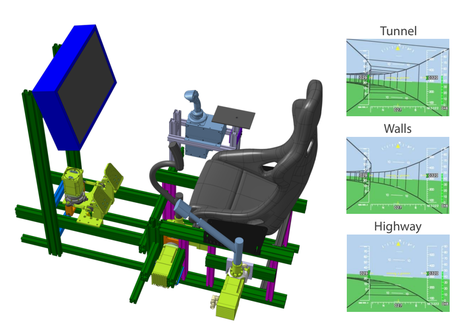






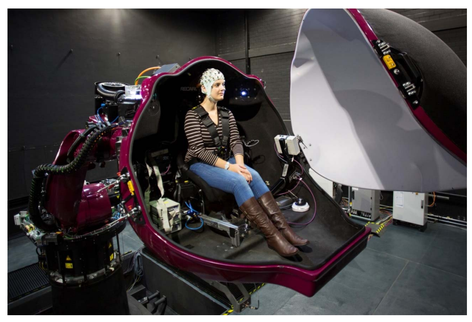
Experimental setups

A fixed-base simulator with control loaded inceptors and a HITS display



A fixed-base simulator with a large field-of-view display

The CyberMotion Simulator with a 6 DoF anthropomorphic arm and an enclosed cabin



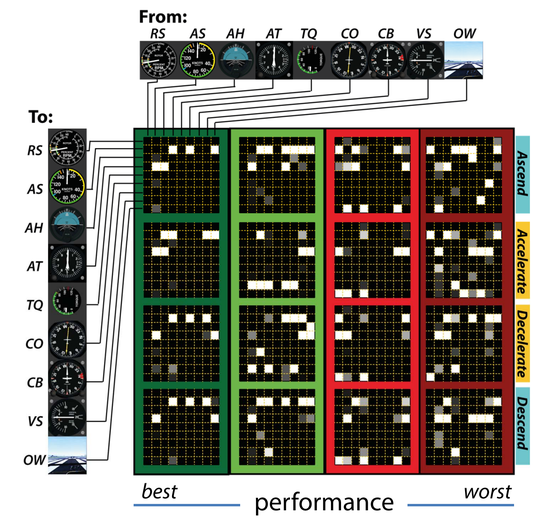
Selected publications

1. Nieuwenhuizen F. M. and Bülthoff H. H. (2014) **Evaluation of Haptic Shared Control and a Highway-in-the-Sky Display for Personal Aerial Vehicles** *AIAA Modeling and Simulation Technologies Conference 2014: held at the SciTech Forum 2014*, AIAA-2014-0808, 1-9.
2. Olivari M., Nieuwenhuizen F. M., Bülthoff H. H. and Pollini L. (2014) **Pilot Adaptation to Different Classes of Haptic Aids in Tracking Tasks** *Journal of Guidance, Control, and Dynamics* **37(6)** 1741-1753.
3. Olivari M., Nieuwenhuizen F. M., Bülthoff H. H. and Pollini L. (2014) **Identifying Time-Varying Neuromuscular System with a Recursive Least-Squares Algorithm: a Monte-Carlo Simulation Study** *IEEE International Conference on Systems, Man, and Cybernetics (SMC 2014)*, 1-6.
4. Scheer M., Bülthoff H. H. and Chuang L.L. (2014) **Is the novelty-P3 suitable for indexing mental workload in steering task?** *Cognitive Processing,* **15,** S135-S136.
5. Glatz C., Bülthoff H. H. and Chuang L.L. (2014) **Looming auditory warnings initiate earlier event-related potentials in a manual steering task.** *Cognitive Processing*, **15**, S38.
6. Flad N. , Nieuwenhuizen F.M. , Bülthoff H.H. and Chuang L.L. (2014) **System Delay in Flight Simulators Impairs Performance and Increases Physiological Workload.** In: *Engineering Psychology and Cognitive Ergonomics, Lecture Notes in Artificial Intelligence*, **8532**, 3-11.
7. Chuang L.L., Nieuwenhuizen, F.M. and Bülthoff H.H. (2013) **A fixed-base flight simulator study: The Interdependence of Flight Control Performance and Gaze Efficiency.** In: *Engineering Psychology and Cognitive Ergonomics, Lecture Notes in Computer Science*, **8020**, 95-104.
8. Bieg H-J., Bresciani J-P, Bülthoff H.H. and Chuang L.L. (2013) **Saccade reaction time asymmetries during task-switching in pursuit tracking.** *Experimental Brain Research*, **230**, 271-281.

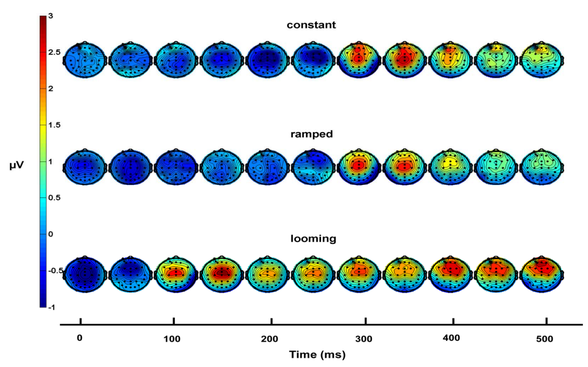
Human Factors research

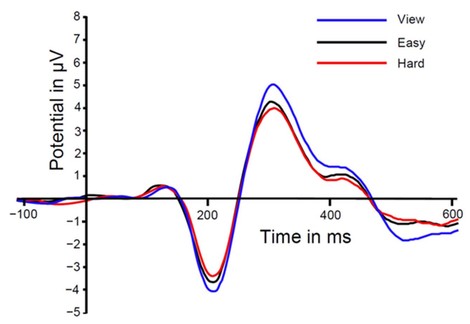
A pilot can be continuously monitored for his operational state (e.g., attention, workload, anxiety levels) with the use of gaze-trackers and physiological sensors.

By measuring the amplitude of EEG signals to task-irrelevant stimuli, we can infer the level of demand that the primary control task places on the operator. High frequency turbulence and controller complexity can induce workload in pilots and reduce situational awareness.



Flight control performance is strongly influenced by eye-movement planning. Individuals with less predictable eye-movements tend to generate inferior flight control performance.





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