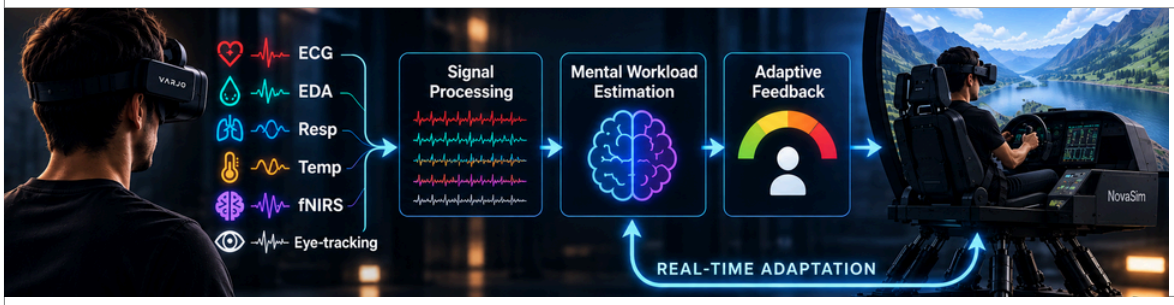
Masterarbeit

„Real-Time Multimodal Sensor Fusion for Adaptive Mental Workload Estimation to a Motion-Base Simulator“



Research Project:

At the TTZ Unbemannte Flugsysteme, we measure **Mental Workload in real time** while operators supervise a UAV swarm in Virtual Reality (VR). Participants sit in a motion-base flight simulator (Brunner NovaSim) wearing a Varjo XR-4 headset and biosignalsplux sensors (ECG, EDA, respiration, skin temperature, fNIRS). A machine-learning model turns those signals into a live workload estimate.

Purpose of the Thesis:

Build and validate the **real-time backbone** of this platform. You will work hands-on in **Python and C++**, extending and hardening the existing acquisition code into a robust streaming pipeline: **multi-device synchronisation and sensor fusion** across Bluetooth physiology and headset eye-tracking, **live signal processing** on sliding windows, machine-learning model inference in the loop, and a **low-latency output interface** to the simulator. Expect concurrency, buffering, timestamp alignment and real debugging against real hardware.

Goals:

- Python development: refactor the biosignalsplux Bluetooth acquisition into a robust, multi-threaded streaming architecture
- Synchronisation & sensor fusion: align physiological and Varjo eye-tracking streams on a common clock; handle drift, jitter and different sampling rates
- Real-time processing: integrate windowed preprocessing, artefact detection and feature extraction via MultimodalPhysioKit
- Model integration & output: run live inference and stream predictions to the NovaSim control interface
- Benchmarking: quantify end-to-end latency and stress-test against packet loss, reconnects and desync

Zeitraum:	Effective immediately, by arrangement
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