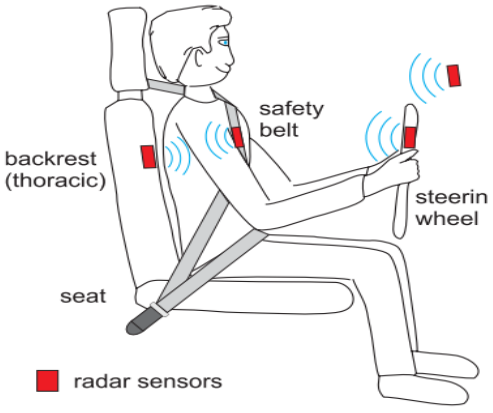
Radar based in-vehicle health monitoring

Continuous monitoring of human physiological states and health conditions in vehicles has received considerable attention due to ever-increasing safety and healthcare concerns in recent years. Physiological indicators, such as heart rate (HR) variability (HRV) and breathing rate (BR), can be used for assessing drivers' status such as drowsiness and monitoring occupants' health condition [1], [2].

These physiological signals are conventionally measured with electrocardiogram (ECG) and respiratory inductance plethysmography (RIP), which often require attaching electrodes or belts to the subject as well as having cables around. Consequently, those solutions are not suitable for real-life driver monitoring. Radar technology, which uses radio waves sensing an object, is of great potential in this area for being unobtrusive, no need for direct contact, easy integration into vehicle environment, etc.

This project will be conducted at Chalmers and Autoliv. We will investigate a radar-based solution for HR / HRV and BR monitoring in vehicle environment. Different measurement setups, such as the radar sensor position and placement, different clothing on the test persons, robustness to subject movement, etc., will be tested. Particularly potential integrated solutions of radar sensor will be developed and investigated. One part of the challenge is related to obtaining a high-quality signal from the measurement object, even in difficult situations where the driver wears relatively thick clothing and is moving considerably due to turning the driving wheel. Another part of the challenge is related to effective signal processing and classification to be able to derive HR / HRV and BR from the signal, even when the measurement signal is of lower quality and may contain artifacts due to movements and other disturbances.

A typical measurement setup in the lab



Envisioned radar sensor integration

Prerequisite:

Master students in biomedical engineering (MPBME), wireless, photonics and space engineering (MPWPS) or other electrical engineering and engineering physics programs. Knowledge of EM waves and microwave radar is a merit.

Supports:

Students will have the access the microwave lab at E2 Chalmers, as well as driving simulator and test vehicle from Autoliv.

Economic compensation will be offered upon finishing the project by Autoliv

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References

[1] K. Fujiwara *et al.*, "Heart Rate Variability-Based Driver Drowsiness Detection and Its Validation With EEG," *IEEE Trans. Biomed. Eng.*, vol. 66, no. 6, pp. 1769–1778, 2019.

[2] F. Guede-Fernández, M. Fernández-Chimeno, J. Ramos-Castro, and M. A. García-González, "Driver Drowsiness Detection Based on Respiratory Signal Analysis," *IEEE Access*, vol. 7, pp. 81826–81838, 2019.

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