

Praxis der Forschung: Integrating Multispectral Sensor to OpenEearable 2.0

1 Background

Diabetes Mellitus (DM) is a chronic, progressive metabolic disease marked by sustained elevations in blood glucose levels, resulting from impaired insulin production, resistance to insulin action, or a combination of both [5]. It affects millions of people worldwide and represents a major public health concern due to its substantial impact on morbidity and mortality [4].

Self-monitoring of blood glucose level (BGL) has long been recognized as a key component of treatment regimens and an essential requirement in diabetes management [6]. Traditionally, people check their BGL with finger-stick tests that draw a tiny blood sample by pricking the skin. Because this can be painful and inconvenient, many patients fail to adhere to the schedule. To make things easier, studies are exploring non-invasive ways to measure BGL more comfortably [1].

Headphones are among the most widely adopted wearable technologies, shaping how people engage with media, manage attention, and interact with their surroundings. Beyond private audio consumption (music, podcasts, calls), PLDs increasingly function as multifunctional *earables*: ear-worn devices equipped with additional sensing capabilities that support fitness tracking, health monitoring, etc.

There are very few studies that explore non-invasive BGL detection from the biosignals collected from the ear [2, 3]. These studies primarily rely on the Polyplethysmography (PPG) sensor, and the detection models are complex and not suitable for running on resource-constrained environments. Additionally, multi-spectral sensor-based BGL detection has not been explored in BGL detection with earables yet. In this Praxis, you will be working on evaluating and integrating a multispectral sensor for BGL detection in Openearable 2.0.

2 Tasks

- Review literature on optical BGL sensing: viable in-ear/on-ear sites, outlining detection principles, noting optimal wavelengths, and summarizing ear-focused studies.
- Evaluate multispectral sensors in the market and identify the suitable ones for BGL detection, as well as match the specifications of Openearable 2.0.

- Integrate the finalized sensor into OpenEarable 2.0.
- Conduct a study with the final product to evaluate the heart rate of the user.

3 Requirements

- Strong programming skills (C++, Python)
- Basic knowledge of busses such as I2C and SPI
- Interest in sensor driver development
- Experience in working with PCB design
- Interest in working with embedded programming
- Experience in signal processing (Optional)

If you are interested in this topic, please contact Supraja Ramesh (supraja.ramesh@kit.edu) / Michael Küttner (michael.kuettner@kit.edu).

Reference

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- [2] Ghena Hammour och Danilo P Mandic. “An in-ear PPG-based blood glucose monitor: A proof-of-concept study”. I: *Sensors* 23.6 (2023), s. 3319.
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- [4] Ghulam Murtaza m. fl. “Examining the growing challenge: Prevalence of diabetes in young adults”. I: *Medicine International* 5.1 (2025), s. 1–8.
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- [6] Mahdi Zeynali m. fl. “Non-invasive blood glucose monitoring using PPG signals with various deep learning models and implementation using TinyML”. I: *Scientific Reports* 15.1 (2025), s. 581.