Sustainable Design of Online Biosensors

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Introduction

The sector of information and communication technology (ICT) has seen a steady increase in global energy consumption, accounting for 5-8% of global electricity consumption in 2020 and for 3% of all greenhouse gas emissions [1]. In particular, the evolving Internet-of-Things (IoT) will become a major consumer with a projected increase from 15×10^9 devices in 2015 to 75×10^9 in 2025 [1]. Biosensors for medical monitoring or fitness trackers are mostly designed as IoT devices and the question is how to design them so that their use will not neutralize sustainability efforts.

Results and Discussion

1. The sustainability of biosensor systems under development can be assessed on the basis of the 17 UN Sustainability Goals (SDG).

2. Solutions developed by the smartphone manufacturer Fairphone and others may be used for material selection and sustainable production processes of biosensor systems.

3. MICS [2] or BTLE [3] are suitable for energy-saving and harvesting for real-time data transmission of online biosensors.

4 Medical monitoring of patients is undergoing a transition from external wearables such as wrist- and skinpatches, rings, chest straps, headbands, etc. to semi-implants or implant-table biosensors. While the first are used to monitor bodily functions, the latter apply to bio-chemical analytes and biomarkers in the body.

5. Wearable and biosensor users are currently confronted with an unsustainable structure of the Internet. An oligopoly of a few large platforms dominates almost all areas via operating systems for smartphones (Google's Android, Apple's iOS) or computers (Microsoft Windows) and via “social” media (Twitter's microblogger, Meta's Instagram, Facebook and WhatsApp, and Google's YouTube).

6. Information is tapped from users via non-transparent spying techniques in order to derive personality profiles for commercial and political advertising campaigns [4].

7. Health data are subject to special protection according to Art. 9 of the European GDPR.

8. Given the current state of the internet, it may not be expected that this protection can be guaranteed if systems or services are used from the above-mentioned oligopoly.

9. Data storage for online biosensor should be designed in edge mode, so that the data is stored at the user's site and transferred to other entities such as the treating physician only with the user's explicit consent.

10. Tools and apps developed by the FOSS community (free-and-open-source software) should best be used for data processing. A good example is the DRIP app for cycle monitoring, whose basic principles may be applied to biosensors for other parameters.

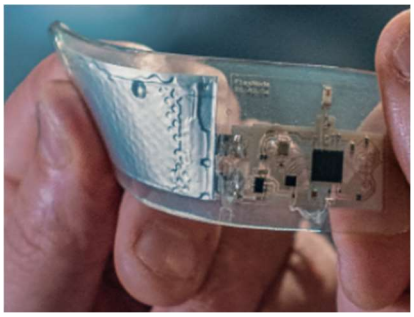

Figure 1: *Roll-to-Roll (R2R) manufactured biosensor with an elastomer integrated BLE utilizing sustainable components for real-time sensing onto e.g., skin*

Conclusions

A CO_2 footprint minimizing design of online biosensors should always be considered in order to meet SDG 7 and 13. Furthermore, the current structure of the Internet with a few Big-Data monopolists is highly unsustainable. The profits from the personal data obtained exceed the budgets of most states on earth, which is incompatible with SDG 10 that calls for reducing income inequalities within and among countries. Given the current situation, biosensor data should be stored only locally.

References

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