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enabling continuous patient monitoring in clinics infrastructure for automated data capture from wearables

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Project Goal

Development and operation of infrastructure for automated data capture from wearables and other connected biomedical sensors in closed medical environments.

Background

Continuous and reliable data collection is a major challenge in the medical field. Wearable devices offer the opportunity to monitor patients continuously and provide deeper insights into patients health status. However, the abundance of data obtained through these channels require sophisticated data management and processing tools.

The presented infrastructure is built on top of Leitwert's Device Management Server (DMS) and **automates** the readout of wearable devices worn by hospitalized patients using wireless technologies. This renders the system scalable and economically viable.

This system aims to integrate wearable device technologies into the clinical routines in healthcare facilities in order to increase patient safety and efficiency in patient monitoring. It **promotes co-creation and collaboration** across the healthcare ecosystems.

Innovation

The **device agnostic platform** is open to multiple devices from independent manufacturers which are operated on the same infrastructure.

The architecture of the system facilitates the data storage on local servers, therefore transferring the data sovereignty to the healthcare provider who is already a trusted entity and offers maximum flexibility to comply with local data protection regulations.

This project paves the way for the **systematic integration of wearable medical devices in clinical workflows** such as continuous measurements of vital signs in hospitalized patients for the assessment of clinical early warning scores. Typically, nursing personnel measures the relevant vital signs manually three times a day. However, depending on the vital parameter and the health condition this can be necessary much more often, e.g. in case of irregular blood pressure. The presented approach increases the quality and efficiency of the monitoring tasks, ultimately **benefiting patient safety.**

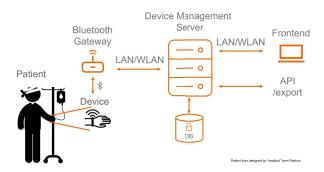
Open Ecosystem

Besides commercially available medical devices, also research devices can easily be integrated. For example, the MHSL Activity Tracker Framework of ETH Zürich^[1] is protocol compatible with the infrastructure. It delivers researchers and clinicians a transparent and easy to configure tool for tracking activity in large cohorts through our system.

[1] http://www.mhsl.hest.ethz.ch/Tools/PhysicalActivityTracker.html

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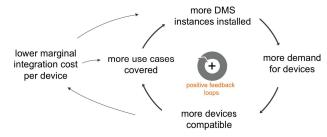
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How it works: As soon as a device is within the reach of a Bluetooth Gateway, a connection is established to collect the latest data and transfer it to the Device Management Server. There the data is available for further processing directly on the local server or by 3rd party applications via API. The system provides standardized processes for device management, assignment and revocation of devices to patients as well as various patient and device monitoring options. The data is accessible through a frontend over a browser.

Business Potential

The presented DMS setup exhibits the typical architecture of a **platform**: it matches value providers with value consumers and allows 3rd parties to develop use cases based on the platform infrastructure. Platform economics can be boosted by demand side economy of scale which unlock self-reinforcing two-sided positive network effects.



Platform economics can be boosted by positive feedback loops.

For health centres a centralized way to manage fleets of wearable devices is highly desirable. Device Management includes configuration and firmware management, device monitoring (e.g. battery level) and maintenance (e.g. charging, sterilization, ...). With the presented infrastructure this can either be done by the clinic itself, a 3rd party or the device manufacturer.

A single centralized platform to manage devices is economically much more attractive and convenient than managing an entire infrastructure per device type. Additionally, the integration cost of a new device type can significantly be reduced. Finally, by using the DMS as a device agnostic platform, an institution is not locked in with a certain device manufacturer.

For medical device companies the system significantly reduces the barrier to get medical devices integrated into a clinical IT infrastructure. With every instance of the system installed at a healthcare institution, the attractiveness for device manufacturers increases as the demand for devices increases.

Beyond clinics: the DMS technology stack is also well suited as middleware for applications in remote monitoring and home care.

Timeline of the project: the system is operational since April 2018.





Device-agnostic management system for automated data capture from biomedical mobile sensors or wearables in clinics (DMS)

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Background

The number of biomedical mobile sensors such as wearables, provided by various manufacturers with device-specific platforms increases daily, generating a huge amount of sensitive data. Health care providers and researchers face the challenge to capture, store and manage their patients data according to high clinical standards.

Purpose

Development of a device-agnostic management system (DMS) to face concerns in terms of data privacy and to handle the increasing number of devices. Data sovereignty should remain at the hospital to provide a transparent data process e.g. for high quality clinical trials.

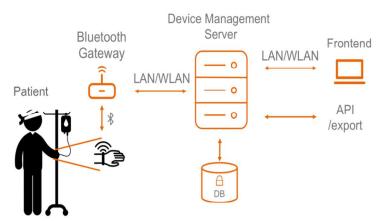


Figure 1: Operating principle of the Device Management System (DMS)

Methods

The platform is open to any device from third-party manufacturers with unlocked API (application programming interface). They connect via Bluetooth or Wi-Fi. The data gets accessible through a browser-based frontend.

The architecture of the system facilitates the data storage on local servers (see Figure 1), meaning that the healthcare provider (University Hospital Basel), who is already a trusted entity, keeps data sovereignty.

The technology allows data management, data exchange and therefore product development within a transparent and well-regulated cooperation between healthcare institutions and companies with commercial interests.

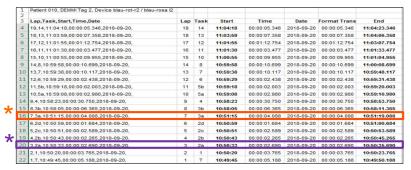
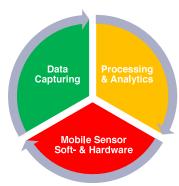


Table 1: By using timestamps, data can be labeled. The Section «Task» displays certain movement figures of the patient (see Figure 3)

Our Vision:

Providing an *end-to-end* solution for the use and R&D with wearables at the University Hospital Basel



Status

The 1.0 Version of the system was successfully embedded into the IT-infrastructure of the University Hospital Basel and is functional. Until mid-June 2018, two different devices from two manufacturers were linked and the system was tested for its performance. Currently two explorative research projects are using the platform. One collaboration with the UKBB and the iMove-trial which generates accelerometric movement patterns of in-house patients from an upper arm worn wearable (see Figure 3). Data is captured, labeled and exported via the platform.

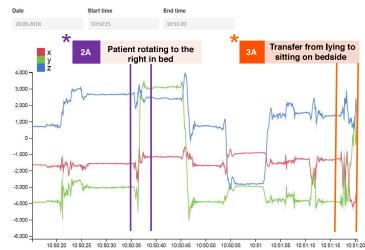


Figure 3: The browser-based frontend allows visualization, further labeling and export of the collected data (see Table 1)

Outlook

This technology might pave the way for the systematic integration of wearable medical devices in clinical workflows, such as continuous measurements of vital signs in hospitalized patients combined with early warning scores by integrating deep neural networks. In addition with an app (which functions as a gateway) it might be possible to discharge patients earlier by checking their vital signs remotely.

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