Low power activity monitoring using accelerometer data from an inertial measurement unit (IMU)

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Purpose Activity monitoring of elderly people and geriatric patients can help improve their physical and mental fitness, prevent illness, detect emergency situations, and accelerate the recovery process. The goal of this project was to develop and implement a holistic concept in which people´s physical activity can be measured, and their type of movement recognized. This data should be recorded in regular time intervals, so the behavior of a person, in dependence on the time of the day, can be interpreted later. The data should be acquired by and stored on a microcontroller with the ability to operate for at least one week without the need of recharging or data streaming. A small device size is also required, to increase user acceptance and usability. **Method** A custom-made device that can be attached to the belt was built and equipped with a low-power IMU sensor module (a 3-axis accelerometer) and a microcontroller with BLE (Bluetooth Low Energy) functionality. The device can be attached to the belt in different ways and will recognize its orientation automatically. It is possible to identify whether the person is lying on the back, on the front, on the right side or on the left side, jumping, running, or walking. Weak gaits that cannot trigger step counting will also be accounted for. The activity data is stored on the microcontroller for up to a week, occasionally read by a Raspberry Pi via BLE and transferred to a database. These database entries can be visualized and evaluated on the Node-RED dashboards, one of which is shown in Figure 1. Compared to (Kurban & Yildirim, 2019), (Sansrimahachai et al., 2017), or (Capela et al., 2016), our approach does not require machine learning and thus, requires only low computing power and low data storage capacity on the microcontroller. Because of that, our application does not require a constant BLE connection for data streaming, which leads to a decreased energy consumption, a longer battery life and an overall smaller device size. The wireless architecture is shown in Figure 2. **Results and Discussion** The developed concept enables comprehensive activity monitoring. The saved activity data not only contains information about the type of movement, but also about the intensity, repetition, and duration of that movement in relation to the time of the day. This data can be used by doctors or other professionals to evaluate a person's overall health. Due to the long battery life, (older) people, who are not technically adept, do not have to recharge the device by themselves, but can get help from family members or other professionals once a week.

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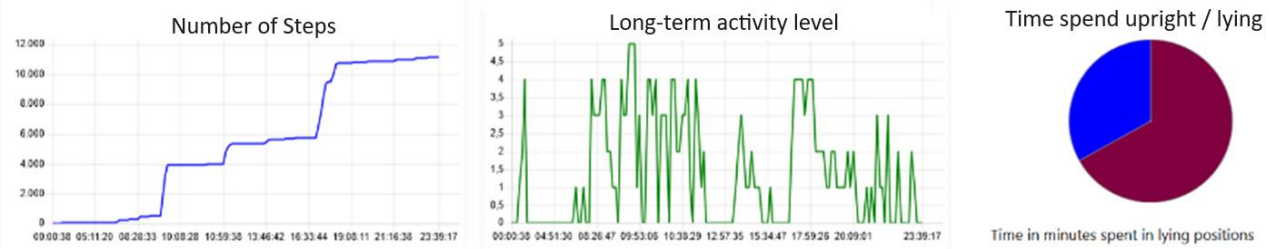

Figure 1. Node-RED dashboard "Activity diagrams for the selected day."

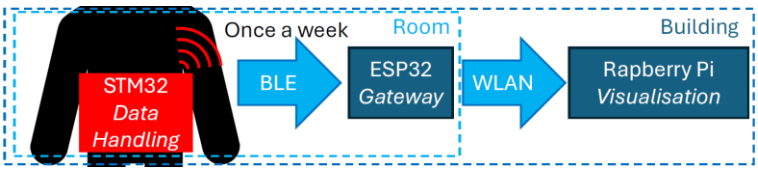

Figure 2. Wireless communication architecture.