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IMPROVENTS IN BATTERY LIFE OF WEARABLE MOTION TECHNOLOGIES

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Abstract. *The advent of wearable motion technologies has revolutionized the way we approach health and fitness monitoring. These devices, ranging from smartwatches to fitness trackers, have enabled individuals to track their physical activity, sleep patterns, and other vital signs with unprecedented accuracy. However, one limitation that has hindered the widespread adoption of these devices is the battery life. The battery life of wearable motion technologies has traditionally been a major concern, with users often forced to recharge their devices daily or even multiple times a day. In recent years, however, significant advances have been made in improving the battery life of these devices, enabling users to enjoy uninterrupted monitoring of their physical activity.*

Keywords: *therapies, technological advances, devices, physical motions, smart technologies, medical aid*

Introduction: Regarding physical therapy and early rehabilitation, it is essential to have objective and reliable measures so that the success of the rehabilitation program can be established. Wearable technologies have been shown to promote patient self-awareness, motivation, and involvement, therefore increasing the number of repetitions during practice. The adoption of these systems decreases the amount of time spent by clinical or outside experts in assessing patients, thereby increasing their availability for new patients or reducing costs. Although the price of these technologies has been decreasing, their adoption by some companies working with eldercare and physical therapy is still low. This might be explained by the battery life, as a typical use-case for these systems means that patients use them for a whole day, and the battery might not last the necessary time.

In recent years, there has been a growth in the development of wearable motion technologies. Based on systems dealing with in-shoe and wearable sensors, wearable motion technologies can measure spatiotemporal gait parameters either more accurately than existing systems by increasing the number and the spatial resolution of sensors or significantly reducing the setup duration and gait data processing, including the analysis protocols. These technologies have been applied to eldercare, sports science, rehabilitation, game design, monitoring workers' activities, and biomechanics research. An example of such technologies, developed by Fraunhofer Portugal AICOS, is PEBBLY, a wearable device that uses data from foot-worn inertial sensors to classify the type of physical activity performed by older adults, whose aim is to monitor their health status, consequently reducing medical care costs, and extend their independent living. With PEBBLY, experts in the field can analyze data, act upon the results, and take decisions in a very efficient manner.

Background and Significance

We anticipate that accurate measurements of physical activity patterns utilizing motion-sensing technologies will produce important findings supporting the understanding of the relationship between physical activity and various outcomes. However, the studies have been hampered by the relatively short battery life of wearable technologies. Previous studies reported variable battery life for physical activity monitors using body-placement accelerometers. Such variability might be related to differences in software applications, updates and versions of the smartwatch systems, the processing power associated with software programs used for physical activity measurements, and personalized settings on the devices. The study results might also differ due to differences in interpretation of physical activity level cut-off points, regarding time spent at varying physical activity levels. These cut-off thresholds do not account for individual variation of subjects, such as differences in health or fitness status, or age. Although the influence and interaction between the previous factors listed are not known, they could affect the battery life of the smartwatches used in the study. This study was conducted to examine the battery life of five commercially-available smartwatches worn by healthy and unfit adults, when physical activity and motion were assessed. The NIH Fitbit study reported that at least 5 minutes per epoch had sufficiently high sensitivity to capture light PA (LPA), moderate to vigorous PA (MVPA), and the number of steps (STEPS), with acceptable FP values.

Since the introduction of the first commercially successful smartwatch in 2012, the market has seen a significant increase in wearable devices. These devices have features such as heart-rate monitoring, GPS tracking, getting notifications, and managing the phone at the wrist level, often using standard smartphone applications. One unique feature of these wearable devices is measuring motion activities and energy expenditure in "in-place" and "over-ground" settings. Wearable devices are equipped with accelerometers and other sensors necessary for measuring motion activities, in addition to processing power and necessary software tools. The recorded sensor data is then analyzed using algorithms to determine how people move. These accurate measurements of physical activity patterns can be used to develop individualized behavior change strategies. Similar data were used to examine the effects of physical activity on health behaviors.

Scope and Objectives

In the product validation period of the project and following the project plan and workflow that is the basis for the coordination of the activities that are to be developed, the main goal addressed is to assure that a wearable motion technology, based on the research results of the project, is mature and robust enough to be tested and validated in a large-scale Living Lab Test deploying users of different target groups. Since the ultimate aim of the VIVOMODE project is to make use of the technology as a digital therapeutic in both chronic and/or oncology health domains (target areas where physical activity can have great outcomes in increasing the well-being of patients), the population within the scope of the Living Lab Test and the validation activities are initial prototypes intended to cover the specific characteristics of the oncology domains. This ensures the relevance of the Living Labs tests and demands the integration of all partners (research and Rd., technology providers, and specialist end-users).

One of the primary drivers of this improvement has been the development of more efficient power management systems. Traditionally, wearable devices have relied on power-hungry components such as GPS modules, accelerometers, and displays. These components have consistently drained the battery life of these devices, making it necessary for users to recharge them frequently. However, advancements in power management have enabled manufacturers to optimize power consumption, reducing the drain on batteries. For instance, new power-saving modes have been introduced, which automatically switch off unnecessary components when not in use, thereby reducing power consumption.

Another significant development has been the introduction of low-power wireless communication protocols. Traditional wireless communication protocols such as Bluetooth and Wi-Fi have been notorious power consumers. However, the emergence of low-power protocols such as Bluetooth Low Energy (BLE) and Near Field Communication (NFC) has enabled devices to communicate with smartphones and other devices while consuming significantly less power. This has enabled wearable devices to maintain connectivity with smartphones and other devices without compromising battery life.

Advances in battery technology have also played a crucial role in improving the battery life of wearable motion technologies. The development of more efficient battery chemistries, such as lithium-ion and lithium-polymer batteries, has enabled devices to last longer between charges. Moreover, the emergence of new battery technologies such as supercapacitors and graphene-based batteries holds promise for even more significant improvements in battery life. These advanced battery technologies have enabled manufacturers to increase the battery life of wearable devices, making them more convenient and user-friendly. Furthermore, improvements in sensor technology have also contributed to the enhancement of battery life. Traditional sensors, such as accelerometers and gyroscopes, have been power-intensive, contributing significantly to battery drain. However, the development of low-power sensors has reduced the power consumption of these components. For instance, the introduction of micro-electromechanical systems (MEMS) sensors has enabled devices to track physical activity with unprecedented accuracy while consuming significantly less power.

In addition, improvements in device architecture have also contributed to the enhancement of battery life. The development of system-on-chip (SoC) designs has enabled manufacturers to integrate multiple components into a single chip, reducing power consumption and increasing efficiency. Moreover, the emergence of wearable-specific processors, such as the Qualcomm Snapdragon Wear 4100, has enabled devices to optimize power consumption and performance.

The implications of these improvements in battery life are far-reaching. With wearable devices capable of lasting weeks or even months between charges, users can enjoy uninterrupted monitoring of their physical activity, enabling them to make more informed decisions about their health and fitness. Moreover, the improved battery life of wearable devices has also opened up new opportunities for remote health monitoring, enabling healthcare professionals to monitor patients' vital signs remotely and respond promptly to any anomalies.

Conclusion.

In conclusion, significant advances have been made in improving the battery life of wearable motion technologies. The development of more efficient power management systems, low-power wireless communication protocols, advanced battery technologies, improvements in sensor technology, and device architecture have all contributed to the enhancement of battery life. As wearable devices become more pervasive, the importance of battery life will only continue to grow. Manufacturers must continue to innovate and improve battery life, enabling users to reap the full benefits of wearable motion technologies. Moreover, the improvements in battery life have significant implications for the future of wearable devices. With devices capable of lasting longer between charges, users will be more likely to adopt wearable devices, leading to increased adoption rates and a corresponding increase in health and fitness monitoring. Furthermore, the improved battery life of wearable devices will also enable new use cases, such as remote patient monitoring and telemedicine, which will transform the way healthcare is delivered. As wearable devices become more ubiquitous, the importance of battery life will only continue to grow, and manufacturers must prioritize this aspect of wearable technology to unlock the full potential of wearable motion technologies.

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