Adam Belmonte

Response Essay: Dr. Winfree

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Wearable Technology Applications Across Platforms

**Research Topic Overview & Purpose**

The world’s leading organizations promoting health and disease focused literacy and prevention, like the World Health Organization, agree that physical activity (PA) is a central part to maintaining a healthy lifestyle and to avoiding potential health complications. They all also conclude that measuring PA is dependent on three main methods; self-report questionnaires, direct observation by a trained professional, or from wearable devices. These methods all include inherent bias and variability that leads to a general lack of certainty when quantifying PA, leaving researchers on shaky ground when attempting to draw definitive causal conclusions. In addition, self-report and observational methods are prohibitively expense when applied to anything but small samples.

Of the above mentioned methods for measuring PA, the use of wearable devices is becoming the new research standard due to its objectivity and ability to be effectively implemented on large scales. With a robust consumer electronics market creating a culture centered on wearable fitness technology, the foundation for large scale data collection is being established if researchers are able to tap into it. A main component of Dr. Winfree’s research is to bridge the gap between commercially available wearable fitness technologies and the accurate quantification of PA and other behaviors influencing overall wellness. More specifically, Dr. Winfree’s research is based on the examination of the accelerometer technology that provides the measurements central to the functioning of wearable fitness technology. Beyond quantifying fitness and PA, this research focuses on what exactly accelerometer data can help portray related to human behaviors of all kinds.

One of the major hindrances to any large-scale research of human PA is not being able to accurately and efficiently account for the nuances that comprise PA. Traditional methods for assessing PA, such as self-report and direct observation, lack the ability to apply detailed data collection methods to large samples because of the associated costs related to scaling to large groups. The advent of low-priced commercially available wearable fitness devices has allowed for PA to be cataloged, tracked, and collected by a company’s databases and proprietary algorithms. With roughly 80% of the market share, Fitbit is the leader in development and implementation of wearable fitness technologies and also maintains proprietary algorithms that compile and relate user’s behavior back to them with no technical expertise required. Behind the veil of copyright law and ownership, the user (and researchers) cannot be sure exactly what and how these measurements are being measured. Dr. Winfree is investigating the structure of and relationships between these proprietary algorithms that govern commercial wearable fitness technologies, so that these devices can be used freely in various research pursuits.

While not necessarily backsolving these algorithms, understanding how they relate to other known methods and metrics for quantifying PA can allow for this massive pool of commercial (i.e. Fitbit) user data to become relatable for large scientific endeavors. To accomplish this, Dr. Winfree has compared Fitbit data to other data derived from other commercially available accelerometer-based wearable fitness technologies (like ActiGraph). The Freedson VM3 equation for tri-axial accelerometer estimates energy expenditure translates such data into viable measurements of PA-based energy expenditure. Essentially, the Freedson VM3 equation is able to translate a human’s physical motion into units of energy and can thus account for any possible variations derived from other accelerometer-based technologies. Using the Freedson VM3 as a baseline, Dr. Winfree was able to successfully compare Fitbit and ActiGraph units (and algorithms) and create a quantifiable relationship between the units. In turn, this allows for Fitbit devices to step beyond proxy data and be used in financially feasible large scale research into the intricacies of human PA.

**Research Questions**

-How can commercially available accelerometer-based wearable fitness technologies be implemented for large scale research?

-How can tri-axial accelerometers more accurately quantify human movements and behavioral tendencies?

**Research Connections**

With my proposed research being centered around the UAV as the central tool for data collection, much of the technology that enables the UAV to operate has been rigorously developed in the commercial setting. A central component to the recent explosion of commercially available UAV technology can be attributed to the components enabling stable and autonomous flight, mainly the inertial measurement unit (IMU). At the core of the IMU is the application of data collected by one or many accelerometers, of which the multi (‘six’) axis accelerometer is the standard. The ‘six-axis’ accelerometer accounts for the roll, pitch and yaw of the aircraft in space as well as the x, y, and z axes which relates the aircraft to a geographic location. Taken together, this data is processed via an on-unit flight controller and used to adjust the overall presence of the UAV when under autonomous control, or relayed back to the pilot when under manual control.

The use of accelerometer data in UAV navigation and thus data collection is necessary and rolled into the background processing environment of the experience. This is similar to the use of accelerometers in wearable fitness technologies; necessary for functioning yet nearly invisible to the average and most ubiquitous user. Advancements in accelerometer technology, specifically to the precision and sensitivity, will enhance the data quality, quantity, and variety of applications available for researchers and consumers alike.