Chapter 53
Wearable Devices Data for Activity Prediction Using Machine Learning Algorithms

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ABSTRACT

Wearable devices are contributing heavily towards the proliferation of data and creating a rich minefield for data analytics. Recent trends in the design of wearable devices include several embedded sensors which also provide useful data for many applications. This research presents results obtained from studying human-activity related data, collected from wearable devices. The activities considered for this study were working at the computer, standing and walking, standing, walking, walking up and down the stairs, and talking while walking. The research entails the use of a portion of the data to train machine learning algorithms and build a model. The rest of the data is used as test data for predicting the activity of an individual. Details of data collection, processing, and presentation are also discussed. After studying the literature and the data sets, a Random Forest machine learning algorithm was determined to be best applicable algorithm for analyzing data from wearable devices. The software used in this research includes the R statistical package and the SensorLog app.

1. INTRODUCTION AND MOTIVATION

Wearable devices can generate multiple types of data such as heart rate, accelerometer, and gyroscope values, location, etc. This data is useful across multiple disciplines, including health care, cybersecurity, user interface design, personalizing social preferences, etc. Healthcare is one such institution that

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is leveraging this medium of data collection and performing analytics that is informative to healthcare providers, administrators, pharma companies and patients. Such analysis allows the audience in the domain of healthcare to maximize their returns either commercially or personally at an individual level.

Activity Recognition is an emerging field of research, born from the larger fields of ubiquitous computing, context-aware computing and pervasive computing (Pierluigi, Oriol & Petia, 2011; Sztyler & Stuckenschmidt, 2017). Recognizing everyday activities and its relation to overall wellness is generating a lot of interest in the research community of data scientists, pharmaceutical companies and healthcare professionals. Research also documents that monitoring physical activity in real life vs. a controlled environment provides a better context to evaluate patients and or other interested clients (Sztyler & Stuckenschmidt, 2016). The use of accelerometers and gyroscopes in wearable devices such as smartwatches and smartphones are now widely accepted for monitoring physical activity and tailoring interventions as needed (del Rosario, Redmond & Lovell, 2015; Akker, Jones, Hermens & Hermie, 2014), without purchasing expensive wearable ambulatory monitors. Smart phones have also proven to be extremely useful to monitor the activity levels of construction workers, a context which provides a wealth of information for project management related to their work (Akhavian & Behzadan, 2016).

Fitness tracking devices are gaining in popularity and new devices are entering the market at regular intervals. Wearable devices include accelerometers, Gyroscope, barometers, and altimeters to provide high-quality data which is useful for tracking posture, activity, HR, sleep, etc. (Henriksen et al., 2018). A wearable device has the potential to be integrated as an intervention to increase physical activity embedding it as a change to lifestyle (Ridgers et al., 2018; Cadmus-Bertram, 2017; Maher, Ryan, Ambrosi & Edney, 2017) Many of these devices are being used for data collection and research on various aspects related to individual health including monitoring physical activity, sleep quality, heart rate, etc. and their impact on patient health.

The literature reviewed cited above demonstrates that recent studies have analyzed accelerometer data and have investigated the data for physical activity recognition. Nevertheless, few of them have undertaken the difficult task of performing experiments out-of-the-lab. The conditions to perform experiments out-of-the-lab create the need to build easy to use and easy to wear systems to free the testers from the expensive task of labeling the activities they perform. This study attempts to address this challenge and afford the ability to generate and analyze data outside the lab in an open and free environment using data recorded by the accelerometer on wearable devices or cell phones. Data generated in such a format can be used to train models using machine learning algorithms and use the models to test new data.

Random Forest machine learning algorithm was used in this study. A review of recent literature suggests that when the Random Forest algorithm's performance was compared to other techniques such as support vector machine, C4.5 and *k*-nearest neighbor methods, Random forest was the most accurate and suitable for the analysis of data from wearable devices (Balli, Sağbaş & Peker, 2019; Henriksen et al., 2018; Zhang, Stogin & Alshurafa, 2018). Random Forest was also documented to be specifically reliable to predict the gait of a subject. (Ahamed et al., 2018) which is applicable to the current research. Random forest is one of the most popular machine learning algorithms. Machine learning algorithms are successful because they provide in general a good predictive performance, low overfitting, and easy interpretability. This interpretability is given by the fact that it is straightforward to derive the importance of each variable on the tree decision. In other words, it is easy to compute how much each variable is contributing to the decision. Random Forest algorithm has also yielded high accuracy in classification problems due to the identification of important features (Natarajan, Kumar & Selvaraj, 2018).

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