# Chapter 17
# Predicting Human Actions Using a Hybrid of ReliefF Feature Selection and Kernel-Based Extreme Learning Machine

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## ABSTRACT

*Human activity recognition (HAR) is a growing field that provides valuable information about a person. Sensor-equipped smartwatches stand out in these studies in terms of their portability and cost. HAR systems usually preprocess raw signals, decompose signals, and then extract attributes to be used in the classifier. Attribute selection is an important step to reduce data size and provide appropriate parameters. In this chapter, classification of eight different actions (brushing teeth, walking, running, vacuuming, writing on the board, writing on paper, using the keyboard, and stationary) has been performed with smartwatch motion sensor data. Forty-two different features have been extracted from the motion sensor signals and the feature selection has been performed with the ReliefF algorithm. After that, performance evaluation has been performed with four different machine learning methods. With this study in which the best results have been obtained with the kernel-based extreme learning machine (KELM) algorithm, estimation of human action has been performed with high accuracy.*

DOI: 10.4018/978-1-7998-2460-2.ch017

## INTRODUCTION

Wearable sensors are becoming popular in many areas such as medical, security, entertainment and commercial fields. These sensors are exceedingly useful in providing reliable and accurate information about people's actions and behaviors thus, a safe and healthy living environment is provided (Mukhopadhyay, 2015). Thus, it is possible to develop a more successful technology that can track the walking of older people who are in search of a measure against falling. In addition, a cost-effective system can also be established to investigate the relationship between a person's health status and the total number of daily living activities. The initial step in this direction is to develop a system that can classify a walking data set into different everyday life activities (Gupta & Dallas, 2014).

Monitoring and classifying human activities from wearable sensors can provide valuable information about patient's mobility outside the hospital environment. Research in this field has attracted a great deal of attention in recent years. An activity monitoring approach that works with ubiquitous technologies and can be applied in clinical populations will provide great benefit to the decision making process based on the evidence for people with movement handicap (Capela, Lemaire & Baddour, 2015). Smartphones and smartwatches provide a handy, wearable, useful, easy-to-use computing environment rich with storage and computing power. Most of HAR systems have been developed for smartphones. Some of these systems use internal sensors and some use external biological sensors (Incel, Kose & Ersoy, 2013; Pantelopoulos & Bourbakis, 2010). When measuring movement or position, gyroscopes and accelerometers are prevalent selections because these sensors are affordable, small size, and can easily attach to the body. Several smartwatches and smartphones include gyroscopes and accelerometers thus; they are perfect devices for tracking in rehabilitation or real life environments. Wearable device sensors are used to measure the quality of post stroke movement such as upper extremity movement or walking characteristics (Patel, Huges, Hester, Stein, Akay, Dy & Bonata, 2010; Mizuike, Ohgi & Morita, 2009). Activity levels are usually measured by the number of passing of a certain threshold of total acceleration using accelerometer or other sensor data worn on the body (Fulk & Sazonov, 2011; Steele, Belza, Cain & Warms, 2003). On the other hand, activity level analysis lacks of content-based information. A system that provides content-based info about a person's actions will be a special interest for researchers and healthcare professionals (Capela, Lemaire & Baddour, 2015).

General guidelines for HAR are preprocessing, segmentation, feature extraction, feature selection and classification. Although a large number of attributes can be extracted from a raw signal, the accuracy of the classifier is not necessarily increased because the redundancy of the features is not a class indicator. For this reason, the feature selection process is used to decrease the data dimension and forward valuable attributes to the classifier (Capela, Lemaire & Baddour, 2015).

Unlike previous works, the main contribution of this study is to use hybrid methodology including ReliefF and KELM for feature selection and classification, respectively. Additionally, a new data set is constituted by collecting data from smartwatch motion sensors for this purpose. Eight different daily human activities (brushing teeth, walking, running, vacuuming, writing on the board, writing on paper, using the keyboard and stationary) are classified. In this study, sensor data (accelerometer, gyroscope) obtained from smartwatch is used and then 42 attributes are extracted. The ReliefF feature selection algorithm is used to detect the effective features. The obtained effective attributes are classified by KELM algorithm. Experiments have been carried out with different classification methods (support vector machine, kernel-based extreme learning machine, Naive Bayes and neural network) to evaluate the success of this algorithm.