Monitoring Human Performance with Wearable Accelerometers

Human-observer based methods for measuring human motion are labor intensive, qualitative, and difficult to standardize across laboratories, clinical settings, and over time. Moreover, many conditions that affect normal human movements are currently diagnosed during short visits to the clinician. Advances in wearable and wireless sensor networks have opened up new opportunities in healthcare systems. In this proposal, we will develop specific hardware and novel machine learning algorithms able to manage the response from several accelerometers and perform medical diagnosis on a variety of medical conditions. To make the accelerometer information accessible to doctors, machine learning algorithms are needed to extract, represent, and parse subtle human motion, body gestures, and pyschophysiological indicators from the stream of accelerometer data. Toward this goal, we have developed novel machine learning algorithms for temporal segmentation and classification of subtle human motion events. These techniques allows quantification of subtle human motion, allowing to improve monitoring and assessment of several medical conditions. In addition, our systems will provide full time monitoring and analysis using a lightweight wearable system. We propose four driving applications for our technology.

The scientific contribution of this proposal is in advancing machine learning, and human sensing in support of improved medical diagnose and treatment monitoring. The proposed work will: (i) model human activity and several symptoms through sensor analysis, (ii) integrate and fuse information from several accelerometers, automatically select indicatives of a disorder and monitor in real-time the well being of an individual, (iii) validate the efficacy of the automated medical condition detection through medical assessments applying current methods of diagnostic evaluation, (iv) propose novel machine learning methods for discovery of multiple temporal patterns that discriminate two sets of temporal signals (i.e. two medical conditions) , and (v) provide quality measures to characterize subtle human motion.

We expect that our wearable system will serve as an important reference for researchers interested in improving quality of life for the elderly and disabled. The technology proposed here may ultimately lead to automated assistance in elder care through more complete analysis, and evaluation of treatment improvement at home. On the other hand, wearable sensors will allow vast amounts of data to be collected and mined for next-generation clinical trials. Data will be collected and reported automatically, reducing the cost and inconvenience of regular visits to the physician. Therefore, many more study participants may be enrolled, benefiting biological, pharmaceutical, and medical-applications research. We also expect that our algorithms for temporal discovery of discriminative events will allow advances machine learning to other problems such as automated discovery of activity primitives in unlabeled data and unsupervised learning of activities.