Detecting Short Time-Duration Physical Activity Through Statistical Modeling of Accelerometry Data

Human activity detection forms a major part of the work being undertaken in IDH and has many applications in the healthcare domain. We are interested in being able to detect short time-duration activities from data collected from accelerometers placed on the body. As part of this work we are interested in adapting the use of time warping algorithms, particularly the Continuous Profile Model, for this purpose.

The Continuous Profile Model (CPM) is a model that allows for the simultaneous alignment of time varying data and the extraction of the underlying canonical template. Local variances in time can be dilated or constricted in order to being the data into alignment in time. The model makes the assumption that the input data are a set of measurements generated from an underlying process and uses the input set to model that process and align the input set in time. Other approaches, such as Dynamic Time Warping offer a similar approach to the problem, but through different underlying mechanisms.

The aim of this mini-project is to utilise and extend these approaches to detect short time-duration human motion activity from accelerometer data and to modify the approaches to add maximum-quantity constraints on the level of time manipulation.

The mini-project will consist of three phases. 1) Initial reading and acquisition of knowledge relating to the algorithms to be used. 2) Adaptation of algorithms to short time duration activity extraction. 3) Application of developed approaches to an existing data-set. The principal deliverable of the project will be an extension of one or more existing algorithms to detect short time duration activity from accelerometer data and an analysis of the new approach applied to existing data.

The student should be familiar with statistical models and have a good level of mathematical ability. Familiarity with Markov models in general and hidden Markov models in particular, and the underlying mathematics, is highly desirable. Familiarity with the expectation maximisation (EM) process would also be useful. The student will learn how to evaluate and understand an existing statistical algorithm and how to modify it for a particular task. They will also learn how this class of algorithm can be applied to experimental data.

This is an interesting project due to its applications in a number of fields. CPM originated as a technique with applications in speech processing and Liquid Chromatography - Mass Spectrometry and has been applied, through our own work, to detecting a person's activity patterns over time. It is this application we are most interested in, where the ability to control the amount of time variation gives us greater control over how behaviour is detected. This has higher level applications in healthcare and the detection of early warning signs in a broad spectrum of health conditions.

There are a number of avenues that could be explored from this initial project in the realm of human activity detection that would make suitable PhD projects. One such avenue would be to look at further extensions of the algorithm to automatically detect repeated segments of behaviour throughout the course of a single day or over multiple days. Another extension would be to apply these techniques to a cohort of people to analyse and generalise different activities to build a generic model.