The smart materials being developed by chemists in the CLARITY work programme will be integrated into body sensor networks and will allow a variety of important physiological and biometric indicators to be detected.

To date, most data gathering and experimentation with this technology happens within a laboratory. The Tennis Ireland installation provides infrastructure for data gathering, analysis and feedback that will allow this technology to be tested in the field, during real exercise. For example, the work on conducting polymers will result in textiles for measuring stretching, bending and pressure movements. This 'smart foam' will be built into the wearable platform of one of our industry partners and trialled with tennis players to monitor specific muscle movement and strain. Data collection and feedback can be piggy-backed on the existing system, with the added benefit of a synchronized multi-view video to augment expert analysis of data from the wearable sensors.

A longer-term example is the 'sweat patch' being developed to measure the pH of sweat. A change in sweat pH may signal an increased reliance on anaerobic metabolism, but there is a lack of reliable methods for assessing pH during exercise. CLARITY is working on a new fluid-handling platform based on polyamide lycra. The device consists of a super-absorbent material that provides a passive pumping mechanism to control fluid flow. The optical detection of pH-induced colour changes in the dye is achieved via a paired emitter-detector LED system. The Tennis Ireland installation provides an ideal framework for testing this innovative technology in a real application scenario with real users.

Please contact: Noel E O’Connor
CLARITY Centre for Sensor Web Technologies, Dublin City University, Ireland
Tel: +353 1 700 5078
E-mail: oconnorn@eeng.dcu.ie

Synchronizing Sensed Data in Team Sports

by Dónall McCann, Mark Roantree, Niall Moyna and Michael Whelan

In this article we will be discussing the synchronization of sensor data in team sports. Synchronization allows us to use more expressive queries, to query across all participants in a given activity and to potentially discover new knowledge from the semantically enriched data. A collaborative research effort between groups working on data management and on health and human performance (both at Dublin City University) involved a series of experiments using wearable sensors during team games and the capture and querying of sensed data.

When dealing with sensor data for a team sport, it is often useful to be able to query across multiple sensors and thus to be able to compare data from several players for any given moment in time. In order to do this, the data from all sensors must be synchronized so that the start time of the game or activity can be identified in the data from each individual sensor.

This is necessary because sensor devices may be activated asynchronously, since the device begins recording when it first comes into contact with the player’s skin. While many sensor devices will record a start time, this information is not necessarily reliable as there is often no correlation between the system time and the time kept by the match officials, or indeed between the times on any two sensors. In addition, the devices may be unreliable and may malfunction, or the device may become detached during the course of the game.

From an abstract perspective, sensors can be regarded as generating values that correspond to various states, eg first half, second half etc. A 'profile' is a combination of various states. Each state occurs once and in the order specified. The goal is to semantically enrich sensor data with an additional field that identifies the state associated with every sensor reading. Our method is to convert the sensor stream to XML, which facilitates the subsequent semantic enrichment process. In simple terms, the synchronization process involves identifying one or more specific moments in time, such as the beginning or end of the game. Once the reading corresponding to that time is identified, the data can be synchronized with the data from all the other devices involved in the experiment.

The sensors used in our experiments record a heart rate value every 5 seconds, and approximately 1200 values are generated while the device is worn. The six states corresponding to a Gaelic football match can be seen in Figure 1. This example graph is for a midfield player who has a profile of gradually increasing activity through Pre-Game and Warm-Up, and remaining constantly active throughout each half. This profile can be easily split into states because of the period of rest located between the two periods of high activity. However, this profile is atypical among the thirty players involved in a given game. A more typical graph is shown in Figure 2, corresponding to a defensive player. This graph is characterized by short bursts of activity interspersed with periods of rest, making it much more difficult to correctly identify the state boundaries. This provides a significant challenge to creating a generic process for normalizing and synchronizing sensor streams.

In order to perform our synchronization, we define a 'model' profile of the ideal shape of the data graph. This comprises two periods of consistently high activity on either side of a period of relatively low activity. This model profile is compared to the data from each sensor device until the closest match is found, in terms of intensity and dura-
Inertial Sensing: A Little Bit of CLARITY

by John Barton, Brian Caulfield & Niall Moyna

The increasing availability of cheap, robust and deployable sensor technology will usher in a new wave of ubiquitous information sources. A particular implementation of ambient sensors is in the area of wearable electronics in body area networks incorporating inertial sensing devices. As part of the CLARITY Centre for Sensor Web Technologies, the Tyndall Wireless Inertial Measurement Unit (WIMU) is being used in a number of projects focussing on two key themes: Health and Fitness, and Helping the Aged.

Wireless Inertial Measurement Unit

The Tyndall Wireless Inertial Measurement Unit (WIMU) is a 6 Degrees of Freedom (6DOF) inertial sensing device, comprising triple-axis accelerometers, gyroscopes (angular velocity) and magnetometers. The triple-axis acceleration and angular velocity sensor output values can be combined in a nonlinear matrix equation to give both position and orientation information. The system can be visualized by using a fixed frame of reference for position measurement (x, y, z), the Earth-Fixed Frame, and utilizing a moving non-inertial frame (u, v, w), the IMU-Fixed Frame, which has its axes parallel to those of the IMU sensors.

The 25mm WIMU was developed based upon Tyndall's 25mm modular wireless sensor node technology. It is one of a large family of layers currently available for the Tyndall25. The 25mm wireless node has been used to develop a platform for low-volume prototyping and research in the wireless sensor network domain. A number of research projects currently underway at the institute are using it as a platform for sensing and actuating in scalable, reconfigurable distributed autonomous sensing networks, and it is supported by Science Foundation Ireland (SFI) through Tyndall's National Access Program (NAP).

Link:
http://www.computing.dcu.ie/~isg

Please contact:
Donall McCann, Mark Roantree, Niall Moyna, Michael Whelan Dublin City University, Ireland E-mail: donall.mccann@computing.dcu.ie, mark.roantree@computing.dcu.ie, niall.moyna@dcu.ie, michael.whelan@dcu.ie