PhD studentship

Title
Platform and algorithm development for match and training load monitoring in football through body worn sensors

Timeframe
September 2013 - September 2016, Full time

Director of studies
Jos Vanreunterghem

Background
Success in football depends on the ability to kick a ball, yet equally on the ability to speed up, slow down, or rapidly change direction (Mohr et al., 2003). The importance of these so-called utility skills is recognised in football coaching, and has for example led to their inclusion in generalized football performance tests (Rösch et al, 2000). Sports medicine, on the other hand, has considered utility skills more from a biomechanical perspective, and has come to understand that most injuries in football occur in utility skills due to the excessive mechanical loading imposed on the musculoskeletal system during acceleration or deceleration, and increasingly so in the later parts of the game (Ekstrand et al, 2011).

Mechanical loading should not be confused with physiological loading in a cardiorespiratory or metabolic energy context. Utility skills with high acceleration or deceleration involve high external forces acting on the body leading to eccentric muscle contractions (Heiderscheit et al., 2005), torsional stress (Koga et al., 2010), compressive stress (Maly, 2008), or shear stress (Koga et al., 2011). These stresses to the musculoskeletal system are critical features of structural degeneration of bone, cartilage, muscle, tendon or ligament tissues, and with insufficient recovery will cause non-contact lower limb injuries. High mechanical loading does not necessarily mean high physiological loading, or vice versa. Despite a growing desire to monitor utility skills in training and during matches, the emphasis has been on trying to understand the physiological loading rather than mechanical loading. The latest scientific evidence about effective injury prevention suggests that one should also carefully monitor mechanical loading, but the notion of mechanical loading has not yet translated into coaching practices (Twomey et al., 2009).

There has been a rapid growth in popularity of GPS based systems or semi-automatic video based position tracking systems to track players. These systems are mostly known to register displacement. The displacement data, however, is inaccurate for high speed movements (Johnston et al., 2013), and is considered inaccurate for speed and acceleration estimation due to its low sampling rates (Gaudino et al, 2013). From these inaccurate datasets the role of utility skills involving acceleration or deceleration has only been addressed against metabolic cost or match fatigue (Osgnach et al., 2010;
Akenhead et al., 2013), not yet against mechanical loading. Manufacturers of GPS based systems have realised these shortcomings and since recently complemented the units with tri-axial accelerometers and gyroscopes measuring at high frequencies. This opens up a novel opportunity to measure mechanical loading, but three important steps are needed to facilitate translation into coaching practice: test its reliability, cross-validate the signals against lab-based measure of mechanical loading, and vector-based interpretation of the signals. This PhD proposal supports all three, yet with the main focus on the latter.

**Research aims**

These will be based around the mathematical challenges related to accelerometry data. The student will work in close collaboration with sport scientists, helping them identify meaningful patterns, and generating mechanically relevant summative outcomes, for example related to hamstring injury risk, or related to age differences in player loading during matches.

**Outcome deliverables**

1. A suitable database platform for sport scientists to upload accelerometry data and produce relevant outcome measures from the developed algorithms.
2. Publications related to the development of vector-based interpretation of accelerometry to quantify mechanical loading, including tests of reliability and cross-validation.
3. Preparation and delivery of workshops on interpretation of GPS and accelerometry data.

**Other responsibilities**

1. Support the dynamic joint loading team with computing and mathematical support for small selection of projects for which data automation and interpretation can be advanced.
2. Support the dynamic joint loading team with workshop deliveries on vector field analysis applied in Biomechanics.
3. Occasional support in teaching of Sport Science and/or Science of Football curricula delivering mathematics and computing related sessions, or a topical session on the applied contents of your PhD work.
4. Supporting undergraduate and postgraduate students with application of Matlab and Visual3D in their research projects.

**Further information**

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**Selective bibliography**


Malfait, B. et al. (submitted) How reliable are lower limb kinematics and kinetics during a drop vertical jump?


