TennisSense: A multi-sensory approach to performance analysis in tennis

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Introduction: The TennisSense Project [1], that is run in collaboration with Tennis Ireland [2], aims to create the infrastructure required to digitally capture physical, tactical and physiological data from tennis players in order to assist in their coaching and improved performance. This study examined the potential for using Wireless Inertial Monitoring Units (WIMU) [3] to model the biomechanical aspects of the tennis stroke and for developing coaching tools that utilise this information. There is significant evidence in the current literature that the ability to accurately capture and model the accelerations, angular velocities and orientations involved in the tennis stroke could facilitate a major step forward in the application of biomechanics to tennis coaching, as observed in Tanabe & Ito (2007) [5] and Gordon & Dapena (2006) [6] (detailed in the Conclusion).

METHOD: The TennisSense Technology Infrastructure comprises a UbiSense Spatial Localisation System [4] and a Wireless Inertial Monitoring Unit (WIMU) worn on the forearm (racket arm) of the player, that records Acceleration, Angular Velocity and Orientation in all three axes; using Accelerometer, Gyroscope and Magnetometer Sensors respectively. In addition a total of nine IP cameras are positioned around the court, with pan, tilt and zoom capability. We recorded five separate training sessions of 20 minutes duration, using a single WIMU on the player's forearm, the UbiSense System and the full 9 Camera Rig.

RESULTS & DISCUSSION: For this initial study we looked solely at the accelerometer data from the WIMU that was synchronised with the camera data. The data was graphed using MATLAB® and compared to the video data. The most useful sequences of data were training drills; where the player attempts to reproduce an identical shot each time. It was clear from a manual inspection of these sequences; that significant similarities existed in the graphed accelerometer data between correctly executed shots of an identical type.

CONCLUSION: This examination of the results leads us to conclude that accelerometer data from 1 or more on-body sensors, could be readily used in a tool to automatically identify shot type, shot quality and subsequently the biomechanical determinants of correct/incorrect technique; based on a golden template of accelerometer data with appropriate matching criteria. The utility of such a tool is inferred from the literature examining the contributions of biomechanical factors to tennis stroke outcomes, specifically: Tanabe & Ito (2007) [5] identify wrist flexion, radio-ulnar pronation and humeral internal rotation as major contributors to speed of serve; and Gordon & Dapena (2006) [6] conclude that elbow extension and wrist flexion appeared to be the major contributors to generation of racket speed.

REFERENCES: [1] Tennissense http://www.cdvp.dcu.ie/tennisireland/ [2] Tennis Ireland http://www.tennisireland.ie/ [3] Tyndall WIMU http://www.tyndall.ie/mai/wim.htm [4] Ubisense. http://www.ubisense.net/ [5] Tanabe & Ito (2007) A three-dimensional analysis of the contributions of upper limb joint movements to horizontal racket head velocity at ball impact during tennis serving *Sports Biomechanics* Sept 2007; 6(3): 418-433 [6] Gordon & Dapena (2006) Contributions of joint rotations to raquet speed in the tennis serve *Journal of Sports Sciences* Jan 2006; 24(1): 31-49

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