Title: Towards Intelligent Monitoring of Lower Extremity Loadings in Badminton from Lab to on-Court Analysis

Area: Biomechanics/Sports Medicine & Injuries

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Background:

High incidence of injuries to the knee and ankle joints were documented in the literatures (Chard & Lachmann, 1987; Fahlström et al., 1998; Fong et al., 2007; Jérgensen & Winge, 1987; Kroner et al., 1990). The injuries were then classified into chronic injury due to the loading accumulation and acute injury due to fatigue and unexpected incursion (Goh et al., 2013; Reeves et al., 2015). This project was aimed to investigate, estimate, and monitor the knee and ankle joint loadings of badminton athletes from lab test with 'gold-standard' facilities to on-court intelligent analysis.

Methodology:

As illustrated in the **Figure 1** of the framework in this project, we employed the wearable IMUs (inertial magnetic unit) for further investigation following our previously established protocol of motion capture and musculoskeletal modelling techniques. We also developed a Principal Component Analysis (PCA) model to extract features in the loading parameters, and a multivariate Partial Least Square Regression (PLSR) machine learning model to correlate easily-collected variables, such as the approaching velocity, and peak acceleration, with the vertical loading rate, knee and ankle loading parameters (moments and contact forces).

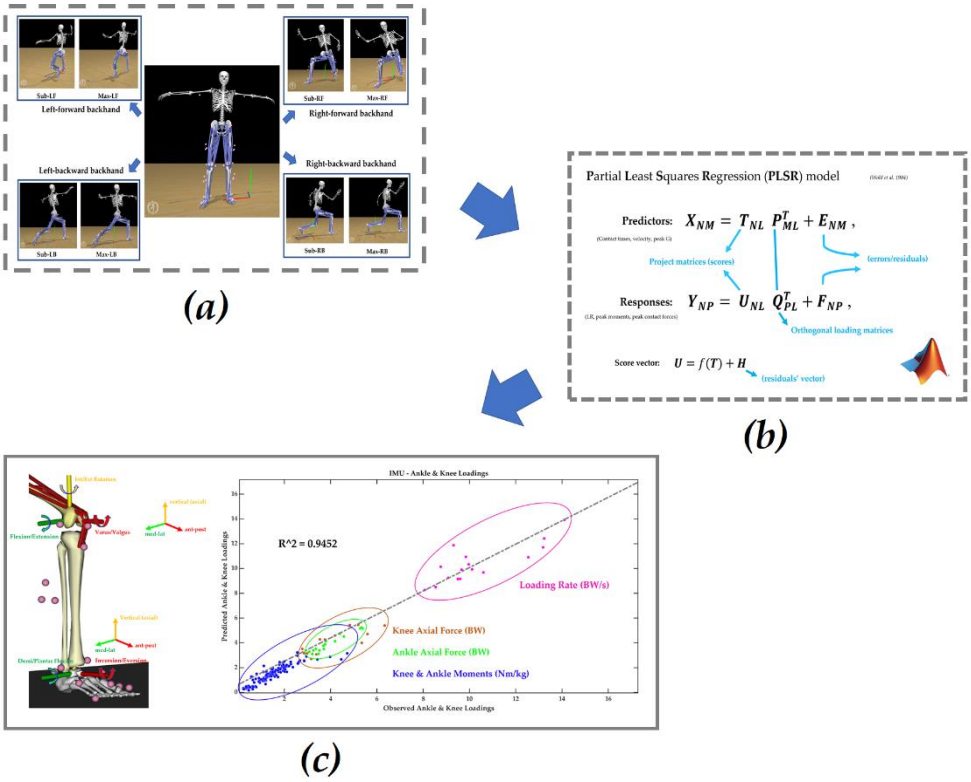

Figure 1. Intelligent framework in the current project

Key findings & Implications:

Promising accuracy (94.52%) of the PLSR model using the input parameters was observed, further sensitivity analysis found a single variable from ankle IMU could predict an acceptable (90%) range of patterns and magnitudes of knee and ankle loadings. The attachment of this single IMU sensor could not only record and predict loading accumulation and distribution but also exert little influence on the movement of the lower extremity.

Information from this project shall be integrated into an intelligent model monitoring the loadings (specifically loading rate, moments and contact forces) in the knee and ankle joints on account of the footwork performed on court during training and competition sessions, and assist the training scheme design and dynamic adjustment in a scientific manner, thus help prevent fatigue, reduce injury risks and improve training efficacy and athletic performance.

References: Chard, et al. (1987). *British Journal of Sports Medicine*; Fahlström, et al. (1998). *Scandinavian Journal of Medicine and Science in Sports*; Fong, et al. (2007). *Sports Medicine*; Jérgensen, et al. (1987). *International Journal of Sports Medicine*; Goh, et al. (2013). *Journal of Science and Medicine in Sport*; Kroner, et al. (1990). *British Journal of Sports Medicine*; Reeves, et al. (2015). *Sports*.