Equine Veterinary Journal

Supplementary Item 1:

Inertial-measurement-unit and motion capture synchronisation:

To correlate the timing of events between the cameras, the IMUs, and the force/pressure plate, the data from each of these instruments were synchronised. The cameras and the force plate were synchronised by means of a hardware link between the two instruments. This ensured that the sampling moments between measurements of these systems had a fixed and known timing relationship. At the time of these experiments, no solution for hardware-based active synchronisation was available for the IMU sensors. Therefore, the IMU data were synchronised with the camera and force plate data during the data analysis (post-processing). Synchronisation of the motion capture and IMUs was based primarily on the correlation between movements of the camera markers and the IMUs. Two camera markers were located directly above and below each IMU. The cannon bone was assumed to be a rigid structure, so that these marker pairs closely followed the orientation of associated IMUs. Using the position signals for both markers in each pair, the angular velocity signal of the vector between these markers was calculated. This signal correlated well with the angular velocity signal that was directly measured by the IMU's gyroscope sensor. By evaluating the cross-correlation function between these two signals, the time shift between the camera and IMU data was determined; the maximum of the cross-correlation function indicated the relative time shift at which the two signals best aligned. Interpolation was used to determine a more exact value of this time shift, so that the achieved synchronisation remained smaller than one sample period. The achieved synchronisation was estimated to be better than 500 μs.

While the IMUs captured all strides in the experiment, the camera system only captured those few strides that were in view of the force plate. The cross-correlation function could become confused by this fact, since individual strides can generate very similar motion data. This means that the camera data can sometimes align with the IMU data at multiple positions, so that the cross-correlation function has several maxima of similar magnitude. To mitigate this problem, this experiment was started with the horse in view of the cameras, so that the first strides were visible for both systems. Also, a crude manual synchronisation was performed first to avoid confusion in the subsequent cross-correlation-based synchronisation.