

quantum VALIDATION STUDY

INTRODUCTION

Wearable sensor technologies are increasingly adopted in biomechanics to address logistical and financial constraints of laboratory-based motion capture. Quantum Movement has developed a portable hybrid system that integrates inertial measurement units (IMU) and optical data to estimate joint kinematics in diverse environments – including on-field, on-court, in-gym settings – with minimal setup.

For professional sports teams, continuous access to biomechanical data is essential for monitoring athlete readiness, guiding return-to-play decisions, and addressing injury risks. Portable systems enable frequent, sport-specific assessments, allowing individualized, data-driven interventions without relying on third-party biomechanical resources.

Accurate biomechanical data is critical for identifying mechanical deficits, tracking progress, and monitoring movement patterns across the season. While marker-based optical systems such as Vicon are the gold-standard, their limited accessibility and practicality restrict their use in applied settings. This study aimed to validate the Quantum Movement system against Vicon.

METHODS

Protocol:

Eight athletes performed three repetitions of single-leg (SL) drop jumps, SL drop landings, and 90° Cut. Four IMUs (Xsens DOT, Xsens Technologies B.V., Enschede, Netherlands), sampling at 120 Hz, were secured using Quantum Movement straps on the thorax, pelvis, left thigh, and left shank. Simultaneous motion capture was performed using a 12-camera Vicon system (Vicon Motion Systems Ltd., Oxford, UK) operating at 200 Hz, which served as the reference standard for joint angle estimation.

Data Processing and Analysis:

Agreement between systems was assessed using Mean Absolute Error (MAE) and Pearson Correlation Coefficients (r), calculated for each joint and activity.

RESULTS

Quantum Movement showed strong agreement with Vicon across all joints and activities. MAE ranged from 6.7° to 12.4°, consistent with current research validation ranges (5–13°)^[1,2]. Pearson correlations were high at the hip and knee ($r = 0.930$ – 0.986), with slightly lower correlations at the spine ($r = 0.707$ – 0.877), aligning with current research where $r > 0.90$ is deemed acceptable for field-based application^[3].

Figure 1. Correlation plot of all activities

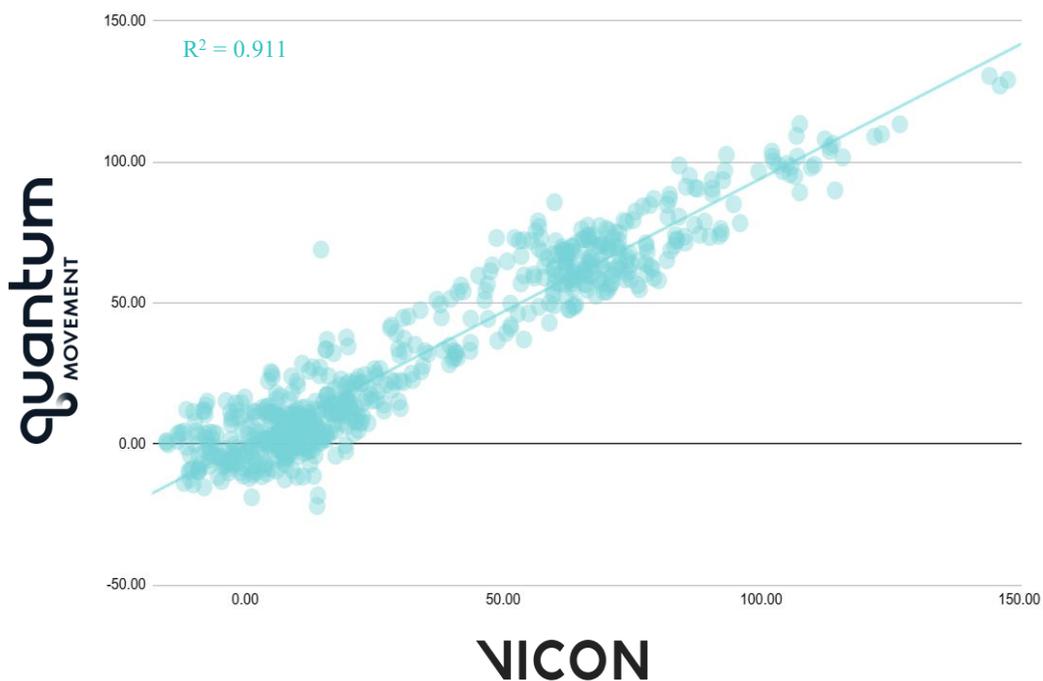


Table 1. Reported Pearsons Correlation Coefficient (r), Mean Absolute Error (MAE) for all activities and joints

	Joint	MAE	r
90° Cut	Knee	10.866°	0.983
	Hip	8.351°	0.963
	Spine	8.718°	0.877
	Joint	MAE	r
Drop Jump	Knee	8.826°	0.981
	Hip	9.234°	0.930
	Spine	9.093°	0.717
	Joint	MAE	r
Drop	Knee	8.111°	0.981
	Hip	7.186°	0.963
	Spine	6.735°	0.707

REFERENCES

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- [3] Camomilla, V., Bergamini, E., Fantozzi, S., & Vannozzi, G. (2018). Trends supporting the in-field use of wearable inertial sensors for sport performance evaluation: A systematic review. *Sensors*, 18(3), 873.