A Hard Take Down: Can Markerless Motion Capture Track Wrestling Head Impacts?

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Summary

Markerless motion capture shows promise for sport biomechanics analysis but faces challenges such as occlusion. This study assessed Theia markerless technology for tracking head kinematics in wrestling. Six wrestlers (4 male, 2 female) performed nine maneuvers across 157 trials, but only 46 provided usable head acceleration data. Successful trials often involved maneuvers with less occlusion, while tight grappling reduced tracking accuracy. Our findings highlight the limitations of using current markerless motion capture technology in wrestling but suggest that some phases of takedowns can still be tracked. Further research is needed to train machine learning models with combat sports injury data, particularly where two or more individuals occupy close quarters.

Introduction

Wrestling has one of the highest concussion rates in collegiate sports [1], yet head kinematics in the sport remain largely unexamined. Advanced motion capture technologies capable of tracking dynamic, high-speed movements can help elucidate injury mechanisms in high-risk sports. Traditional marker-based systems can be impractical for sports like wrestling, where physical contact can displace or destroy markers. Markerless motion capture, such as Theia, offers a potential solution by capturing athlete movements without the need for physical markers; however, its ability to accurately measure head kinematics in wrestling remains undetermined [2]. This pilot study examines the feasibility of using Theia markerless technology to track head impact kinematics in wrestling, specifically assessing the proportion of usable trials across various takedown techniques.

Methods

Data were collected over three sessions with six varsity wrestlers (four males, two females, ages 18-23) paired by weight class. Motion capture footage was recorded at 60 and 120 Hz. Wrestlers selected maneuvers they could safely perform. Preferred takedowns were included to capture common techniques. A successfully tracked takedown trial in Theia occurred if the model stayed on the athlete during either the offensive contact initiation or when the head hit the ground at move completion. For ground maneuvers (e.g. Gut Wrench), the model had to remain on the athlete throughout the entire move. The proportion of head-tracked trials across different takedown techniques was assessed.

Results and Discussion

Among 157 trials, 156 were captured with video for Theia processing, but only 46 provided usable head kinematics data during head acceleration events. The High Gut Wrench had the highest success (16/30 trials, Figure 1), while the Front Headlock (5/10), High Crotch to Ankle Lace (5/10), Double to Trip (9/30), Fireman Throw (7/26), High Crotch to Double (3/10), and Single Trip (1/29) all had limited tracking. The Arm Throw did not produce usable data. Tracking failures were likely due to body segment occlusions (Figure 2).

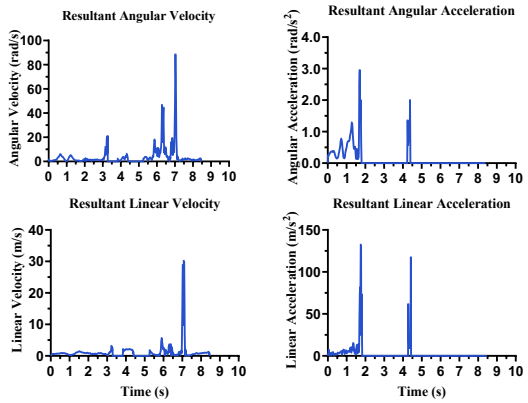

Figure 1: Time series head kinematic data from a successfully tracked Theia trial during High Gut Wrench.

Figure 2: Screenshots of loss of head model (blue skeleton) tracking during takedown progression (A to F).

Conclusions

There are challenges using markerless motion capture for wrestling head kinematic analysis. Theia's tracking success varied by takedown, indicating some movement phases and techniques are more suitable for analysis than others. Future work should develop multi-modality pose estimation models for wrestling-specific data and explore the utility of sparse anatomical models for head-specific tracking. Optimizing camera placement and data processing is crucial for improving tracking accuracy in wrestling biomechanics.

References

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