The OpenBiomechanics Project

The Open Source Initiative for Anonymized, Elite-Level Athletic Motion Capture Data

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Abstract

Interest in quantifying human movement, particularly in elite sport, increases with each passing year. However, analysis of sport biomechanics data has traditionally been restricted to academic laboratories and professional sport organizations. Public sport biomechanics resources would democratize access to human movement data and accelerate progress and innovation for the sport biomechanics field as a whole. In this paper, we introduce ***The OpenBiomechanics Project***, an initiative started by ***Driveline Baseball Research & Development*** to provide free, elite-level, research grade motion capture data to the general public for independent individual exploration and analysis. We begin by providing raw and processed data from a sample of 100 baseball pitchers. We then discuss future directions within baseball, expansion to other sports and athletic movements, and outline supporting documentation and additional resources.

1 Introduction

Open access resources exist in other biomechanics sub disciplines [1, 2].

2 Data collection

Data collection took place at Driveline Baseball in Kent, Washington, USA as part of each athlete's motion capture assessment. After a standardized warm up consisting of static and dynamic stretching, resistance band exercises, and preparatory throwing drills, we applied between 45 and 48 reflective markers directly to the athlete's skin over relevant bony landmarks (Table **??**). We then allowed athletes to complete a final warm up consisting of preparatory throws from the pitching mound. Once the athlete indicated they felt ready to throw with game-like effort, we recorded up to five fastball pitches from a pitching mound at a regulation distance (18.4 m).

Although athletes were cued to throw at the provided strike zone, we did not require athletes to throw a strike for a trial to be considered valid. We considered a trial valid if all reflective markers remained affixed to the athlete throughout the pitching motion. A radar gun positioned behind home plate measured pitch velocity to the nearest tenth of a mile per hour which we recorded and paired with each motion capture trial.

During each athlete's assessment, fourteen cameras (Prime 17W; Optitrack/NaturalPoint Inc., Corvallis, OR, USA) recorded marker positions at 360 Hz while three force plates embedded in a custom concrete mound (1 x FP4080-15-TM-2000, 2 x FP9090-15-TM-2000; Bertec Corp., Columbus, OH, USA) collected ground reaction force data at 1,080 Hz. Marker and ground reaction force data were synchronized and recorded using Motive Optitrack software.

3 Data processing

We exported pitching trials that met validity criteria as C3D files.

4 How to Use

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4.1 Terms of Use

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4.2 Naming Conventions

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4.3 Fileshare and GitHub Repository

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4.4 Citing and Contributing

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5 Future Directions

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6 Additional Resources

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References

[1] Camargo, J., Ramanathan, A., Flanagan, W., and Young, A. A comprehensive, open-source dataset of lower limb biomechanics in multiple conditions of stairs, ramps, and level-ground ambulation and transitions. *Journal of Biomechanics*, 119:110320, 2021.

[2] Erdemir, A. Open knee: open source modeling and simulation in knee biomechanics. *The journal of knee surgery*, 29(02):107–116, 2016.

Abbreviation	Rigid Body	Description
C7	Thorax	Seventh cervical vertebrae
CLAV	Thorax	Jugular notch
LANK	Left shank, left foot	Left ankle lateral malleolus
LASI	Pelvis	Left anterior superior iliac spine
LBAK[a]	Thorax	Left scapular inferior angle
LBHD	Head	Left, posterior
LELB	Left upper arm, left forearm	Left lateral humeral epicondyle
LFHD	Head	Left, anterior
LFIN	Left hand	Third metacarpophalangeal joint
LFRM	Left forearm	Left forearm
LHEE	Left foot	Heel
LIC[a]	Pelvis	Left iliac crest
LKNE	Left thigh, left shank	Left lateral femoral condyle
LMANK	Left shank, left foot	Left ankle medial malleolus
LMELB	Left upper arm, left forearm	Left medial humeral epicondyle
LMKNE	Left thigh, left shank	Left medial femoral condyle
LPSI	Pelvis	Left posterior superior iliac spine
LSHO	Left upper arm	Left acromial plateau
LTHI	Left thigh	Left thigh
LTIB	Left shank	Left shank
LTOE	Left foot	Left second metatarsophalangeal joint
LUPA	Left upper arm	Left upper arm
LWRA	Left forearm, left hand	Left radial styloid
LWRB	Left forearm, left hand	Left ulnar styloid
RANK	Right shank, right foot	Right ankle lateral malleolus
RASI	Pelvis	Right anterior superior iliac spine
RBAK	Thorax	Right scapular inferior angle
RBHD	Head	Right, posterior
RELB	Right upper arm, right forearm	Right lateral humeral epicondyle
RFHD	Head	Right, anterior
RFIN	Right hand	Third metacarpophalangeal joint
RFRM	Right forearm	Right forearm
RHEE	Right foot	Right heel
RIC[a]	Pelvis	Right iliac crest
RKNE	Right thigh, right shank	Right lateral femoral condyle
RMANK	Right shank, right foot	Right ankle medial malleolus
RMELB	Right upper arm, right forearm	Right medial humeral epicondyle
RMKNE	Right thigh, right shank	Right medial femoral condyle
RPSI	Pelvis	Right posterior superior iliac spine
RSHO	Right upper arm	Right acromial plateau
RTHI	Right thigh	Right thigh
RTIB	Right shank	Right shank
RTOE	Right foot	Right second metatarsophalangeal joint
RUPA	Right upper arm	Right upper arm
RWRA	Right forearm, right hand	Right radial styloid
RWRB	Right forearm, right hand	Right ulnar styloid
STRN	Thorax	Xiphoid Process
T10	Thorax	Tenth thoracic vertebrae

[a] Left back and iliac crest markers were removed from our marker set in 2021. Therefore, LBAK/LIC/RIC markers may not be present in all C3D files