On Field Pose Estimation for Sprint Mechanics Analysis and the Effect of Brightness on Accuracy

J.M. van Knippenberg[1,2], G.M. Blenkinsop[1], H. Cai[1], C. Long[2], S.A. McErlain-Naylor[1]
[1]Loughborough University, Loughborough, United Kingdom
[2]NFL UK & Ireland, London, United Kingdom
Email: j.m.van-knippenberg@lboro.ac.uk

Summary

Evaluation of pose estimation models vs manual digitization for kinematic variables in sprinting and the effect of brightness on pose estimation performance. MediaPipe is inferior to Yolov8-x when compared to manual digitizing. Filtered knee RMSE's range from 0.051 to 0.1 m. Postprocessing brightness adjustments can enhance pose estimation accuracy.

Introduction

Pose estimation models offer a promising method to assess sprint biomechanics remotely. New models are constantly being proposed, however many of these require substantial memory and computing power. Evaluation of these models often occurs in non-sport based contexts [1] or in labs [2,3] where the lighting is constant. The aim is to evaluate lightweight open-source pose estimation models against manual digitization for kinematic variables in sprinting and the effect of brightness on pose estimation performance.

Methods

A diverse sub-sample of 3 (more to be added) participants performed 6 successful 40 yards sprints on an artificial pitch (completion times: 5.34-7.38 s). Lumix DMC-FZ200 cameras recording at 200 Hz (640x480) were positioned side-on at 9 m from the runway at 1 m height. Calibration was performed using a known-sized object. YOLOv8-x and MediaPipe inference ran through python scripts and manual digitization was performed in Kinovea. Joint coordinates were further processed in MATLAB where a 4th order low-pass Butterworth filter (fc = 12 Hz) was applied. To simulate the effect of different lighting conditions outdoors, the brightness was altered (with symmetric powers of 2 from -32 times darker to 32 times lighter, including 0) in Adobe Acrobat Pro. The difference in hip, knee and ankle coordinates is presented as root mean squared error (RMSE).

Results and Discussion

Filtering is necessary to reduce pose estimation noise and the effect of tracking mistakes (Figure 1). The MediaPipe coordinates display delayed onset of tracking compared to YOLOv8 and manual (Figure 1) and may thus be inferior for sprint mechanics analysis. Brightness also affects pose estimation accuracy (Figure 2). The RMSE's are relatively flat and clustered between 4 times darker and 4 times lighter. Errors potentially increase more with decreased brightness (Figure 2). Two methods exist to manipulate brightness: changing exposure during testing and changing brightness in postprocessing. The results imply that researchers and practitioners could slightly overexpose the video in variable weather conditions to avoid large losses in accuracy in any lower lighting condition. However, these simulated effects do not account for the effect of exposure on motion blur. Instead, researchers could apply postprocessing brightness enhancing software to improve pose estimation accuracy as in this study.

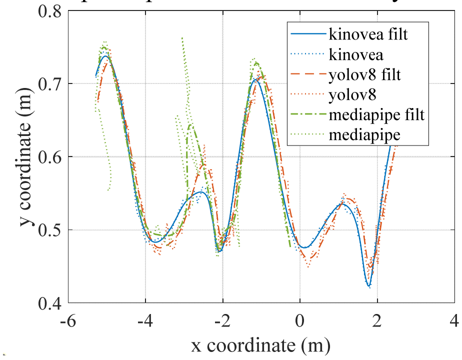

Figure 1: Example graph of raw and filtered knee x, y coordinates (right to left run) for the manually digitized (Kinovea), YOLOv8-x and MediaPipe results.

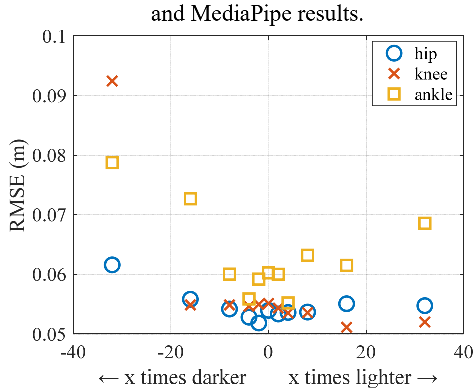

Figure 2: RMSE for the different brightness conditions for filtered hip, knee and ankle coordinates.

Conclusions

MediaPipe may be inferior to Yolov8-x when compared to manual digitizing for kinematic variables in sprinting. Postprocessing brightness adjustments can enhance pose estimation accuracy.

Acknowledgments

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References

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