Basketball Jump Shot Prediction Using Mediapipe Pose Estimation and LSTM Networks

Ali Mehdi[1] , Min Hsu[1], Lan Yuen Guo[1]
[1]Department of Sports Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan.
Email: yuen@kmu.edu.tw

Summary

This study developed a markerless basketball jump shot prediction system using MediaPipe Pose Estimation and LSTM networks. Key joint angles (shoulders, elbows, wrists, hips, knees) were analyzed from videos captured at a 45-degree angle to identify biomechanical patterns during the release phase. The model achieved 86% accuracy for regular players but dropped to 82% for occasional players, reflecting movement variability. This integration offers a cost-efficient and scalable approach to basketball biomechanics analysis.

Introduction

The success or failure of a basketball jump shot is influenced by biomechanics during the release phase, where the alignment and motion of key joints such as shoulders, elbows, wrists, hips, and knees are critical [1]. Traditional marker-based motion analysis systems are accurate but expensive, time-consuming, and unsuitable for routine applications [2]. Markerless motion tracking tools like MediaPipe Pose Estimation offer cost-effective alternatives for joint movement analysis [3]. This study combines MediaPipe Pose Estimation with Long Short-Term Memory (LSTM) networks to analyze joint angles during the release phase and predict the success or failure of basketball jump shots.

Methods

16 participants from Kaohsiung Medical University, including 10 regular players **(21.8 ± 2.25 years)** and 6 occasional players **(22.3 ± 1.8 years),** each performed 50 jump shots. Videos were recorded at 60 fps using a mobile phone (iPhone 12 Pro Max) positioned at a 45-degree angle from a side view, focusing on shoulders, elbows, wrists, hips, and knees. Videos were processed using OpenCV to enhance clarity and segment frames for analysis. MediaPipe Pose Estimation was employed to identify 33 body landmarks, extracting the 2D coordinates of key joints. The release phase was defined as the frame interval from maximum elbow extension to ball release, ensuring biomechanical consistency. Joint angles from the release phase were input into the LSTM model to predict basketball shot success. Model performance was assessed using a confusion matrix and metrics like accuracy, precision, recall, and F1 scores.

.

Results and Discussion

The LSTM model demonstrated strong performance in predicting basketball jump shot outcomes, where Class 0 represents missed shots and Class 1 represents successful shots. In Approach 1, which focused on regular players, the model achieved a training accuracy of 86% and a testing accuracy of 81%. For missed shots (Class 0), the model recorded a precision of 65% and an F1 score of 62%, while for successful shots (Class 1), it achieved a precision of 85% with an F1 score of 87%. The overall weighted F1 score for the test set was 80%, indicating balanced classification performance.

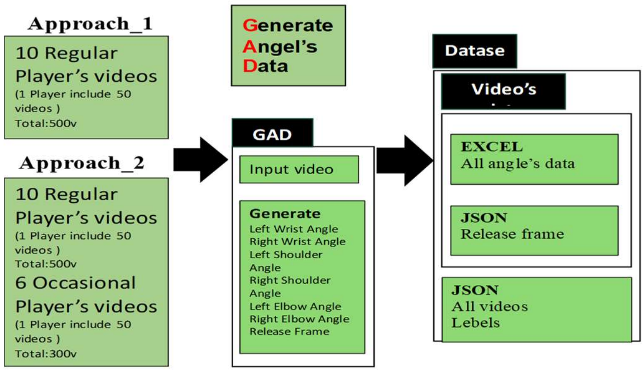

Figure 1: **Workflow Data Processing and Generating**

Table 1: Confusion Matrix for Approach 1 and Occasional Player

Approach_1				**Approach_2**			
	Predictive Label				**Predictive Label**		
True Label		0	1	**True Label**		0	1
	0	22	9		0	115	71
	1	16	55		1	27	39

In Approach 2, where the model was trained on 100% of regular player data and tested on occasional players, it achieved a training accuracy of 82% and a testing accuracy of 78%. The F1 score for the test set was 73%, reflecting increased variability due to biomechanical differences among occasional players. The performance decline suggests that the model had more difficulty predicting outcomes for players with less refined shooting techniques. The confusion matrix for both approaches is presented in **Table 1.**

Conclusions

This study highlights the potential of MediaPipe and LSTM integration for cost-effective, versatile sports training, emphasizing consistent joint angles for success and future applications in basketball jump shot analysis.

Acknowledgments

This work was supported by the National Health Research Institute, Taiwan [NHRI-EX114-11227EI]. Special thanks to Ou Xin Quan (NKUST), Cheng-He Su, Pei-Yi Cai, and Prof. Ing-Jer Huang (NSYSU) for their assistance in AI model development.

References

[1] Dill S et al. (2023). De Gruyter, 9: 34-36.
[2] Salian A et al. (2024). IEEE, 25: 374-386.
[3] Yan W (2023). IEEE Access, 5: 34-36.