Recognition and Classification of Hurling-specific Activities using Computer Vision

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Summary

This study presents a computer vision-based method for the recognition and classification of four hurling-specific activities. The performance of three Machine Learning (ML) models including Support Vector Machine (SVM), Random Forest (RF) and k-Nearest Neighbor (k-NN) are presented in terms of the mean accuracy, precision and recall. The RF model achieved the best performance in the classification of hurling-specific activities represented by a mean accuracy of 70%.

Introduction

Hurling is a technically demanding ball and stick field game. Movement analysis of hurling can give insight into performance and injury risk parameters. Human Activity Recognition (HAR) is the task of recognizing and classifying human movement and is generally conducted using accelerometer-derived data from body-worn sensors [1]. Computer vision (CV) is a subdivision of artificial intelligence (AI) enabling computer systems to extract meaningful data from visual inputs. CV techniques enable complex action recognition tasks, such as those over long sequences in sports to be analysed for athlete detection, action recognition and the extraction of kinematic information through human pose estimation (HPE) [2].

Mediapipe Pose (MPP) is an open-source ML solution encompassing 33 landmarks enabling tracking of human poses via CV techniques. The validity of MPP for the tracking of joint angles has been assessed against laboratory standards during stationary cycling [3] and showed promising results. The aim of this study is to assess the viability of a CV-based technique by means of the extraction of joint angles, for the classification of hurling-specific sport activities.

Methods

Five hurling players (age: 22.0 ± 5.61 years; height: 178.4 ± 5.64 cm; body mass: 83.6 ± 17.73 kg) participated in this study voluntarily, performing four hurling-specific activities: jab lift, overhead catch, soloing and striking. Each activity was performed for one minute. Movements were captured using a Panasonic HX-WA20 camera with a frame rate of 28.7 fps, resulting in a total of 34460 tagged instances. The MPP model was applied to the video of each hurling movement in Python (version 3.9.16). Using the associated landmarks, the knee, hip, shoulder and wrist joint angles of the right-sided limbs were extracted and tagged with the corresponding activity in Microsoft Excel (version 2410). Three supervised classification models, specifically SVM, RF and k-NN were applied for the classification of hurling activities. The dataset was split into train/test datasets at a ratio of 80/20. K-fold cross validation (K = 5) was applied to the training data to assess the generalizability of the models. The performance of the RF, SVM, and k-NN models were compared in terms of the mean values of accuracy, precision, and recall.

Results and Discussion

The performance results of the three ML models are presented in Table 1. The RF model achieved the highest accuracy, precision and recall. RF is particularly suited for sport activity recognition tasks because it can effectively handle high-dimensional, multi-class problems and can generalize well with new, unseen data, thus, a reliable choice for this type of classification task. Previous work has shown the accuracy of accelerometry based activity recognition in hurling [4], but there are drawbacks to using sensors for HAR tasks. Variations in environmental conditions, which are intrinsic to sporting environments could lead to errors in methodology owing to varying sensor specifications [5]. Although further exploration into the methods outlined in this research is required, it is suggested that CV-based methods may serve as a viable alternative to body-worn sensors for the task of activity recognition in the sport of hurling.

Model	Mean Accuracy	Mean Precision	Mean Recall
RF	.707	.711	.707
SVM	.556	.602	.556
k-NN	.680	.680	.680

Table 1: Performance metrics for the RF, SVM and k-NN models in the classification of four hurling activities.

Conclusions

An AI-driven protocol is presented combining HAR and HPE for hurling sport movement analysis, for which a RF model gave the highest accuracy for the classification of activities.

References

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