DEVELOPMENT OF A HEAD ACCELERATION EVENT CLASSIFICATION ALGORITHM FOR FEMALE RUGBY UNION

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Introduction

Both concussive and sub-concussive head accelerations have now been linked with numerous acute and chronic neurocognitive changes[1]. Instrumented mouthguards have been used to detect head accelerations, recording kinematic data from many sports[2]. However, coughs, bites, and sneezes can cause false positive impact recording. Thus, time consuming video verification of impact is often required. Recently, this burden has been alleviated via the development of machine learning algorithms that can isolate the true impacts [3]. However, since each contact sport has different impact characteristics, these algorithms must be specifically calibrated or validated. Despite the growth of female rugby union participation and an increasing number of professional players, no algorithms for female sport or rugby union have been developed. This study aims to develop the first algorithm to classify head acceleration data from exclusively female rugby union players.

Methods

Mouthguards instrumented with kinematic sensors were given to 25 participants for six competitive rugby union matches in an inter-university league. Video were recorded from the centre line of the pitch to enable the identification of genuine events. Data were collected using the previously validated boil-and-bite instrumented mouthguards. In total, 214 impacts were recorded from 460 match-minutes. Four machine learning algorithms were trained to predict genuine and spurious events using five matches, then tested using a sixth match. The classifiers were trained to determine key patterns in the descriptive features of the filtered six-axis kinematic data. Features were grouped into four categories, pulse parameters, positional derivatives, power spectral density, and wavelet transformations. The area under the receiver operator curve (AUROC) and area under the precision recall curve (AUPRC) were used as the performance measures of the models. Shapley additive explanation (SHAP) values were calculated to analyse the effect of feature values on the classifier's outputs.

Results

When tested upon the test dataset, the SVM classifier achieved the highest AUROC and AUPRC, followed by the CatBoost, XGBoost and Adaboost DT, summarised in table 1. The best performing 20 features for the CatBoost and SVM classifiers as identified by SHAP values were also found for the top performing models. The most important features for classification were predominantly pulse parameters and wavelet transformations at very low or high frequencies, shown in Figure 1.

Classifier	Test AUROC	Test AUPRC
SVM	0.92	0.85
CatBoost	0.91	0.82
XGBoost	0.89	0.82
AdaBoost DT	0.89	0.81

Table 1: Performance of the classifiers on the test dataset, measured with AUROC and AUPRC.

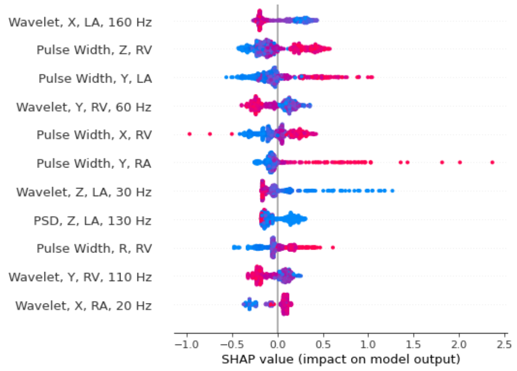

Figure 1: A summary of SHAP values generated.

Discussion

The classifiers in this study achieved state of the art performance in this classification task, illustrating that it is possible to create high performing head acceleration event classifiers for female rugby union. This will aid future researchers to more quickly and accurately identity head acceleration events within female rugby union. These findings represent an important development for head impact telemetry in female sport, contributing to the safer participation and improving the reliability of head impact data collection within female contact sport.

References

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Acknowledgments

We would specifically like to thank the Zienkiewicz Centre for Computational Engineering for the scholarship of DP.