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Extracting features from rowing stroke accelerations to reduce the analysis effort of coaches

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Introduction

The development of rowing electronics has been stagnant in the last decades. By advancing the technologies used inside the rowing boat, crews can improve the efficiency of the training sessions with more real-time data and eliminate the overhead effort of coaches to analyze the captured data. In this study, a method for extracting features from acceleration waveforms is developed and validated. These features are necessary for using complex algorithms on rowing strokes to automate the analysis process. The features represent the rowing technique phases based on the use of the rower's body parts.

Method

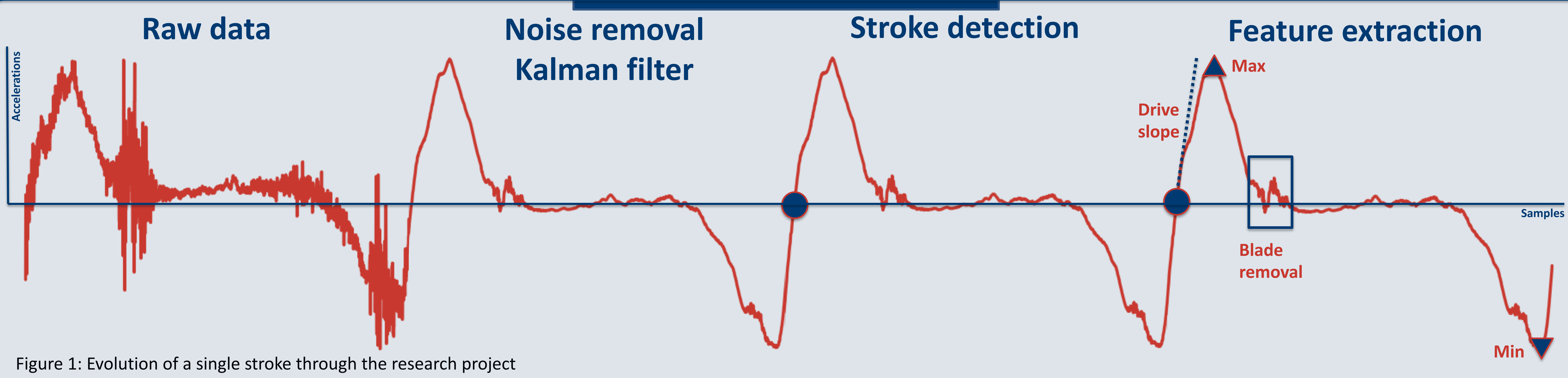

Figure 1: Evolution of a single stroke through the research project

Stroke detection: The timing of the features in Figure 1 is entirely based on stroke detection. The correct zero crossings are filtered with windowed peak detection algorithms, with the zeros between a negative and positive peak. **Feature extraction:** With windowed RMS filtering the movement of the blade out of the water is detected. The timing of every feature (stroke rate included) is also recorded in the dataset. **Validation:** After statistical analysis, the results are plotted in scatter diagrams, and a logistic regression model is learned on the dataset to predict if the stroke is recorded on the experienced boat (called Filippi) or the novice boat (called BBG). This prediction is used for validating the effectiveness of the extracted features for differentiating good and bad techniques. **Error identification:** The weights of the learned model applied to the features are used in 3 different stroke analysis algorithms to identify the worst-performing feature in an individual stroke.

Results

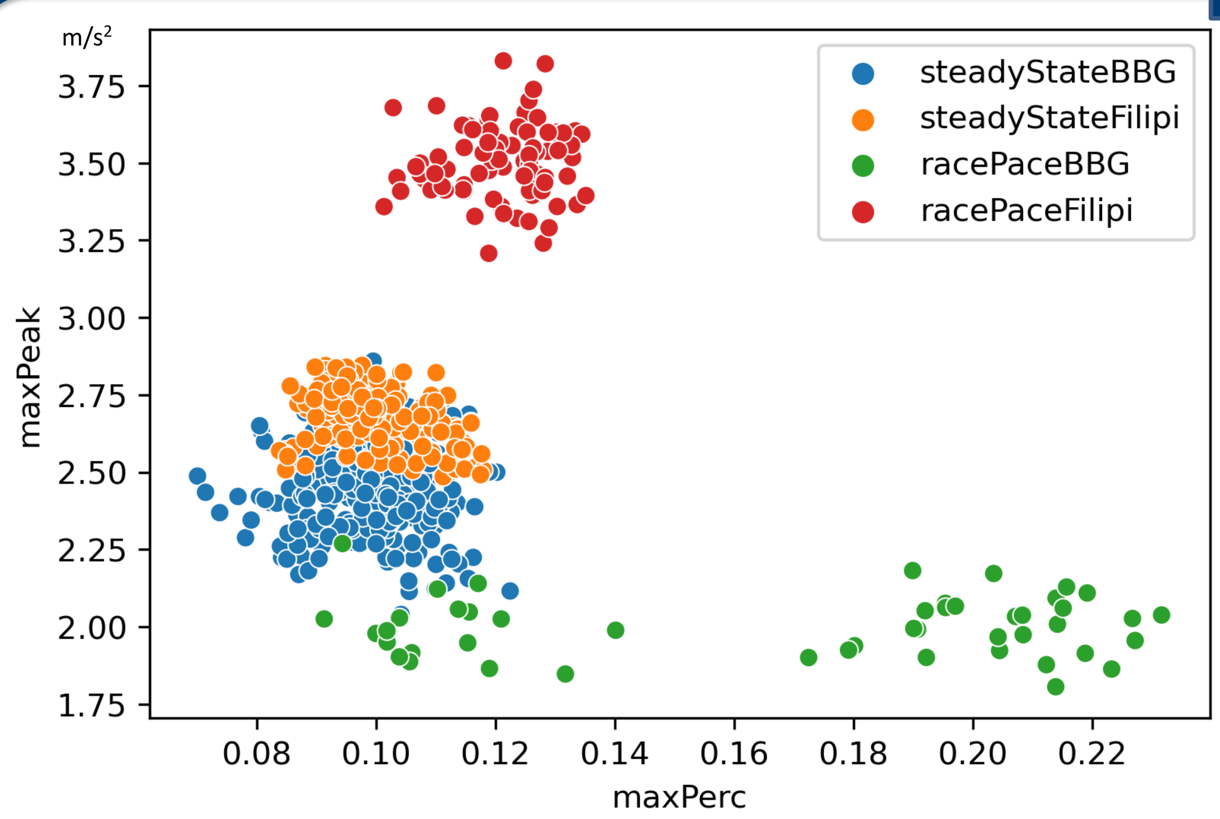

Figure 2: Maximum acceleration peaks with relative timing extracted with 4 categories

Table 1: Results of logistic regression machine learning model

Selected data	Result (f1-score)
All data	91 %
Steady state	92 %
Race pace	100 %

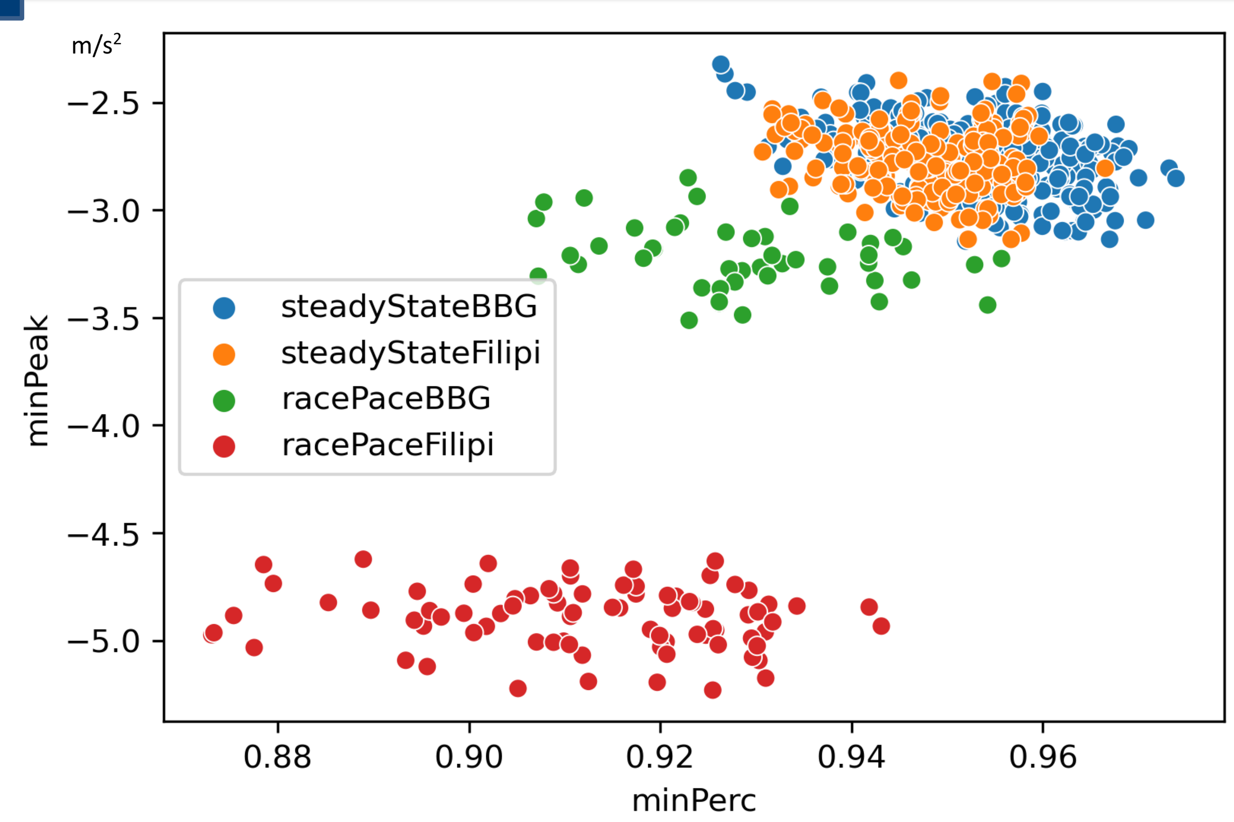

Figure 3: Minimum acceleration peaks with relative timing extracted with 4 categories

The dataset divided into 4 categories gives a good representation of the grouped data in the scatterplots (Figure 2-3). This means that the differentiation between good and bad techniques can be made. With machine learning the results are given in Table 1. The identification of the worst-performing feature per stroke has no definitive result due to the limitations of the dataset.

Conclusion

With the presented technique to process acceleration waveforms and extract features, a wave of modernization in rowing is possible. The results can still be improved by adding additional sensors for measuring the boat's stability and registering the oars' movements. Three methods to identify technical errors are tested with promising results. However, to further develop these methods and algorithms, more participation in the training planning is necessary to record specific stroke rates and power efforts. Because of the lack of collaboration with the coach, there were no strokes recorded between steady state and race pace. Also, the inclusion of an experienced coach is necessary to help with providing extra feedback on recorded strokes. With better-labeled data, the methods used here could be trained to do a full analysis of the rowing technique.

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