TECHNISCHE UNIVERSITÄT MÜNCHEN
LEHRSTUHL FÜR INFORMATIONSTECHNISCHE REGELUNG
ORDINARIA: UNIV.-PROF. DR.-ING. SANDRA HIRCHE

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MASTER'S THESIS

Symmetry- and Time-Warp-Aware Models for Surfboard Maneuver Detection Across Conditions

Problem description:

The thesis investigates how explicit modeling of symmetries (e.g. frontside vs. backside) and time-warp (different maneuver speeds, wave energies, and surfer skill levels) can improve data-driven models for surfboard maneuver detection and phase segmentation. Using IMU and pressure-pad data from TRAX as a case study, the student will compare standard sequence models (e.g. TCN/RNN) with symmetry- and time-warp-aware variants, and evaluate their ability to generalize across conditions via dedicated train/test splits (e.g. train on frontside + small waves, test on backside + larger waves, or train on slower turns and test on faster ones).

This thesis will be performed in collaboration with TRAX Technologies GmbH
https://traxsurf.com/

Tasks:

- Synchronisation and annotation of multi-modal surf data (board IMU and pressure pads), including categorisation by wave size and execution speed,
- Systematic comparison of standard sequence models (e.g., TCN/RNN) against symmetry- and time-warp-aware variants for manoeuvre detection,
- Evaluation of model generalisation using stress-test data splits (e.g., training on frontside/slow/small-wave data and testing on backside/fast/large-wave scenarios),
- Critical analysis of how explicit structural modelling affects detection robustness and the accuracy of performance quantification metrics.

Bibliography:

[1] Fabian C Klingner, Florian P Klingner, and Marije T Elferink-Gemser. Riding to the top a systematic review on multidimensional performance indicators in surfing. *International Journal of Sports Science & Coaching*, 17(3):655–682, 2022.

[2] Marouen Souaifi, Wissem Dhahbi, Nidhal Jebabli, Halil brahim Ceylan, Manar Boujabli, Raul Ioan Muntean, and Ismail Dergaa. Artificial intelligence in sports biomechanics: A scoping review on wearable technology, motion analysis, and injury prevention. *Bioengineering*, 12(8), 2025.

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Start:	tbc
Intermediate Report:	tbc
Delivery:	tbc

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