

## Topic: A Multimodal Approach to Analyze the Relation Between Motivation and Performance in Soccer

Understanding how and why players perform at their best is crucial to improving physical education and training procedures. While athletic performance is quantifiable and can be objectively measured, the underlying factors that influence performance remain less understood. Motivation is discussed as a critical factor of a player's performance, being influential in initiating, directing, sustaining, and terminating efforts by the player [1]. Methods of understanding motivation are questionnaires such as the Intrinsic Motivation Inventory (IMI), but these questionnaires tend to have limitations as they are not deployable to measure motivation continuously and objectively during the sporting drill. Therefore, this thesis investigates approaches to indirectly assess motivation during sports based on athletes' performance.

An increase in computational efficiency and improved deep learning algorithms have led to video-based modality being a crucial tool used in sports performance analysis, action recognition, and event detection [2] [3] [4]. Combining more than one modality can reveal patterns and correlations that can be beneficial for sports analytics as it can provide more comprehensive and nuanced insights that would be difficult to gain from a single source [5]. Zhang et al. show that the utilization of IMU data in conjunction with video-based modalities improves information extraction through multimodal approaches [6]. Jones et al. discuss that gamification can be used to enhance motivation. Therefore, in this thesis, video and IMU data are fused to analyze the performance of athletes while performing a drill.

A soccer rondo drill in a 360-degree environment is taken as an example scenario in which various gamification elements can be used to influence player motivation, as shown in the literature [7]. In this work, gamification encompasses elements such as a team leaderboard, audio cues, achievable badges with progress bars, and a point counter. To investigate the influence of these gamification elements on motivation and performance, the player is observed in two distinct scenarios while performing the same drill. One scenario contains gamification elements while the other scenario does not. This work aims to develop a framework to determine the effectiveness of multimodal algorithms in classifying between the two scenarios.

To conduct a comprehensive analysis, this exploratory approach will look into multimodal data fusion methods using overhead video data and IMU data from chest and head to assess player performance during the drills [8]. Preprocessing techniques will be employed to synchronize and normalize data from different sources, with a primary focus on extracting features as quantifiable performance indicators including speed, movement patterns, and response time of the player. To observe the impact of gamification elements, this work will statistically evaluate the metrics from the features that were extracted. Furthermore, these performance-based features will be used to classify between the two scenarios. Motivational questionnaires collected after each scenario will be used to provide contextual insight into players' motivational factors to evaluate the relationship between motivation and performance in a gamified soccer drill.

This work consists of the following steps:

- **Comprehensive literature review:** Review existing literature in the field of sports analytics and AI in sports performance analysis specifically using multimodal approaches for video data and IMU data. Additionally, the existing literature correlating motivation with performance will be reviewed.
- **Data Preprocessing:** This includes data preprocessing, synchronization, merging, and analysis of both overhead video data and IMU data.
- **Extraction and exploration of features from data sources:** Extract features from the overhead video data and IMU data. Examples of the type of features being extracted are ball speed and overall pace of the player from the overhead video data and IMU data respectively.
- **Exploring the multimodal approaches for classification:** Explore state-of-the-art multimodal approaches to maximize the information gained from the features of the overhead video and IMU. Approaches, for example, can include early and late fusion with 3D

convolutional networks, Long Short-Term Memory (LSTM) networks, and Recurrent Neural Networks (RRN). The different approaches will be compared based on their classification results and the best one will be used for further evaluation.

- **Classifying between scenarios:** Use the chosen multimodal methods to classify between the two scenarios using performance-dependent metrics. The classification results will then be mapped to the gamification elements and motivational questionnaires to gain insights into the relationship between motivation and performance in the context of gamification.

The thesis must contain a detailed description of all developed and used algorithms as well as a profound result evaluation and discussion. The implemented code has to be documented and provided. An extended research on literature, existing patents, and related work in the corresponding areas has to be performed.

**Advisors:** Rebecca Lennartz, M. Sc., Maike Stoeve, M. Sc.,  
Prof. Dr. Bjoern Eskofier  
**Student:** Roobesh Balaji  
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