Skate Sense: A Visual Feedback System for Skateboarding Using Pose-Based Motion Analysis

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Abstract. Skateboarding is characterized by a self- guided intuitive learning process based on observation, repetition and experimentation. For beginners, identifying technical mistakes and understanding basic movement quality can be challenging without direct feedback. This paper presents Skate Sense, a web-based prototype that explores how computer vision and interactive visualization can support the learning process in skateboarding. The system combines marker-less pose estimation, movement analysis and interface design to visualize body movement directly within skateboarding videos. The prototype focuses on the Ollie trick - a basic jump with the skateboard and provides phase-based feedback using skeleton overlays, reference poses and visual indicators. The presented approach aims to make movement characteristics more understandable while supporting self-directed learning.
Keywords: Skateboarding, Motion Analysis, Pose Estimation, Visual Feedback, Human-Computer Interaction, Sports Technology

1 Introduction

Skateboarding differs from many traditional sports through its informal learning culture, where progression is mainly achieved through experimentation, repetition and exchange within the community [1]. Unlike many organized sports, beginners often learn without structured coaching, making it difficult to recognize technical mistakes and understand how movements can be improved.

Research in motor learning highlights the importance of external feedback for supporting skill acquisition and refining movement patterns [2]. In self-guided learning environments, however, such feedback is often limited to personal observation or advice from experienced skaters.

This work explores how computer vision can support the learning process by providing visual feedback directly within skateboarding videos. The prototype focuses on

making movement execution easier to understand while preserving the exploratory nature of skateboarding.

2 Related Work

Digital movement analysis commonly relies on either sensor-based or camera-based approaches. Inertial Measurement Units (IMUs) are widely used in sports applications to capture acceleration, orientation and movement characteristics [3]. However, these methods usually require additional, expensive hardware attached to the athlete or equipment. Recent advances in computer vision enable markerless human movement analysis using standard cameras. Pose estimation frameworks such as MediaPipe estimate body landmarks from video sequences and provide the foundation for skeleton-based movement analysis [4].

Visual feedback has been shown to support motor learning when presented in an accessible and task-oriented manner [2]. Furthermore, recent applications demonstrate the potential of computer vision for video-based movement analysis in sports, for example in climbing and bouldering, where pose estimation is used to provide technique-related feedback [5].

Existing digital skateboarding systems mainly focus on performance metrics, trick recognition or equipment-related measurements [6, 7]. Skate Sense builds upon these systems by translating pose-based motion analysis into understandable feedback for skateboard beginners.

3 Methods

3.1 System Overview

The Prototype consists of a web-based frontend and a server-side video analysis pipeline. Users can upload or record a skateboard trick, which is processed automatically before an annotated video containing visual feedback is returned.

User interaction and computational processing are separated within the system architecture. While the backend performs pose estimation, movement analysis and feedback generation, the frontend provides recording, upload, visualization. And functionality [Figure 1].

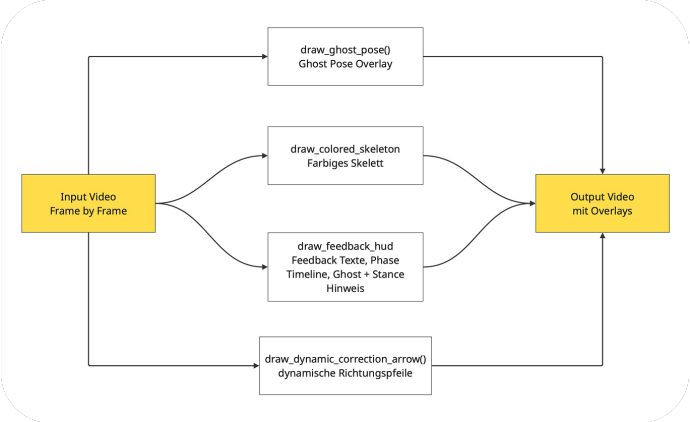

Figure 2: Schematic Overview of the processing pipeline

3.2 Pose-Based Motion Analysis

Movement analysis is based on markerless pose estimation using MediaPipe, which extracts human body landmarks from each video frame [3]. These landmarks are used to calculate joint positions and spatial relationships throughout the movement sequence, allowing characteristic body postures to be identified during the trick execution.

To improve robustness, the extracted landmark positions are smoothed before further analysis. The resulting pose data forms the basis for movement phase detection and subsequent feedback generation.

3.3 Feedback Generation

The video analysis divides the skateboard trick into four characteristic phases: preparation, pop, air and landing. The detected movement is compared against a predefined ghost pose representing a successful trick execution.

Differences between the recorded movement and the reference are visualized through skeleton overlays, ghost poses and simplified visual indicators. Instead of presenting numerical measurements, the system emphasizes intuitive visual cues that help users identify movement deviations without requiring biomechanical expertise.

4 Application Design and interactive Feedback System

The primary design challenge is not the extraction of movement data itself, but communicating the analysis results in a way that is easy to understand. Therefore, the interface was designed with a strong focus on clarity and low cognitive load. Feedback is integrated directly into the recorded video [Figure 2].

By embedding feedback directly into the original video, users can immediately relate the visual information to their own movement execution. This supports self-directed learning while preserving the exploratory character of skateboarding.

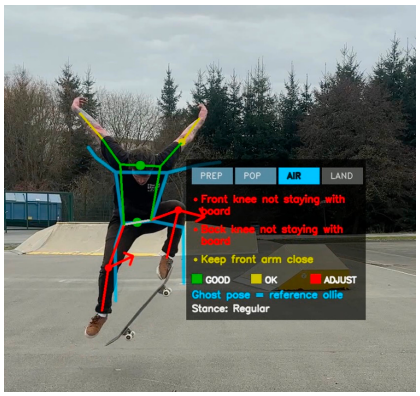

Figure 2: Example of the Skate Sense feedback interface showing skeletal visualization, movement phase information and visual guidance elements.

5 Conclusion and Future Work

The system demonstrates the potential of markerless pose estimation for supporting skateboard learning without requiring additional sensors or wearable devices. By combining skeleton visualization, reference poses and phase-based feedback, the prototype provides an intuitive way of communicating movement quality.

Current limitations include varying recording conditions, camera perspectives and the challenge of defining generalized reference movements for different skating styles.

Future work will investigate more advanced movement comparison methods, support additional skateboard tricks and user studies evaluating the influence of visual feedback on learning performance.

Acknowledgments. This paper is based on the results of the authors bachelor thesis at Hof University. The author would like to thank Prof. Michael Zöllner for his supervision and valuable feedback throughout the project.

Disclosure of Interests. The authors declare that they have no competing interests related to this work.

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