Topic: Development of a Pose Estimation System for Gymnastics

Performance in competitive gymnastics is dependent on different factors, such as the position of the body during different key moments of the exercise. Therefore, it is important for athletes to receive immediate feedback regarding their pose at these key moments, such that they can improve if necessary.

Currently, a manual approach is used to assess these parameters of interest, which is time-consuming and delays the feedback to the athletes. In movement analysis, many algorithms have been developed for automatic pose estimation. Originally, these algorithms required the athlete to wear markers at locations of interest, which affects their performance. In recent years, the use of deep learning has significantly improved the performance of markerless pose estimation [1], which is applied more easily than marker-based methods. This method can then be used to extract kinetic and kinematic parameters of interest (semi-)automatically from video images [2].

Markerless motion capture is especially useful in sports, since it is unobtrusive and does not disturb athletes, and can be used for two dimensional (2D) and three dimensional (3D) movement reconstruction. Recordings with a single camera can be used for 2D reconstruction, as well as reconstruction of 3D poses and contact points with the ground [3], even when cameras are moved during the capture [4]. However, to reconstruct three dimensional motion, generally multiple cameras are required. Different systems have been developed with multiple cameras for various sports [5], including figure skating [6]. Similar to gymnastics, motion reconstruction of figure skating is challenging due to the movement speed, self-occlusion, and the fact that some poses are very athletic and therefore outside the normal motion range, which is what deep learning models are based on.

Therefore, the goal of this thesis is to develop a pose estimation method to identify and track gymnast performance, as well as investigate different relationships relating body pose to performance. This pose estimation is used to estimate kinetic and kinematic parameters related to the movement, which can then be related to the quality of the exercise performance. The aim is to develop an algorithm that can work in or very close to real time, to be able to provide the athletes feedback during the training itself.

The proposed work consists of the following parts:

- Literature study into different 2D and 3D pose estimation approaches
- Implementation and comparison of suitable 2D and 3D pose estimation algorithms
- Data processing of experiment to extract performance parameters of interest
- Analysis of performance parameters

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.

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References

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