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CS229 proposal

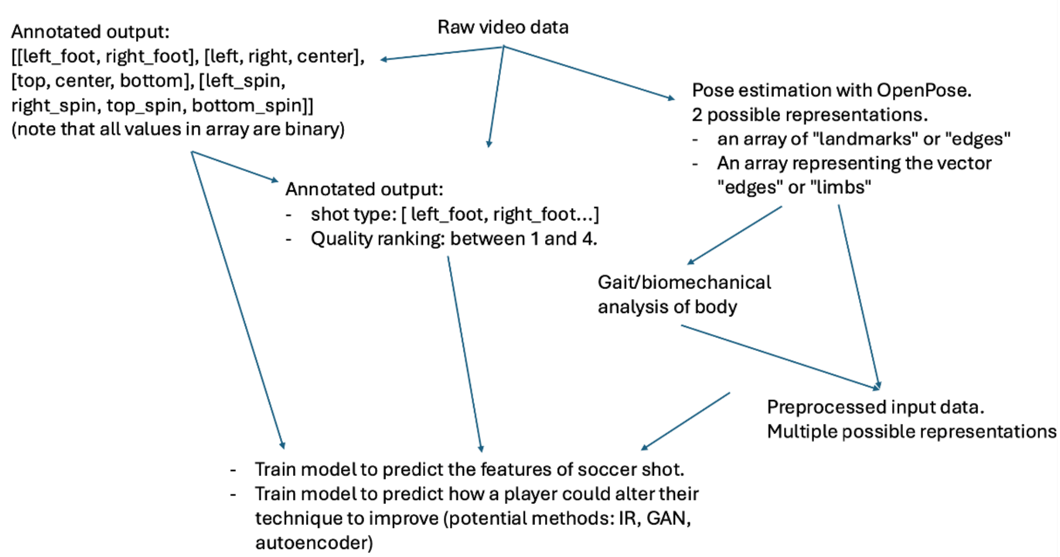
Pose Estimation and gait analysis to determine the outcome of a free kick

Project category: Computer Vision

Motivation

Many sports require precise technical execution, and it can be difficult to diagnose and fix biomechanical issues. In soccer, much more is left to feel and creativity. We propose that there is a place in the sport to which biomechanical analysis could be helpful to players: shooting technique. Over time a soccer player develops a unique kicking style that allows him/her to manipulate the ball as (s)he pleases; but there are still common mechanical processes that occur between top players. By analyzing these themes and the biomechanics of the process itself, we may be able to predict the outcome of a shot, the biomechanical behaviors of joints and muscles and further assess the injury risk of each motion. The project can be a useful tool for a young soccer player trying to improve and prevent injury by gaining insights into improper movements.

Method



1. Dataset preprocessing: Generate, annotate, and preprocess a data set. Video clips representing free kicks will be annotated with vectors representing ball spin, quality, and direction.
2. Pose estimation: Use OpenPose. Save data in processed numpy array.
3. Biomechanical analysis: Apply kinematic and inverse kinematic analysis using the pose data. Generate data to predict biomechanical behaviors of joints and muscles to better understand shot strength and efficiency. Ultimately, we intend to use this data to calculate muscle loading.
4. Shot recognition: Using pose estimation (time-series or single pose skeleton) + inverse kinematics data, we can apply the methods of deep learning to predict the outcome of a shot in terms of quality, ball spin, and ball direction.
5. Kick quality and injury risk suggestion: ML model to predict biomechanical changes that result in improved kick quality or mitigated injury risk. A few viable options from our current research: reinforcement learning, inverse reinforcement learning, GAN, and autoencoder. This will prove to be more challenge.

Experiments

1. Modeling process exploring: The input extracted from pose analysis can be processed as either vectors representing the "limbs" of the skeleton, or as points representing the "joints". By implementing these models, we may be better suited to predict the quality, direction, and spin of the shot. There is no single way to do this, and it seems logical to explore the techniques mentioned in the methods section.

2. Model evaluation: We plan to evaluate our machine learning algorithm by utilizing different video streams to verify the model's ability. We will assess the model using various metrics, including accuracy and precision. Because of the small data set, we will likely use k-fold cross validation. We will ensure that the model's predictions are biomechanically plausible, checking whether the predicted muscle strains align with known risks of injury.