Project Proposal

Course: Image Analysis and Computer Vision (IACV)
Project Topic: F11 – Visual Analysis of Sport Events
Application: Basketball – Early Prediction of 3-point Shot Outcome
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1. Objective

The goal of this project is to analyze basketball 3-point shots from monocular video acquired by a fixed camera and to **predict the outcome of the shot (in/out)** using only an initial portion of the ball trajectory (early prediction). The prediction will then be validated using the full video.

The project focuses on geometric reasoning, camera calibration, and motion analysis, without performing full 3D reconstruction.

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2. Experimental Setup and Assumptions

- Fixed monocular camera.
- Standard basketball court geometry.
- Basket height assumed to be 3.05 m (regulation).
- The basket and relevant court lines are visible.
- The ball trajectory is assumed to lie approximately in a vertical plane defined by the shooting position and the basket.

Videos will mainly be acquired by the authors to ensure controlled and reproducible conditions. Pre-existing videos may be used if sufficient landmarks are visible.

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3. Prior Knowledge and Annotations

The method relies on limited and well-defined prior knowledge:

- Standard dimensions of the basketball court (used for calibration).
- Regulation basket height.
- Approximate release height of the ball (assumed or measured).
- Known basket radius (for geometric decision criteria).

Minimal manual interaction is required:

- Selection of court landmarks (e.g., line intersections) for calibration.
- Selection of the basket center in a reference frame.
- Selection of the shooting position on the court plane.

- Optional manual selection of the temporal window corresponding to the shot.

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4. Methodology

1. **Camera Calibration and Geometry**
   Court landmarks are used to relate image coordinates to real-world coordinates on the court plane, providing metric scale and reference.
2. **Ball Detection and Tracking**
   The basketball is detected in each frame using a pre-trained CNN-based detector (e.g., YOLO, used as a feature detector only). Temporal filtering (e.g., Kalman filtering) is applied to obtain a smooth trajectory.
3. **Trajectory Estimation with Geometric Constraints**
   Each detected ball position defines a projection ray. By intersecting these rays with a vertical plane corresponding to the shooting plane, a sequence of 3D ball positions constrained to this plane is obtained. The motion is then represented in a 2D coordinate system within the shooting plane.
4. **Early Shot Outcome Prediction**
   A ballistic model is fitted using only an initial portion of the trajectory (e.g., a fixed percentage of frames, a time window, or up to the apex). The model is extrapolated to the basket position to predict whether the ball enters the hoop.
5. **Validation**
   Predictions are compared with the actual outcome observed in the full video. Accuracy is evaluated as a function of the amount of trajectory information used.

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5. Expected Outcomes

- A complete and reproducible pipeline for basketball shot analysis.
- Early prediction of shot outcome based on partial observations.
- Quantitative evaluation of prediction performance.
- Visual results illustrating detection, tracking, and trajectory estimation.