**Football Bounce Detection System - Project Document**

**1. Introduction**

This document outlines the development of an AI-based football bounce detection system using Faster R-CNN. The system is designed to analyze motion in football videos by detecting bounce events, including ground contact, peak height, and leaving ground moments.

**Client Requirements**

* Implement an AI-driven football detection system.
* Detect and analyze bounce events using computer vision.
* Generate a structured output (CSV) for analysis.

**2. System Architecture**

The system follows a modular pipeline:

1. **Input:** Football video frames.
2. **Processing:** AI-based object detection using Faster R-CNN.
3. **Analysis:** Motion tracking and velocity computation.
4. **Output:** A structured CSV file with bounce event data.

*(Insert Block Diagram Here)*

**3. Workflow & Implementation**

**Step 1: Load Faster R-CNN Model**

* Initialize the object detection model.
* Load trained weights.

**Step 2: Read Images from Folder**

* Extract frames from the input video.
* Sort images in sequential order.

**Step 3: Run Object Detection**

* Process each frame using Faster R-CNN.
* Detect football location (bounding box extraction).

**Step 4: Extract Football Y-Position**

* Compute the vertical center of detected footballs.

**Step 5: Compute Velocity**

* Calculate velocity using positional differences between frames.

**Step 6: Identify Bounce Events**

* Detect **Ground Contact** (Velocity ≈ 0).
* Identify **Bounce Peak** (Velocity change from + to -).
* Identify **Leaving Ground** (Velocity change from - to +).

**Step 7: Save Results to CSV**

* Store event data in a structured CSV file.

*(Insert Flowchart Here)*

**4. Data Processing & Analysis**

* Faster R-CNN detects football positions in frames.
* Velocity computation determines motion patterns.
* Bounce events are detected based on velocity trends.

*(Insert Sequence Diagram Here)*

**5. Output & Results**

* The system generates a CSV file containing:
  + **Frame Name**
  + **Ground Contact Event**
  + **Bounce Peak Event**
  + **Leaving Ground Event**

*(Insert Table Representation Here)*

**6. Challenges & Solutions**

* **Challenge:** Variability in lighting conditions.
  + **Solution:** Preprocessing techniques for better contrast.
* **Challenge:** False detections due to occlusions.
  + **Solution:** Confidence threshold tuning and filtering.

**7. Future Enhancements**

* Use advanced AI models for better accuracy.
* Implement real-time bounce tracking.
* Enhance visualization with interactive plots.

**8. Conclusion**

The Football Bounce Detection System successfully analyzes football motion using AI, providing structured event data for further analysis. This technology can enhance sports performance tracking and research.