Football Analyst Using Deep Learning

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Outline

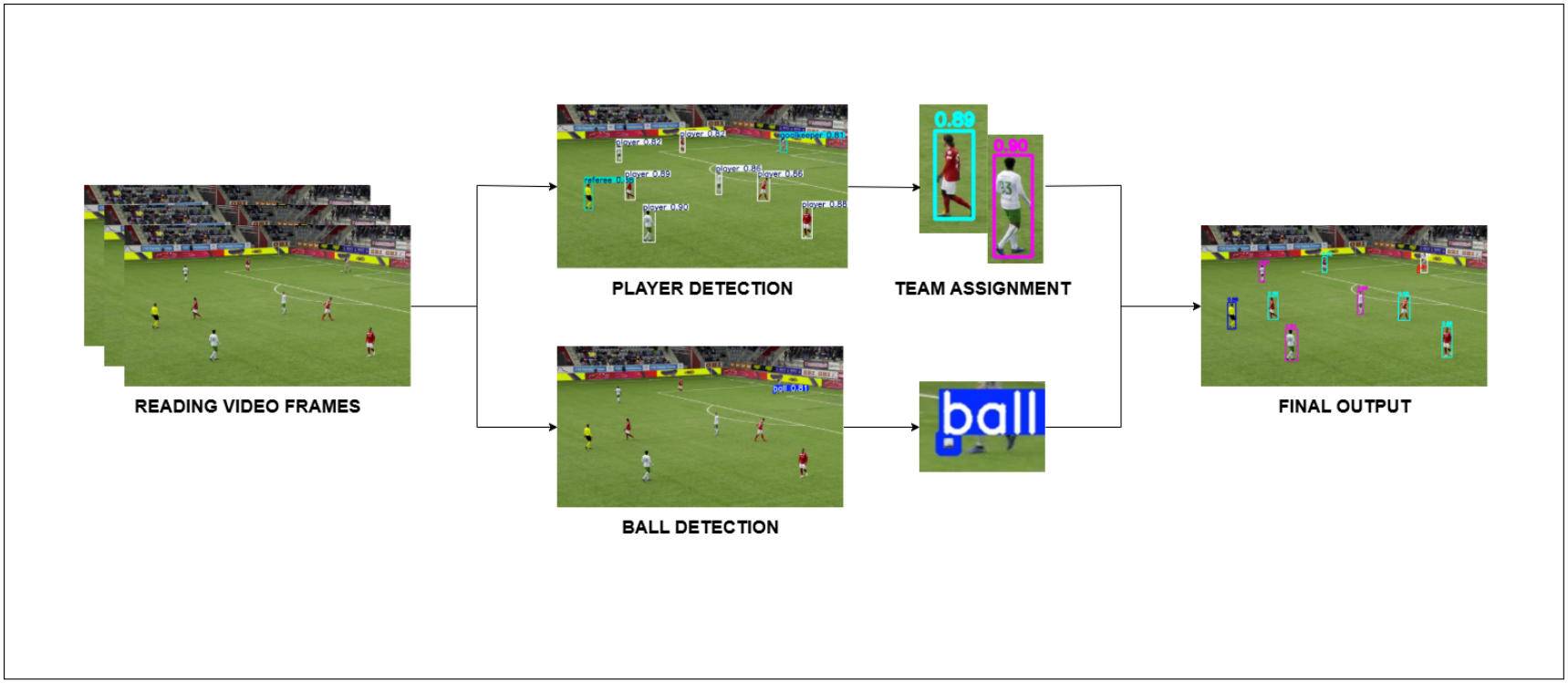
State Problem

- **Current Analysis in Vietnam:**
  - Relies on traditional and manual methods, such as stopwatch and handwritten notes.
  - Accuracy depends on the observer's focus, leading to errors in tracking short plays or transitions.
- **Limitations:**
  - Lack of statistical tools and automated software.
  - Inability to measure ball possession time accurately or identify transitions in control.
  - Cannot provide detailed analysis of ball-controlled areas on the field.

The Problem

- **Reason:**
  - **Technological Advancement:** Opportunity to apply modern AI and computer vision techniques.
  - **High Demand:** Increasing need for precise and efficient analysis in football.
  - **Passion for Innovation:** Combining interests in technology and sports for impactful solutions.
- **Project Goal:**
  - Build an automated system to analyze the ball possession ratio of two teams in a football match using Deep Learning.

Architecture



Introduction to YOLO

YOLO (You Only Look Once) is a state-of-the-art, real-time object detection system. It frames object detection as a single regression problem, directly predicting bounding boxes and class probabilities from an input image.

Why use YOLO

- **Speed**
- **Accuracy**
- **Versatility**

Prepare Data

- Collect Data from SoccerNet GameState.

- Perform data sampling, and only keep the labels necessary for the project.

Object Detection with YOLO

- Detects players, goalkeepers, referees, and the ball in each video frame.
- Fine-tuned YOLOv8x on a custom football dataset for better recognition.
- Divided into two models:
  - **Player Detection Model**: Detects players, referees, and goalkeepers.
  - **Ball Detection Model**: Detects the ball with a low confidence threshold to improve recall.
- Filters objects based on confidence, keeping only the highest-confidence ball detection.

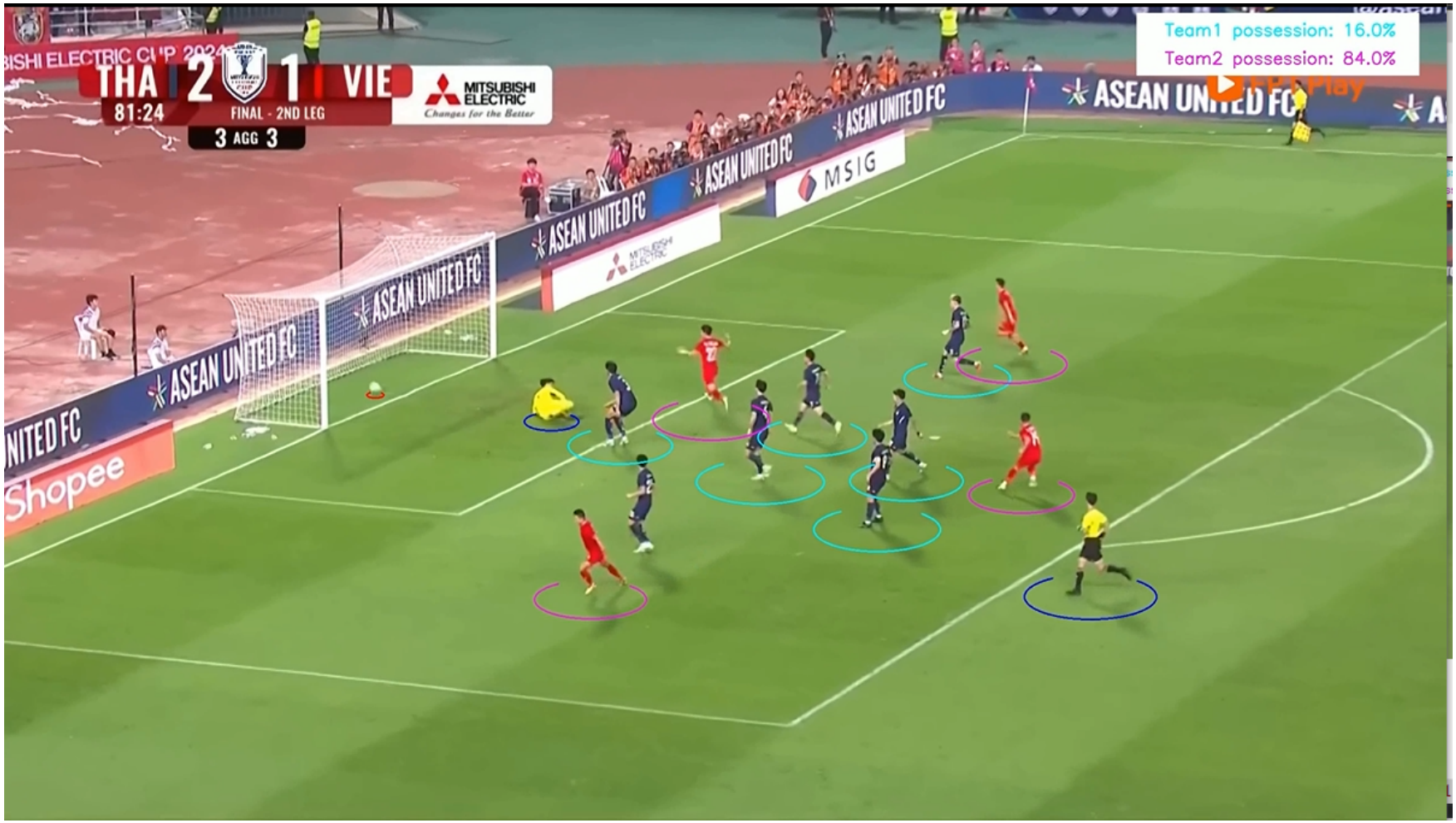
Player Team Classification with K-Means

- Uses **K-Means clustering** to classify players into two teams based on jersey color.
- Steps:
  - Crop player images from the detection results.
  - Extract dominant colors from cropped images (center area only to avoid noise from the field).
  - Apply K-Means clustering to group colors and predict team assignments.
- Outputs the team assignment for each player.

Match Analysis

- Calculates ball possession percentage for each team.
- Steps:
  - Decide which team has possession of the ball based on the nearest player to the ball in each frame.
  - Update possession time for the respective team.
- Determines which team controlled the ball longer throughout the match.

Demo


Team1 possession: 16.0%
Team2 possession: 84.0%
THA 2 1 VIE
81:24
FINAL - 2ND LEG
3 AGG 3
MITSUBISHI ELECTRIC
Changes for the Better
ASEAN UNITED FC
MSIG
Shopee

Evaluation

We fine-tuned two models: *Player Detection* and *Ball Detection*. The performance evaluation of the *Player Detection* models after fine-tuning is shown below:

Class	**YOLOv8x**				**YOLOv11x**			
	P	**R**	**mAP50**	**mAP50-95**	**P**	**R**	**mAP50**	**mAP50-95**
All	0.903	0.792	0.838	0.614	0.882	0.795	0.830	0.584
Player	0.968	0.963	0.990	0.774	0.939	0.962	0.984	0.744
Referee	0.940	0.908	0.966	0.718	0.918	0.911	0.956	0.700
Goalkeeper	0.987	0.951	0.979	0.775	0.954	0.947	0.977	0.725

Table: Comparison between YOLOv8x and YOLOv11x models for each class.

Ball Detection Evaluation

We fine-tuned the *Ball Detection* model using YOLOv8x. The performance evaluation after fine-tuning is shown below:

YOLOv8x				
Class	**P**	**R**	**mAP50**	**mAP50-95**
All	0.979	0.760	0.894	0.552

Table: Performance of the **Ball Detection** model using YOLOv8x.

K-Means Evaluation

We evaluated the K-Means algorithm on team assignment accuracy using cropped player images. The evaluation results are summarized in the table below:

Metric	**Value**
Total number of cropped images	10535
Correctly assigned images	9709
Team assignment accuracy	92.16%

Table: Performance of the K-Means algorithm in team assignment.

Future Development

- **Feature Expansion:**
  - Jersey number recognition.
  - Player tracking.
  - Field recognition.
- **Advanced Player Analysis:**
  - Heatmaps for individual players.
  - Movement speed tracking.
  - Successful pass count.
- **Potential Extensions:**
  - Player segmentation for offside detection.
  - Evaluating foul situations.

Thank you for your attention!