CSCI 1430 Final Project Report: Real-time Soccer Match Analysis Using YOLO

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Abstract

Our project focuses on developing a real-time soccer match analysis program. The program's primary features include tracking players' positions in real time, identifying team formations, and generating detailed game metrics. This report presents an overview of the dataset utilized, the methodology employed, and the final outcomes achieved in our project.

1. Project Report Advice [Delete This Section]

1. Overriding principle: show us your effort.
2. If you wish us to consider any aspect of your project, it should be presented here.
3. Please include a problem statement, related work, your method, your results (figures! tables!), any comparison to existing techniques, and references.
4. If you made something work—great! If you didn't quite make it work—tell us about the problems, why you think it didn't work, and what you would do to fix it.
5. Length: Approximately four pages for techical description. For social impact, no more than one page total.
6. Please include an appendix to the report which details what each team member contributed to the project. One paragraph max each.
7. Any other materials should go in an appendix.

2. Introduction

Data analytics has become an integral part of the sports industry, with clubs investing in sports analytics and technical innovations to gain competitive advantages. Many sport teams and fans are taking strategic and analytical approaches to better understand the players and the games. However, the accessibility of such advancements still remains highly unequal. Wealthier and bigger teams are able to afford costly data analysis tools and proprietary systems, enabling them to widen the performance gap with less affluent clubs.

Our project aims to address this issue by developing a relatively simple and efficient algorithm to analyze soccer matches in real-time. Some key features will include tracking player positions, identifying team formations, and generating actionable game metrics. We hope to bridge the gap between professional and amateur analysts, empowering smaller clubs and passionate fans with tools to enhance their understanding of the game. By taking part in making advanced technology more accessible to the public, we could promote greater inclusivity in the sports industry and foster new opportunities for growth.

3. Related Work

Cite and discuss work that you used in your project, including any software used.

The backbone of this project is the YOLO (You Only Look Once) algorithm, a classification method that detects objects in a single run of the model [2]. YOLO's single-shot detection approach, which predicts class probabilities and bounding boxes in one evaluation, makes it particularly well-suited for the fast-paced nature of soccer matches, where player positions and formations change rapidly. Prior research demonstrates YOLO's exceptional speed—45 FPS for the base model and 155 FPS for Fast YOLO—highlighting its suitability for real-time data processing [3].

Leveraging an efficient and accessible algorithm aligns with the project's mission to provide advanced game insights and analysis to a broader audience. To achieve real-time object detection while maintaining simplicity and adaptability, we explored the application of YOLO in constrained environments with limited computational resources [1].

4. Method

The project addresses the challenge of democratizing soccer match analysis by providing real-time tracking of players' positions, identifying team formations, and gen-

erating game metrics. Current data analysis programs are expensive and resource-intensive, making them difficult to access by smaller clubs and individual analysts. The main implementation of this project requires object detection and classification (for players, balls, referees, etc.) on a soccer field in real time, while ensuring high accuracy and computational efficiency.

To solve this problem, we implemented a pipeline that combines computer vision techniques and data analysis, with the core detection task handled by the YOLO (You Only Look Once) object detection algorithm.

4.1. Dataset Preparation

We acquired data to train our YOLO model from the Football Players Detection dataset hosted by Roboflow [4]. This dataset consists of 300+ annotated images captured during football games, with bounding boxes labeling individual players on the field, enabling precise localization of players within the frame.

Figure 1. Sample data showing video frames with annotations for ball, players, and referee's positions

The images include a wide range of video frames from different matches, with varying camera angles, lighting conditions, and player orientations. The variations in stadium settings, audience, visibility, and field markings make the dataset robust for real-world applications.

Potential limitations from the dataset include overlapping bounding boxes when players are close together. When training our model, we would have to account for edge cases where multiple players are annotated in an overlapping region. Furthermore, since the dataset lacks additional attributes such as team affiliation, we would need additional annotation to check the accuracy of our team assignments.

4.2. Object Detection with YOLO

5. Results

Present the results of the changes. Include code snippets (just interesting things), figures (Figures 2 and 3), and tables (Table 1). Assess computational performance, accuracy performance, etc. Further, feel free to show screenshots, images; videos will have to be uploaded separately to Gradescope in a zip. Use whatever you need.

Method	Frobnability
Theirs	Frumpy
Yours	Frobbly
Ours	Makes one's heart Frob

Table 1. Results. Please write an explanatory caption that makes the table/figure self-contained.

Figure 2. Single-wide figure.

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Figure 3. Double-wide figure. *Left:* My result was spectacular. *Right:* Curious.

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5.1. Technical Discussion

What about your method raises interesting questions? Are there any trade-offs? What is the right way to think about the changes that you made?

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6. Conclusion

What you did, why it matters, what the impact is going forward.

References

[1] Wei Fang, Lin Wang, and Peiming Ren. Tinier-yolo: A real-time object detection method for constrained environments. *IEEE Access*, 8:1935–1944, 2020. 1

[2] Anton Morgunov. Object detection with yolo: Hands-on tutorial, 2024. 1

[3] Joseph Redmon, Santosh Divvala, Ross Girshick, and Ali Farhadi. You only look once: Unified, real-time object detection. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, June 2016. 1

[4] Roboflow. football-players-detection dataset. https://universe.roboflow.com/roboflow-jvuqo/football-players-detection-3zvbc, aug 2024. visited on 2024-12-14. 2

Appendix

Team contributions

Please describe in one paragraph per team member what each of you contributed to the project.

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