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Visual Tracking for Application to AFL Football

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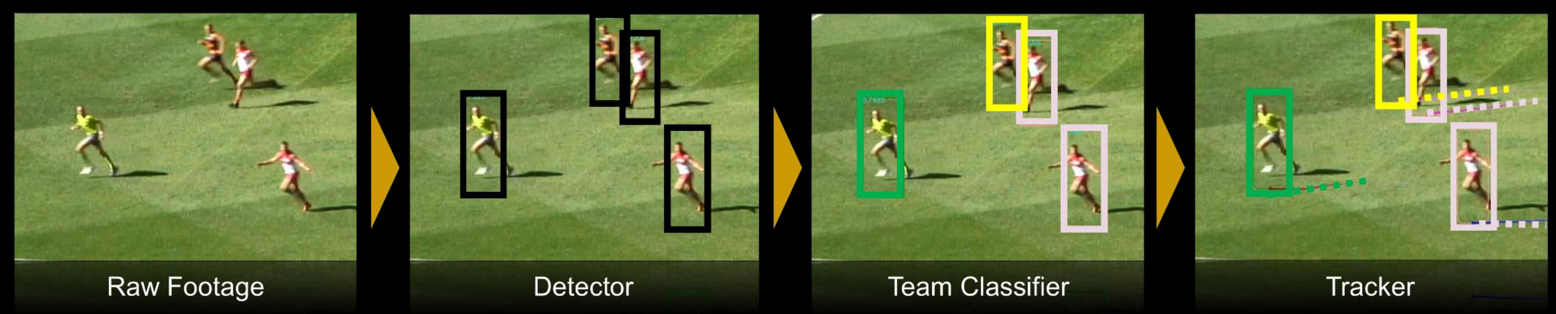
Introduction

Visual object tracking is a fundamental problem in the field of computer vision, with the case of tracking AFL football yet to be researched. Factors such as occlusion, pose variability, lighting differences, player movement, and similarity in appearance of players, make the problem more difficult than the well studied pedestrian tracking problem.

This work investigated and adapted current state-of-the-art methods for better performance in the AFL case.



Data Collection

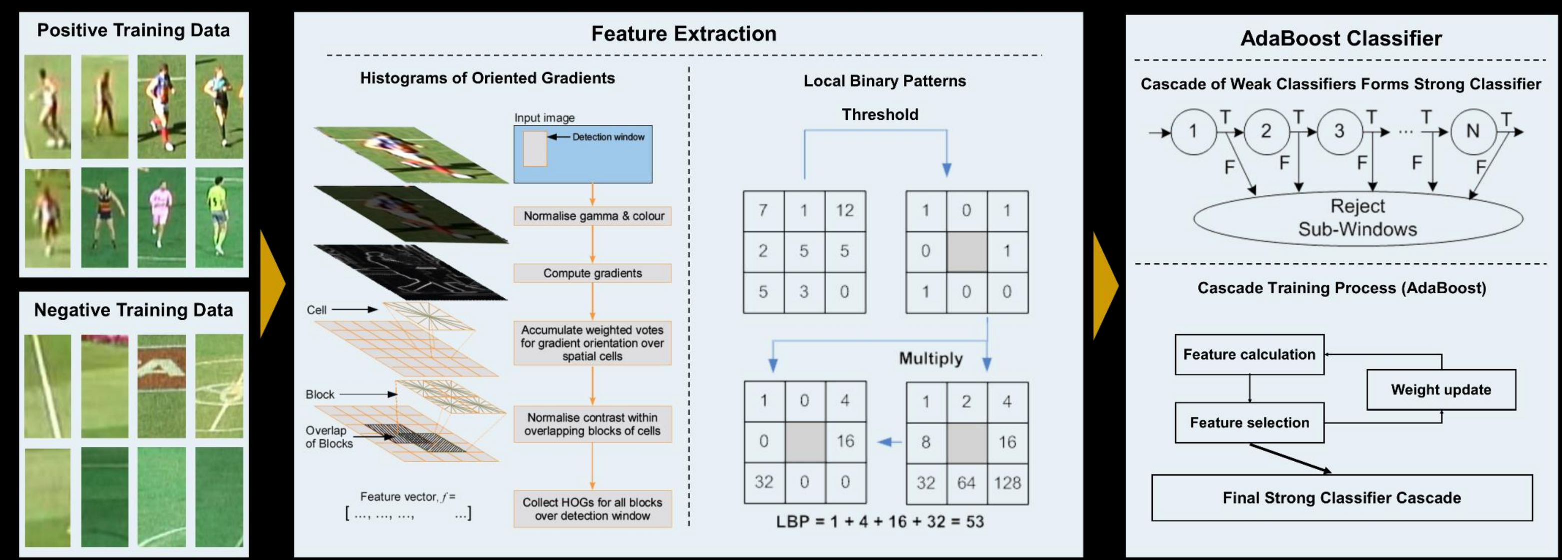
Both testing and training data needed to be collected:

- 5 static HD cameras film entire field from grandstand
- Approximately 50 hours of footage collected in total
- Different lighting conditions (sunny, overcast, night)
- Seven different teams plus officials
- Over 15,000 players and officials manually annotated and classed based on team, pose and occlusion

Detection

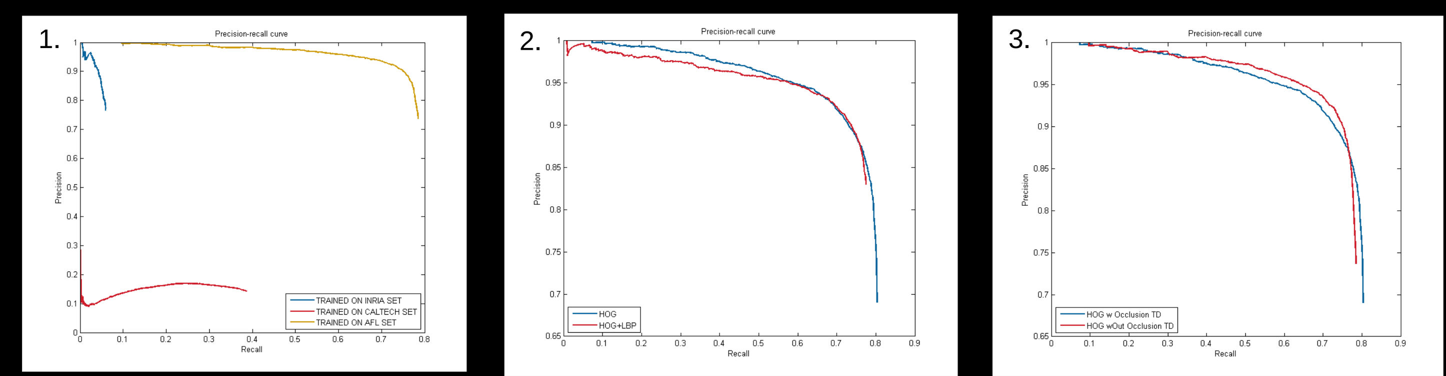
The detection framework consisted of:

- Fast channel features cascade classifier [1] trained with AdaBoost [2] and 4 iterations of bootstrapping [3]
- Histograms of Oriented Gradients (HOG) [4] feature
- Local Binary Pattern (LBP) additional feature [5]



Detectors trained and tested on ~12,000 and ~5,500 positive samples respectively. Results presented a few key findings:

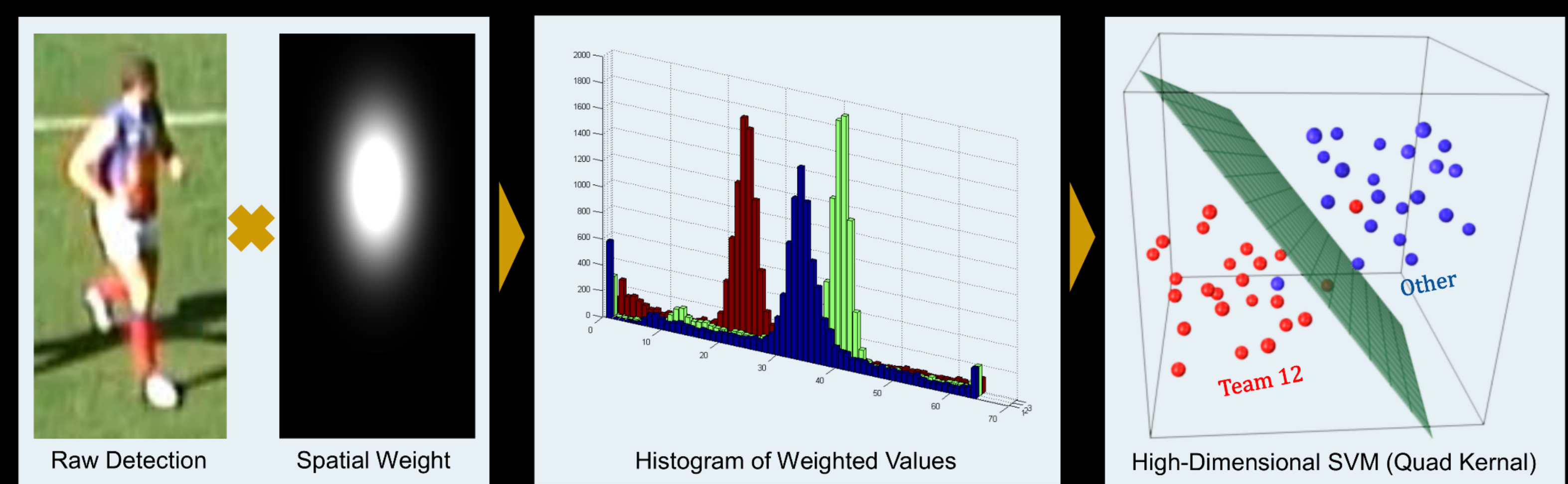
1. Using AFL specific training data is fundamental
2. Sole HOG performs better than HOG+LBP combination
3. Including partly occluded samples in the training set provided a less accurate classifier



Team Classification

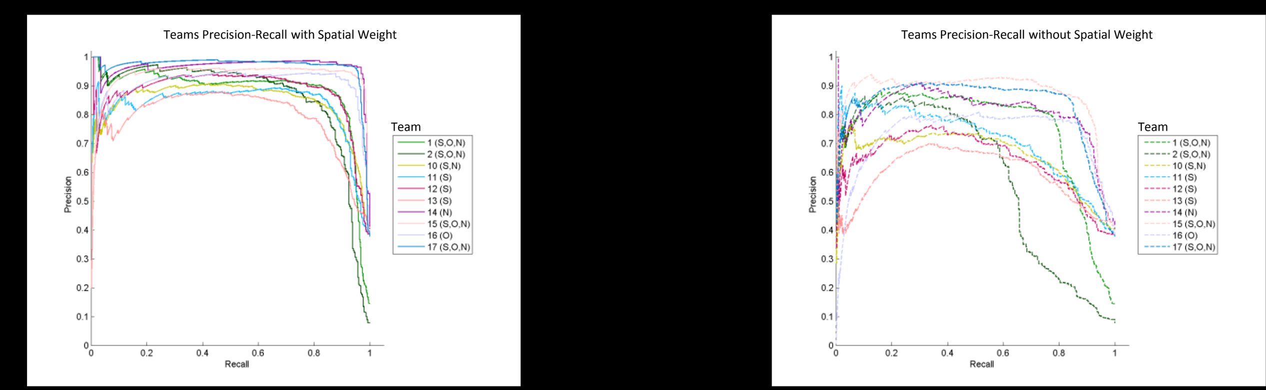
Each AFL team has their unique uniform, generally with different colours and patterns. The team classification framework:

- Support Vector Machine (SVM) [6], single team vs all
- Colour (HSV) histograms with weighted spatial maps as features



The promising team classification results show that:

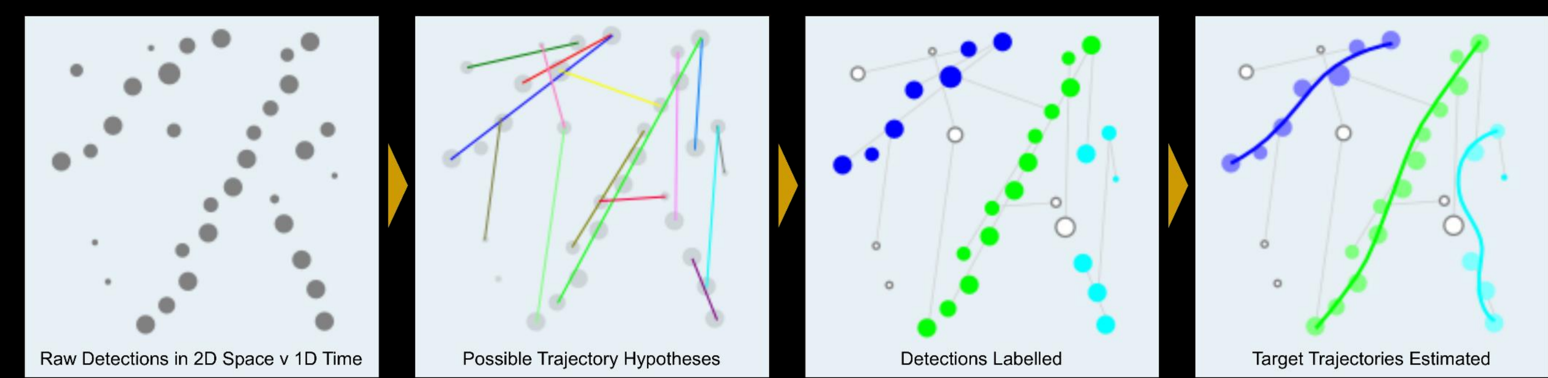
1. Using spatial weight has significant improvement
2. Teams with higher contrasting uniforms are classified more accurately
3. Classification performance degrades when in sunny conditions where shadowing and overexposure occur



Tracking

The tracking process links detections across frames:

- Discrete-continuous energy minimisation approach [7]
- Additional Kalman Filter approach used as initial guide for the energy minimisation algorithm



Conclusion

- Off the shelf pedestrian detectors don't work for AFL
- Using AFL training data is vital for a reliable detector
- Significant pose and lighting variation able to be handled
- SVM on colour histograms sufficient for team classification

References

[1] P. Dollár, R. Appel, S. Belongie and P. Perona "Fast Feature Pyramids for Object Detection", PAMI 2014.

[2] Freund, Yoav, and Robert E. Schapire. "A desicion-theoretic generalization of on-line learning and an application to boosting." *Computational learning theory*. Springer Berlin Heidelberg, 1995.

[3] Sung, Kah-Kay, and Tomaso Poggio. "Example-based learning for view-based human face detection." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 20.1 (1998): 39-51.

[4] Dalal, Navneet, and Bill Triggs. "Histograms of oriented gradients for human detection." *Computer Vision and Pattern Recognition, 2005. CVPR 2005. IEEE Computer Society Conference on*. Vol. 1. IEEE, 2005.

[5] Ojala, Timo, Matti Pietikainen, and Topi Maenpaa. "Multiresolution gray-scale and rotation invariant texture classification with local binary patterns." *Pattern Analysis and Machine Intelligence, IEEE Transactions on* 24.7 (2002): 971-987.

[6] Cortes, Corinna, and Vladimir Vapnik. "Support-vector networks." *Machine learning* 20.3 (1995): 273-297.

[7] Andriyenko, Anton, Konrad Schindler, and Stefan Roth. "Discrete-continuous optimization for multi-target tracking." *Computer Vision and Pattern Recognition (CVPR), 2012 IEEE Conference on*. IEEE, 2012.