Learning from the Pros:
Extracting Professional Goalkeeper Technique from Broadcast Footage

Soccer Track

1. Introduction

Of the millions of goalkeepers worldwide, only 20 play regularly in the English Premier League (EPL). As an amateur goalkeeper playing grassroots soccer, who better to learn from than top professional goalkeepers? In this paper, we harness computer vision and machine learning models to appraise the save technique of professionals in a way those at lower levels can learn from. Building on previous black-box analyses [1], we use 3D body pose data from broadcast footage to train a white-box "*expected saves"* (xS) model, from which we can identify the optimal goalkeeper technique in different match contexts. In summary, we make the following novel contributions:

1. A new open-source dataset of saves and body pose from broadcast footage
2. An analysis of techniques employed by professionals in different match contexts
3. A white-box xS model that can be used to derive teachable insights for professional and grassroots players alike

2. Methods

Using broadcast footage of 764 matches from the 2018 World Cup and 2018-2020 EPL seasons, we assembled a dataset of 959 images of goalkeepers reacting to 1v1 shots. These images were passed to a pose estimation model [2] to extract 3D body pose coordinates for the goalkeeper (e.g., Figure 2), ensuring viewpoint-invariance for each instance by rotating it such that the goalkeeper maximizes goal coverage. We introduce the "*Goalkeeper Engagement Metric*" (GKEM) to measure the ratio between the distance from the striker to both the goalkeeper and goal center, allowing us to assess the pressure the goalkeeper is putting on the striker. Finally, the body pose coordinates and GKEM are combined to form a feature vector for each save. We perform the following experiments:

- **Cluster analysis -** K-Means clustering to group features into distinct clusters, each representing different expert-driven save techniques.
- **Predictive model** - an xS SVM classification model to predict the probability of a save given the save technique derived from the cluster analysis.
- **Technique appraisal** - analysis to identify which techniques are optimal in different situations.

3. Results

We identify 4 distinct save clusters, each aligning with expert-defined save techniques (Figure 1). The SVM xS model achieved 73% accuracy on the test set. The xS model shows a correlation

between shot features such as angle, distance and effectiveness of different techniques. The xS model predicts the value of a goalkeeper employing a save technique in a shooting situation and produces optimal technique maps (Figure 2). These plots can be used as a guide and coaching tool for goalkeepers at all levels.

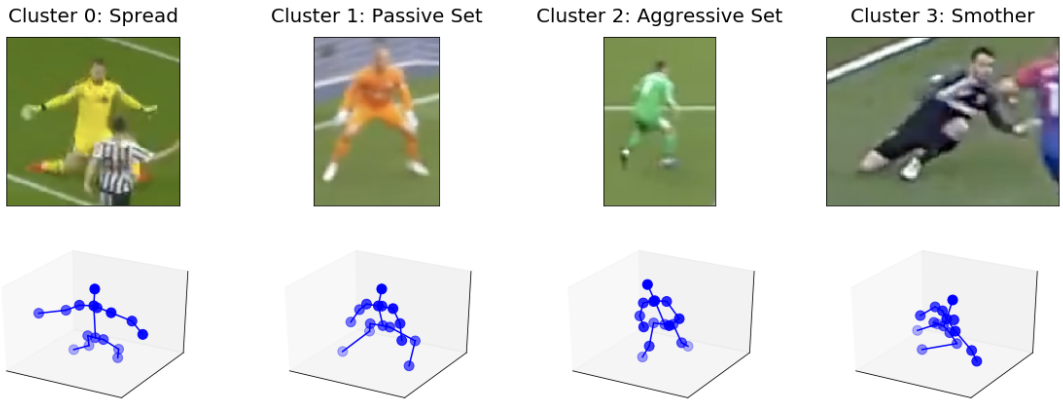

Figure 1- Examples of saves in each cluster found using the K-Means algorithm. The chosen examples are those that are closest to their cluster center. Saves in clusters 1 and 2 use similar body pose but differ by their value of GKEM.

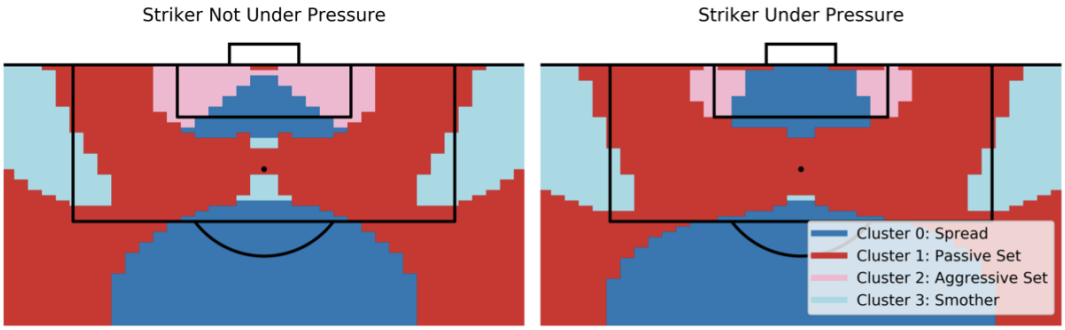

Figure 2 - Optimal technique maps for match situations in which the striker is either under pressure from the opposition team, or not. The highlighted areas show the save technique that maximizes the probability of the goalkeeper making a save when the shot is taken from that position on the pitch.

4. Conclusion

Our work impacts the sports industry by presenting example uses of advanced AI and computer vision techniques within grassroots sports. We presented methods for extracting situational save technique from professionals, that not only allow them to analyze if they used optimal techniques but highlights the same information to amateurs to learn from. Our work could be re-applied using camera-phone footage and self-collected shot location data so that amateur goalkeepers can compare their technique to professionals.

References

[1] P. Power, A. Cherukumudi, Sujoy Ganguly, Felix Wei, Long Sha, Jennifer Hobbs, Héctor Ruiz, and P. Lucey. Trading places – simulating goalkeeper performance using spatial & body-pose data. 2019.
[2] Xingyi Zhou, Qixing Huang, Xiao Sun, Xiangyang Xue, and Yichen Wei. Towards 3d human pose estimation in the wild: a weakly-supervised approach, 2017.

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