

# Optimizing Jersey Number Recognition for Effective Player Tracking in the Game State Reconstruction

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## 1. Method

Game State Reconstruction competition [3] consists of four main parts: player tracking, pitch localization and camera calibration, jersey number recognition, and team affiliation.

Based on the evaluation metric of the competition, we found that jersey number recognition and team affiliation are crucial factors. Accurate jersey number recognition and correct team affiliation are prerequisites for successful scoring tracking and pitch localization.

According to the competition framework, tracklab [1] has strong tracking performance, integrating Ocsort, DeepOcsort, StrongSort, and various ReID methods. However, MMOCR and EasyOCR used in jersey number recognition were originally used for traditional optical character recognition. If they are used directly for jersey number recognition without fine-tuning, it is easy to recognize the numbers as English letters, resulting in a low recognition accuracy. At the same time, SoccerNet officials also mentioned that the inference speed of jersey number recognition is very slow and needs to be optimized.

Based on the above observations, our team primarily focused on optimizing the jersey number recognition module. In order to improve the inference speed of the model, we adopted YOLOv8 as the primary model. We were surprised to find that by mapping the numbers 0-99 to 0-99 class labels, we could simultaneously accomplish both jersey number detection and recognition using a single YOLOv8 model.

During the training process, due to the lack of sufficient data, we first labeled a portion of the data, and then employed data augmentation techniques to expand the dataset, including methods such as CopyPasteMix, SwapDigit [2], scaling, rotation, and adding random noise. Meanwhile, we also screened out some high-quality data from the SVHN street view dataset for data augmentation. These augmentation methods helped improve the model's generalization capability.

However, the model trained in this way can easily misidentify images without jersey numbers as containing

numbers. The key to this problem lies in how the model can learn to balance the boundary between blurred numbers and images without jersey numbers, and achieve a proper trade-off. To address this, we also trained a Yolo discriminator network using the same dataset to determine whether a player image contains a jersey number. The trained model achieved an impressive 83.24% accuracy on the challenge dataset of jersey number recognition at the SoccerNet 2023 competition, while also delivering very fast inference speeds.

By replacing the jersey number recognition module in the framework with our trained model, we significantly improved the accuracy and real-time performance of jersey number recognition, thereby fully unleashing the potential of the framework's tracking module.

## References

- [1] Victor Joos, Vladimir Somers, and Baptiste Standaert. TrackLab. <https://github.com/TrackingLaboratory/tracklab>, 2024. 1
- [2] Hengyue Liu and Bir Bhanu. Jede: Universal jersey number detector for sports. *IEEE Transactions on Circuits and Systems for Video Technology*, 32(11):7894–7909, 2022.
- [3] Vladimir Somers, Victor Joos, Silvio Giancola, Anthony Cioppa, Seyed Abolfazl Ghasemzadeh, Floriane Magera, Baptiste Standaert, Amir Mohammad Mansourian, Xin Zhou, Shohreh Kasaei, Bernard Ghanem, Alexandre Alahi, Marc Van Droogenbroeck, and Christophe De Vleeschouwer. SoccerNet game state reconstruction: End-to-end athlete tracking and identification on a minimap. 2024. 1