Multi-camera Sports Players 3D Localization with Identification Reasoning

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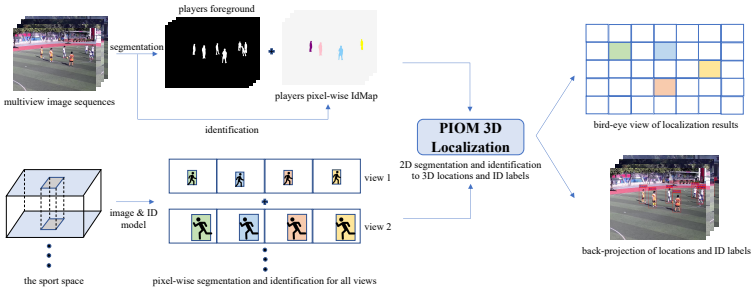
Introduction



Firstly, we use 2D monocular segmentation and identification to extract sports players' segmentation masks and identification in pixel level. At the same time, with the 3D coordinate settings for the sports space, we introduce an image & ID model and an image distance norm to fuse the multiview pixel-wise segmentation and ID labels with their 3D spatial relation. With multiple players PIOM localization algorithms, we then obtain sports players 3D location and their unique IDs.

Method

1. Statistical Modelling

We use a multi-dimensional Bayesian model to formulate the localization as the posterior occupancy probabilities.

$$P\big((X,Y)|B\big) = P(X,Y)P\big(B|(X,Y)\big)$$

2. Image&ID model

We introduce an Image&ID model to visually describe the relation between the likelihood probabilities and the players' segmentation and identities.

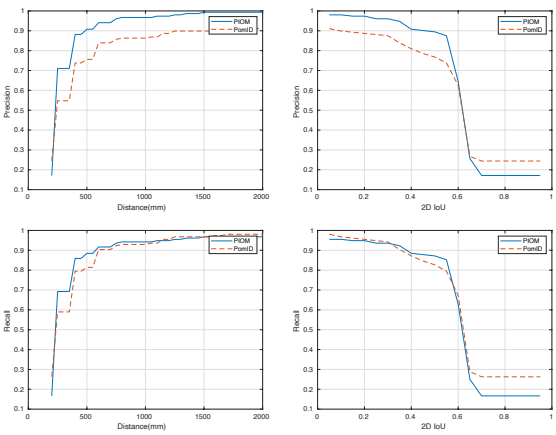
$$R_k = arg\max_{\xi} \frac{\sum_c \big(\mathcal{R}_k^c \sum_{i=1}^{MN} r_i | r_i = \xi\big)}{\sum_c \big(\mathcal{R}_k^c \sum_{i=1}^{MN} r_i\big)}$$

3. Convergence and optimization

We use $K-L$ divergence to estimate the error between the calculated posterior probabilities and the distribution of given evidence, to obtain an optimal solution.

Results

we conduct experiments on a youth football match dataset. And we compare the results with two previous methods POM, POM-CNN and one of our previous method PomID.



This shows the P-R curve on the metrices of bird-eye distance and 2D IoU, compared with our method PIOM and our previous method PomID.
Our proposed method achieve high P-R ratios, especially when the metrices are representing the typical human size on the playground.

Each player has a bounding box that is back-projected from the calculated 3D location and a unique ID label that can trace the specific player with location presented.

Conclusion

In this paper, we

- jointly apply object segmentation and our early research on player identification. With identification labels, we provide each segmentation mask with pixel-wise ID information.
- introduce an Image&ID model to visually describe the position of a player standing at the sports court with a certain ID. Then we use an image distance norm to evaluate the overall errors between the model and multiview input evidence. This creates a tractable loss function to make iteration efficient.
- we develop the PIOM by using a multiple dimensional Bayesian model, to calculate the locations separately according to different ID labels, providing the results as probabilities of locations being occupied by multiple players with unique ID labels.
- conduct experiments based on a youth football dataset and compare the performance with 3 previous baselines to show that our proposed method outperforms the previous localization approaches by a large margin.