



**HAL**  
open science

# Straightforward Adaptation of Particle Filter to Fish Eye Images for Top View Pedestrian Tracking

Hicham Talaoubrid, Khizar Hayat, Baptiste Magnier

► **To cite this version:**

Hicham Talaoubrid, Khizar Hayat, Baptiste Magnier. Straightforward Adaptation of Particle Filter to Fish Eye Images for Top View Pedestrian Tracking. ICASSP 2024 - 2024 IEEE International Conference on Acoustics, Speech and Signal Processing, Apr 2024, Seoul, South Korea. IEEE, 2024. hal-04554295

**HAL Id: hal-04554295**

**<https://imt-mines-ales.hal.science/hal-04554295>**

Submitted on 22 Apr 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## Introduction and Context

Object tracking in computer vision, essential for detecting, locating, and predicting object movement in videos [5], faces challenges with fisheye cameras due to wide-angle views, distortion, and complex perspective shifts. Particle Filters offer a solution by providing a flexible framework for tracking objects in nonlinear, wide-angle scenes. They excel in handling fisheye image characteristics like distortion correction and probabilistic state estimation, making them valuable for robust object tracking in fisheye camera setups.

## Particle filtering for tracking

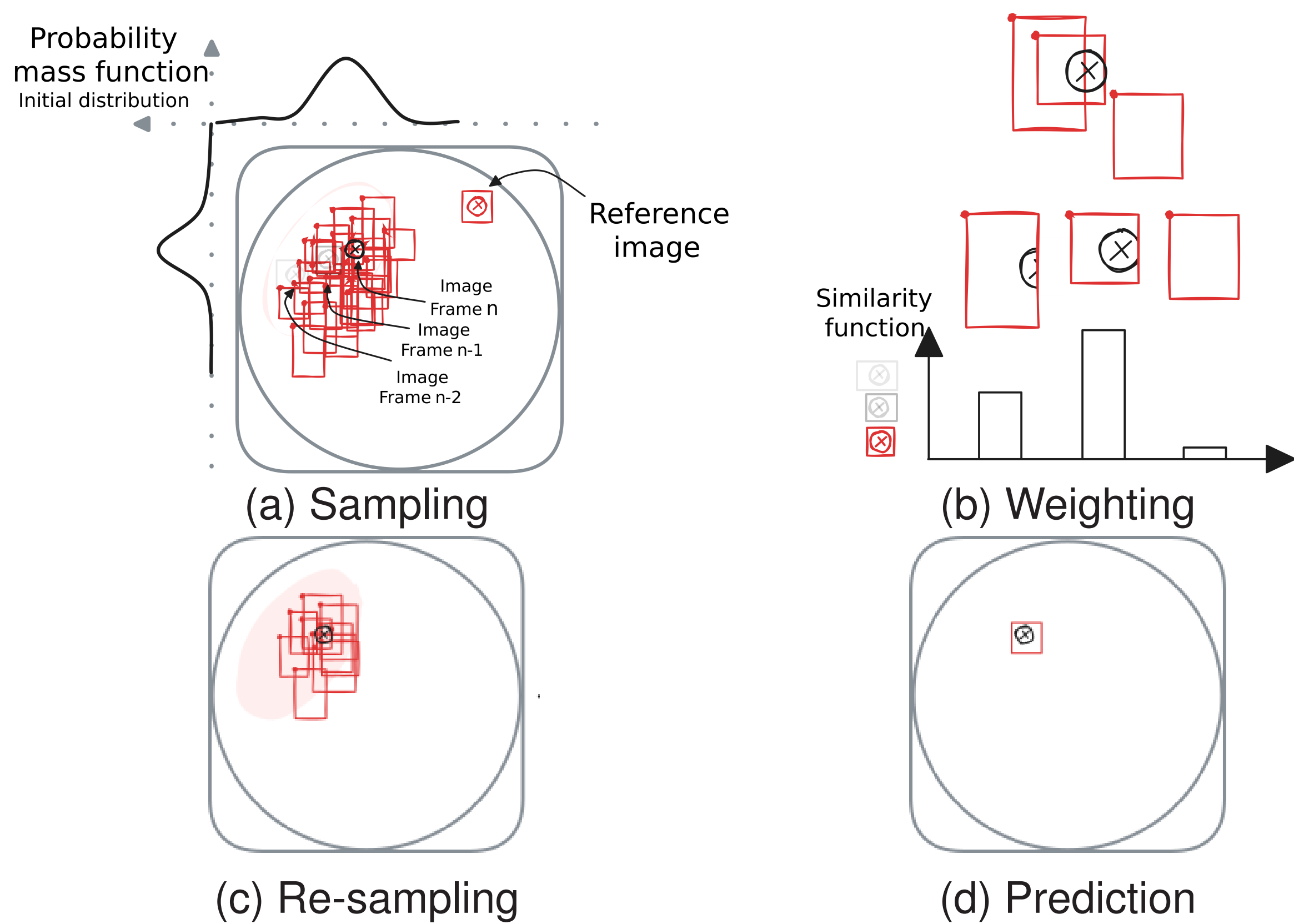


Figure 1: Sequential steps used by PF [2] for tracking. (a) Particles are initialized from prior (position at frame  $t-1$ ), (b) Weights are updated. (c) Particles are resampled based on the calculated weights for a prediction in (d).

## Adapting to fish eye camera

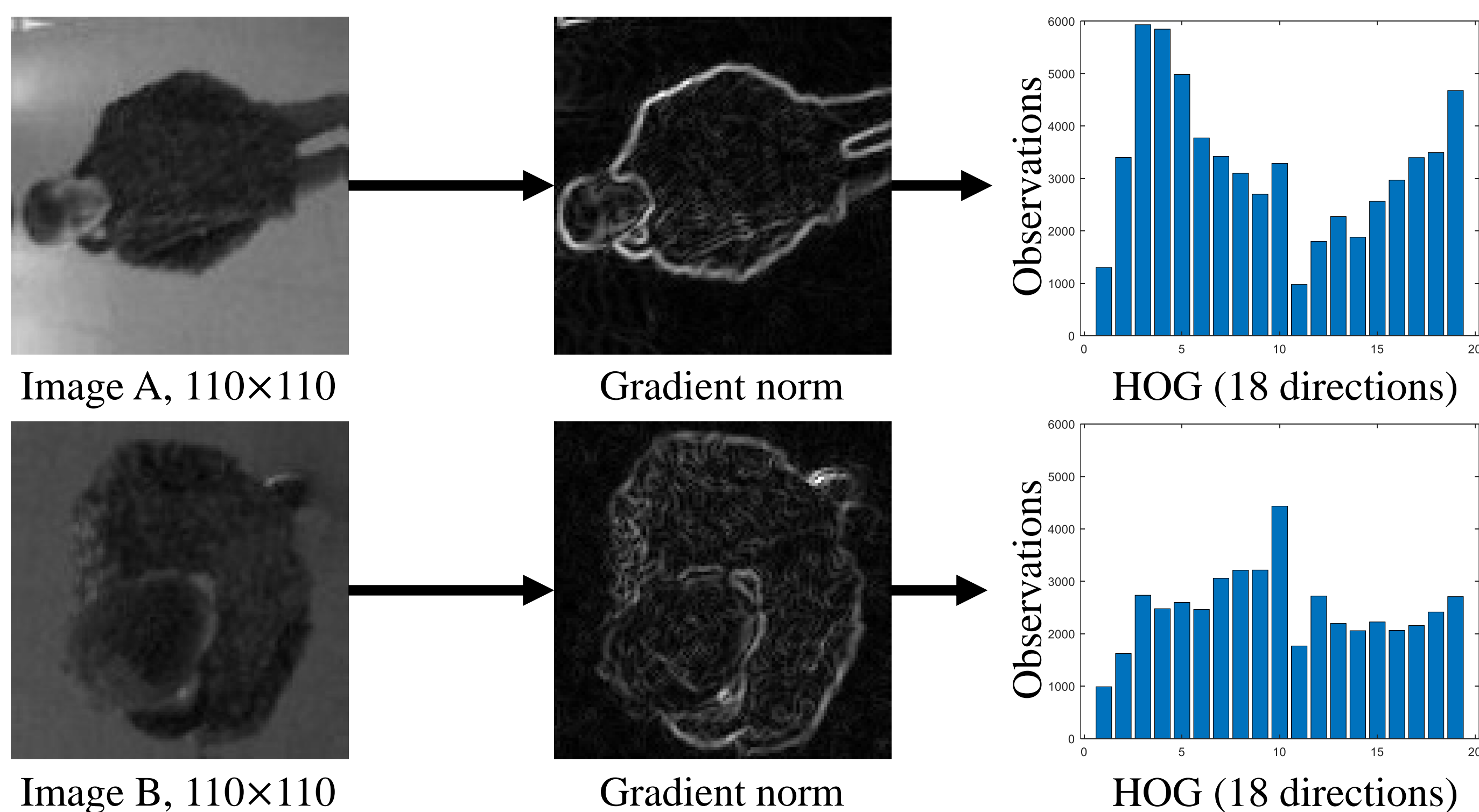


Figure 2: Fisheye overhead images, depicted in grayscale in (a) and (b), present challenges for pedestrian tracking due to distortions. Continuous tracking becomes challenging as individuals move across different image areas. Restricting the tracking to histograms of oriented gradients, as shown in (b), reveals the challenge posed by individuals approaching the center of the image, where only the top of their head and shoulders are visible.

## Weighted contribution from HOG: Simpson Index

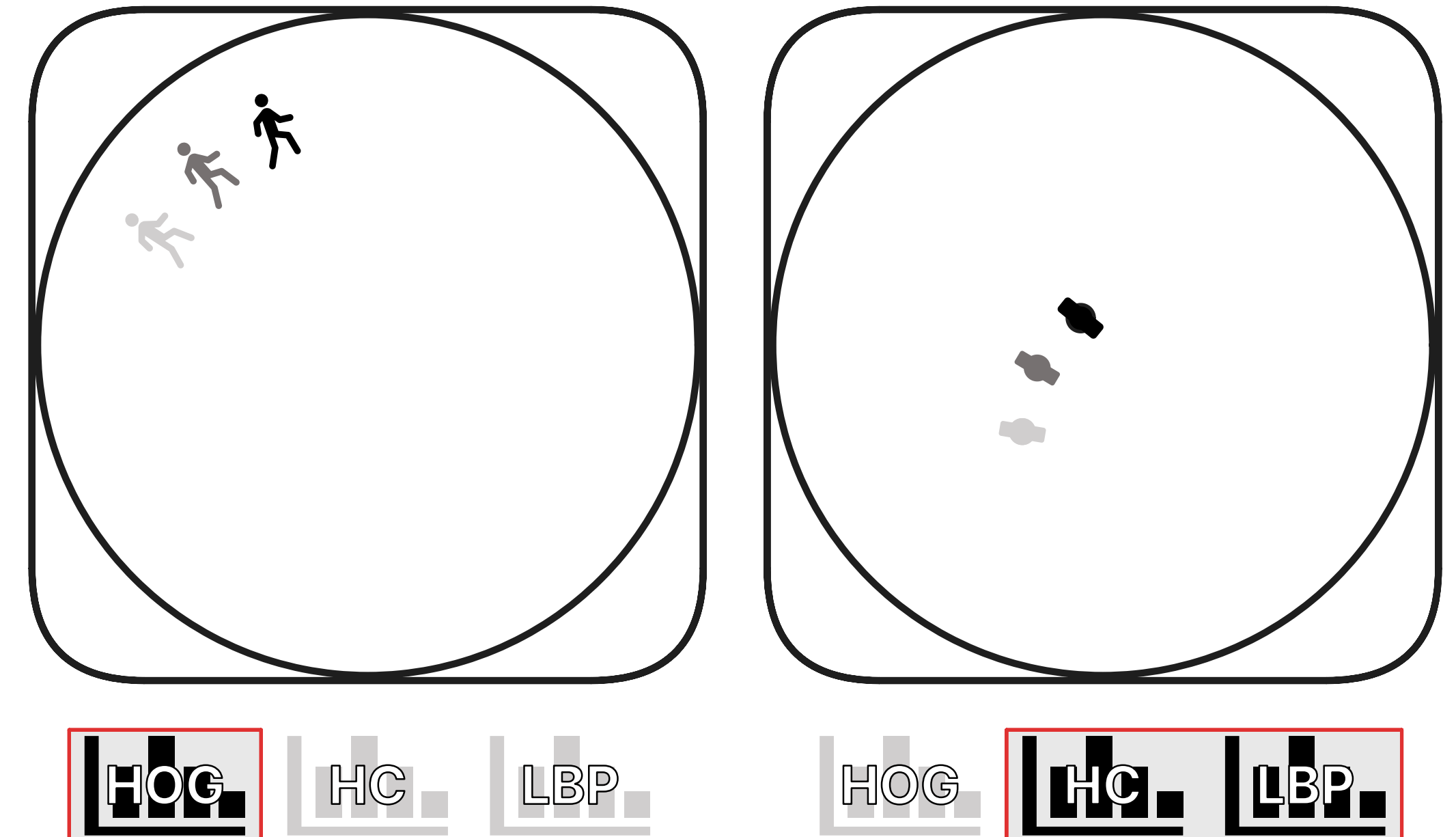
We propose weighting histogram distances based on particle positions relative to the image center. Closer particles carry more weight for both color and texture histograms, reducing comparisons using HOG. We calculate weights using the Simpson index [1].

Assuming  $H_F$  as reference feature histograms, and  $p^{(i)}$  as the  $i^{th}$  particle, with  $H_{OG}^{(i)}$  and  $H_F^{(i)}$  as their respective histograms, we define the distance for comparison:

$$d = \mu \cdot \mathcal{B}(H_{OG}^{ref}, H_{OG}^{(i)}) + (1 - \mu) \cdot \mathcal{B}(H_F^{ref}, H_F^{(i)}), \quad (1)$$

where  $\mu = e^{1-S(HOG)}$ , representing the HOG histogram weight using the Simpson index.

## Changing the target throughout tracking



(a) Person in the image edge (b) Person in the image center

Figure 3: Depending if the tracked person is in the center or in the edge of the fish-eye image particle similarity function will base more on HOG or in HC (with a careful choice of color space [3]) and LBP [4] using a weighted sum. Weights are calculated using Simpson index.

## Results

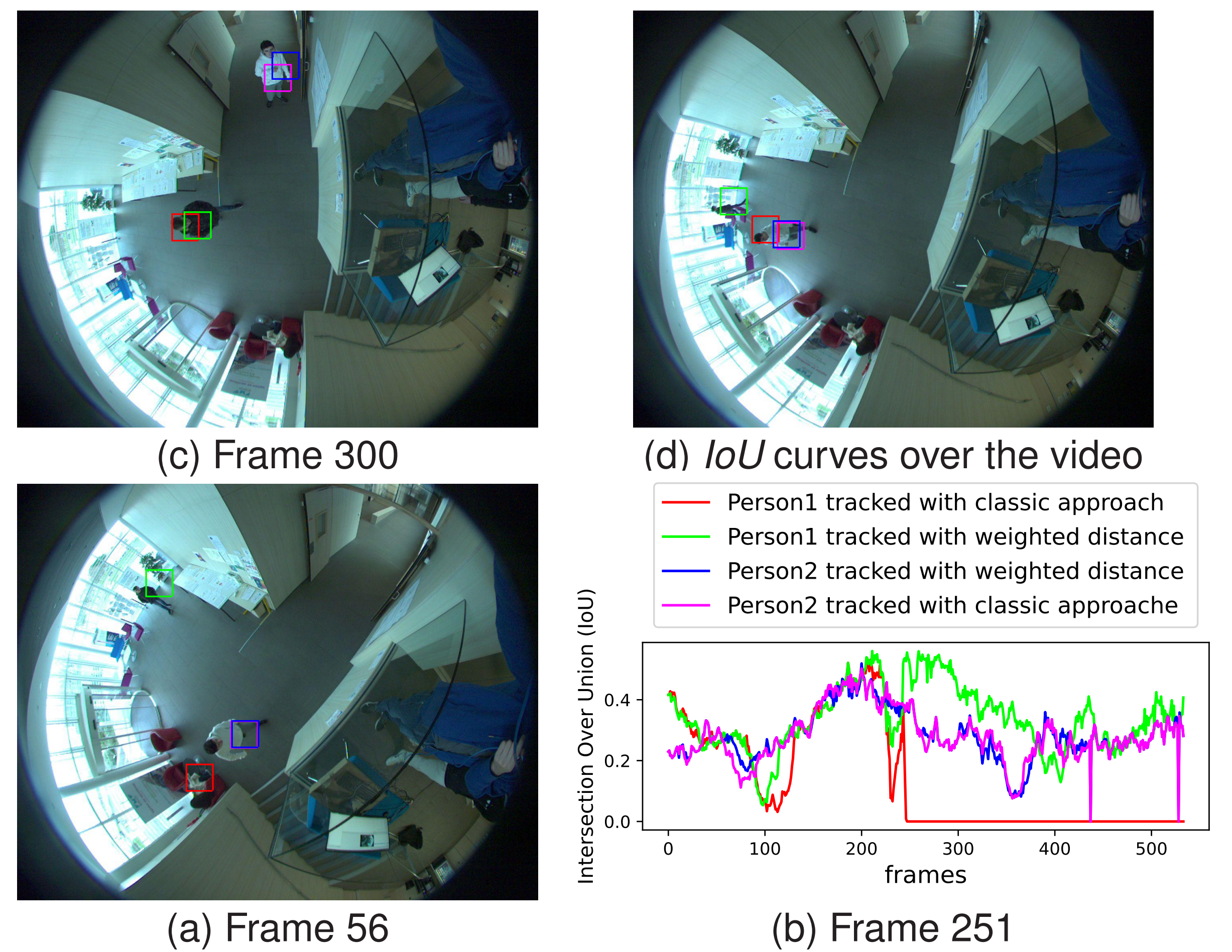


Figure 4: Detection example with the new weighted distance (in green and blue) compared to the conventional approach.

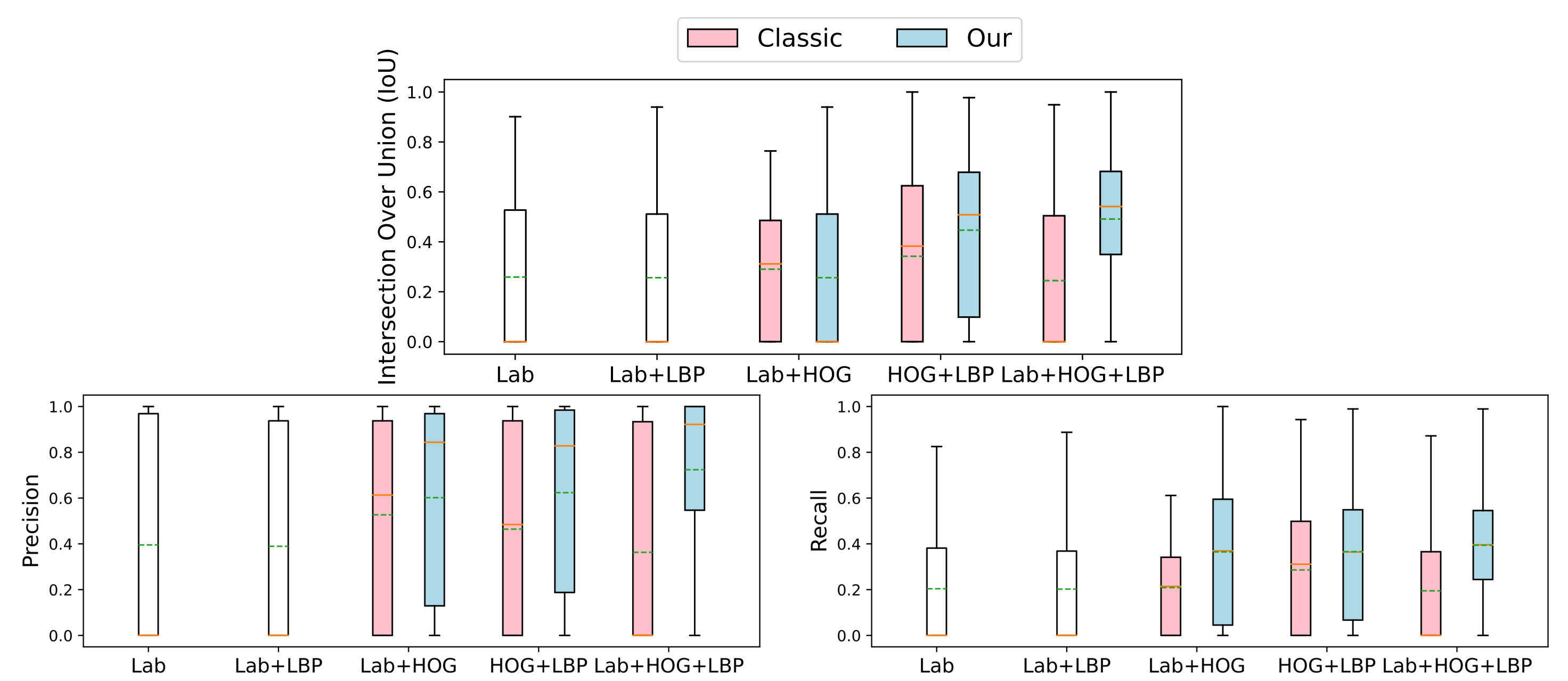


Figure 5: box plots representing the three measures ( $IoU$ ,  $Prec$  and  $Rec$ ), computed across all videos and weighted by the frame count. These plots employ color coding, with the orange line indicating the median value and the green line representing the mean. The performance evaluation of the particle filter is presented for different histogram combinations: Lab, LBP, and HOG.

## References

- [1] H. Simpson, "Measurement of diversity," *Nature*, vol. 163, no. 4148, pp. 688–688, 1949.
- [2] M. D. Breitenstein, F. Reichlin, B. Leibe, E. Koller-Meier, and L. Van Gool, "Robust tracking-by-detection using a detector confidence particle filter," in *ICCV*. IEEE, 2009, pp. 1515–1522.
- [3] H. Talaoubrid, M. Vert, K. Hayat, and B. Magnier, "Human tracking in top-view fisheye images: Analysis of familiar similarity measures via HOG and against various color spaces," *J. of Imaging*, vol. 8, no. 4, pp. 115, 2022.
- [4] T. Ojala, M. Pietikainen, and T. Maenpaa, "Multiresolution gray-scale and rotation invariant texture classification with local binary patterns," *IEEE TPAMI*, vol. 24, no. 7, pp. 971–987, 2002.
- [5] O. Haggui, M. A. Tchalim, and B. Magnier, "A comparison of OpenCV algorithms for human tracking with a moving perspective camera," in *IEEE EUVIP*, 2021, pp. 1–6.



Dataset