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

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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

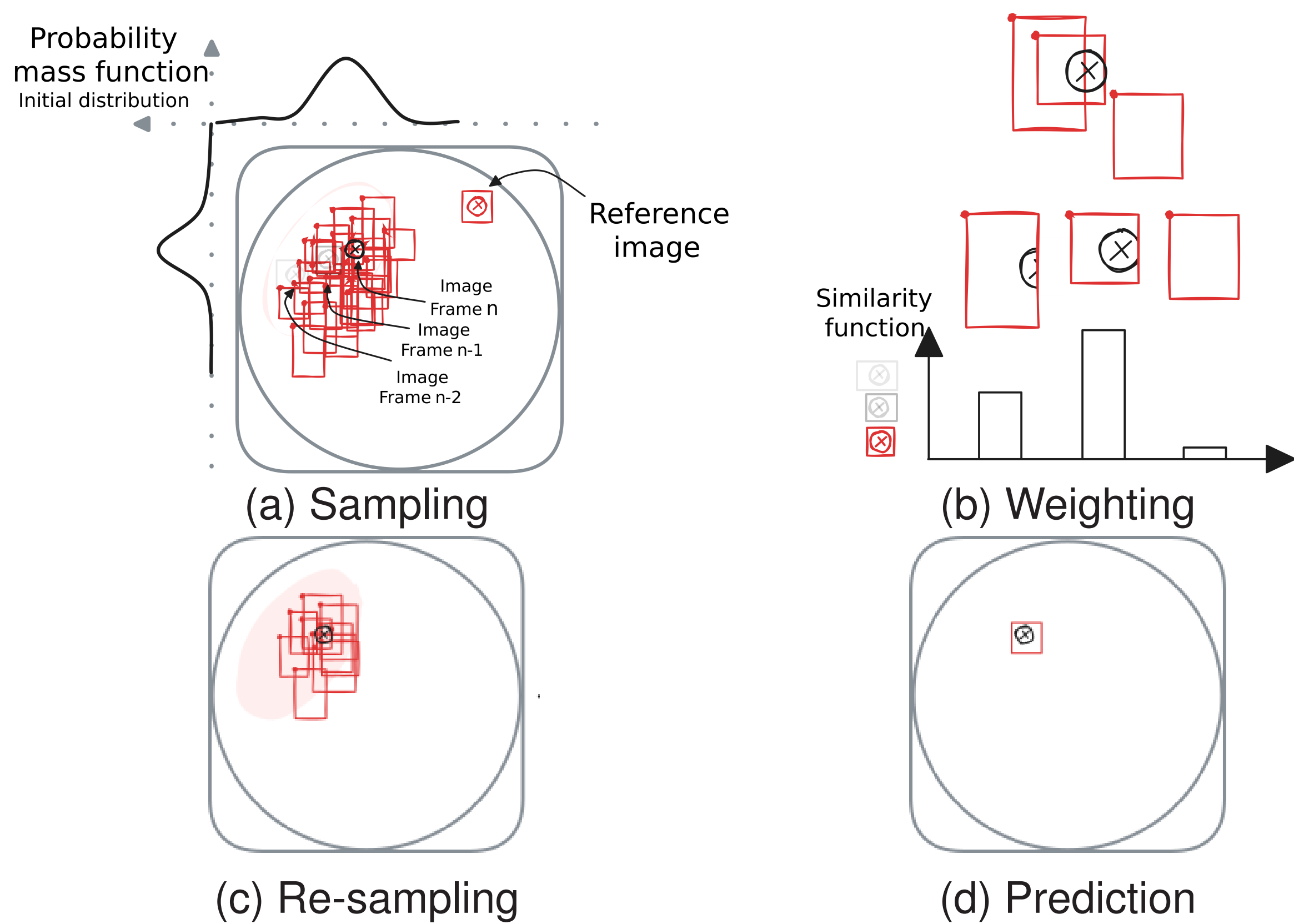


Figure 1: Sequential steps used by PF [2] for tracking. (a) Particles are initialized from prior (position at frame $t-1$), (b) Weights are updated. (c) Particles are resampled based on the calculated weights for a prediction in (d).

Adapting to fish eye camera

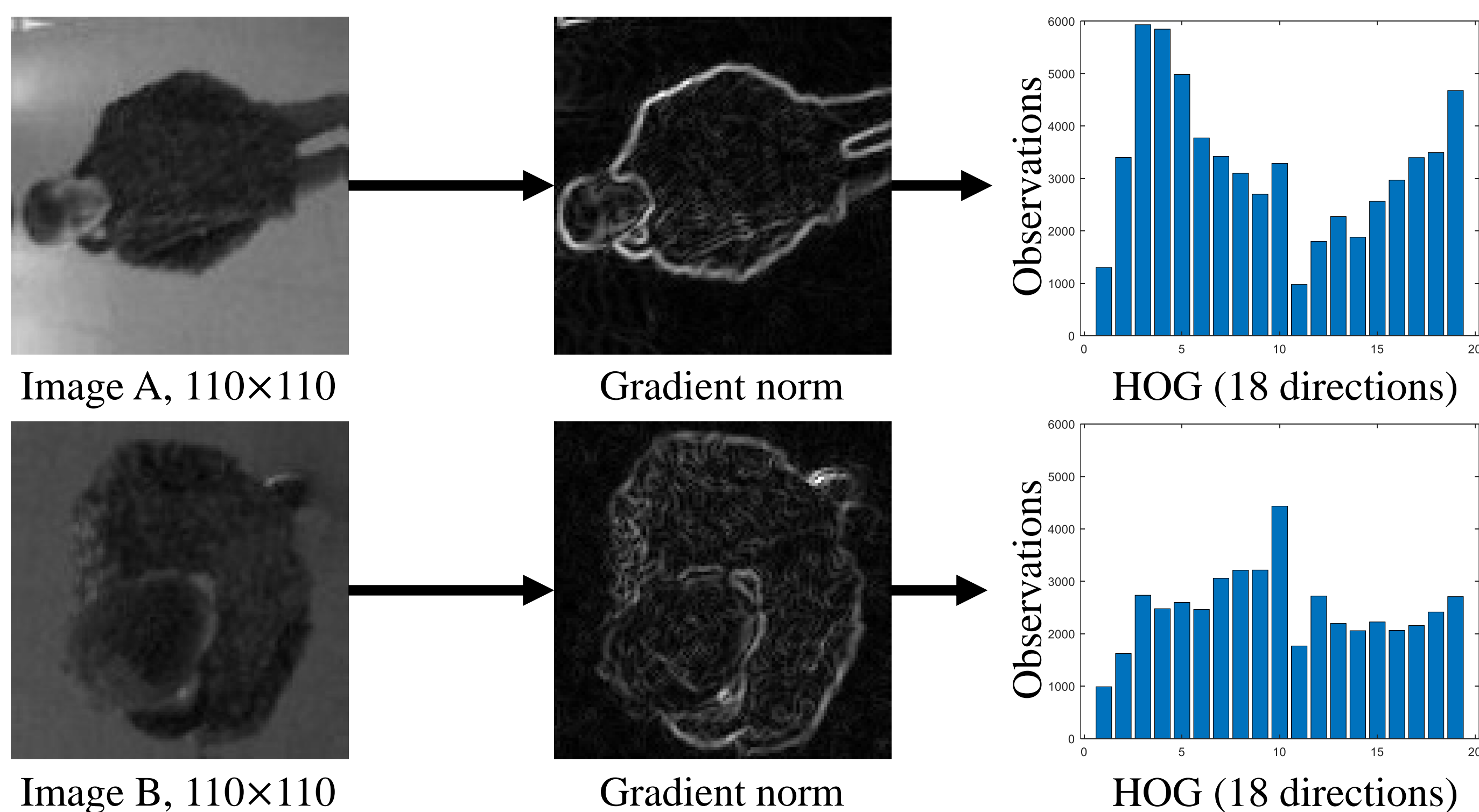


Figure 2: Fisheye overhead images, depicted in grayscale in (a) and (b), present challenges for pedestrian tracking due to distortions. Continuous tracking becomes challenging as individuals move across different image areas. Restricting the tracking to histograms of oriented gradients, as shown in (b), 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

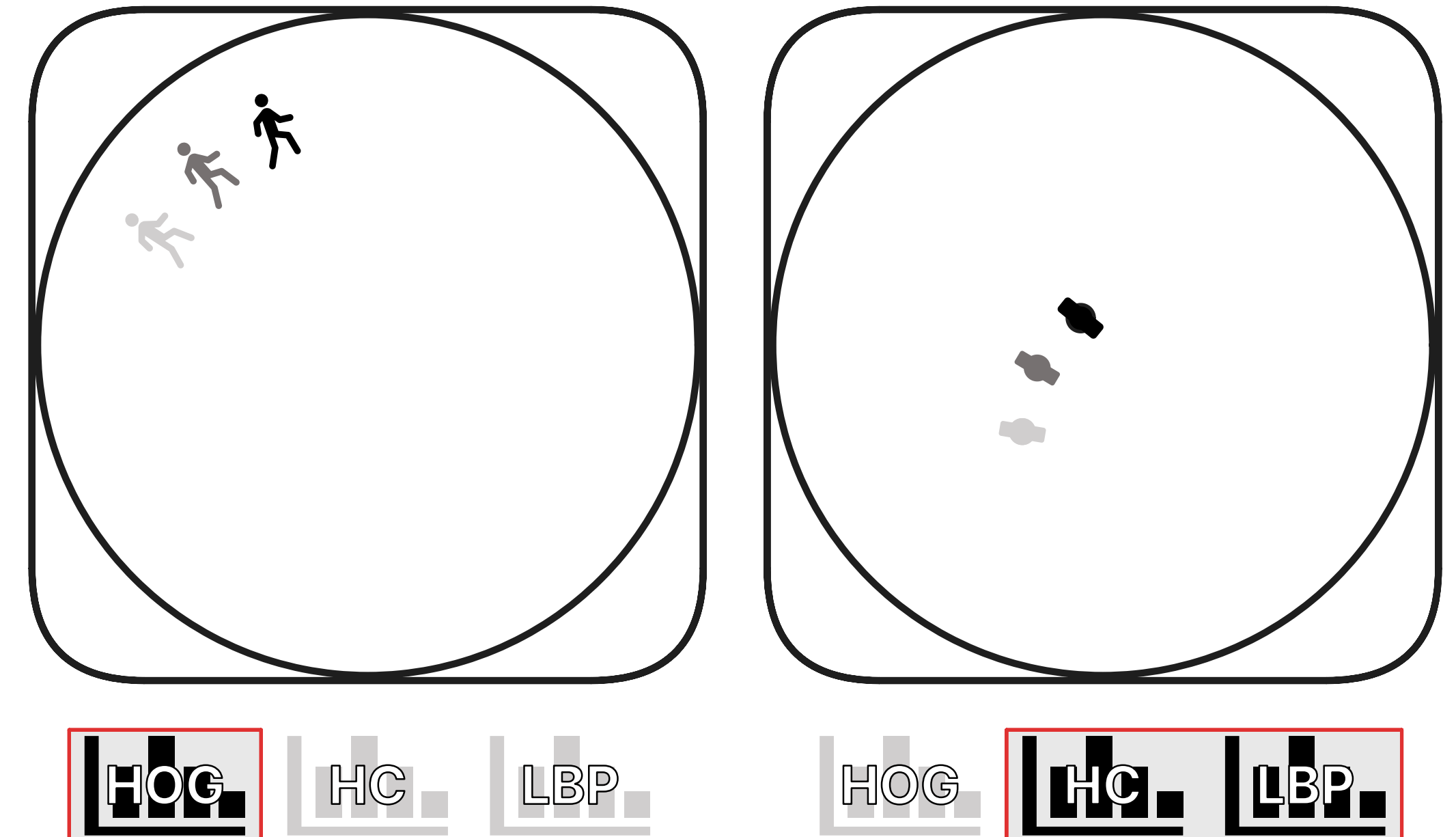
We propose weighting histogram distances based on particle positions relative to the image center. Closer particles carry more weight for both color and texture histograms, reducing comparisons using HOG. We calculate weights using the Simpson index [1].

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

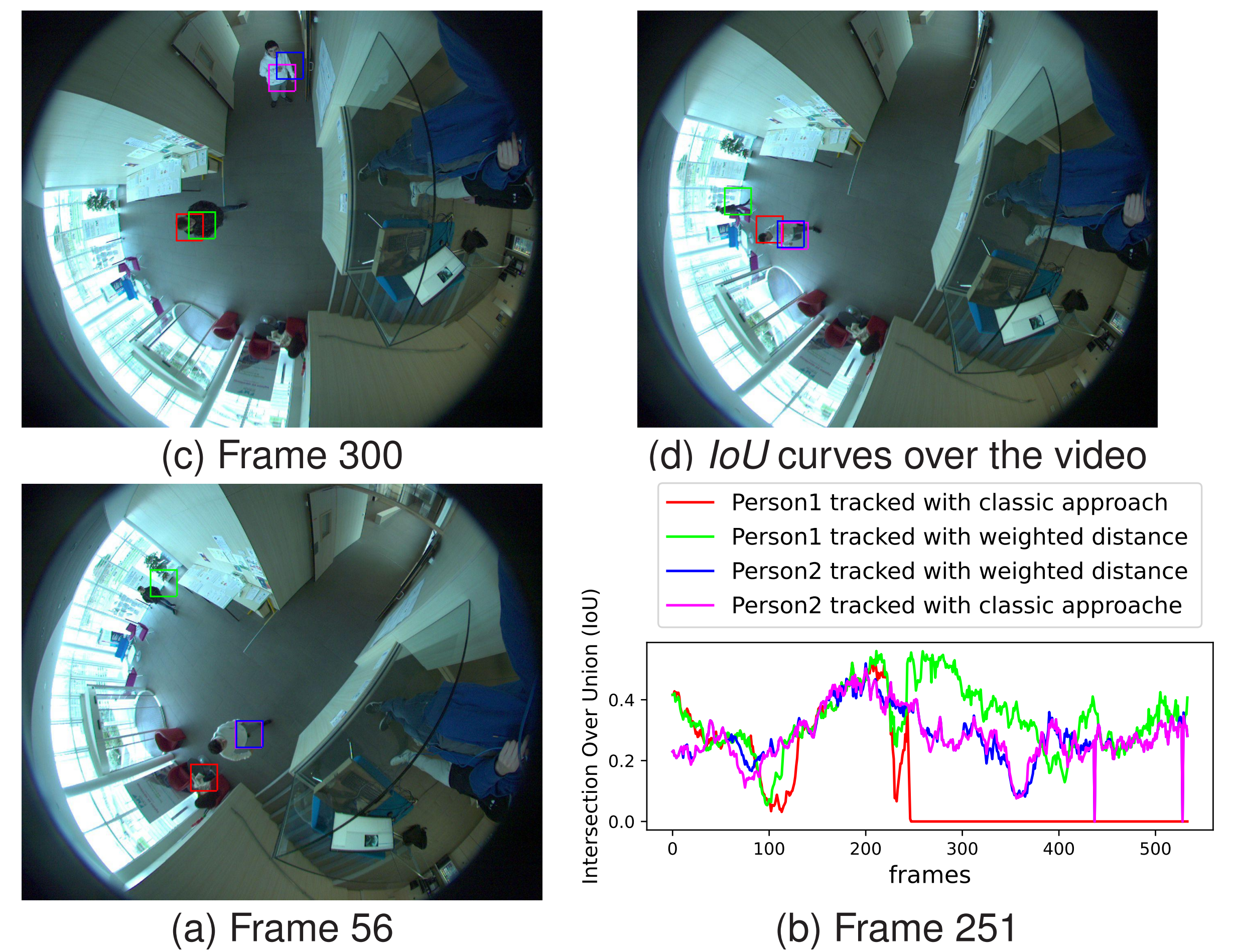


Figure 4: Detection example with the new weighted distance (in green and blue) compared to the conventional approach.

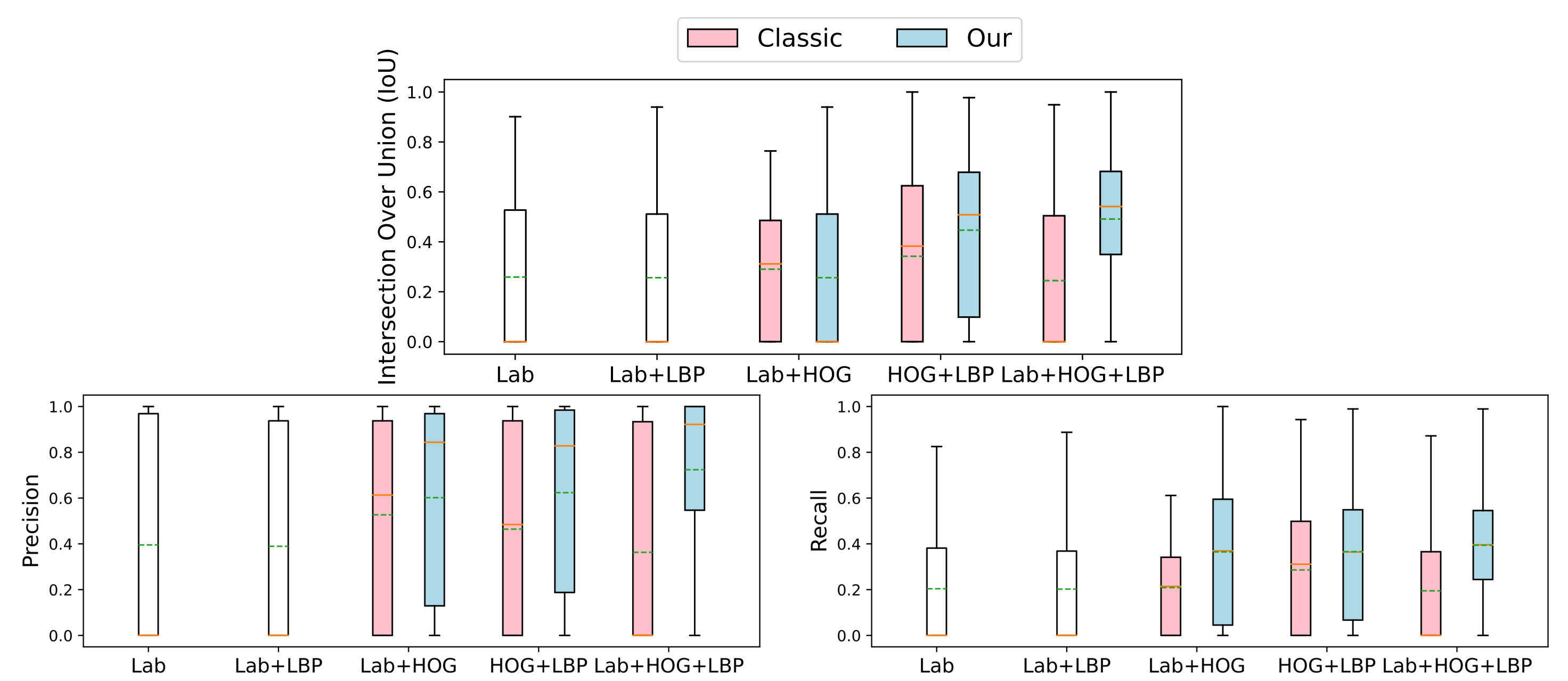


Figure 5: box plots representing the three measures (IoU , $Prec$ and Rec), computed across all videos and weighted by the frame count. These plots employ color coding, with the orange line indicating the median value and the green line representing the mean. The performance evaluation of the particle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

References

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Dataset