Visual Object Tracking Report
Computer Vision

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Summary

This report briefly summarizes the optimizations, design decisions, and modifications implemented over the baseline particle filter for visual object tracking.

Baseline (Initial): The original implementation used only the global color histogram with Bhattacharyya similarity.

Baseline (Corrected): A thorough code review revealed an incorrect derivative in Step 3 when computing the bounding box, which significantly increased the JI.

Several approaches were tested to improve robustness. The modifications include:

- **Adaptive Update & Spatial Division:** The color model was adaptively updated and combined with a spatial division of the bounding box (computing histograms for subregions).
- **Texture Description (LBP):** Texture information via Local Binary Patterns (LBP) was added to the adaptive color model, testing various descriptor combinations.
- **HOG Descriptor (Gradient):** Shape/gradient information was incorporated using a HOG descriptor computed with `skimage` and `cv2` (faster approach). Several combinations were tried.
- **Acceleration Model & Adaptive BBox:** We also attempted an acceleration model (to predict faster movements) and an adaptive bounding box size (to adjust scale changes). These methods, however, did not work properly nor improved the JI, so they were discarded.

Below is a summary of the approaches tested (values reached for N=100, unless noted otherwise):

Implementation	JI Index
Baseline (Initial)	0.334213
Baseline (Corrected)	0.497864
Adaptive + Spatial descriptor	0.483059
Texture descriptor (LBP)	0.496133
HOG (gradient) descriptor	**0.51416**
HOG (gradient) descriptor (N=300)	**0.516001**

The following parameters were fine-tuned for each implementation:
```
K = 32, std_noise = [0.25,0.25,0.01,0.01,1e-2,1e-2,1e-3,1e-3], alpha = 27.0, prediction
= 'weighted_avg', learning_rate = 0.05, update_threshold = 0.8, w_color = 0.1, w_texture
= 0.1, w_hog = 0.8.
```