

Object Tracking using Statistic-based Feature Fusion Technique

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Introduction

Goal

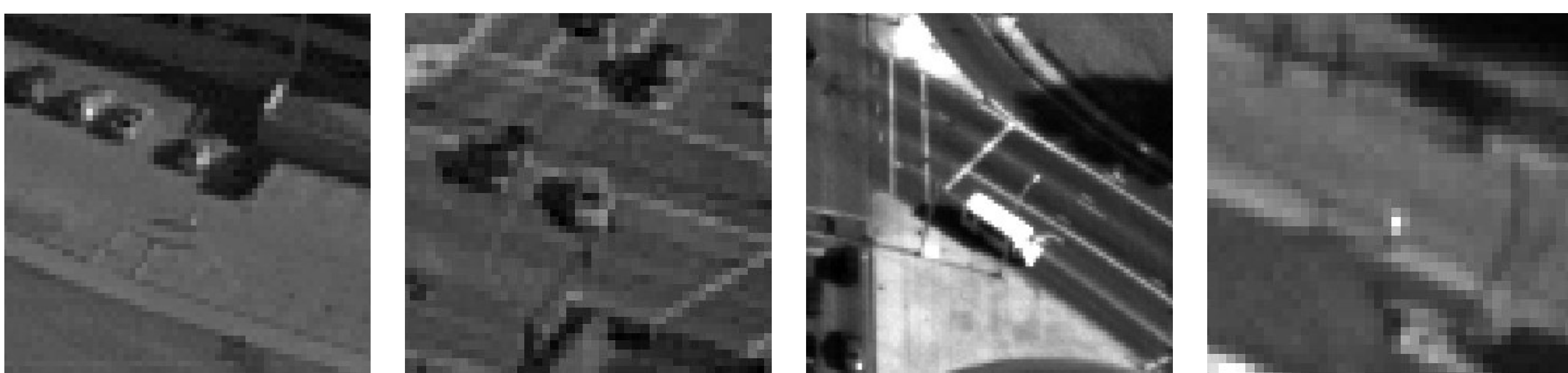
Automatically track objects in wide area motion imagery (WAMI).

Constraints/Challenges

Very low resolution, presence of noise, illumination variation, occlusions, complex object motion, and complex object shapes.

Proposed Innovation

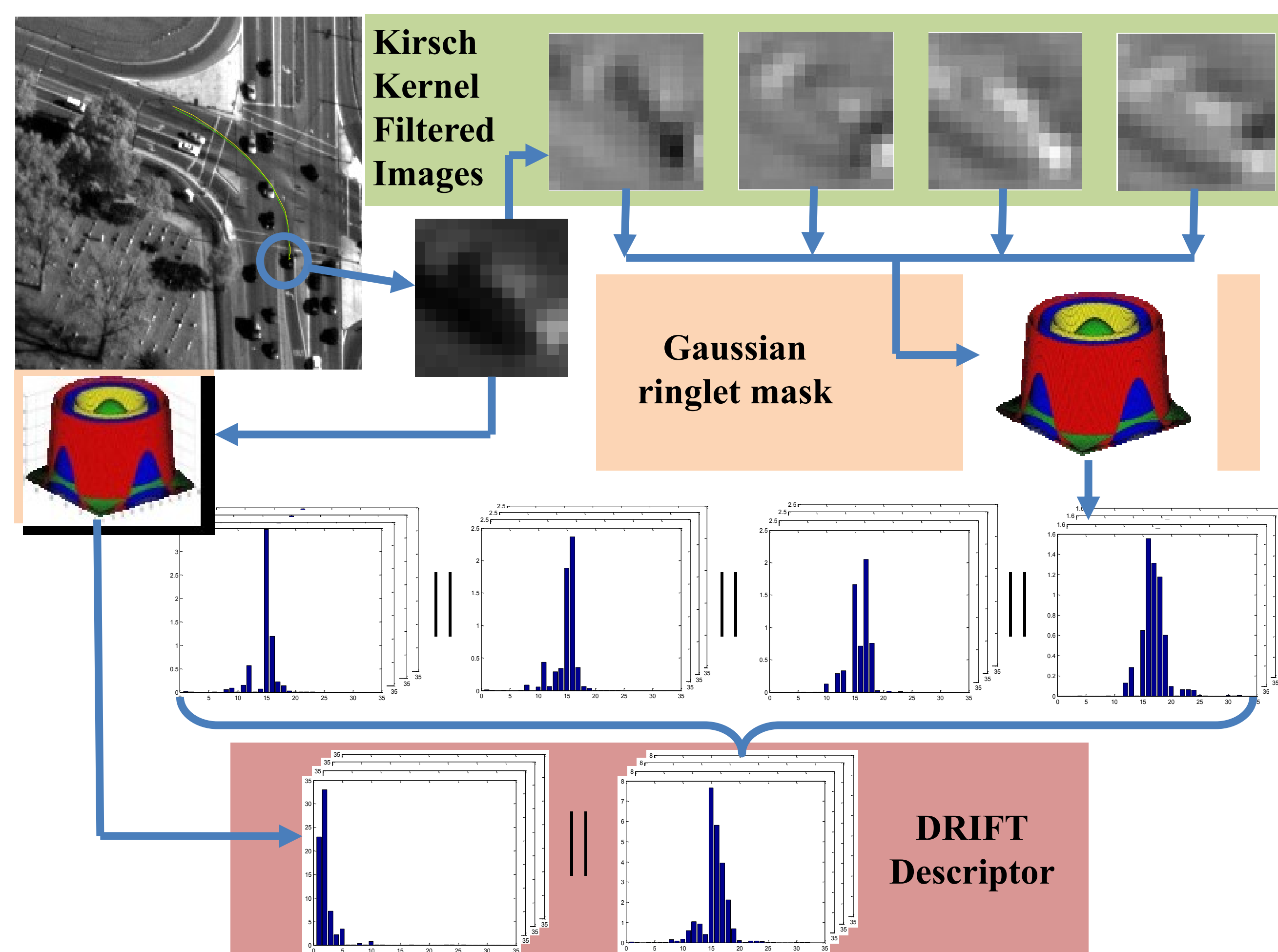
To better combine features of the DRIFT algorithm through fusion based on past frame effectiveness



DRIFT Algorithm

Feature Extraction Method

1. Intensity image extracted from video frames
2. Four directional Kirsch kernels used to filter images
3. Gaussian ringlet masks used to create feature histograms for each Kirsch filtered image and the intensity image
4. Histograms from Kirsch filtered images concatenated to retain rotation invariance
5. All Histograms concatenated to create feature descriptor



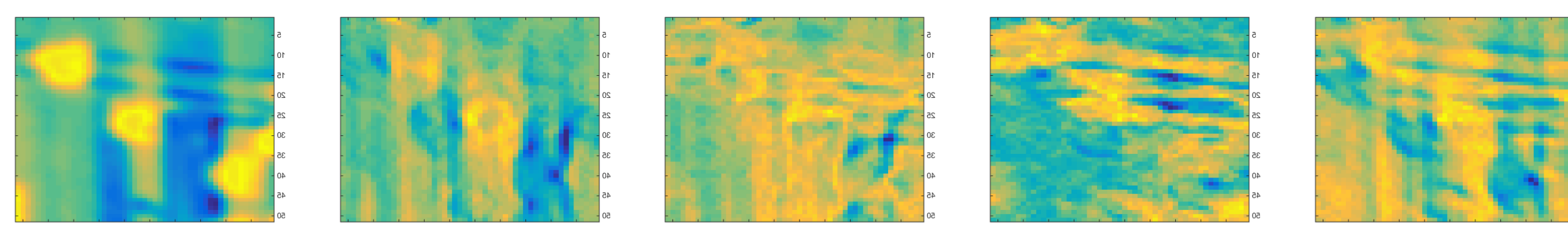
Fusion of Likelihood maps

- Each feature histogram is classified using Earth Mover's Distance
- A likelihood map is created for each feature for the search area
- Weights selected from previous frame performance
- Fusion based on variance ratio between target and background:

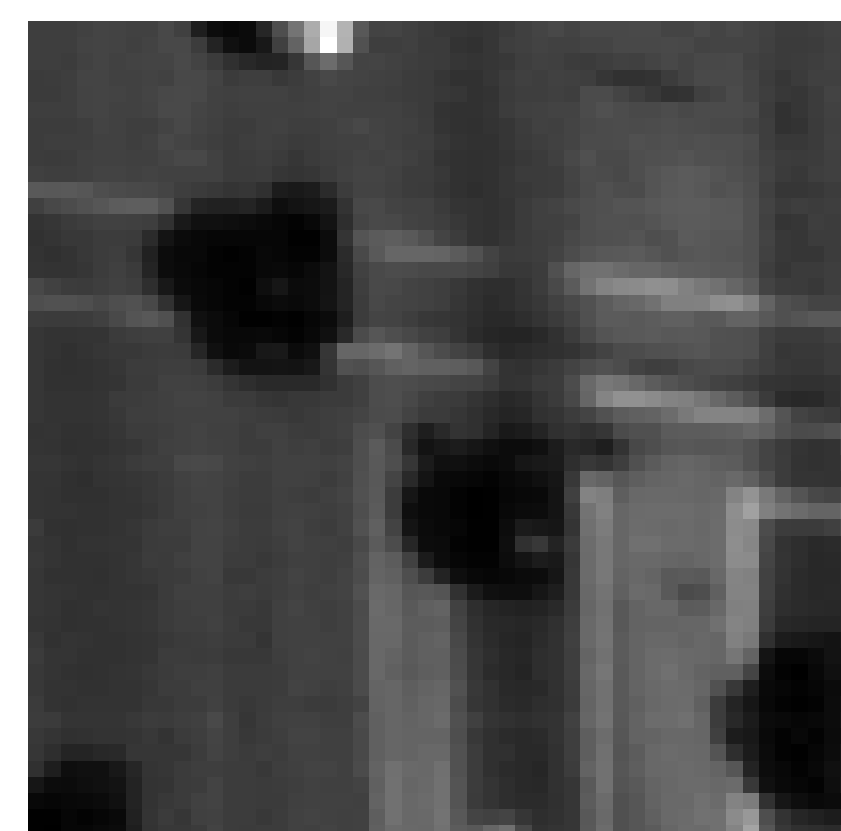
$$w_i = \frac{VR(L_i, p, q)}{\sum_{i=1}^N VR(L_i, p, q)}$$

$$VR(L_i, p, q) = \frac{var(L_i, (p + q)/2)}{[var(L_i, p) + var(L_i, q)]}$$

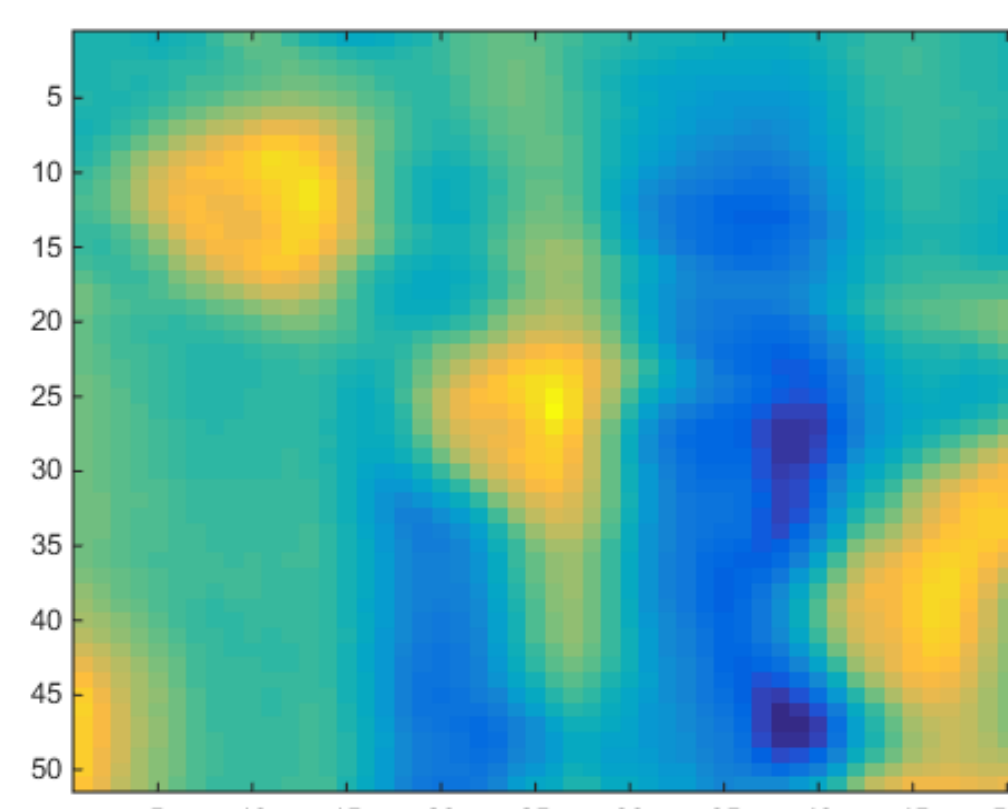
where object pixels, p , and background pixels, q



Feature Likelihood Maps

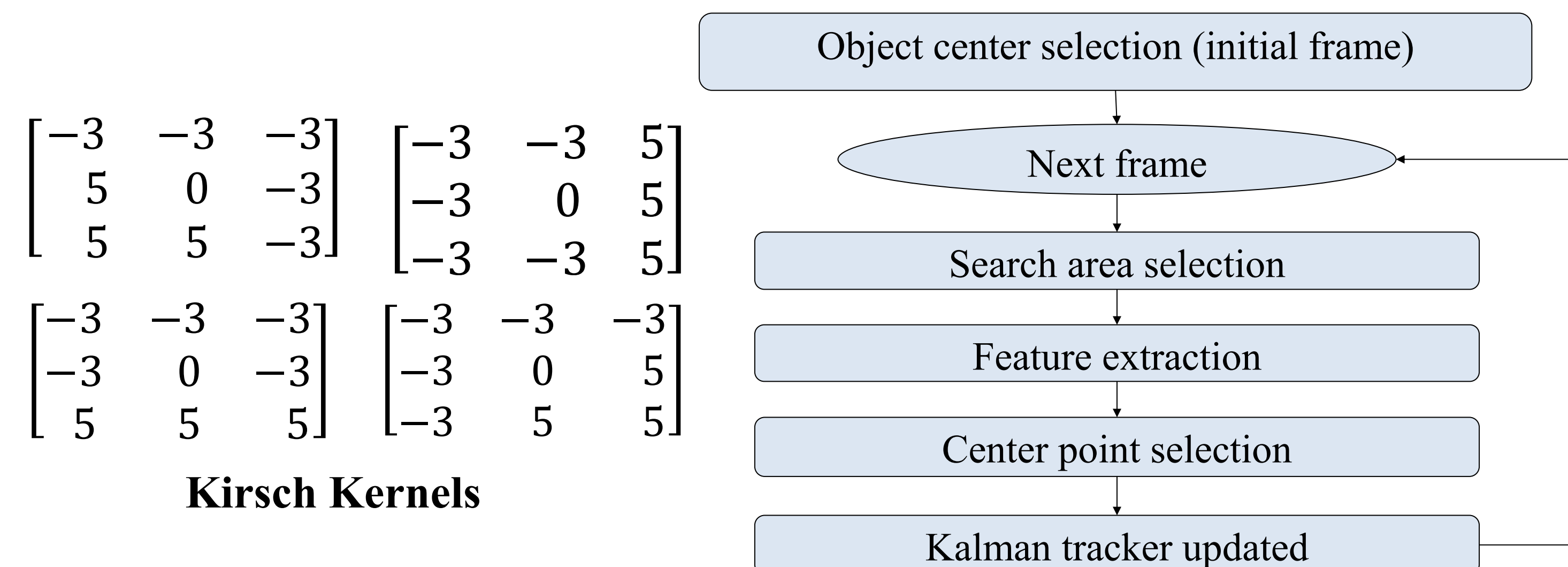


Search Area



Fused Likelihood Map

Tracking process



Kalman Tracker

Kalman tracker based on state equations of position and velocity to estimate position if an object is not detected

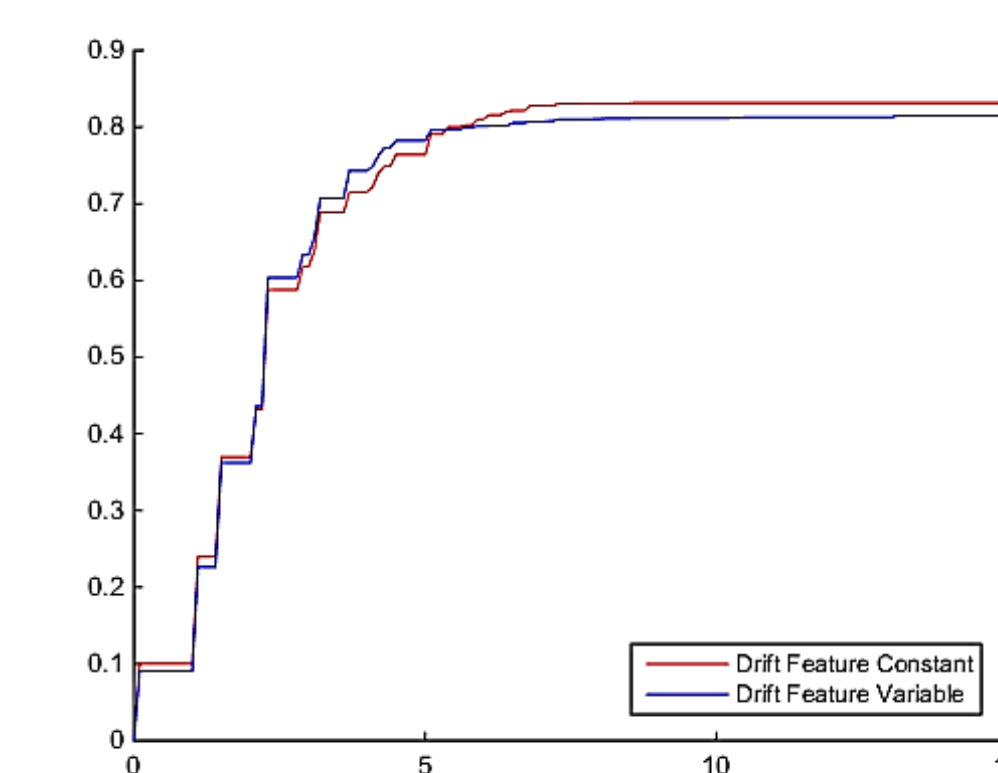
Each frame is processed by enhancement algorithm first. Search area is selected based on Kalman Tracker, camera properties, and target properties. Feature is extracted using DRIFT descriptor. Classification is used to determine closest match. The reference feature and Kalman Tracker are updated.

Results

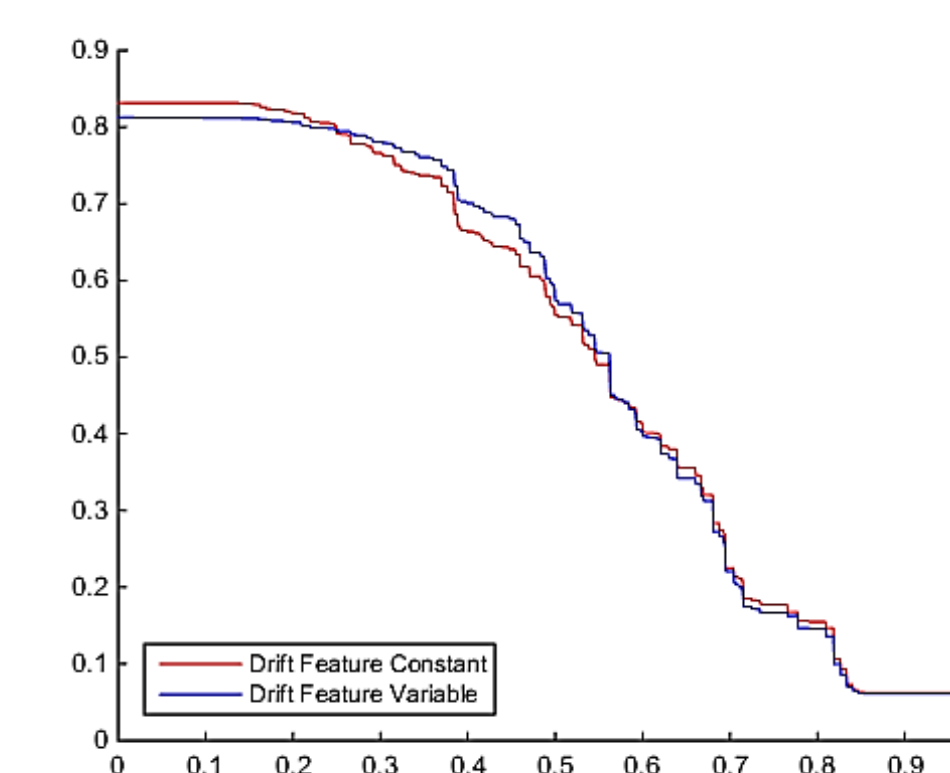
- Results for constant weighting and variance ratio based weighting are compared
- 8 WAMI sequences were used for evaluations

Spatial Robustness – Evaluated using different initial bounds

Precision Plot



Success Plot

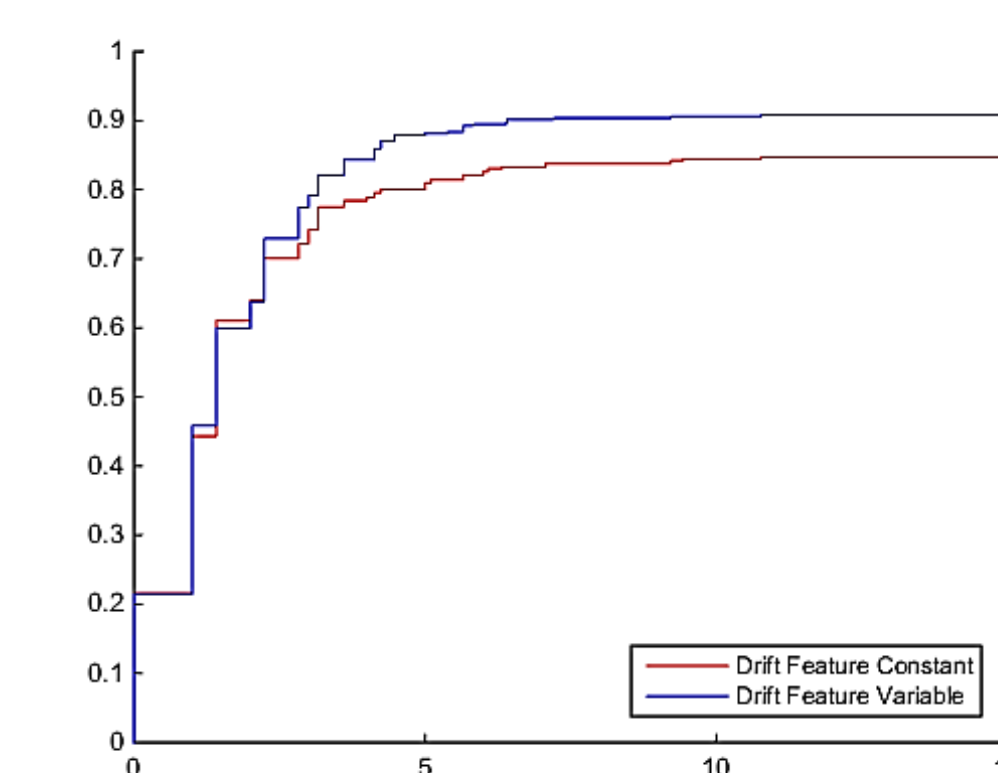


Center Error Threshold

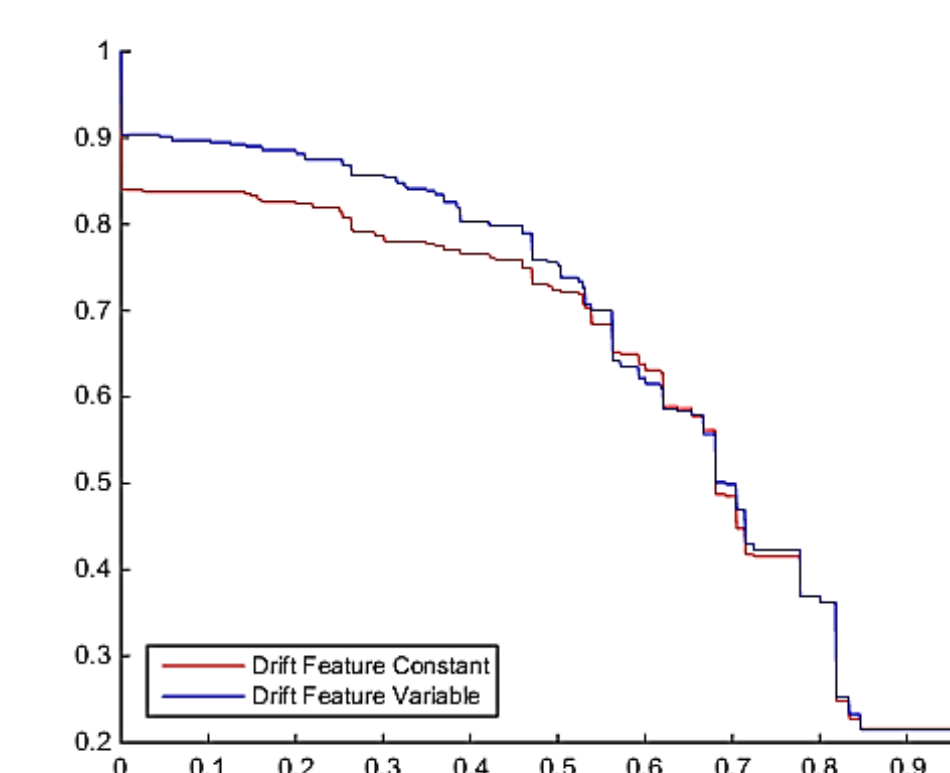
Overlap Threshold

Temporal Robustness – Evaluated using different starting frames

Precision Plot



Success Plot



Center Error Threshold

Overlap Threshold

	Center Location Error			Frame Detection Accuracy	
	DRIFT Constant	Drift variable		DRIFT Constant	Drift variable
CLIF1	11.22	1.31	CLIF1	0.66	0.74
CLIF2	1.55	1.86	CLIF2	0.72	0.68
CLIF3	0.43	0.49	CLIF3	0.88	0.86
CLIF4	1.76	1.16	CLIF4	0.71	0.78
BD1	40.79	42.66	BD1	0.36	0.36
BD2	0.70	0.63	BD2	0.83	0.85
BD3	1.68	1.96	BD3	0.72	0.69
BD4	25.96	12.71	BD4	0.58	0.70
Average	10.51	7.85	Average	0.68	0.71