

Nonlinear Image Enhancement and Super Resolution for Enhanced Object Tracking

Introduction

Goal

Automatically track vehicles and other objects of interest in wide area motion imagery (WAMI).

Constraints/Challenges

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

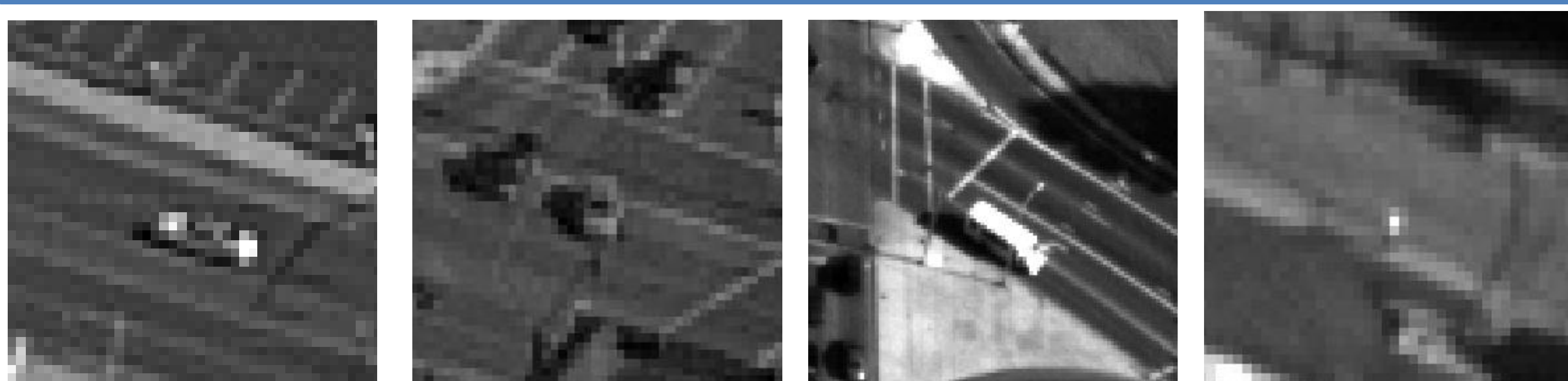


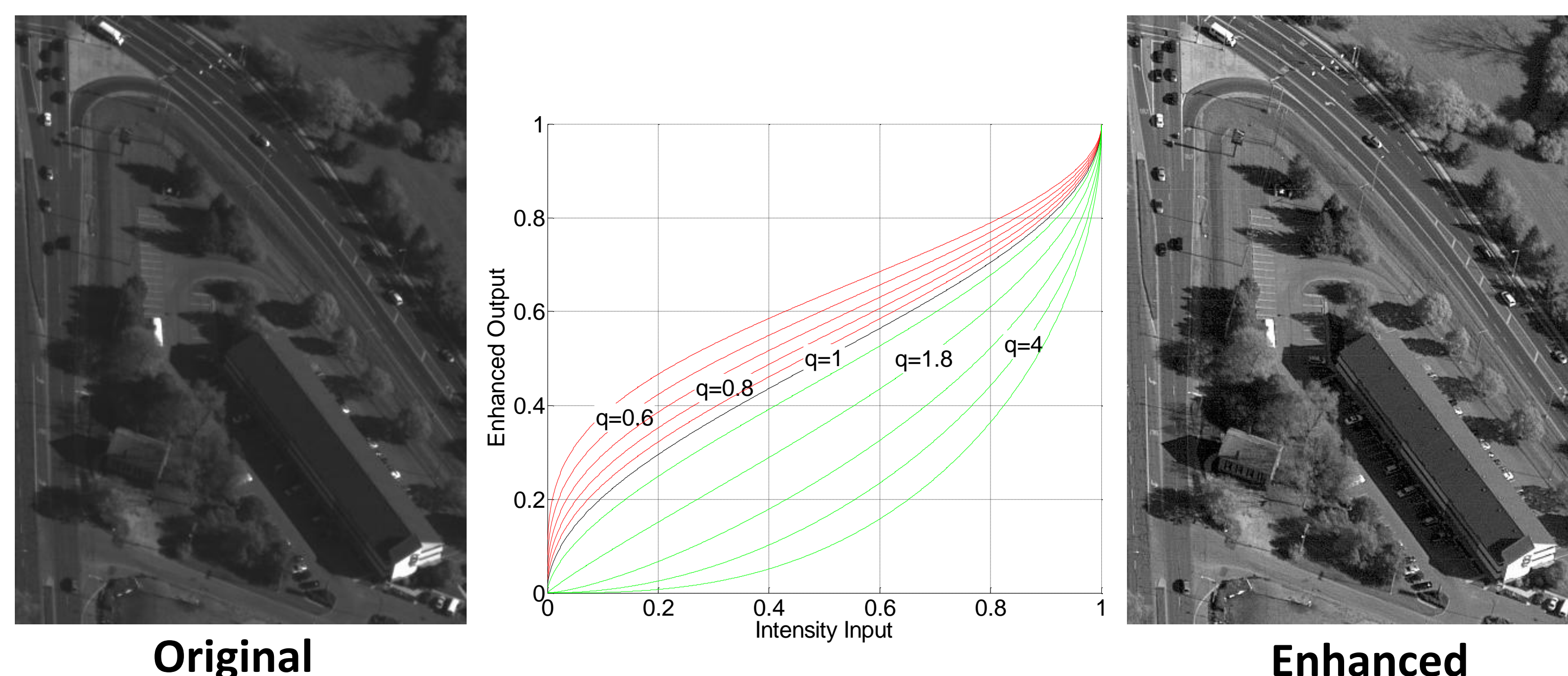
Image Enhancement and Super resolution

Image Enhancement

1. Self-Tunable Transformation Function (STTF), nonlinear enhancement function,

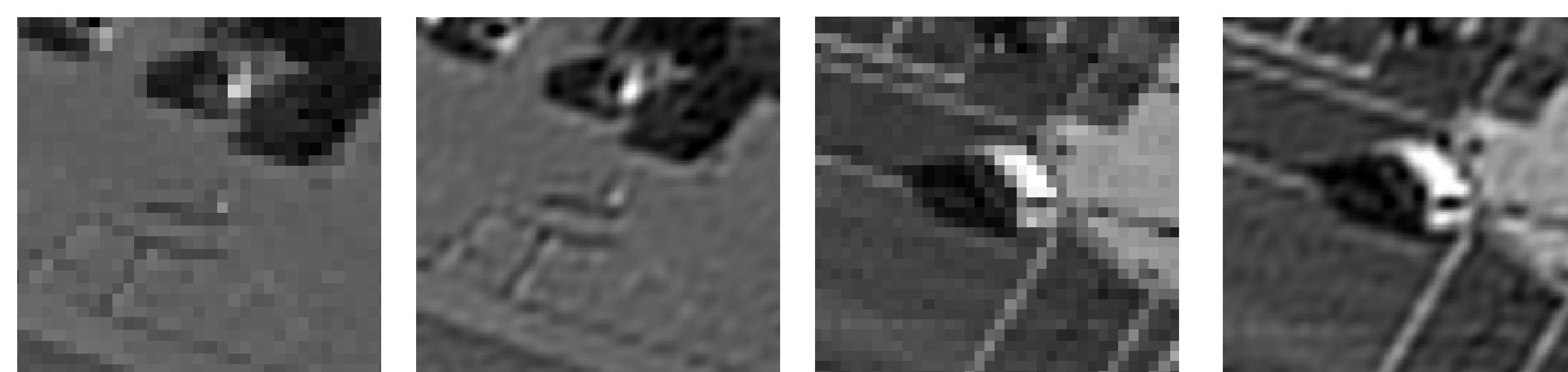
$$I_{enh}(x, y) = \frac{2}{\pi} \sin^{-1}(I_n(x, y)^q)$$

2. High frequency boosting using Laplacian high-boost filter
3. Contrast enhancement using neighborhood based technique



Super Resolution

Feature based kernel regression learning method
Multi-level local Fourier phase feature based covariance estimation
4x magnification used for tracking

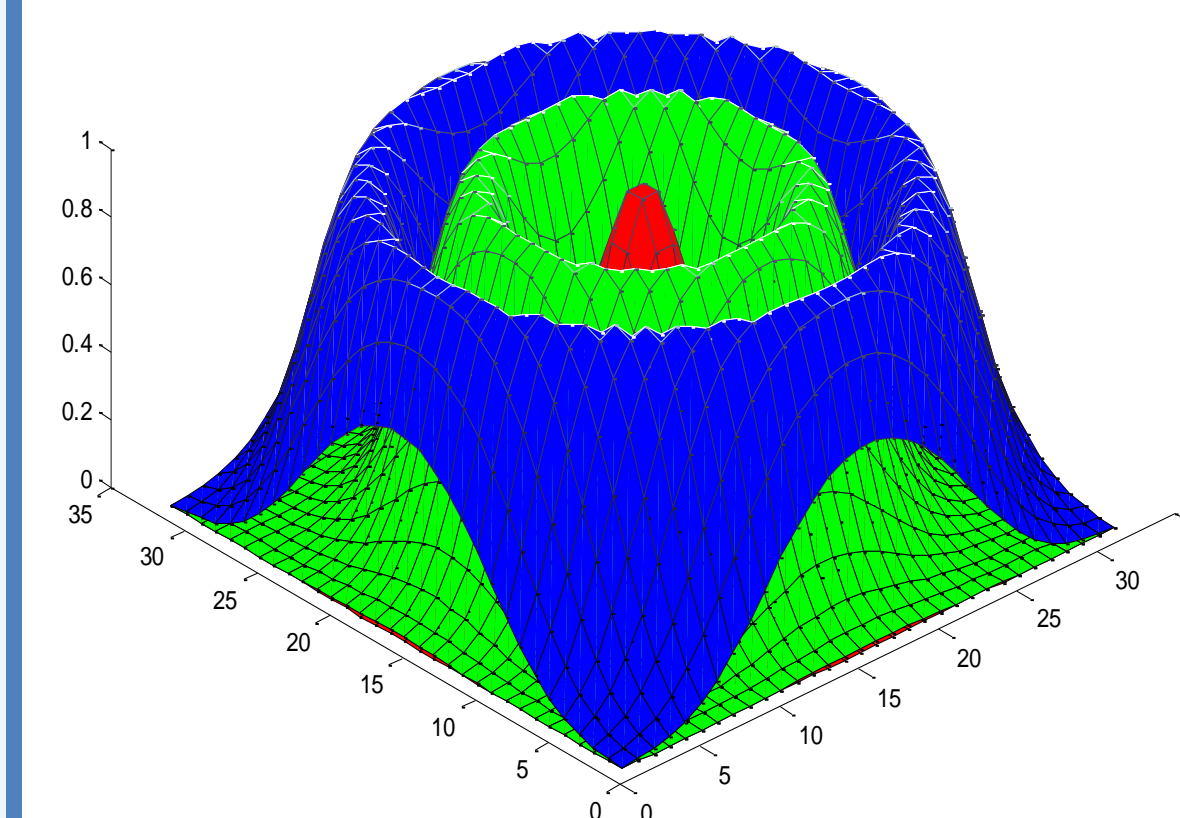


Original Super resolved Original Super resolved

GRID and Kalman Tracker

Detection

Gaussian ringlet intensity distribution detection method,
Circular Gaussian ring histogram mask used to determine features of object

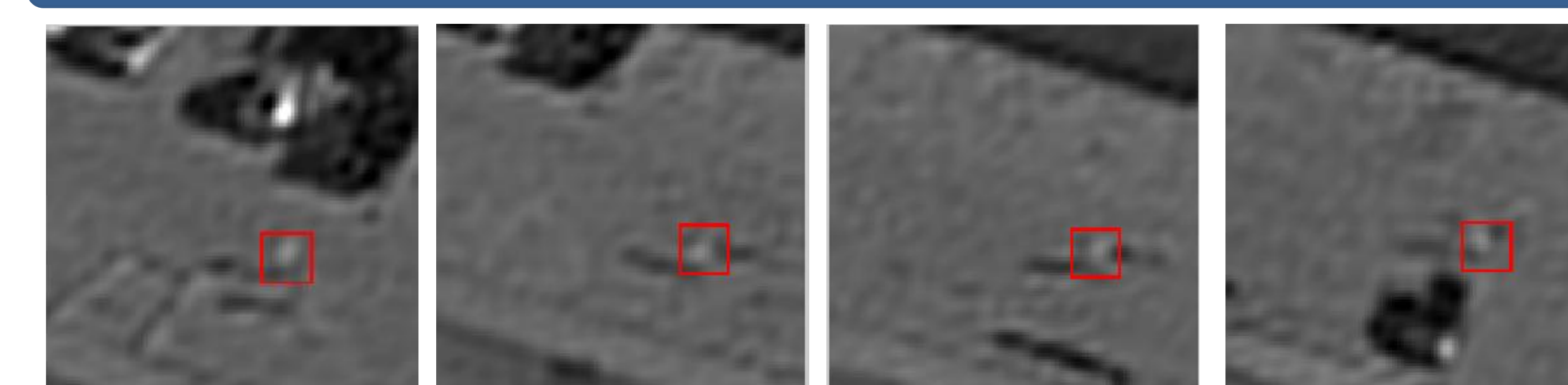


Kalman Tracker

Kalman tracker based on state equations of position and velocity
Estimates position if object is not detected

Each frame is process by enhancement algorithm first.
A window around estimated object location in previous frame is super resolved.
The object location is estimated in the current frame using GRID and Kalman Tracker.

Results

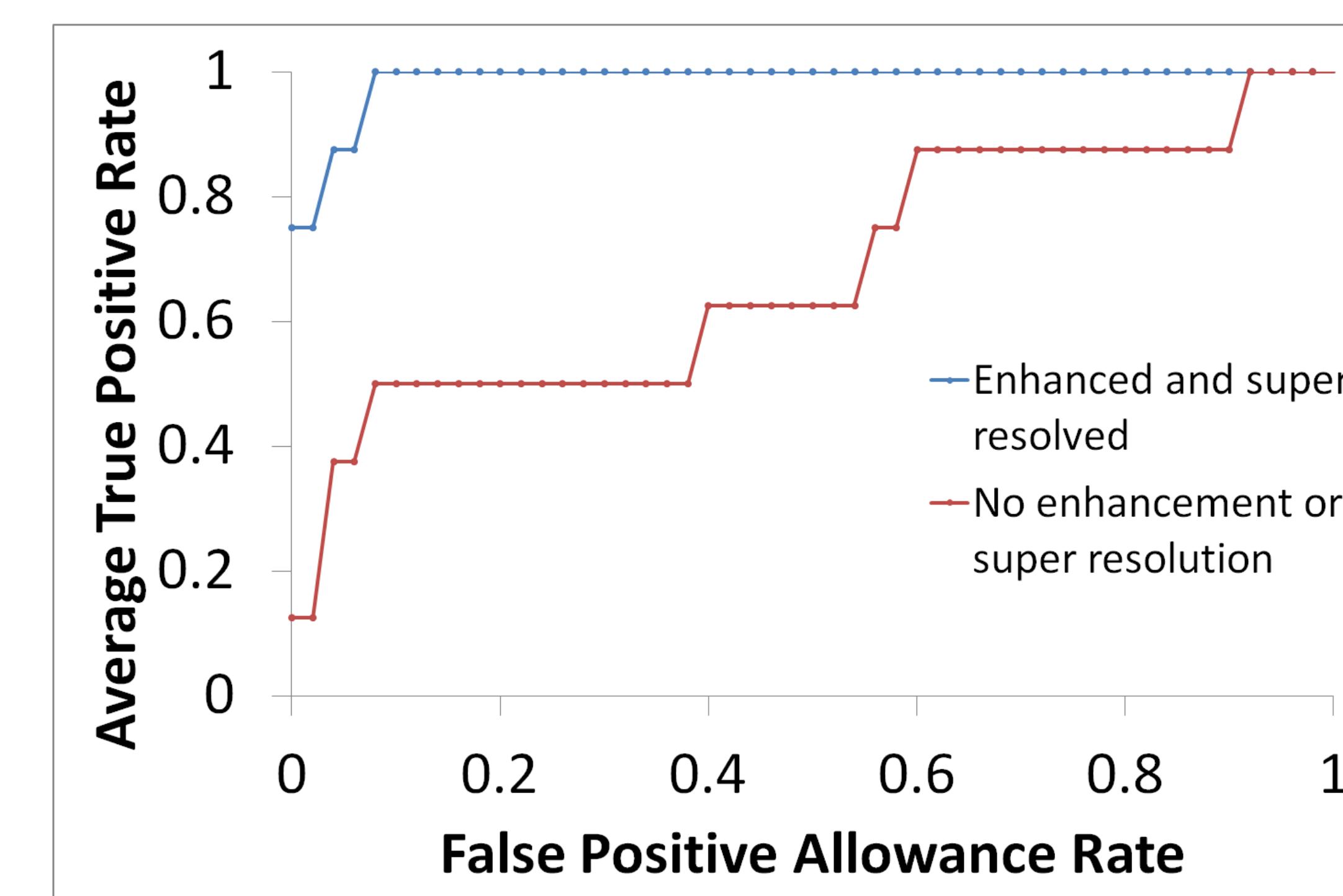


Frame 1 Frame 7 Frame 13 Frame 19
Pedestrian Tracking



Frame 1 Frame 7 Frame 13 Frame 19
Vehicle Tracking

Comparison of 10 object tracking results' average binary detection rate with false positive allowance rate



Tracking process

