UNIVERSITY of DAYTON
VISION LAB
Center of Excellence for Computer Vision and Wide Area Surveillance Research
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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.

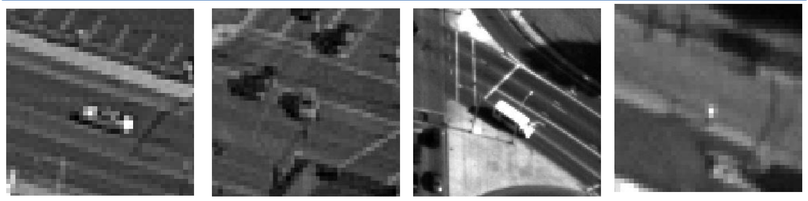


Image Enhancement and Super resolution

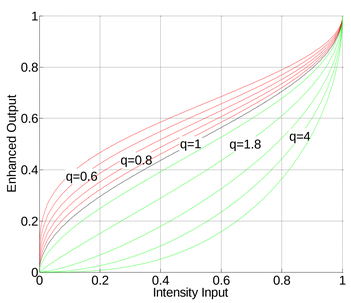
Image Enhancement

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

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

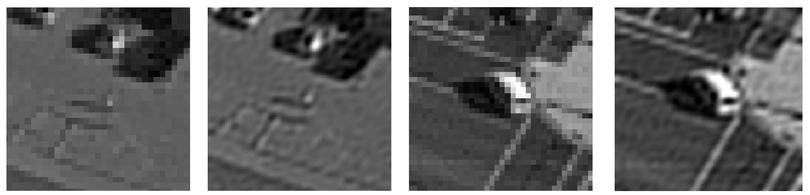
2. High frequency boosting using Laplacian high-boost filter
3. Contrast enhancement using neighborhood based technique

Original



Enhanced

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

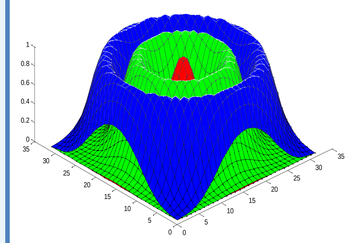


Original | Super resolved | Original | Super resolved

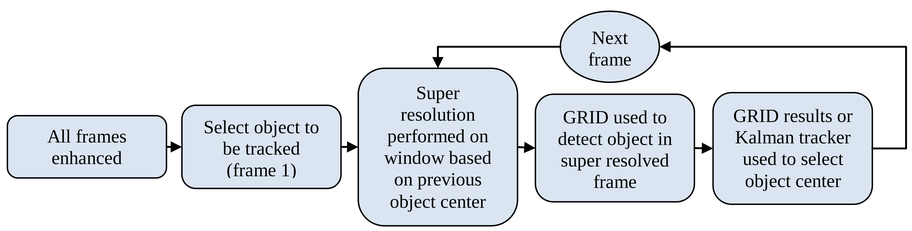
GRID and Kalman Tracker

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

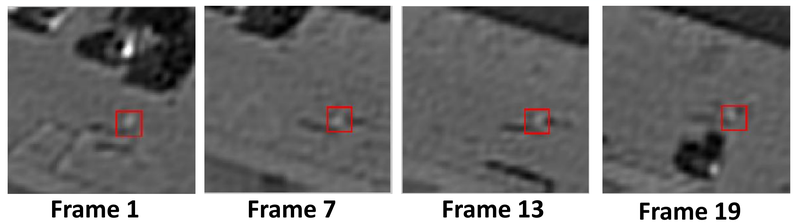


Tracking process



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.

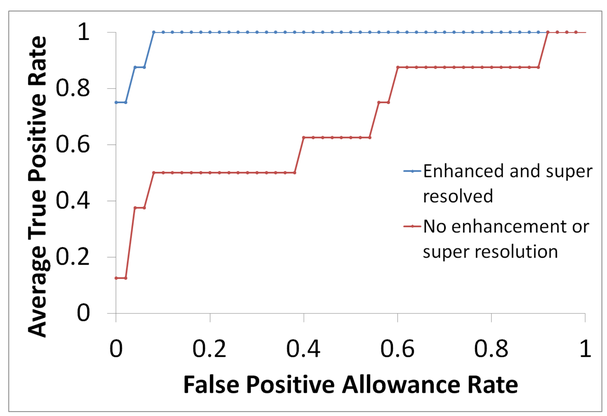
Results



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



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