Object Tracking with Kernelized Correlation Filters (KCF)

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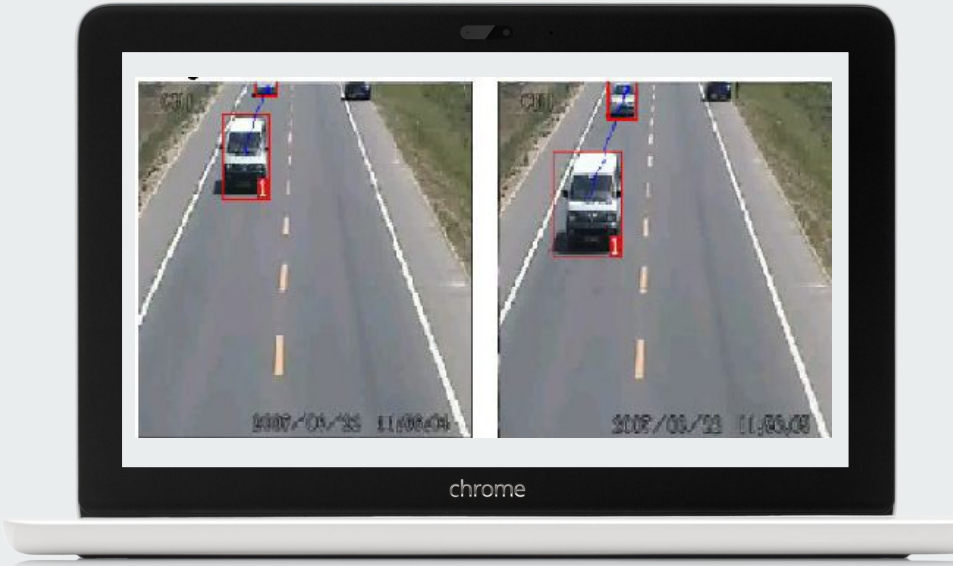


Outline

The Problem

Method

Results

Future work

The Problem

-Given a series of video frames, it is required to track at least one object in the video. We are required to develop one algorithm and test it in different datasets.

Method

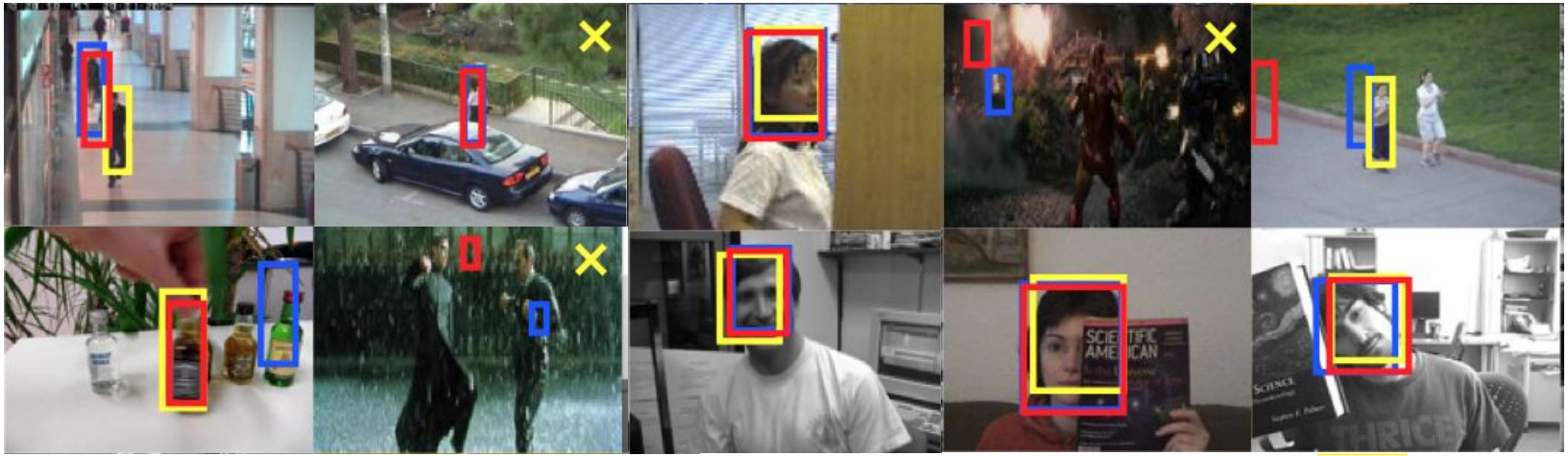
- *Kernelized Correlation Filters (KCF)*

KCF

Kernelized Correlation Filter (KCF):

- Traditional correlational filter
- Kernel trick
- Circulant matrices
- HOG

Comparison with TLD & Struck

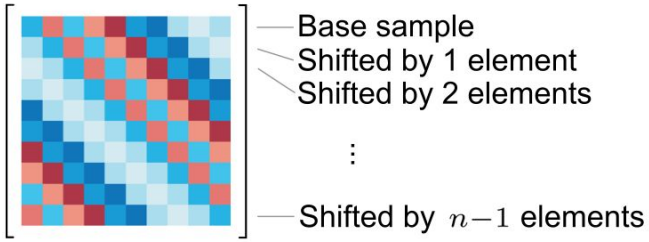


Kernelized Correlation Filter (proposed) TLD Struck

Equations

1. Ridge Regression: $\min_{\mathbf{w}} \sum_{i} \left(f(\mathbf{x}_i) - y_i\right)^2 + \lambda \left\|\mathbf{w}\right\|^2$
2. Analytical solution: $\mathbf{w} = \left(X^T X + \lambda I\right)^{-1} X^T \mathbf{y}$
3. Circulant Matrix: $X = F \operatorname{diag}\left(\hat{\mathbf{x}}\right) F^H$
4. Solution in Frequency Domain: $\hat{\mathbf{w}} = \dfrac{\hat{\mathbf{x}}^* \odot \hat{\mathbf{y}}}{\hat{\mathbf{x}}^* \odot \hat{\mathbf{x}} + \lambda}$

Circulant Matrix

$C($ $) =$ 

$$X = C(\mathbf{x}) = \begin{bmatrix} x_1 & x_2 & x_3 & \cdots & x_n \\ x_n & x_1 & x_2 & \cdots & x_{n-1} \\ x_{n-1} & x_n & x_1 & \cdots & x_{n-2} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_2 & x_3 & x_4 & \cdots & x_1 \end{bmatrix}$$

+30 +15 Base sample -15 -30

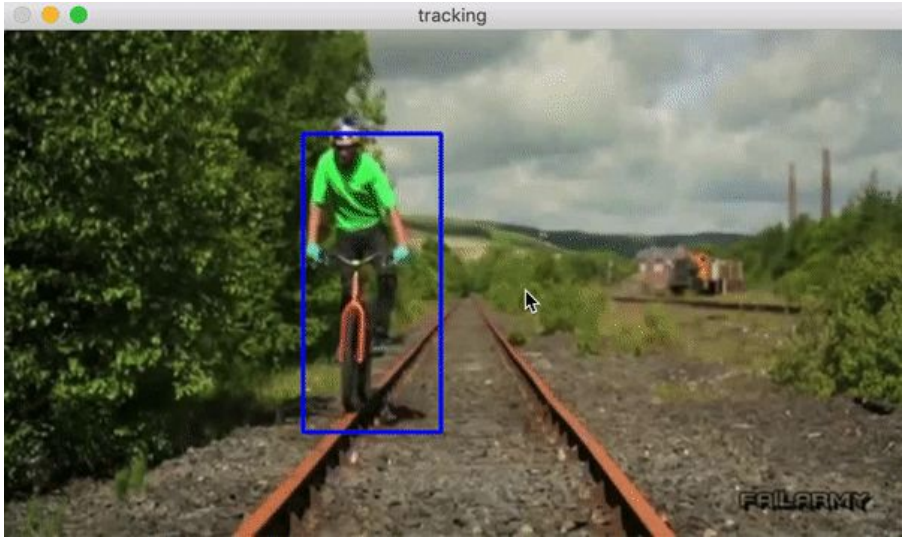
Performance

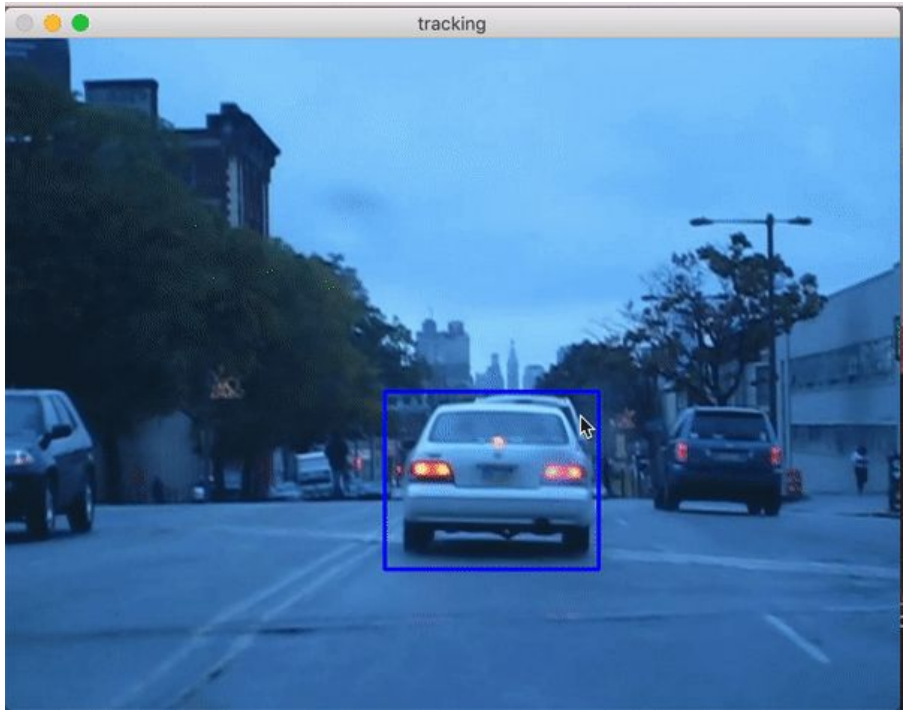
Algorithm	Feature	Mean precision (20 px)	Mean FPS
KCF	Raw pixels	*56.0%*	*154*
KCF	HOG	***73.2%***	***172***

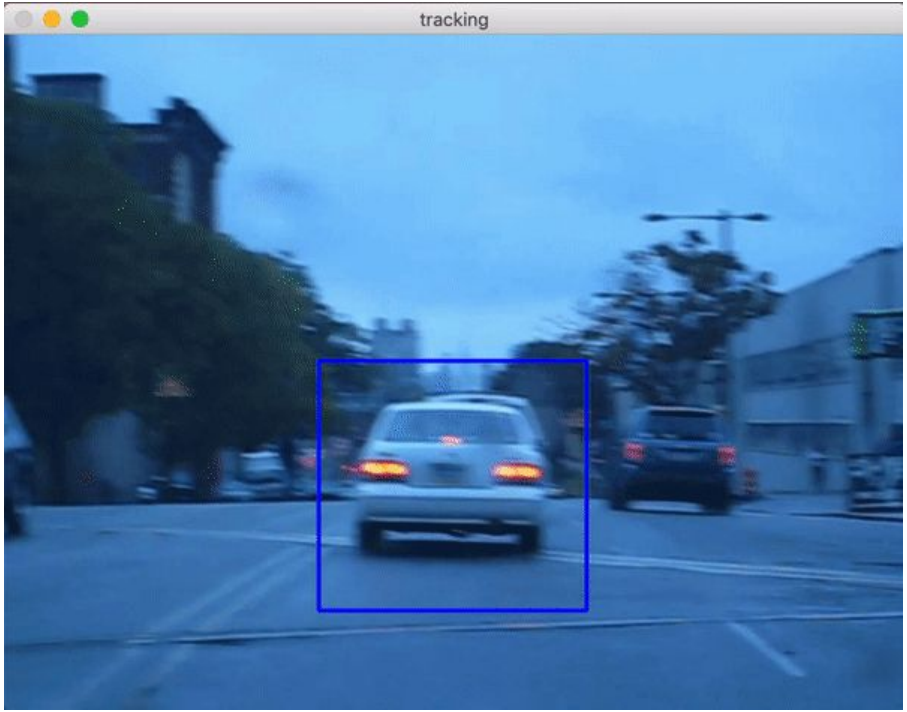
Results

-The initial size of bounding box affects results significantly
-Different dataset behaves differently
-Some parameter need to be adjusted for each dataset

tracking
FAILARMY


tracking
FAILARMY


tracking


tracking

Fail to Track

Future Work

- Certain parameters need to be improved
- Test in more datasets
- Develop automatic tracking program without initial bounding box
- Multi-object Tracking

Thank you!

References

1. Henriques, J., Caseiro, R., Martins, P., Batista, J.: Exploiting the circulant structure of tracking-by-detection with kernels. In: ECCV. pp. 702–715 (2012)

2. J. F. Henriques, R. Caseiro, P. Martins and J. Batista, "High-Speed Tracking with Kernelized Correlation Filters," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 37, no. 3, pp. 583-596, 1 March 2015, doi: 10.1109/TPAMI.2014.2345390.

3. K. Zhang, L. Zhang, Q. Liu, D. Zhang, and M.-H. Yang. Fast visual tracking via dense spatio-temporal context learning. In Proceedings of the European Conference on Computer Vision, 2014.

Github Repository

https://github.com/zlz1996/CS585FinalProject