**Documentation – Agnibh Dasgupta – A02292865 – CS 6680 – Final Project Phase 3**

**Steps to run my code:**

Change k in **test.m** file to the number of images in your sequence and run it to add noise and clean the images (you can comment you the filtering section to test for noisy images). Then run **demo\_ECO\_HC.m** to train and test those sequences. The **Comparison.m** file calculates the overlap ratio between the current tracker and the ground truth.

**Approximate time to execute my code:**

Approximately 0.083 seconds per image.

**Documentation for each component of the system:**

**A. Initialization Step:**

1. **get\_sequence\_info –** Gets the parameters and the image
2. **get\_sequence\_results** – Gets the ground truth
3. **init\_features** – Extract features from the initial image
4. **get\_interp\_fourier** – Interpolates the features learned in spatial domain to Fourier domain.
5. **init\_scale\_filter** – Initialize the scale filter parameters
6. **get\_reg\_filter** - Constructs Spatial Regularization filter and calculates energy map for the Factorized Convolutional Operator optimization.

**B. Target Localization:**

1. **extract\_features** – Samples areas of interest and extract features
2. **optimize\_scores** – Optimize scores based on training
3. **scale\_filter\_track –** Track the scale using the scale filter

**C. Training for nth frame:**

1. **shift\_sample** - Shifts the sample to center the target.
2. **update\_prior\_weights** - Update the training sample weights
3. **train\_filter** – Perform conjugate gradient iterations to update the filter and refine the model

**Improvement on the original paper:**

In 100% of cases, the cleaned ECO showed a better overlap ratio than the noisy ECO.

In 20% of cases, the cleaned ECO showed a better overlap ratio than ECO.

Based on my experiment, ECO clearly suffers in the presence of noise. Filtering the noise produces much better results. In a one case, the cleaned image even gave better overlap ratio than noiseless data, I’m not sure why that would be. I considered that an exception. However, filtered sequences consistently gave much better results than noisy sequences.

**Change on the original paper:**

I read the **Tracking Noisy Targets: A Review of Recent Object Tracking Approaches** paper, which tested the effect of noise on state-of-the-art object trackers (<https://arxiv.org/pdf/1802.03098.pdf>) and which showed that ECO performance suffers abruptly in the presence of noise. I wanted to test the resilience of ECO to noise and try to improve it.

Based on their experiments, I added in periodic order, white gaussian noise of variance 0.01, 0.03, 0.05, 0.07, 0.09 and salt and pepper noise. I used Weiner and median filter to clean these noisy images. I’ve trained and tested 5 original OBT sequences, 5 noisy versions of those sequences and 5 cleaned version of those sequences to compare results.

Based on my testing, noisy images gave much worse tracking performance than noiseless images, but filtered images gave better results.

**Difficulties during implementation:**

Running the benchmark sequences and comparing results was difficult, filtering took a lot of time. Also, removing different kinds of noise in one go was challenging.

**Comparison between the proposed approach and modified approach:**

I considered the presence of noise in the sequences (Gaussian and Salt & Pepper) while tracking, cleaning the images via Median and Weiner filters before feeding into the CNN to train and test. The cleaned sequences gave better overlap ratios than the noisy sequences.

The proposed change of preprocessing the images takes much more computational time, however tracks objects better.

**Experimental results comparable with the results published in the paper:**

I used calcRectInt function from the **Learning Spatial-Temporal Regularized Correlation Filters for Visual Tracking** paper (<https://arxiv.org/pdf/1803.08679.pdf>) to calculate an overlap ratio vector between the ground truth and my result. Then I found out the mean of the vector.

Github link - <https://github.com/lifeng9472/STRCF>

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| --- | --- | --- | --- |
| Sequences | ECO overlap ratio count | Noisy ECO overlap ratio count | Cleaned ECO overlap ratio count |
| Crossing | 0.8126 | 0.7824 | 0.7990 |
| Skiing | 0.0488 | 0.0452 | 0.0487 |
| Diving | 0.3082 | 0.2255 | 0.3569 |
| MotorRolling | 0.0949 | 0.0716 | 0.0939 |
| Matrix | 0.2225 | 0.0543 | 0.1903 |

Green - Best

Yellow - Medium

Red – Worse