הבינתחומי הרצליה
בית ספר אפי ארזי למדעי המחשב

Assignment 2: Tracking
Surveillance Based on Computer Vision, Fall 2015

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Submission date**: 22.12.2015**
Please submit using Moodle.
You can submit this assignment in pairs (no larger groups). One of you should submit the HW using moodle, and the other should submit a file with the name of the partner who submitted the HW.

In this assignment, you will implement various algorithms for pedestrian tracking. You can assume throughout the assignment that the camera is static. The focus in this assignment is on understanding the role and significance of the tracker components.

Input: to test your algorithms, use the videos from in the DATA folder.
You can read the videos using:

```
obj = VideoReader(videoName);
videoFrames = obj.read();
```

You can find additional videos in the "CAVIAR" dataset http://homepages.inf.ed.ac.uk/rbf/CAVIARDATA1/ or in PETs.
You can also try on your own videos.
Note, some of these videos are non-trivial, so do not expect to have a perfect tracking on them. When there are several moving pedestrians, you can track only some of them.

Remarks: in a case of a memory problem when reading the sequences and running your algorithm – read only a partial set of the images, e.g., the first half of the sequence. You can also resized each frame by using the matlab function: *imresize(im,scale)*

Output of the tracking algorithm: a bounding box around each pedestrian in each of the frames. The color of the bounding box should determine the identity of the person. That is, the same color for the same person.

Testing: For each output video, provide a script that allows to easily produce the output video, instead of submitting the actual video (this is due to file size constraints). In particular, make sure that the script set the parameters that are provided manually (e.g., rectangle around the subject to be tracked).

1. Implement a naïve tracking algorithm based on change detection. You can use the background subtraction algorithm you implemented in HW1, or use any other algorithm, as long as you give a proper reference.
   a. Make sure you use post processing to detect only significant "blobs" and avoid noise. You can manually set parameters that correspond to pedestrian size in the sequence.
   b. Compute the bounding box around each detection.
   c. Use a naïve tracker – associate detections in two successive frames when their bounding boxes overlap.
   d. Initialization:
      i. Mark by hand the first frame that each target appears in.
      ii. Or: Define a blob that is not associated with any pedestrian (no overlapping is found) as a new pedestrian.
   e. Qualitatively report the results on the sequences, i.e., when it is successful and when it fails. You can add images in the doc file of relevant frames and their results.

2. Extend your algorithm to use a naïve prediction based on motion. In this case, use prediction of location and size in order to associate detections.
   a. Why is the blob size expected to change?
   b. Predict the location and blob size based on the last two or more detections. You can assume a constant velocity or constant acceleration. You do not have to use sophisticated prediction models such as Kalman or Particle filters. When there is more than one detection, choose the one which best agrees with the predictions.
   c. Initialization:
      i. Mark by hand the first two frames of each target.
      ii. Or: Define a blob that is not associated with any pedestrian (no overlapping is found) as a new pedestrian.
   d. Qualitatively report the results on the sequences, i.e., when it is successful and when it fails. Does it improve the results of the algorithm from (1)? If not, when is it expected to improve it? Give an example.

3. The change detection algorithm can be improved by considering the predicted location and size of the tracked object. As a result, the tracking algorithm is expected to improve as well. Propose a method for doing so. You do not need to implement it.

4. Use the normalized histogram of colors in the bounding box in order to associate the two detections. Use SSD, Angle between histograms, and Bhattacharyya distance.
   Matlab tip: to obtain a histogram of a rectangular region: region=im(y:(y+h),x:(x+w)), and h=hist(region(:)).

   a. Test the tracking results when only histogram association is used.

   b. Test the tracking results when using both color histograms and motion prediction.

   c. Describe a situation when prediction cannot be used.

5. Ignore the change detection part of your algorithm, and implement a tracking algorithm that is based only on the histogram of the object. The detected location in each frame is the region for which its histogram is most similar to the model histogram (the inititial one or updated one). For efficiency, use the basic idea of integral histogram presented in "fragment tracking". Use a small number of bins (using color will probably help). Perform an exhaustive search in a region around the predicted location of the object. The prediction can be a naïve one (the same location as in the previous frame), or using a simple motion model.

   a. Give a short description of your algorithm, and the choices you made in your implementation.

   b. Test the tracking results and present examples of success and failures of the method.

   c. Discuss the differences in the results of the three algorithms (3), (4) and (5).

6. Describe a method that gives an alert when two people are about to get close to each other.
   a. Write a description of the method, and when it is expected to fail.
   b. Implement it.
   c. Write a script that demonstrates the success of your method on a specific part of a sequence.

Hand in:

Use Moodle.

Hand in a zip file containing the following files:

A. A word document, named HW2.doc. The word document should include:

   a. Your names.
   b. Answers to all questions.
   c. A short description of what you implemented in each of part of the HW.
   d. Pointers to the output videos with the image names, the parameters used, etc.
   e. A few words on how to use your functions.

B. Your **documented** code. In addition, a script that demonstrates how to invoke the functions with the appropriate parameters.

Please do not hesitate to contact me if you have any problems.

Enjoy!

Yael Moses