הבינתחומי הרצליה
בית ספר אפי ארזי למדעי המחשב

Assignment 1: Change Detection Surveillance Based on Computer Vision, Fall 2015

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Submission date**: 26.11.2015**
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.

Please go over the matlab example in the course website – it will help you!

In this assignment, you will implement change detection algorithms.

In this HW, you will get the video as a set of frames in a given directory, However, if you want to use any other input, you can read and play videos, use matlab built-in function (VideoReader and movie, for example).

A: Naïve Background Subtraction

In this part you have to implement a naïve background subtraction algorithms on gray level images and color images

1. Implement the background subtraction algorithm for gray level and color sequences where the background model of each pixel is:
   (i) average of *n* previouse values of that pixel.
   (ii) median of *n* previouse values of that pixel.

   Write:
   Res=NaiveBS(VideoMat,C,output_type,other_parameters)
   VideoMat: the input matrix
   Res: the output matrix
   C={1/0): {color/Gray} (see **b** below).
   O={1/0}: binary or frames (see **d** velow)
   other_parameters: add a list of the other parametrs you use. Exaplain them as a comment in the file: use % for comment,

a. You have to choose the manner in which the set of *n* pixels is chosen (e.g., the last *n* frames or any other set of *n* frames).

b. When dealing with color images, you have to save the model for each channel (r, g and b) and then make a decision based on the three channels.

c. Your function should produce for each frame a binary map (0 & 1) such that the background is '0' for background pixels and '1' for foreground pixels.

d. Two types of results should be given (using a parameter you choose which one you want to get):

   i. A set of binary maps (one map for each frame) where 0 indicates a bacground pixel and 1 indicates a foreground pixel.

   ii. A set of frames where the bacground pixels are 0 and the resto of the pixels are the original intensity (or color) of the frame.

e. Usefull matlab functions:

   i. *rgb2gray(im)*: converts a color image to gray level image.

   ii. *A.*B*: pointwise multiplications of two matrices.

   iii. *find(A>x)*: returns all indices of elements in A that are larger than x

   iv. *A(find(A>x))=5:* will set all elements that are larger than x in A to

   v. *mean*

   vi. *median*

2. Test your implementation

   a. Use the sequences “office” and “highway” in the “baseline” category of dataset2014 in http://www.changedetection.net.

      i. The *input* directory: each frame is given as a seperate image.

      ii. To read all images in the directory into a matrix that contains all frames, you can use the attached function:

      readImagesDir.m

      implay(mat) : show the matrix mat as a video

      iii. In case it is too heavy for your computer to read all images, modify the function to read a subset of the images.

iv. You can also modify the function to generate directly a matrix that contains gray level rather than color images.

v. For testing your method on graylevel images, you will need to convert the color images into graylevel by using the matlab function *rgb2gray(im)*

vi. The *groundtruth* directory: the ground truth mask that can be used to evaluate your results.
You should not care about it, but just to let you know: the groundtruth imgages are given as grey level images in this durectory. To transform an im_GT you read from this directory into a binary map, Use:
map=im_GT;
map(im_GT>0)=1;
It is part of the evaluation function below.

b. Compare your results to the ground truth using the attached function 'compareResults2GroundTruth'. You should use the original images from thr groundtruth directory.
Plot the false positives and false negatives as a function of the frames (the time).

3. Write a short description of your implementation, how you choosed the parameters, and how the choice of paramers affect the result. Also explain how you merge the three channels to obtain the result.
4. Write a short description of the advantages and the limitations of the naïve background subtraction.

B: Non-parametric background subtraction using (KDE)

You will implement the basic algorithm proposed by Elgammal & Davis 2000. The paper with the details is attached.

1. Implement the basic algorithm on gray level image as described in the paper in Section 2. Use the following variations on the update (see Section 4):
   a. Non-selective update (blind update).
   b. Selective update with the same threshold used for deciding foreground objects.
   c. Selective update with the a different threshold used for deciding foreground objects.

2. **Answer:** What are the tradeoff between the three possibilities? Show examples that demostrate it.
3. **Desribe:** which set of parametrs you have to choose, and how they affect the result.
4. Choose a sequence from dataset2014 in http://www.changedetection.net, for which the KDE algorithm outperforms the naïve background subtraction.
    a. Test your implementation on that dataset.
    b. Compare your results to the ground truth using the attached function 'compareResults2GroundTruth'.
    Plot the false positives rate and false negatives rate as a function of the frames (the time).
    c. Explain why it works better than the naïve one.
5. Choose a pixel in the sequence and present:
    a. The intensity change as a function of frame.
    b. The histogram of the pixel values for all frames (notmalize it to sum up to 1).

    Matlab tip:
    sum(A(:)): the sum of all elemenys in A
    h=hist(A) : generate a histogram array

    bar(h)

    Overlay on the histogram, the values and the gaussian you used in frame 1500. You can use the attached function plotGaussian.m
    Matlab tip:
    hold on; after presenting a figure, to overlay something else on the same figure.
6. Write a short description of your implementation. Add a short description of the advantages and the limitations of the method.
7. Choose a sequence from http://www.changedetection.net for which the method produces bad results.
    a. Explain where the method fails (what assumptions break, etc).
    b. Suggest how to overcome these failures, without changing the background model, i.e., mixture of gaussians.

C: Post processing – optional

It is not for credit and you do not have to submit it. However, it is worth playing with

1. Implement a simple post processing on the output of your algorithm that gives the best results. Filter out small blobs.

   You can use the matlab function *regionprops*

   You can use morphological operations with the matlab function bwmorph to improve your results.

2. Implement hysteresis thresholding ("double threshold) on the output of the mixture of gaussians background subtraction. Show the results with a few sets of thresholds.

Hand in:
Use Moodle.

Hand in a zip file containing the following files:

A. A word document, named HW1.doc. The word document should include:
   a. Your names.
   b. Answers to all questions.
   c. Pointers to the output images with the image names, the parameters used, etc.
   d. 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