Master 2 Paris Saclay - *D&K / AIC*
Object Tracking in Videos

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The goal of this practical work is to understand the challenges and difficulties of object tracking in videos, to experiment and develop solutions based on Mean Shift and Hough transform algorithms.

To this end, we will use OpenCV library with Python (code tested with python3 and OpenCV 4.1.0). Basic code and test videos are available on the following pages:

- https://perso.ensta-paris.fr/~manzaner/Cours/Masters_ParisSaclay/Image_Mining/Tracking_MeanShift.py

- https://perso.ensta-paris.fr/~manzaner/Cours/Masters_ParisSaclay/Image_Mining/Test-Videos.zip

You are expected to write a report and send the PDF to antoine.manzanera@ensta-paris.fr.

The purpose of a tracking algorithm is to provide, for each video frame, the position of an object of interest, given here by the coordinates of the bounding rectangle (RoI), whose values are manually initialised on the first image of the video (the rectangle is defined using the mouse left button, and validated with the key 'q').

1   Mean Shift

Q1 EXPERIMENT the tracking performed by the provided code `Tracking_MeanShift.py` that uses the basic Mean Shift algorithm, on the marginal density of the hue component H. Remind the principle of this algorithm, and illustrate its advantages and limits by your experiments.

Q2 ANALYSE more in-depth the result by displaying the sequences of hue images, and also the weight images corresponding to the back-projection of the hue histogram. Propose and program improvements, by changing the computed density and/or updating the model histogram.

2   Hough Transform

Q3 CALCULATE for each frame, the local orientation, i.e. the gradient argument of pixels, and also the gradient magnitude. Use a threshold on the gradient magnitude to mask pixels whose orientation is not significant. Display the sequence of orientations, where the masked pixels appear in red.

Q4 BUILD a model of the initial object under the form of an implicit model indexed on the orientation (R-Table). Then, calculate the associated Hough transform on all the images of the sequence. Calculate the straightforward tracking, corresponding to the maximal value of the Hough transform at each image. Comment and criticise the obtained results.

Q5 REPLACE the computation of the maximal value by the application of the Mean Shift on the Hough transform (i.e. by replacing the back-projection of the Hue histogram by the output of the Hough transform in the first argument of the Mean Shift). Interpret the result and compare it with the previous one. Propose an update strategy of the model that would allow to be robust to aspect changes of the object.