1. What could be the main reasons why most of the features are not tracked very long in case ‘obama.avi’?

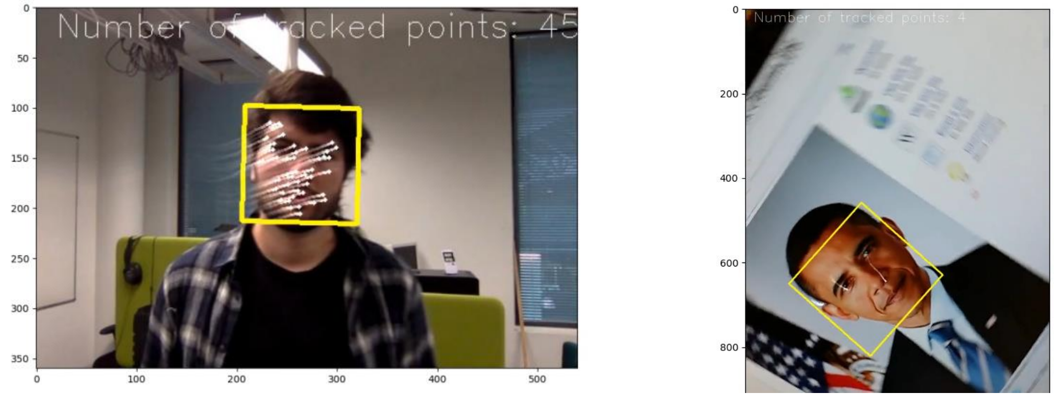

Figure 1 and 2 - Number of tracked points (45 v 4) at second 16 of each video

Video quality can be an issue as the video is recorded through a screen and a low-resolution picture of Obama in Wikipedia website.

Brutish movements in the Obama video, around second 9 there is a brutish movement, which made lose a lot of features.

2. How could one try to avoid the problem of gradually losing the features? Suggest one or more improvements.

Periodically redetect features in the frame and initialize tracking again to ensure we are consistent with tracking points.

Adjust the window size as motion is detected, so features can be tracker for longer

Computer vision HW 08 João Pinheiro

2. Equation 10

$$\Delta p = H^{-1} \sum_x \left[\nabla I \frac{\partial W}{\partial p} \right]^T \left[T(x) - I(W(x;p)) \right]$$

Solution Slides 25

When the geometric mapping W becomes a simple translation $W(x;p) \rightarrow W(x) = x + p$

We no longer track affine maps, we computing optical flow.

So the Hessian can be simplified

$$H = \sum_{pixels} \left[\nabla I \frac{\partial W}{\partial p} \right]^T \left[\nabla I \frac{\partial W}{\partial p} \right]$$

Note: $\frac{\partial W}{\partial p}$ simplifies to identity matrix

$$= \sum_{pixel} \nabla I(x)^T \nabla I(x)$$

$$= \sum_{pixels} \begin{bmatrix} I_x^2 & I_x I_y \\ I_x I_y & I_y^2 \end{bmatrix}$$

$$= \begin{bmatrix} \sum I_x^2 & \sum I_x I_y \\ \sum I_x I_y & \sum I_y^2 \end{bmatrix}$$

using note from before $\frac{\partial W}{\partial p}$ = Identity matrix

$$\Delta p = H^{-1} \underbrace{\sum [\nabla I(x)]^T [T(x) - I(W(x))]}$$

$$\begin{bmatrix} u \\ v \end{bmatrix} = \begin{bmatrix} \sum(I_x I_x) & \sum(I_x I_y) \\ \sum(I_x I_y) & \sum(I_y I_y) \end{bmatrix}^{-1} \cdots$$

$$\begin{bmatrix} \sum(I_x I_x) & \sum(I_x I_y) \\ \sum(I_x I_y) & \sum(I_y I_y) \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = \sum \overset{[\nabla I(x)]^T}{\begin{bmatrix} I_x \\ I_y \end{bmatrix}} \underbrace{[T(x) - I(W(x))]}_{-\underbrace{[-T(x) + I(W(x))]}_{\text{image errors}}}$$

image errors
often known as
temporal derivative
I_t as I is result
image minus the
transformation $T(x)$

I_t

$$\begin{bmatrix} \sum I_x I_x & \sum I_x I_y \\ \sum I_x I_y & \sum I_y I_y \end{bmatrix} \begin{bmatrix} u \\ v \end{bmatrix} = -\sum \begin{bmatrix} I_x \\ I_y \end{bmatrix} I_t$$

$$= - \begin{bmatrix} \sum I_x I_t \\ \sum I_y I_t \end{bmatrix}$$