

## MOTION DESCRIPTORS

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## INSTANTANEOUS ACTION PRIMITIVES

Stabilise moving object

Compute optical flow

Compute descriptors based on the optical flow

## IMAGE STABILIZATION?

Temporal difference: subtract consecutive frames

Threshold temporal difference for regions of interest

Use maximum cross-correlation  $cc(dc, dr)$  of consecutive frames inside region of interest to estimate frame-to-frame translation  $(dc, dr)$ :

$$cc(dc, dr) = \frac{\sum_{(c,r) \in ROI(t)} (I_{c,r}^t - \mu^t)(I_{c+dc, r+dr}^{t+1} - \mu^{t+1})}{\sigma^t \sigma^{t+1}}$$

Where:

$pROI(t+1)$  is  $ROI(t)$  shifted by  $(dc, dr)$  into image  $t+1$ :

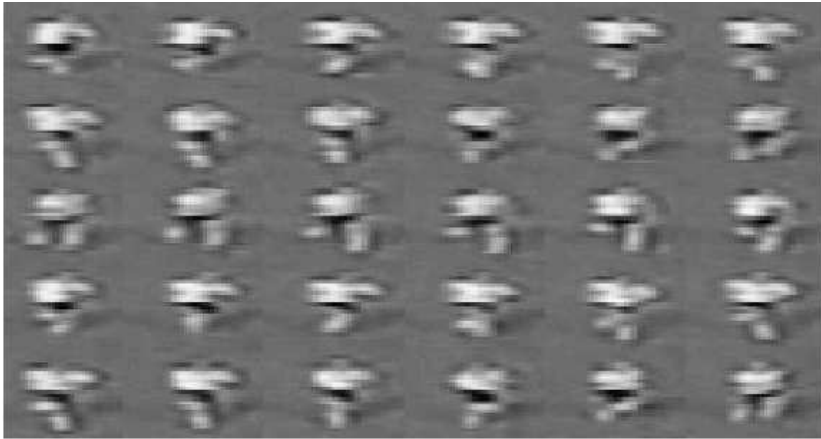
$$\mu^t = \text{mean}(ROI(t))$$

$$\mu^{t+1} = \text{mean}(pROI(t+1))$$

$$\sigma^t = \sqrt{\sum_{(c,r) \in ROI(t)} (I_{c,r}^t - \mu^t)^2}$$

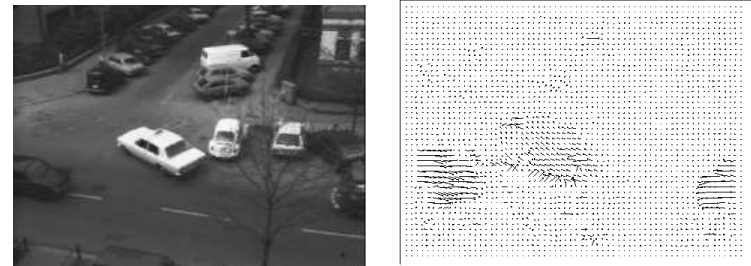
$$\sigma^{t+1} = \sqrt{\sum_{(c,r) \in pROI(t+1)} (I_{c,r}^{t+1} - \mu^{t+1})^2}$$

## STABILISED RUNNER



## OPTICAL FLOW

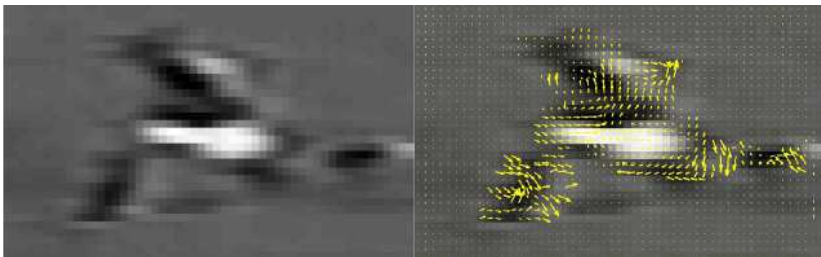
Image velocity  $(u, v)$  at every pixel: where each pixel's data is moving to in next image



Computed by standard algorithms that match local gradients to temporal gradients

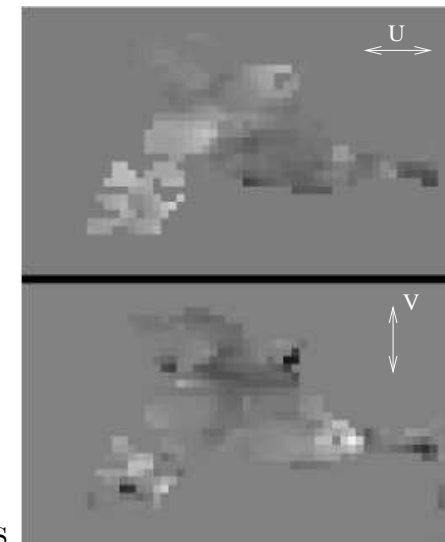
## OPTICAL FLOW DESCRIPTORS 1

Optical flow image =  $[...(u_{c,r}, v_{c,r})...]$



Goal: create a descriptor based on this noisy relative OF

## OPTICAL FLOW DESCRIPTORS 2



$u, v$  components

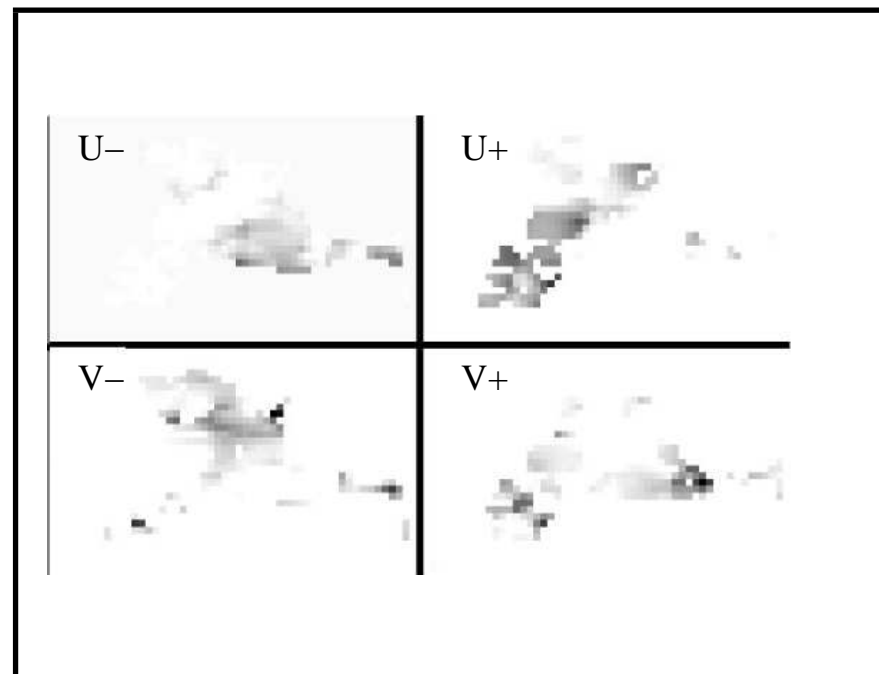
## OPTICAL FLOW DESCRIPTORS 3

Noisy so smooth, but smoothing cancels +/- aspects

Solution: split +/- components

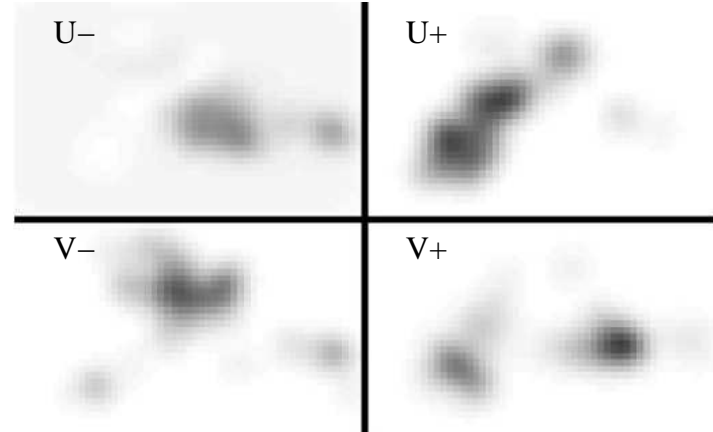
$$f(x) = x \text{ if } x \geq 0 \text{ else } x = 0$$

$$(u_i, v_i) \rightarrow (f(u_i), f(-u_i), f(v_i), f(-v_i))$$



## OPTICAL FLOW DESCRIPTORS 4

Convolve with Gaussian to smooth



Descriptor: sequence (50 frames) of smoothed O.F. windows

## Resulting Descriptor

Gives:  $a_c^i(x, y)$  for every frame  $i$  of seq.  $a$

$c = 1, 2, 3, 4$  optical flow components

$(x, y) =$  pixel positions

Summary: rich, subtle (varies across object), but view dependent