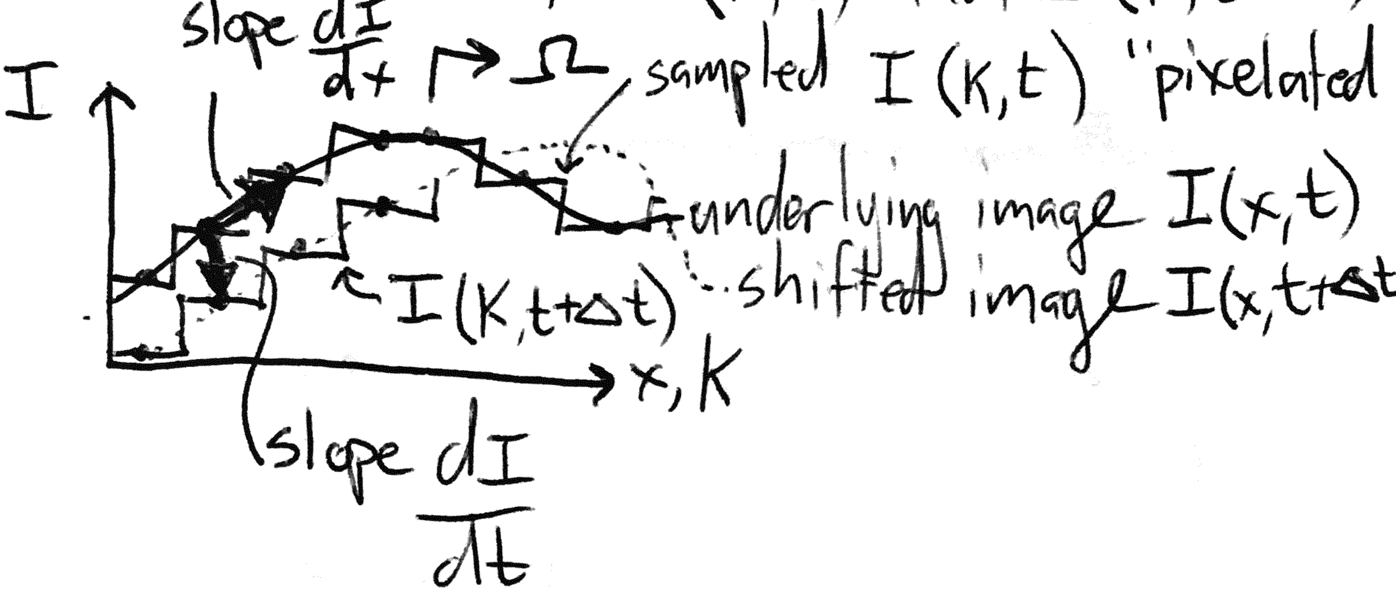
Computing Optic flow from pixel readings (1-D case)

Take two (intensity) snapshots at time t and $t+\Delta t$, $I(K,t)$ and $I(K,t+\Delta t)$



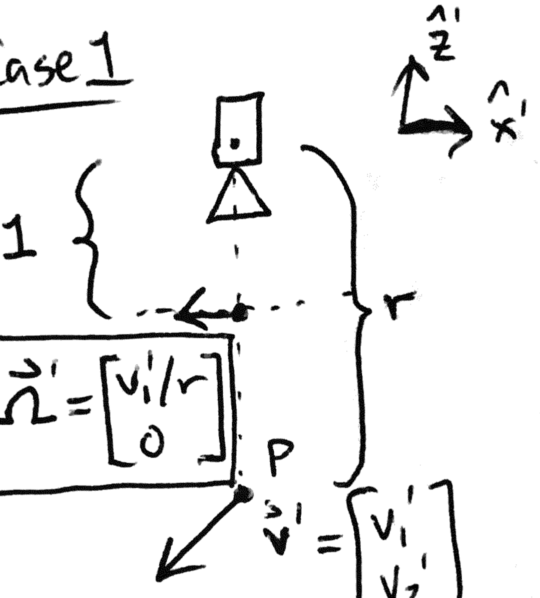
Assumption: assume underlying image $I(x,t)$ has only shifted in position by $\Omega\,\Delta t$ (where Ω is its velocity) but not in shape.

$\Rightarrow$ optic flow estimate is $\boxed{\Omega_m = -\dfrac{dI/dt}{dI/dx}}$ for pixel K.

(2D case is called "Lucas-Kanade")

Def. Optic flow: $\vec{\Omega}'$ is velocity of motion projected onto surface 1 unit of distance from camera:

Case 1

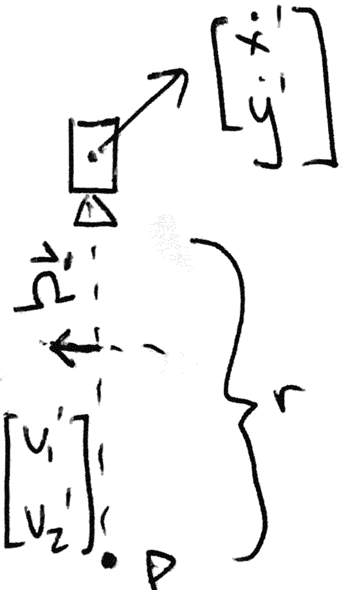


$$\boxed{\vec{\Omega}' = \begin{bmatrix} v_1'/r \\ 0 \end{bmatrix}}$$

$\vec{v}' = \begin{bmatrix} v_1' \\ v_2' \end{bmatrix}$ velocity of point P, in body coords.

Case 2

Consider: P fixed, camera moving at $v' = \begin{bmatrix} \dot{x}' \\ \dot{y}' \end{bmatrix} = -\begin{bmatrix} v_1' \\ v_2' \end{bmatrix}$

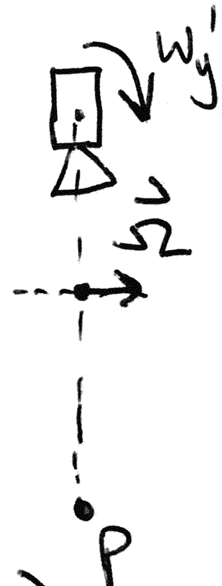


$\Rightarrow$ identical optic flow to case 1.

$$\Rightarrow \boxed{\vec{\Omega}' = \begin{bmatrix} -\dot{x}'/r \\ 0 \end{bmatrix}}$$

Case 3

P fixed, $v' = 0$, $w_y' \neq 0$



$$\vec{\Omega} = \begin{bmatrix} w_y' \\ 0 \end{bmatrix}$$

(independent of r!)

Case 4 (general case)

P fixed, $v' \neq 0$, $w_y' \neq 0$

vector add effects:

$$\boxed{\vec{\Omega} = \begin{bmatrix} w_y' - \frac{\dot{x}'}{r} \\ 0 \end{bmatrix}}$$