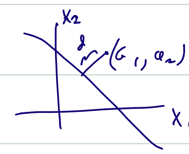
Asst #3 Tutorial. Tonight 5–6 pm DC 2306G

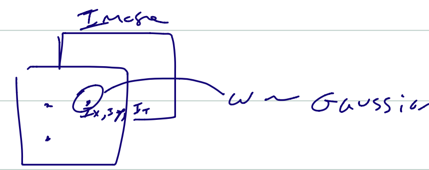
due Thursday next week.



$C_k^T(\underline{a}, 1) = 0$

$(c_{kx} a_x + c_{ky} a_y + c_{kt}) = 0$

$e_k = \underbrace{(I_{kx} v_x + I_{ky} v_y + I_{kT}) = 0}_{\text{optical flow BCC}}$

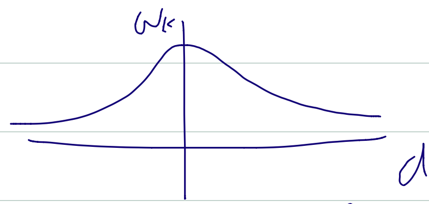


$\arg\min_{a} \sum e_k^2$

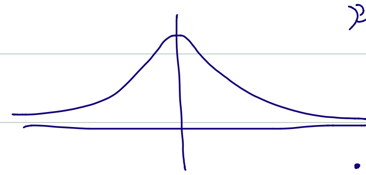
$$\begin{bmatrix} \sum w_k I_x^2 & \sum w_k I_x I_y \\ \sum w_k I_x I_y & \sum w_k I_y^2 \end{bmatrix} \begin{bmatrix} v_x \\ v_y \end{bmatrix} = \begin{bmatrix} -\sum w_k I_x I_T \\ -\sum w_k I_y I_T \end{bmatrix}$$

L & K 1ss Optical flow

$w_k = f(e_k)$



$w_k = \underline{W}(e_k)$



$\cancel{\rho(e) = \frac{e^2}{\sigma^2 + e^2}}$

$\cancel{\dot{\rho}(e) = 2e \frac{e}{(\sigma^2 + e^2)^2}}$

$w(e_k) = \frac{2\sigma^2}{(e^2 + \sigma^2)^2}$

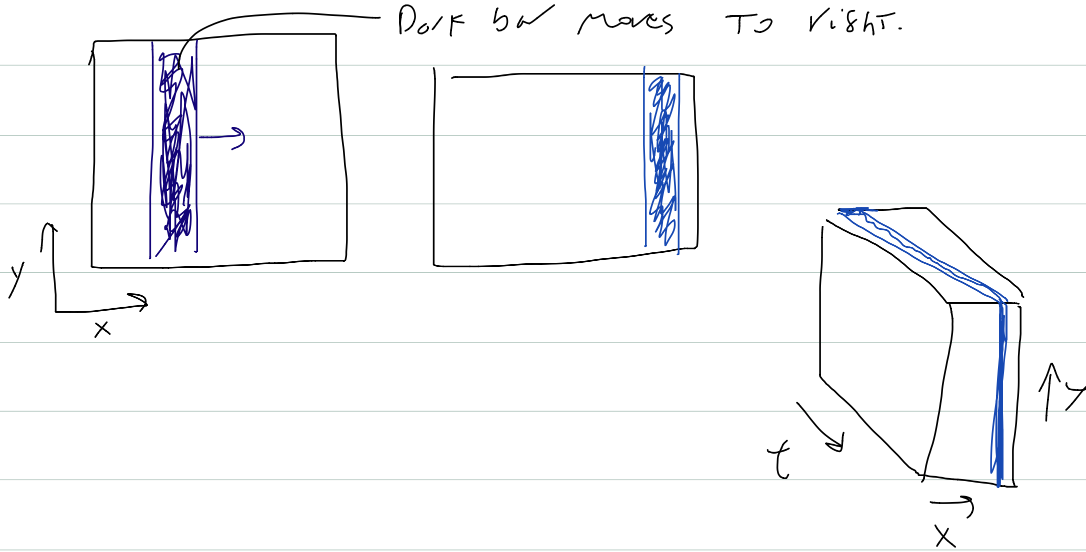
$P(c_k \mid a_n) = N(c_k^T(a_n, 1); 0; \sigma)$

don't forget.

$\tau_{kn} = \frac{\pi_n P(c_k \mid a_n)}{\sum_{n'} \pi_{n'} P(c_k \mid a_{n'})}$

Fourier analysis of Motion

- 3d spacetime volume.



Watson & Ahumada (1985)

Fourier Transform of a moving image

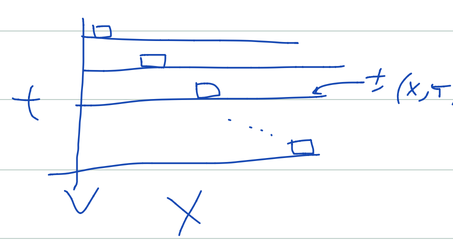
$$I(x,y) = I(x)\cdot\delta(x - rT)$$

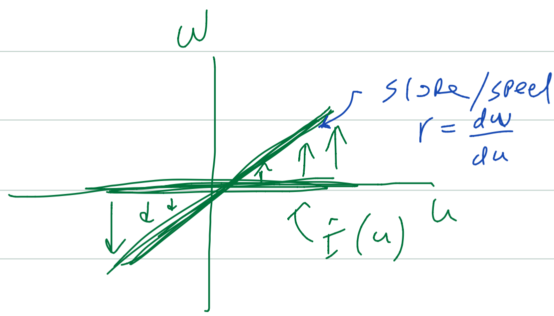
speed

↓ fourier transform

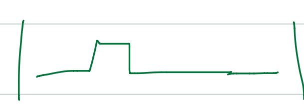
$$\hat{I}(u,w) = I(u)\cdot\delta(u + wr)$$

1d example





$I(x) =$



In 2D

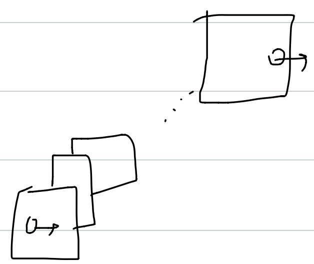
$$I(x,y,T) = I(x,y)\,\delta(x r_x + y r_y + r T)$$

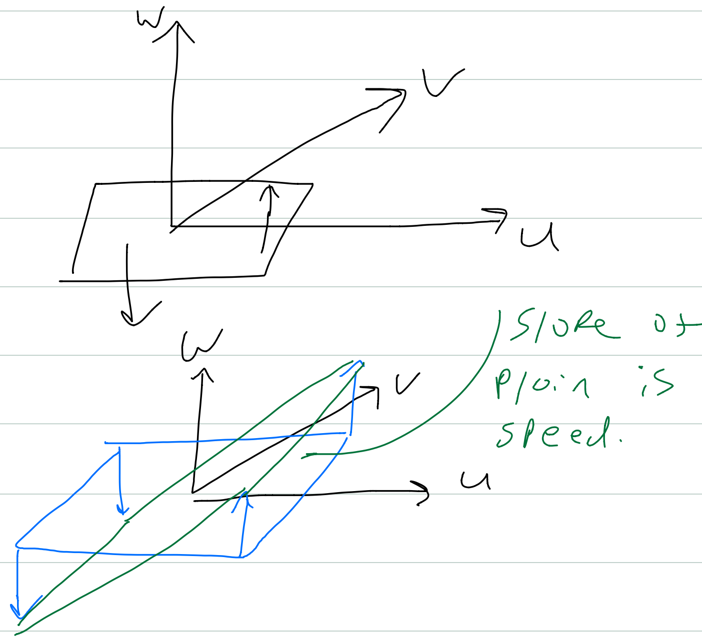
x, y, T position

(r_x, r_y) velocity

$$\hat{I}(u,v,w) = \hat{I}(x,y)\,\delta(w + u r_x + v r_y)$$

u, v, w frequency





$$\mathcal{F}\left\{\frac{\partial F}{\partial x}\right\} = -i \underset{2\pi f_x}{\underset{\wedge}{w_x}}\, \mathcal{F}\{I\}$$

$$\mathcal{F}\{I(x)\} = \int I(x)\, e^{-2i\pi f T}\, dT$$

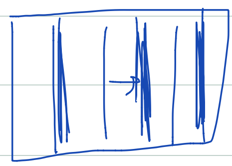
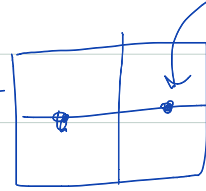
$$\mathcal{F}\{f'(x)\} = \int f'(x)\, e^{-2\pi i f x}\, dx$$

↓ proof by IBP

$$\mathcal{F}\{\frac{\partial I}{\partial x}(x)\} = -i2\pi f_x\, \mathcal{F}\{I(x)\}$$

single sinusoid

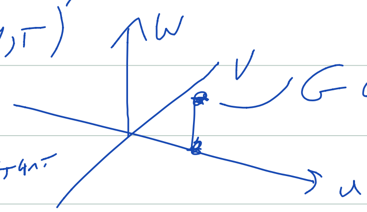
One frequence

$I(x,y) =$  $\hat{I}(u,v) =$ 

energy of single point in frequency domain.

$I(x,y,t)$

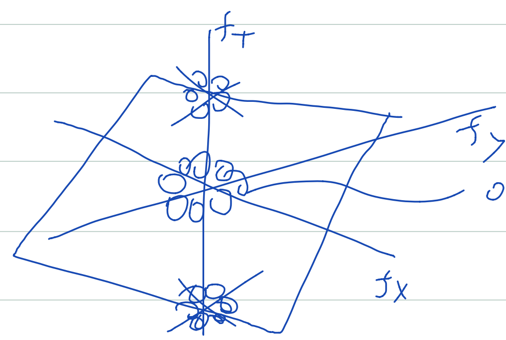
Single sinusoid with constant velocity



Gabor filter

Motion detection Heeger ?

fit plain to filter outputs



orientations 0, 45, 90, 135, 180

3 scales × 8 orientation × 3 speeds.