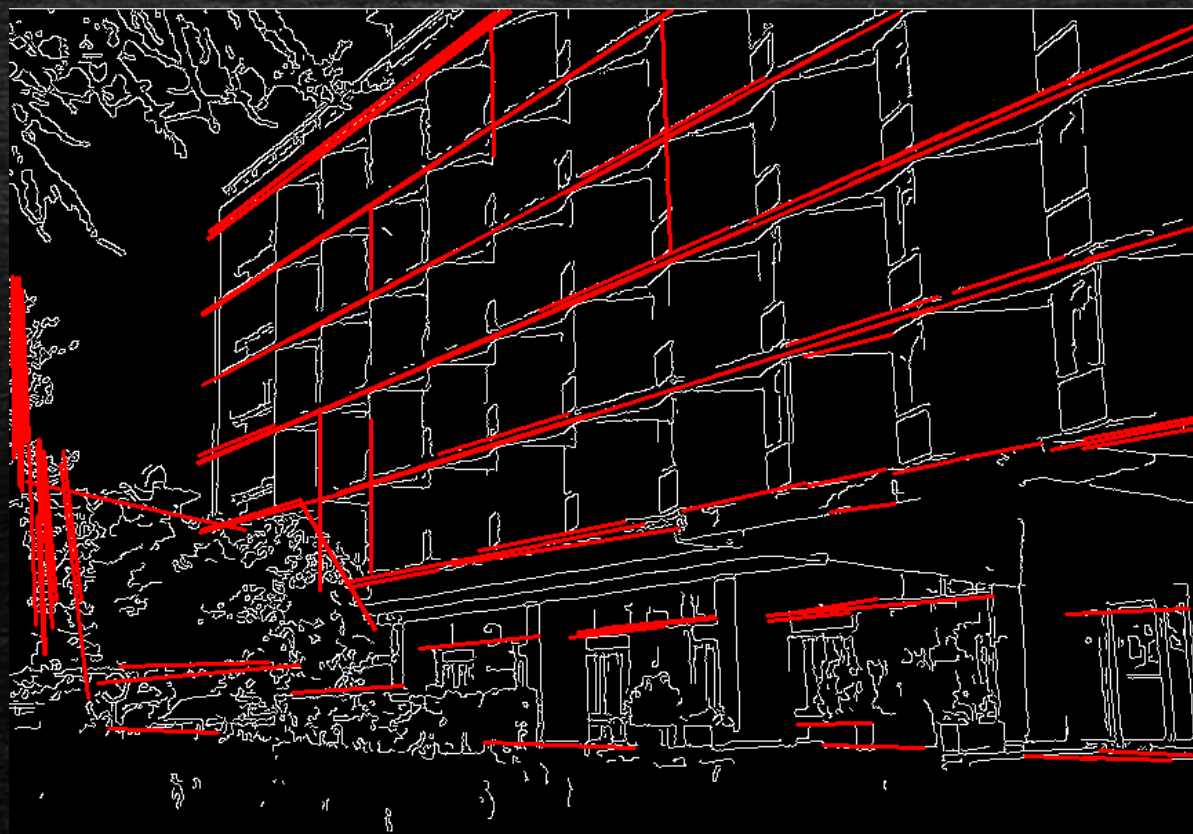
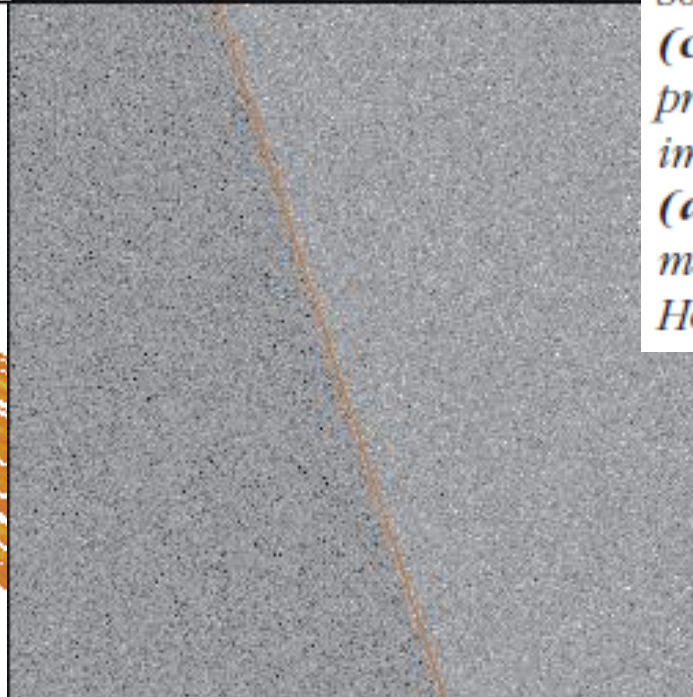
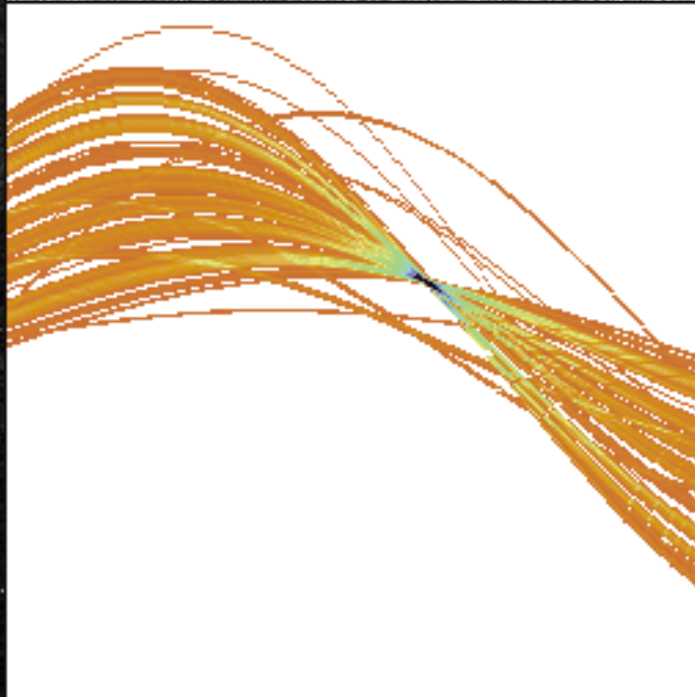
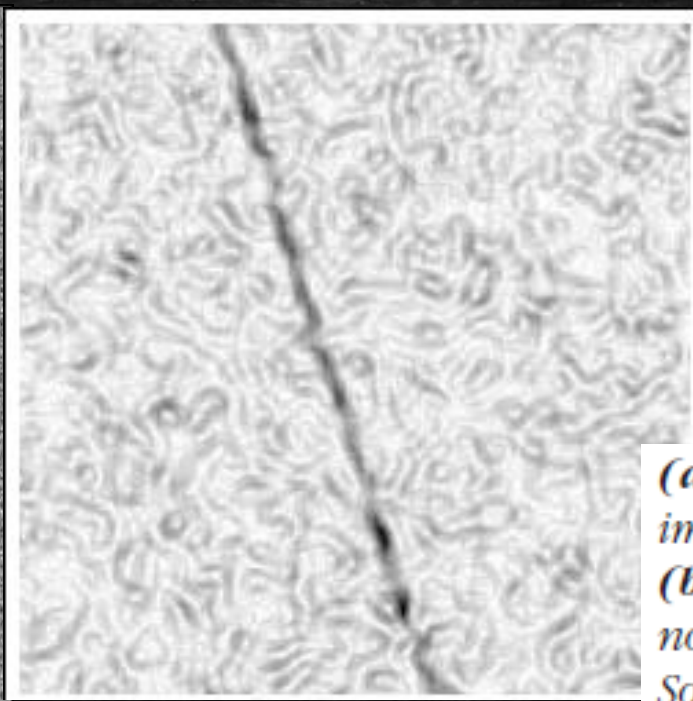
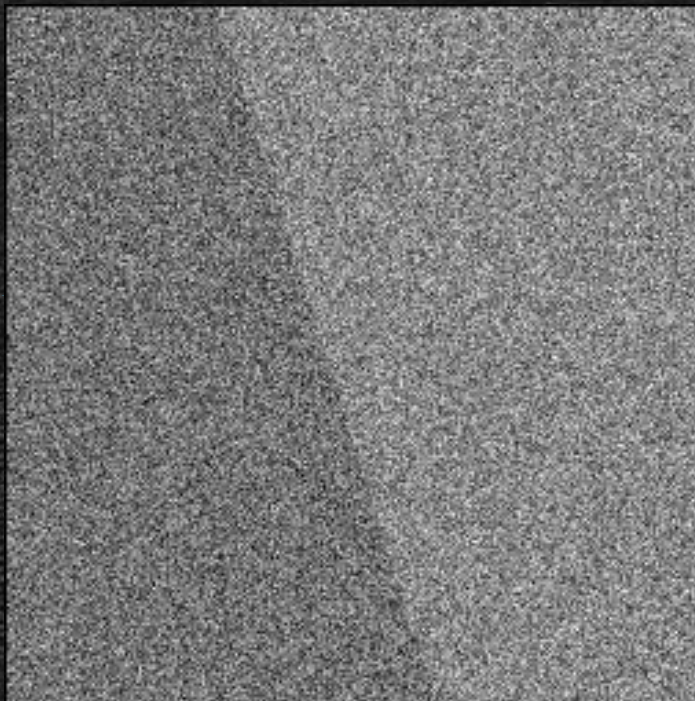


Houghova transformácia





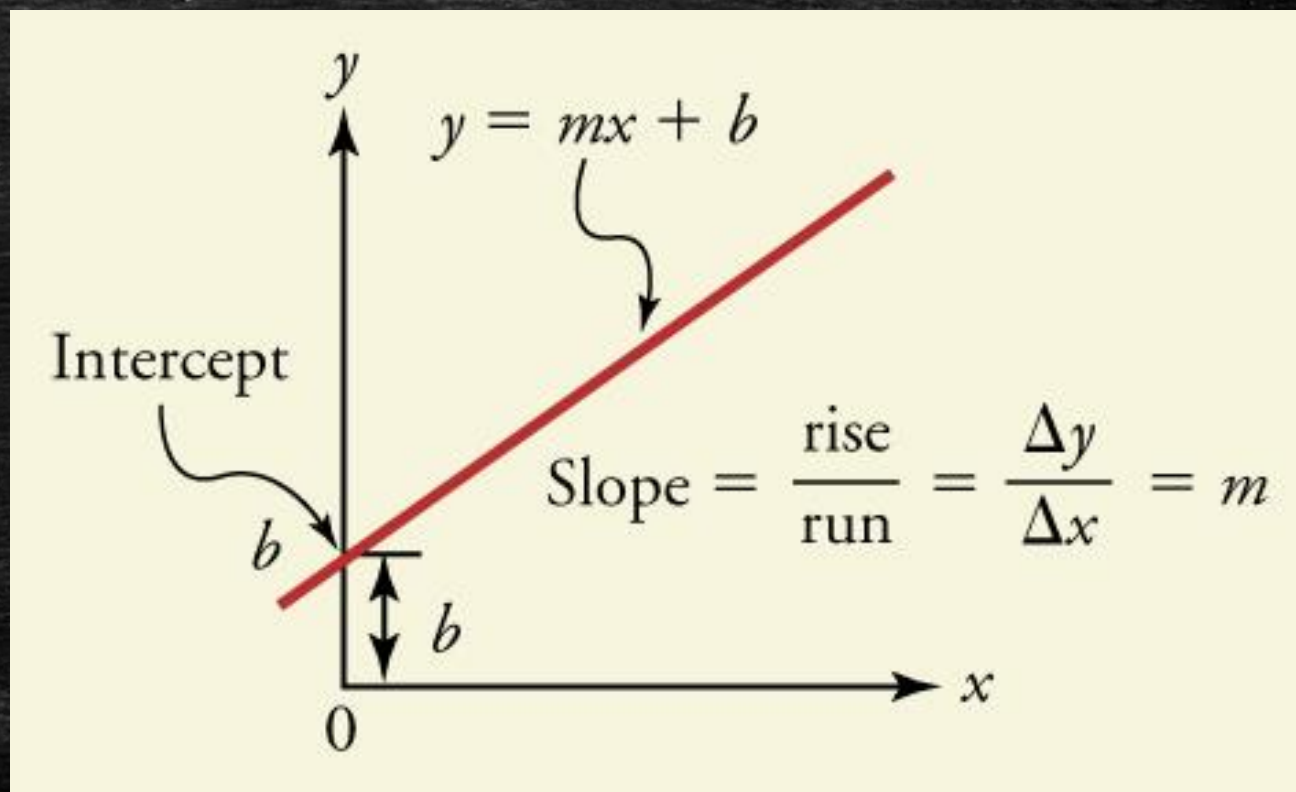
- (a) the original noisy image;*
(b) smoothing to reduce the noise and application of a Sobel gradient filter;
(c) Hough transform produced from the gradient image;
(d) line defined by the maximum point in the Hough transform.

Houghova transformácia

(x,y) – obrazový priestor

$$y = mx + b$$

(m,b) – parametre



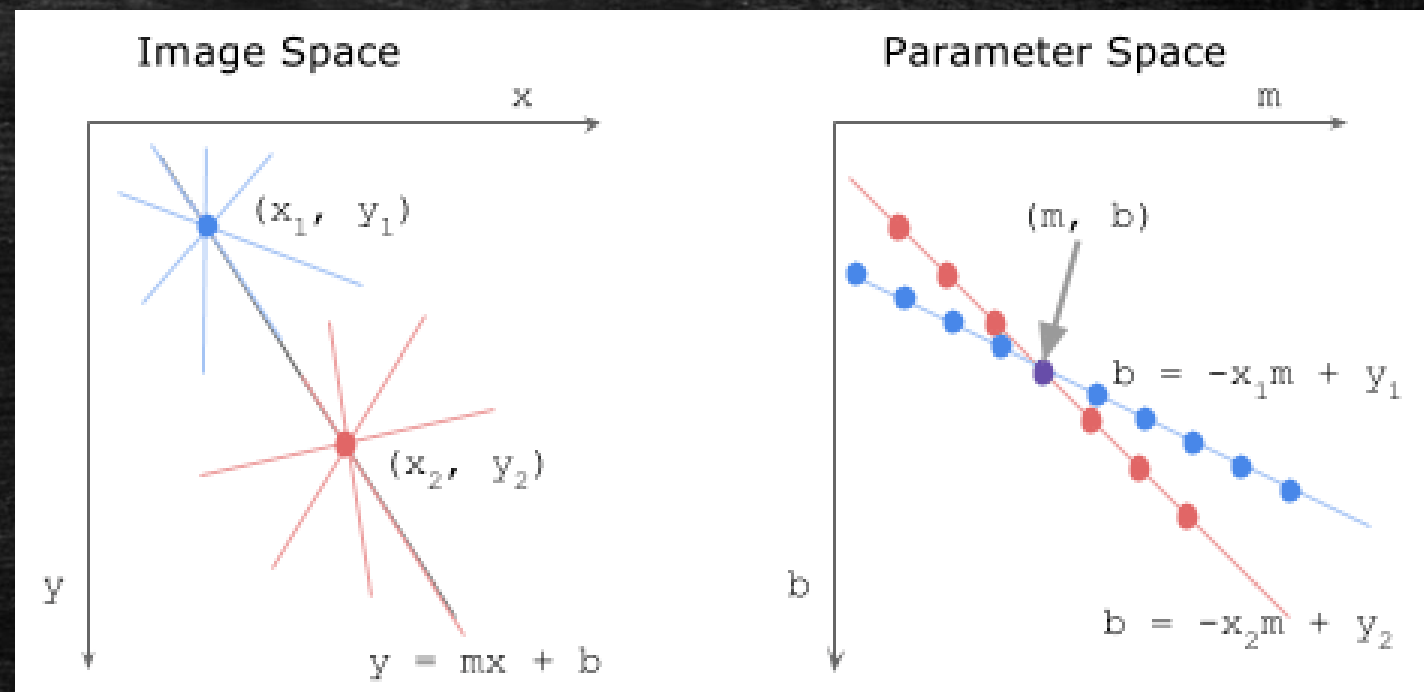
Houghova transformácia

(x,y) – obrazový priestor

$$y = mx + b$$

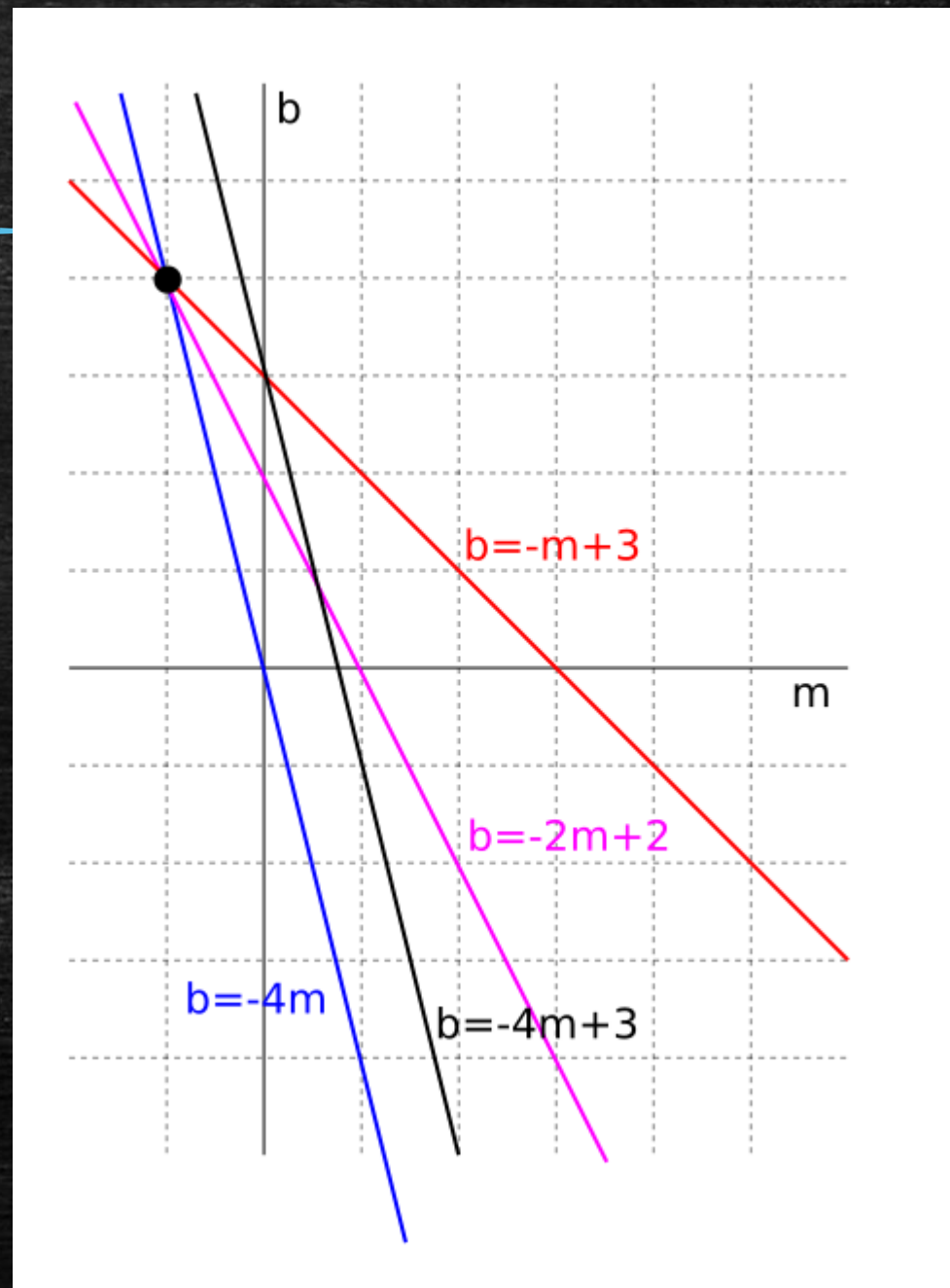
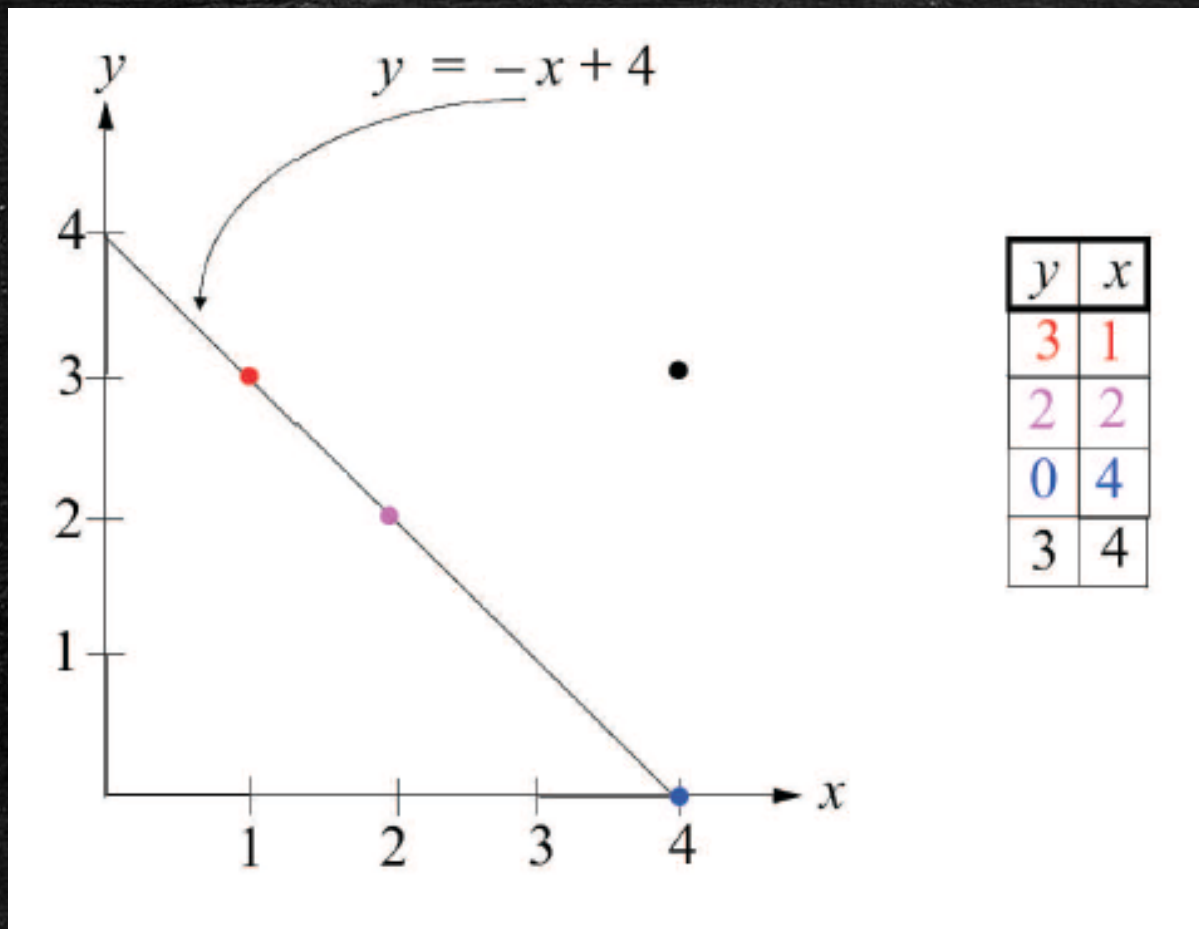
(m,b) – parametrický priestor

$$b = -xm + y$$



Houghova transformácia

$$b = -xm + y$$

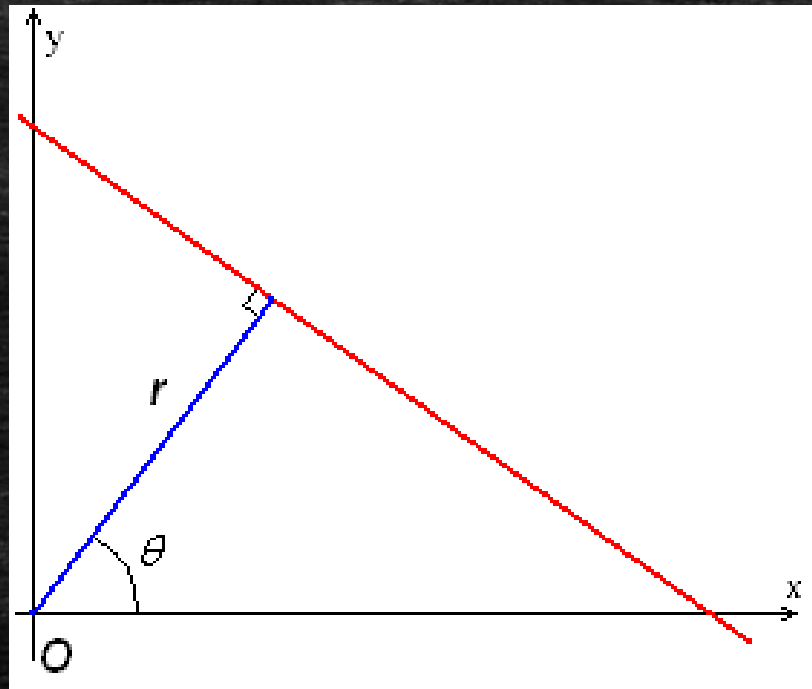


Houghova transformácia

$$y = m x + b$$

Polárne súradnice (ρ, θ)

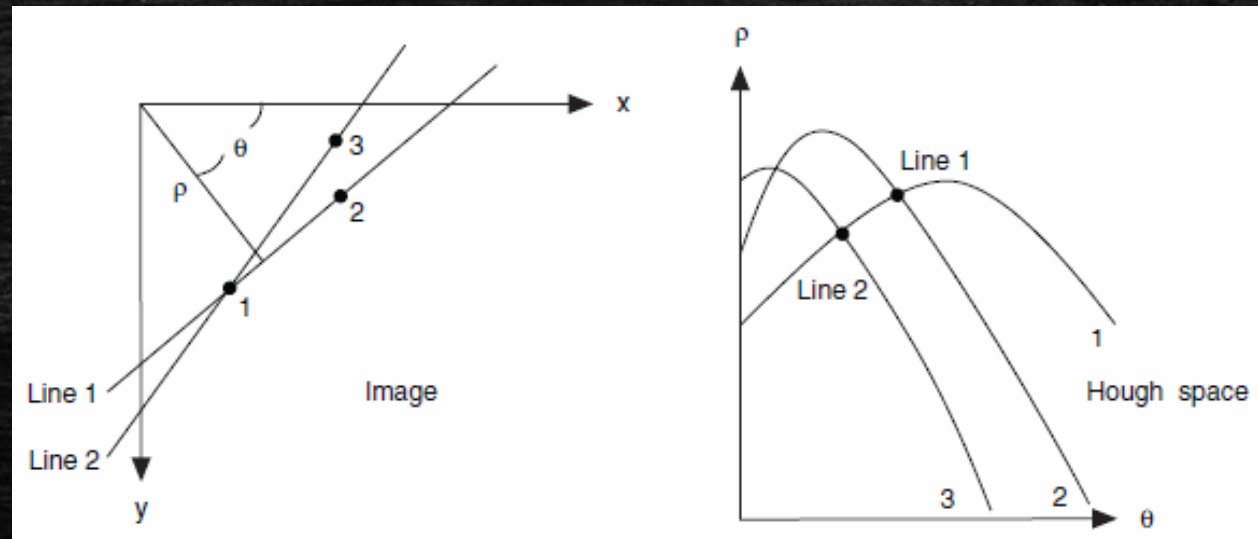
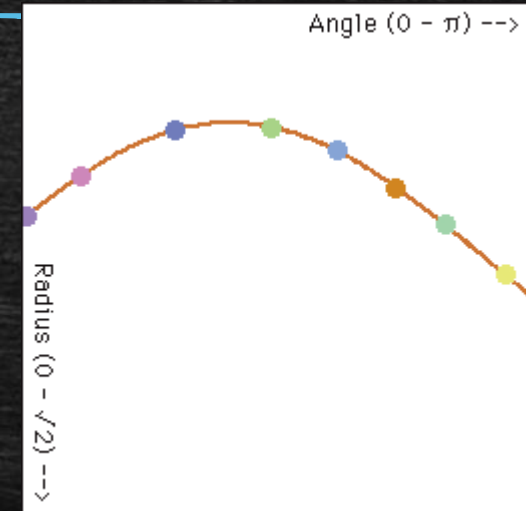
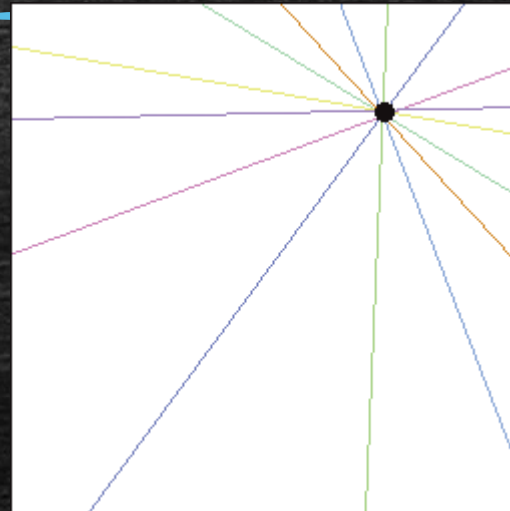
$$\rho = x \cos \theta + y \sin \theta$$



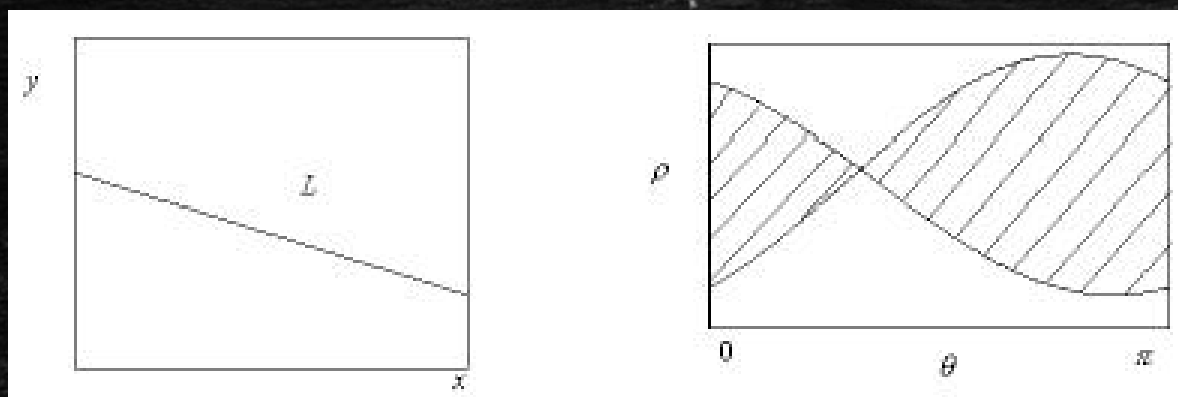
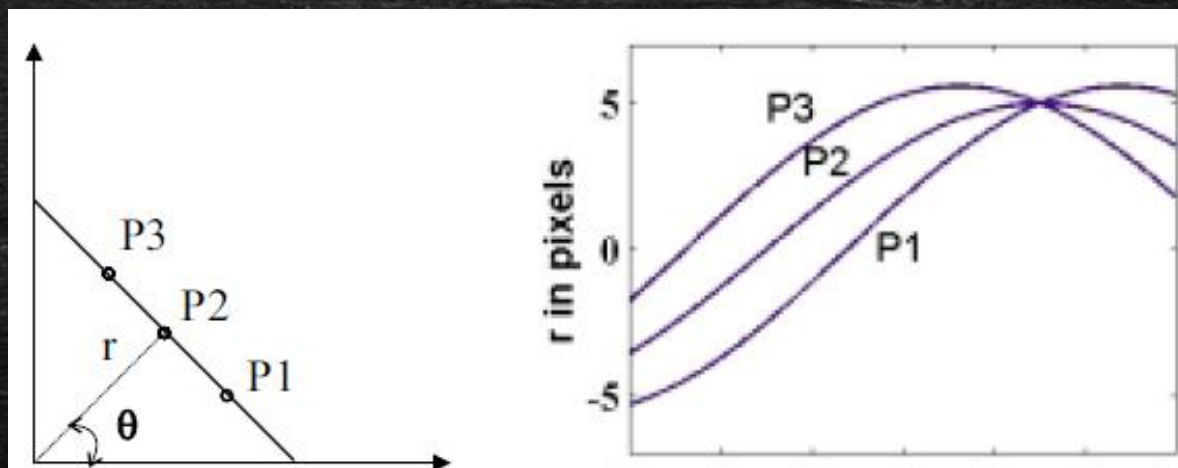
$$\rho = x \cos \theta + y \sin \theta$$

Houghova transformácia

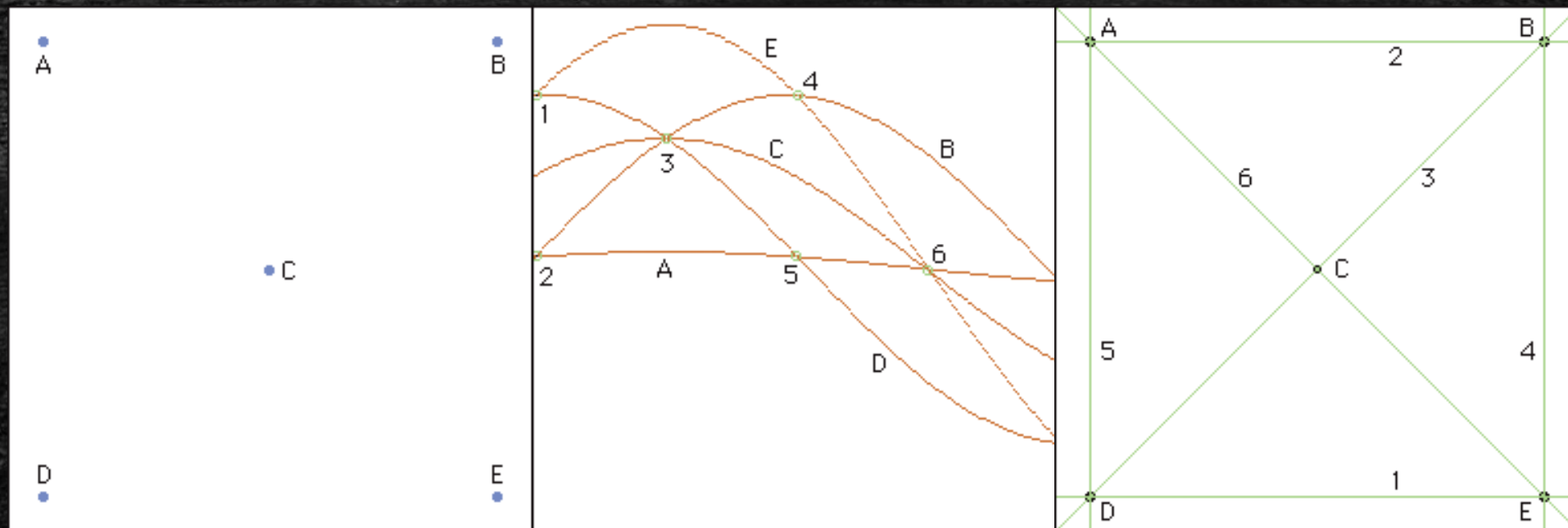
$$\rho = x \cos \theta + y \sin \theta$$



Houghova transformácia



Houghova transformácia



Houghova transformácia

Algoritmus

1. Kvantizácia parametrického priestoru (θ na 360 stupňov, ρ na polovičnú dĺžku diagonály, $(0,0)$ je v stredu obrazu)
2. Každý bod parametrického priestoru je akumulátorom, začína hodnotou 0
3. Pre každý bod hrany (x,y) , zvýš hodnotu akumulátora
4. Nájdi maximá v parametrickom priestore, určujú priamky v obraze



Maximá

Hľadáme lokálne maximá, nie N najvyšších hodnôt

- nájdeme akumulátor, ktorý má maximálnu hodnotu
- určíme zodpovedajúcu priamku
- potlačíme hodnoty v okolí akumulátora
- opakujeme N krát



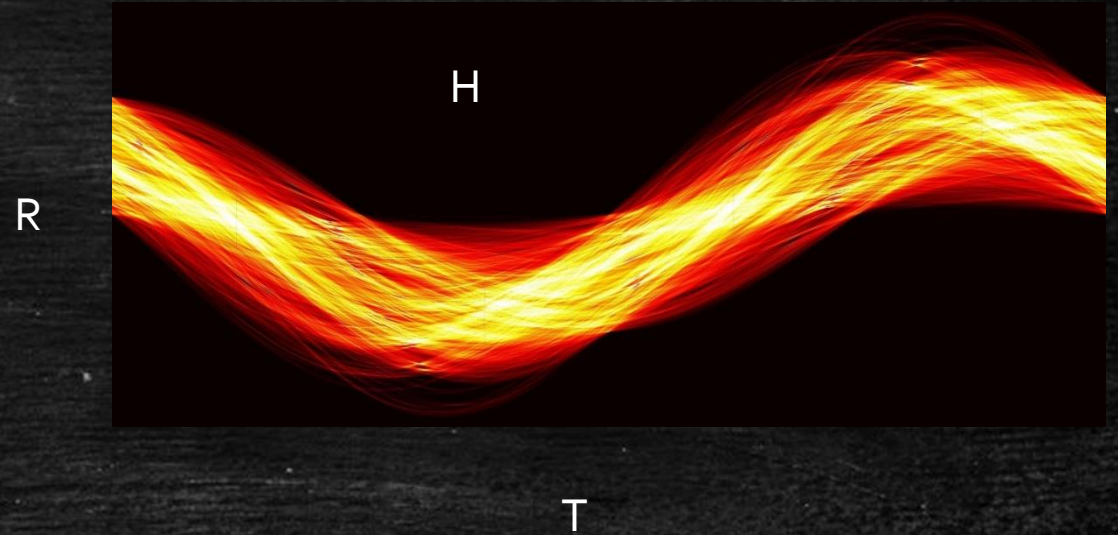
MATLAB

```
[H,T,R] = hough(BW);
```

H – Hough transform matrix

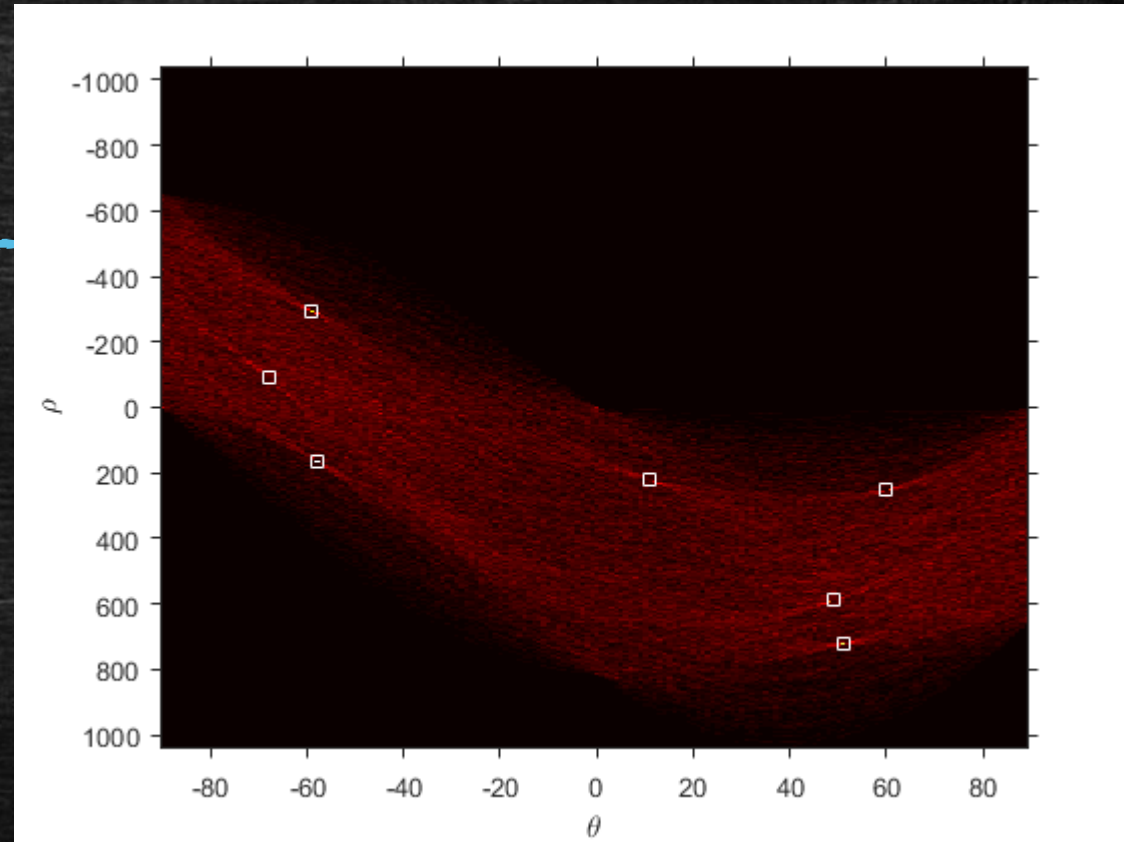
T – array of θ values

R – array of ρ values



MATLAB

```
P = houghpeaks(H,15);  
X = T(P(:,2));  
Y = R(P(:,1));
```



P – $Q \times 2$ matrix, $Q \in \langle 0, numpeaks \rangle$

Holding indices into T and R for the maxima in H

MATLAB

```
lines = houghLines(BW,T,R,P);
```

lines – structure with 4 fields :

point1 – (x,y) start point of the line

point2 – (x,y) end point of the line

theta – corresponding value from T

rho – corresponding value from R

Všeobecná Houghova transformácia

Ľubovoľná analytická krivka v tvare $f(\mathbf{x}, \mathbf{a})=0$

\mathbf{x} – obrazový bod

\mathbf{a} – vektor parametrov

$A(\mathbf{a})$ - parametrický priestor

Pre každý bod (x, y) , zvyšujeme hodnotu akumulátora \mathbf{a} , ktorý spĺňa $f(\mathbf{x}, \mathbf{a})=0$

Maximá v parametrickom priestore určujú krivky v obraze