Képjavítás

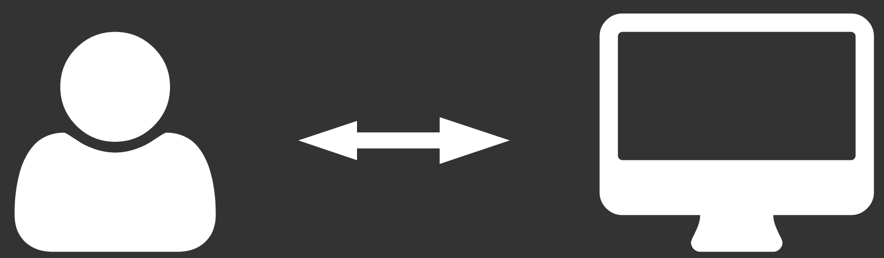
02

Számítógépes látórendszerek

Dr. Vajda Ferenc
Egyetemi docens

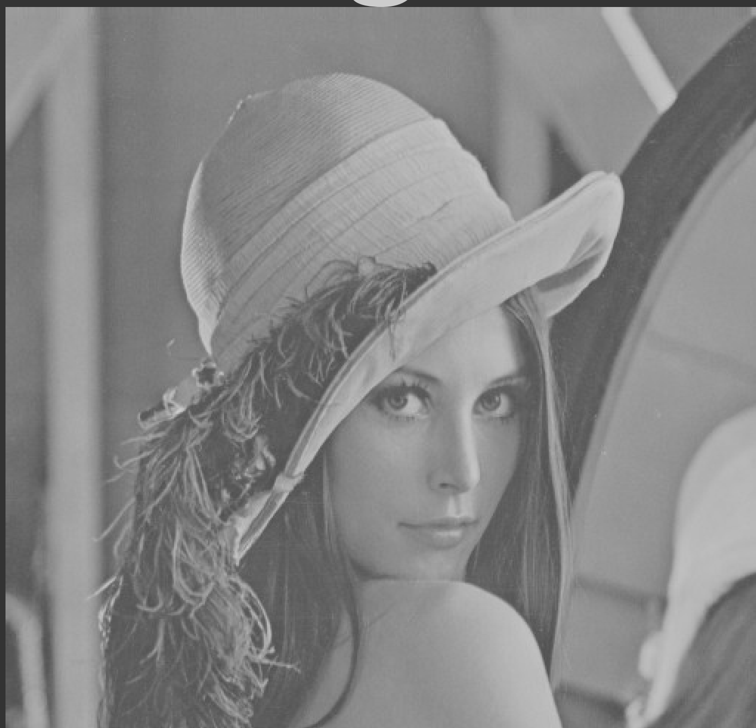
2015

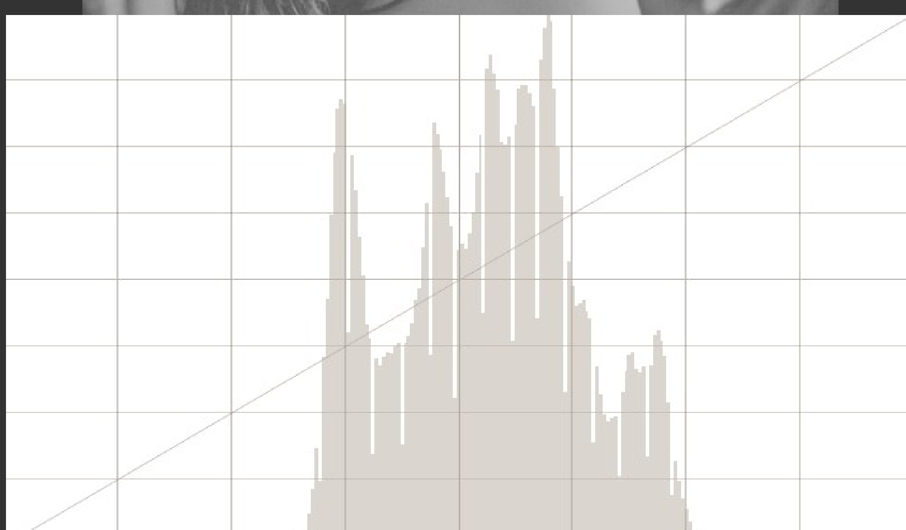
Célok

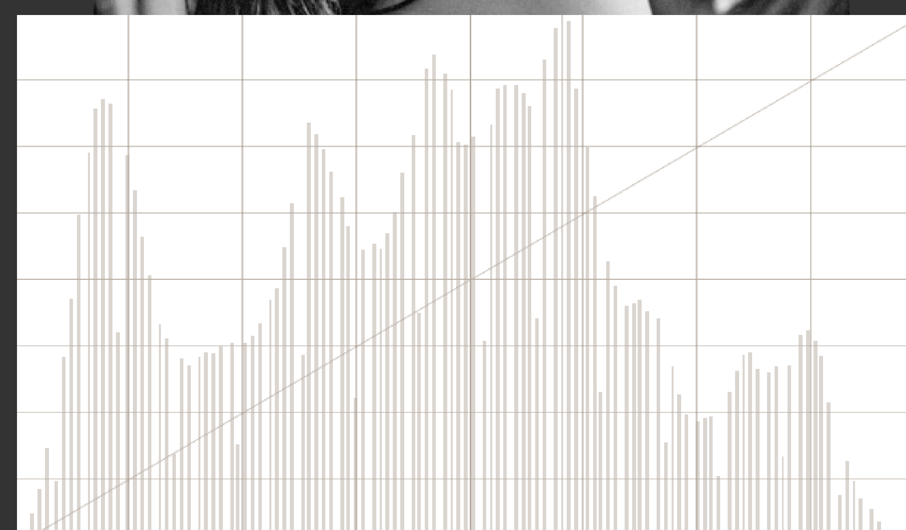


Más jó az ember, és más az algoritmus számára

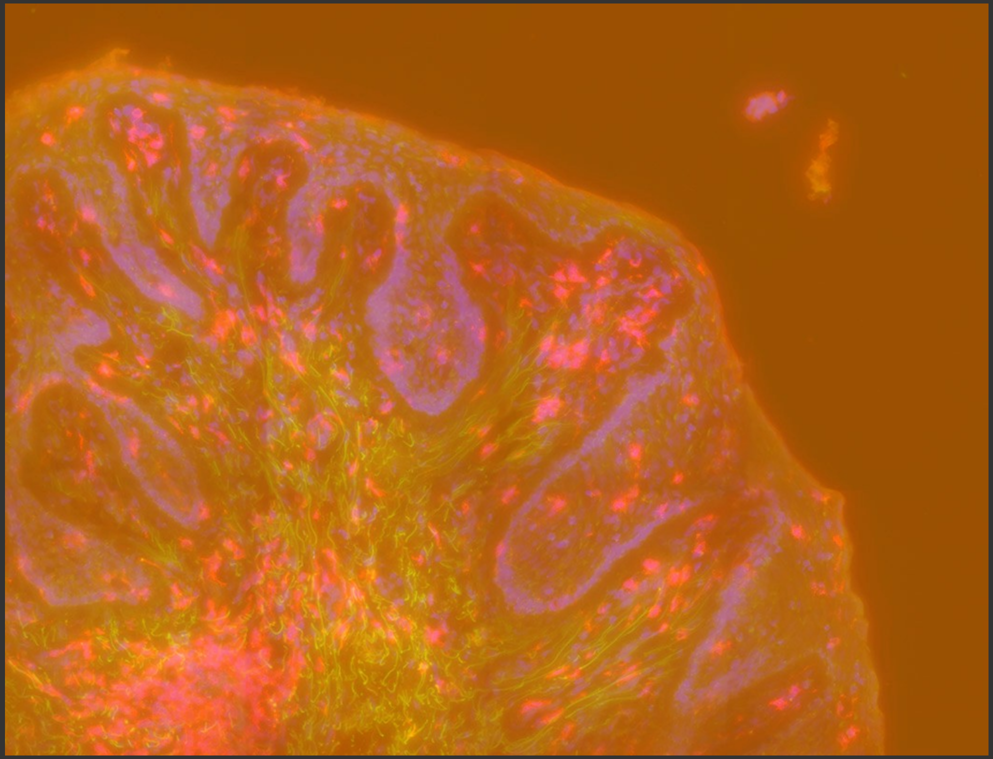
Hisztogramtranszformáció

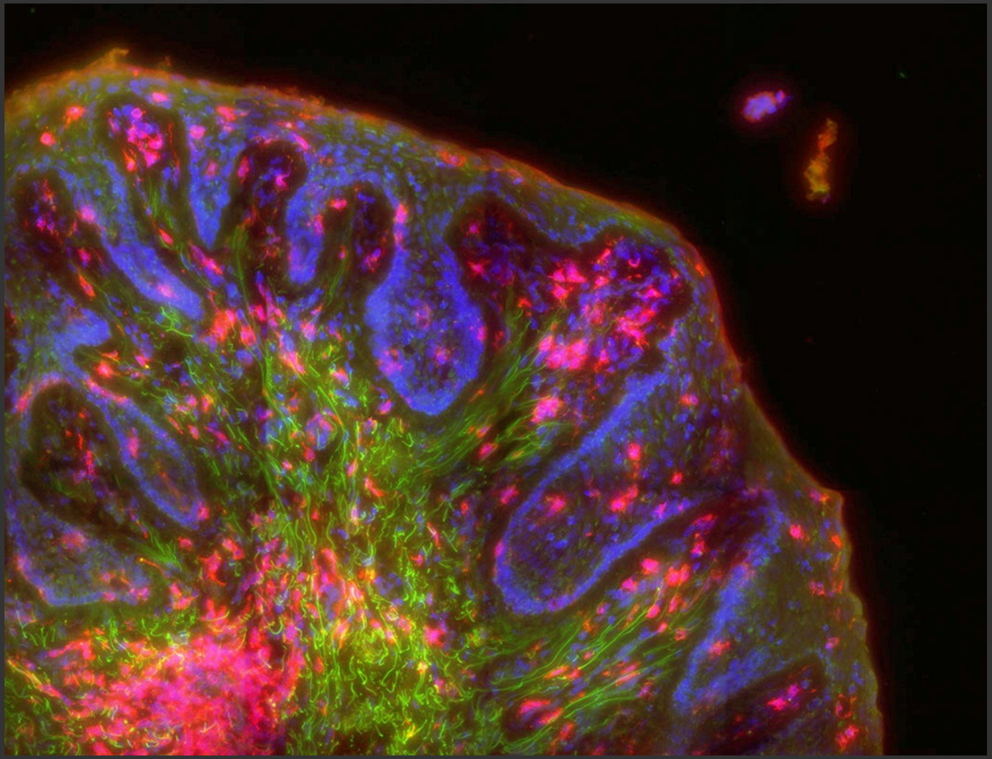






Hisztogramtranszformáció





Képzajok

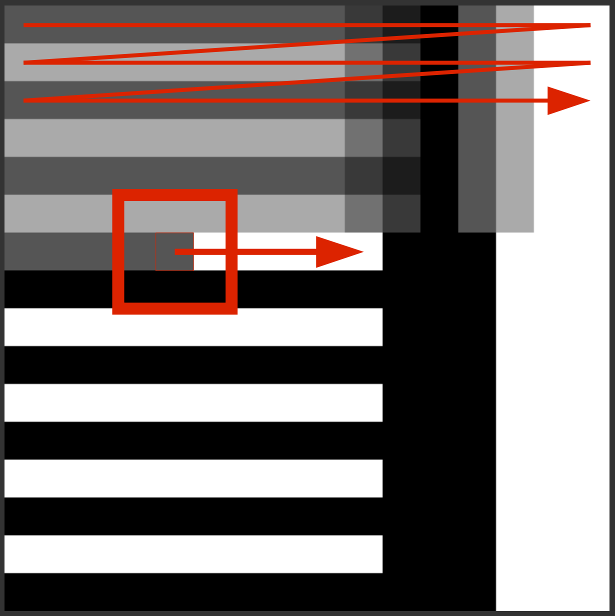
Gauss zaj

Só-bors zaj

Egyszerű átlagolás

$$p'_{x,y}=\frac{\sum_{u=-1}^{1}\sum_{v=-1}^{1} I(x-u,y-v)}{9}$$

$$\begin{bmatrix}1 & 1 & 1\\ 1 & 1 & 1\\ 1 & 1 & 1\end{bmatrix}$$



$$p'_{x,y}=\frac{\sum_{u=-n}^{n}\sum_{v=-n}^{n} I(x-u,y-v)}{(2n+1)^2}$$

$$p'_{x,y}=\frac{\sum_{u=-n}^{n}\sum_{v=-n}^{n} k_{u,v}\cdot I(x-u,y-v)}{\sum_{u=-n}^{n}\sum_{v=-n}^{n} k_{u,v}}$$

$$\begin{bmatrix}1 & 2 & 1\\ 2 & 4 & 2\\ 1 & 2 & 1\end{bmatrix}$$

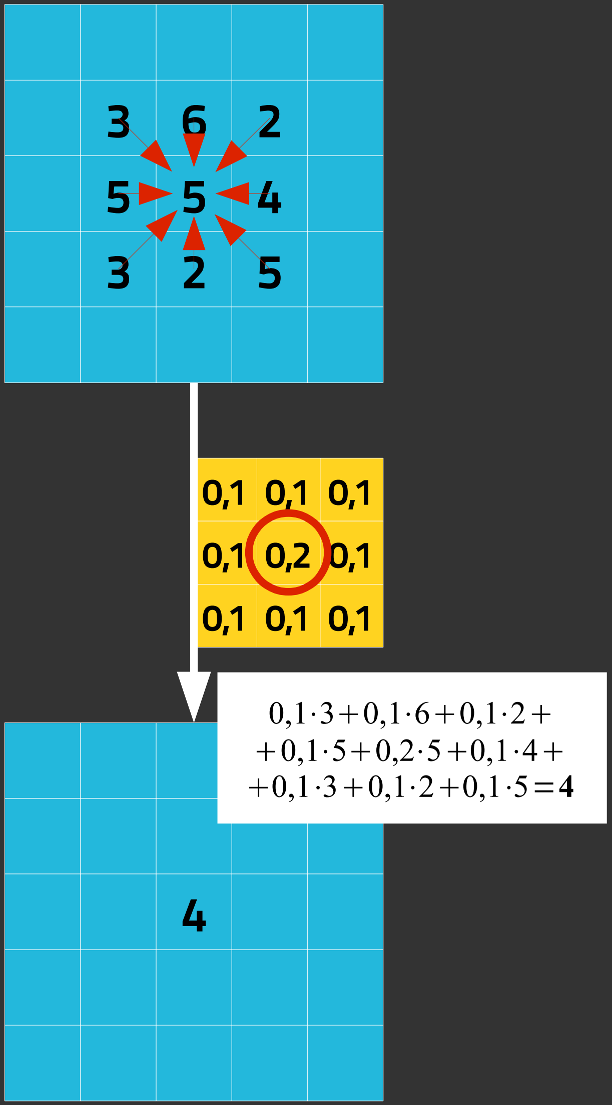
FPGA!

Konvolúció

$$I_o = k * I_i$$

$$(k*I)(x,y) = \sum_{u=-n}^{n} \sum_{v=-n}^{n} k(u,v) \cdot I(x-u, y-v)$$

$$(f*g)(x,y) = \sum_{u=-\infty}^{\infty} \sum_{v=-\infty}^{\infty} f(u,v) \cdot g(x-u, y-v)$$

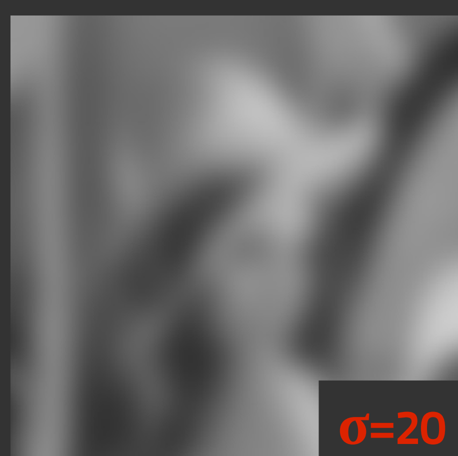


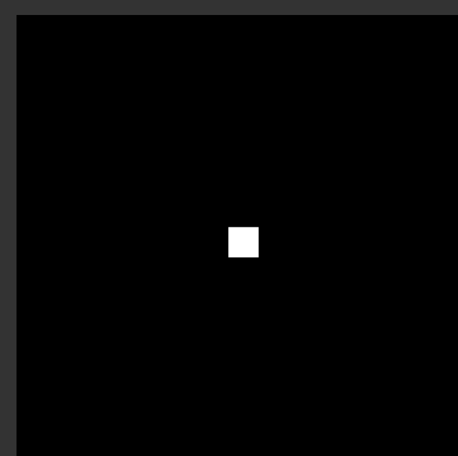
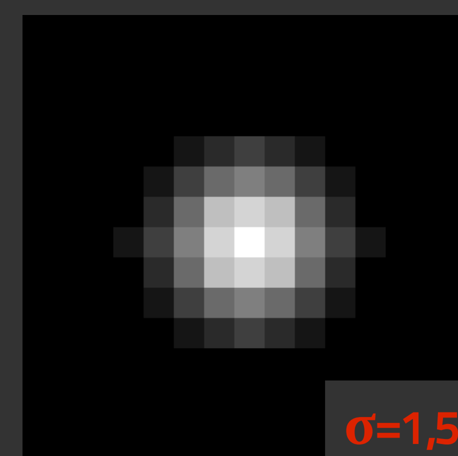
Gauss szűrés

$$k(x, y, \sigma) = \frac{1}{2\pi\sigma^2} e^{-\left(\frac{x^2+y^2}{2\sigma^2}\right)}$$

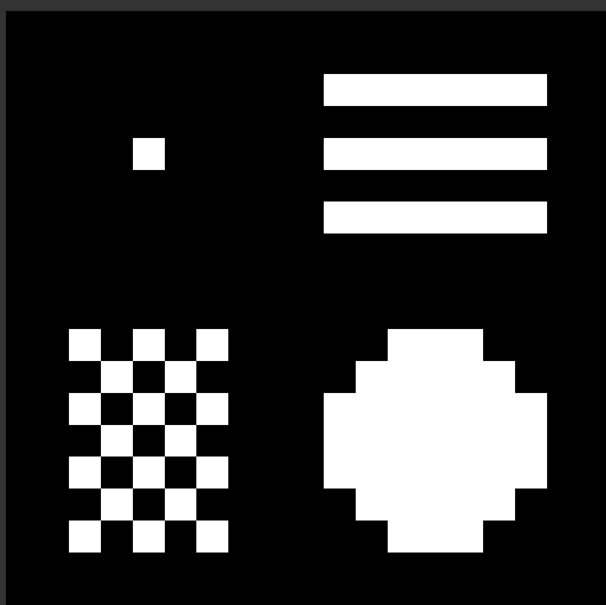
$$\begin{bmatrix} 1 & 4 & 1 \\ 4 & 16 & 4 \\ 1 & 4 & 1 \end{bmatrix}$$

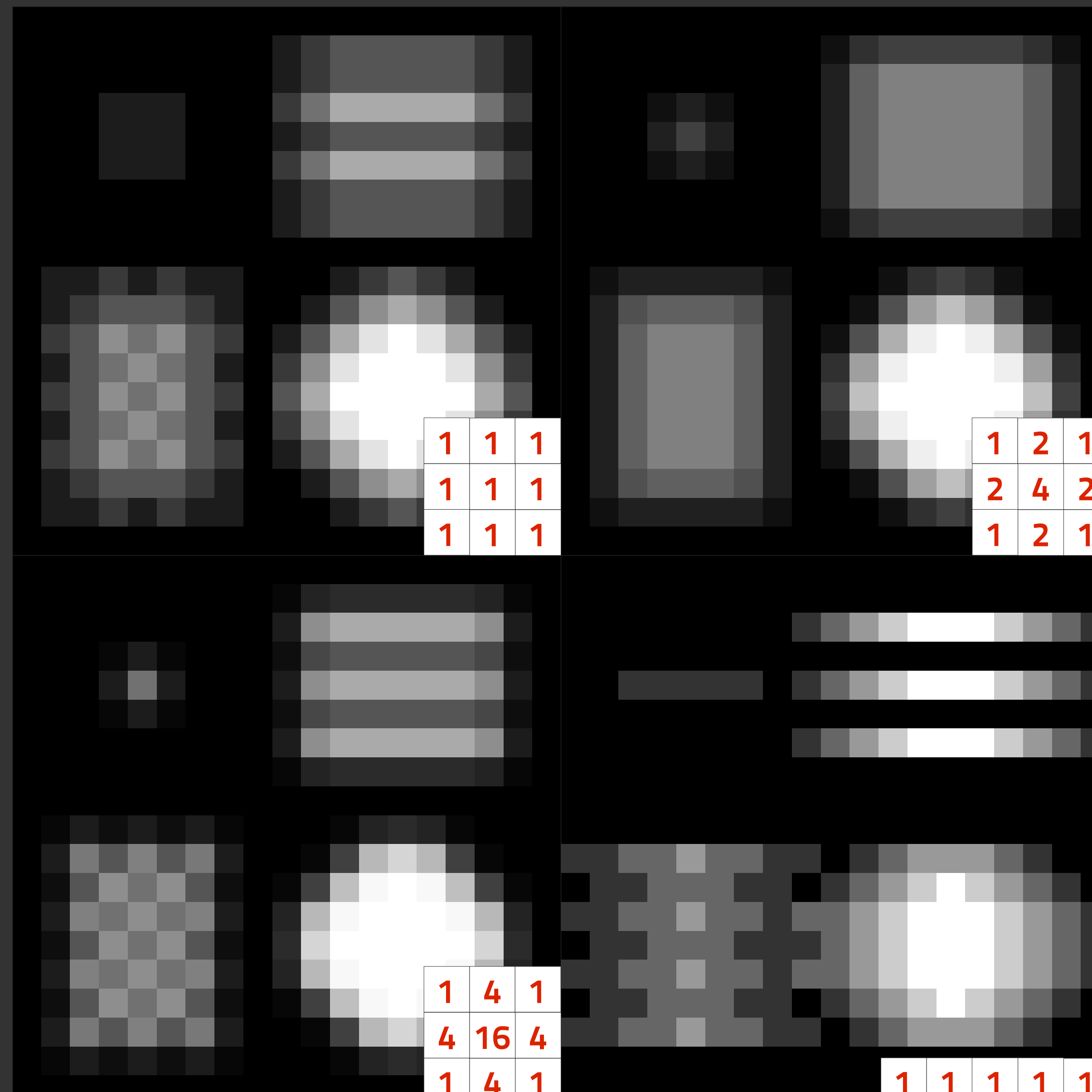
Kernelméret: 3σ

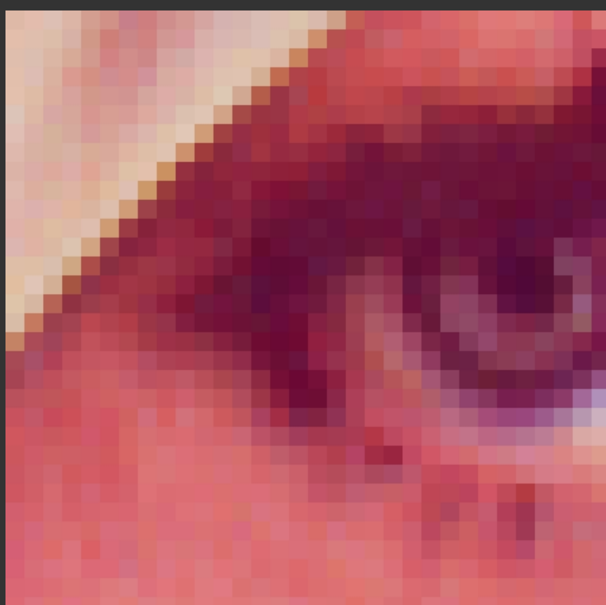



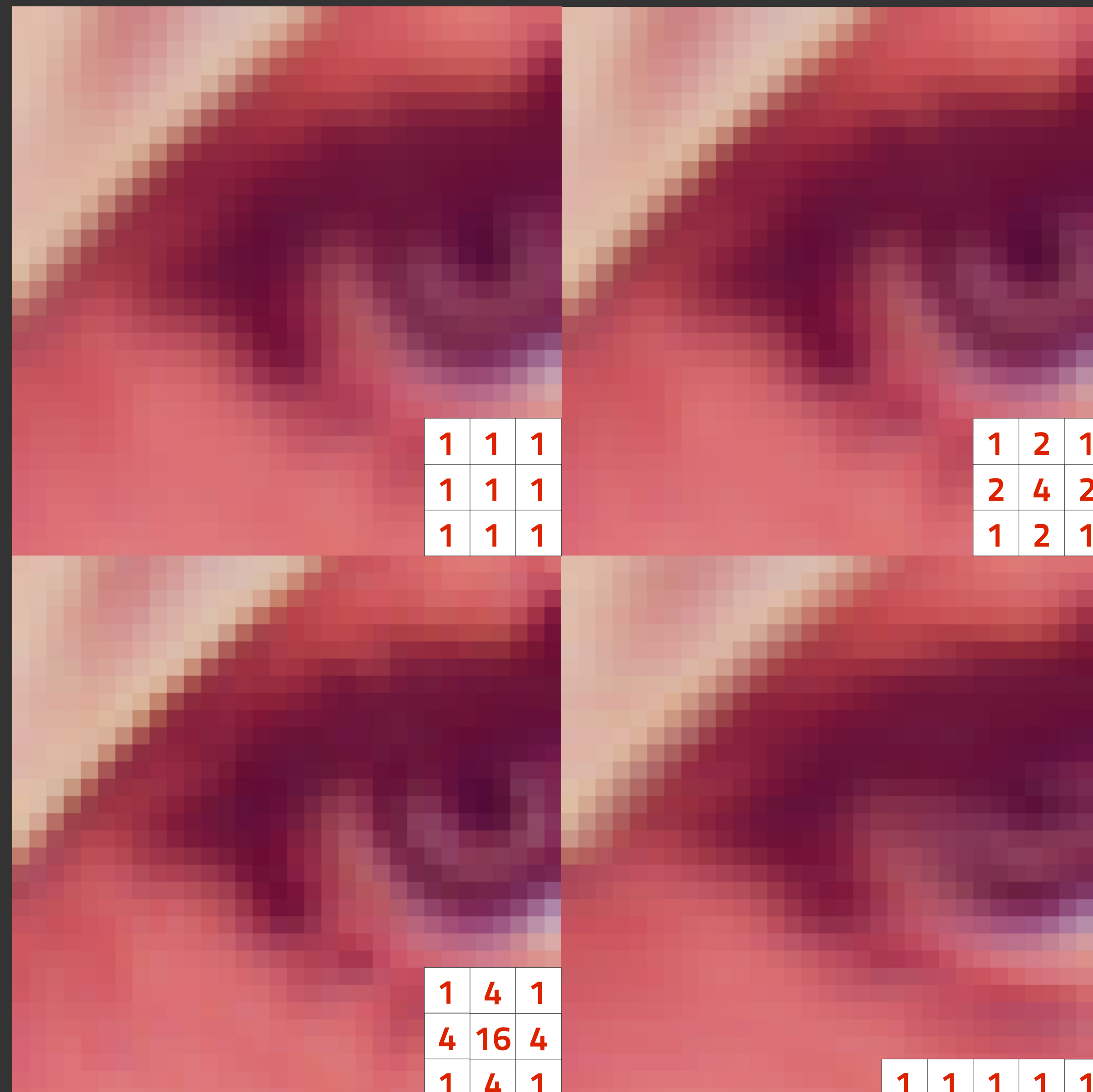
Simító szűrők



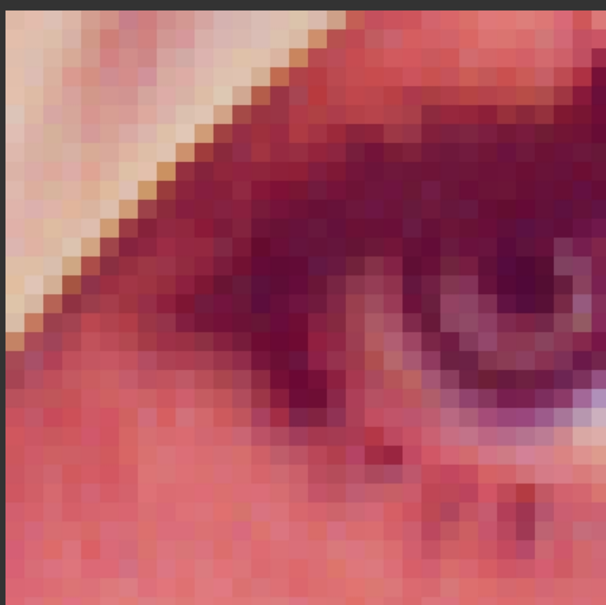


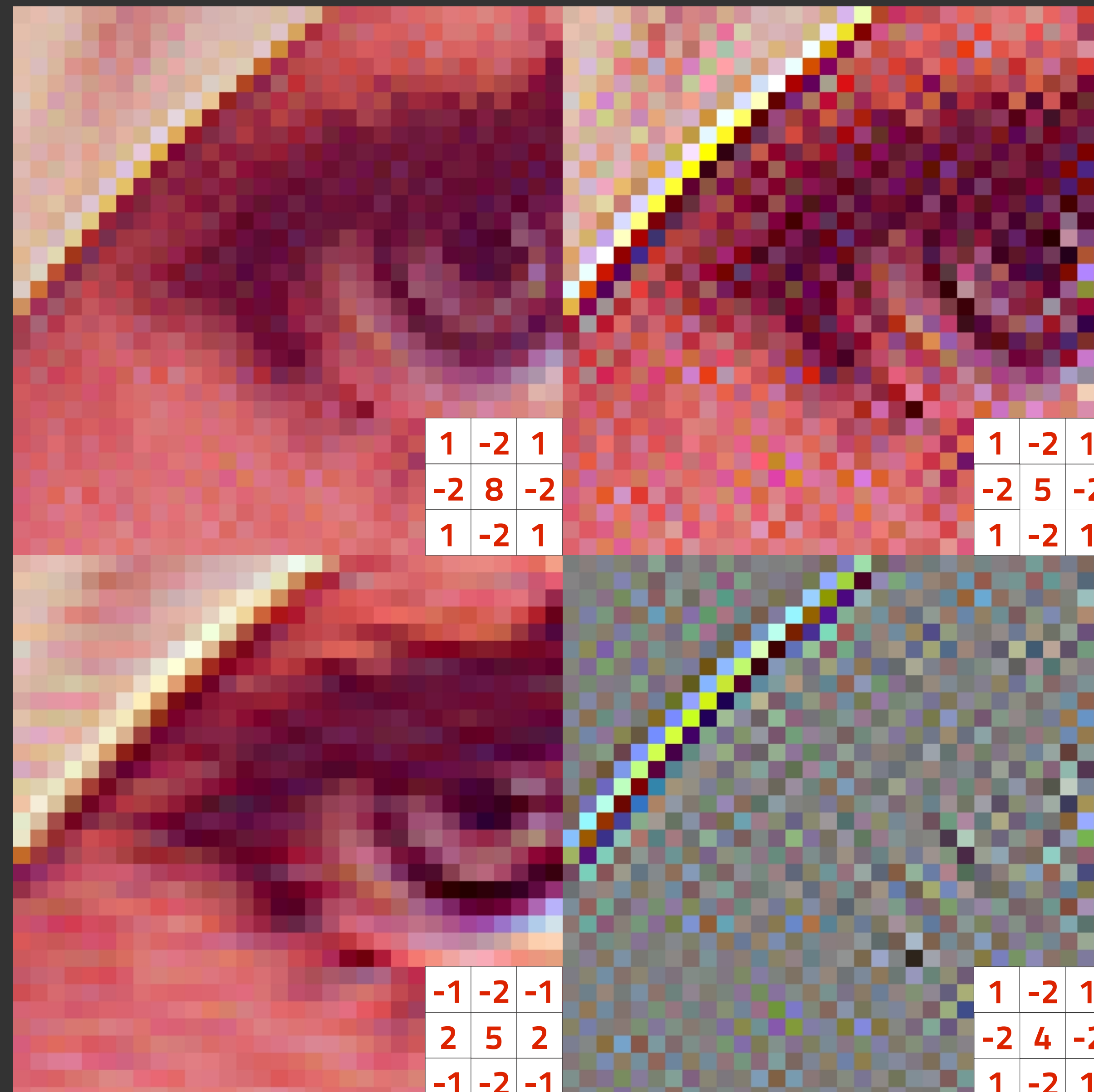
Simító szűrők



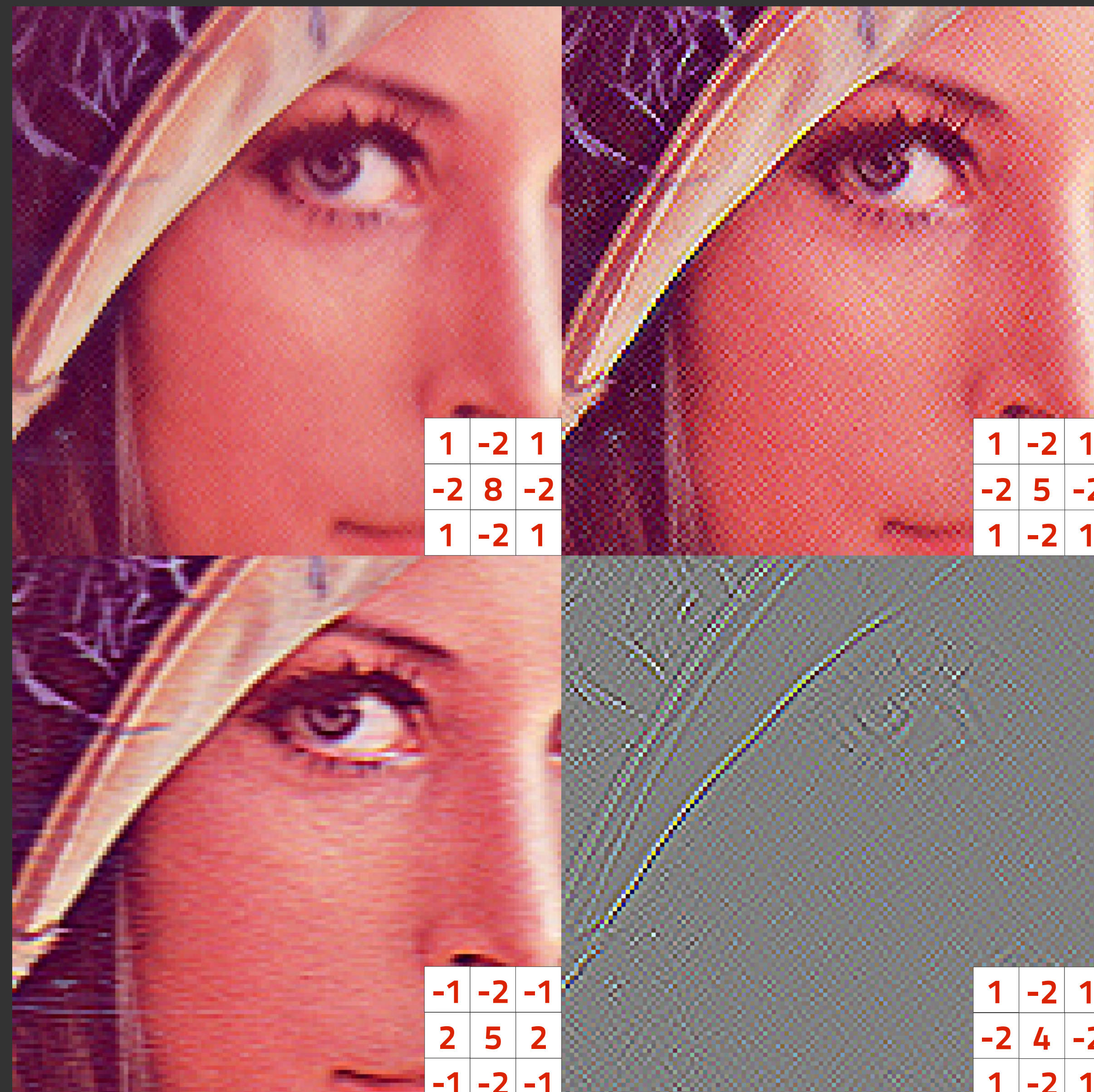


Élesítő szűrők

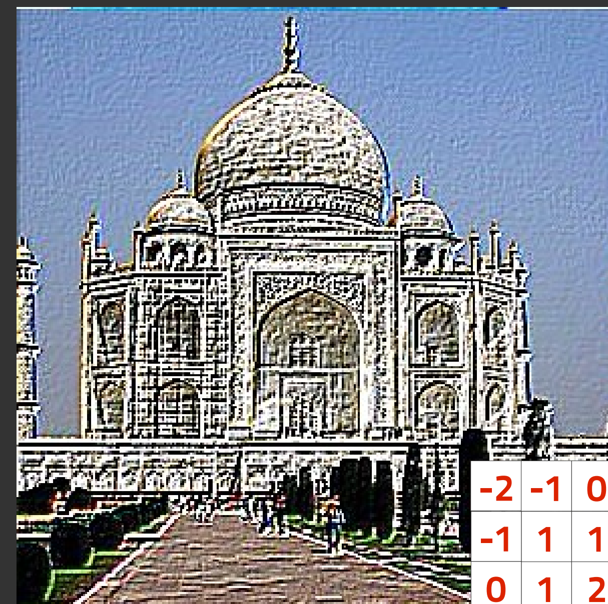


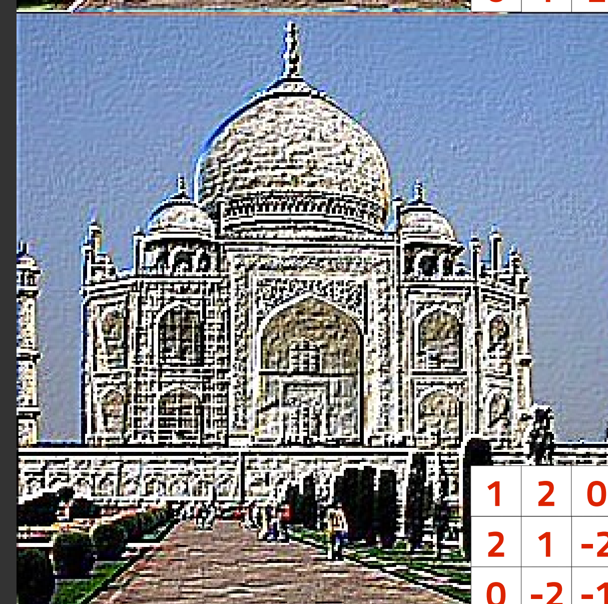


Élesítő szűrők



Térbeli kiemelés





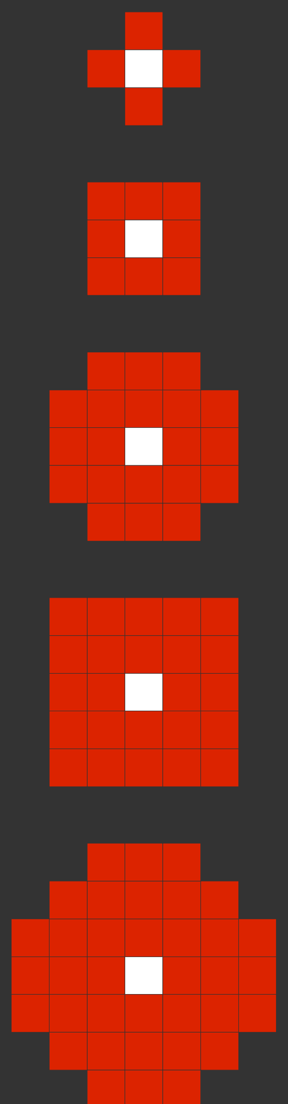
Rank szűrők

k-adik szomszéd

Minimum szűrő (**k=1**)

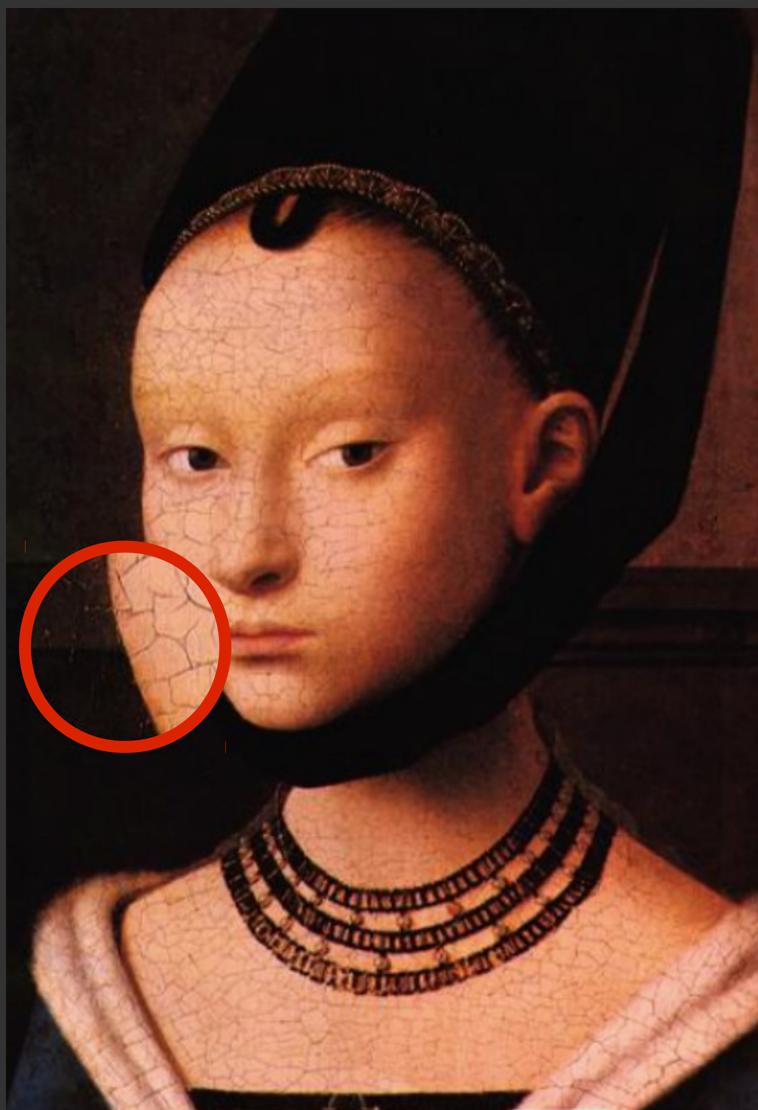
Maximum szűrő (**k=n**)

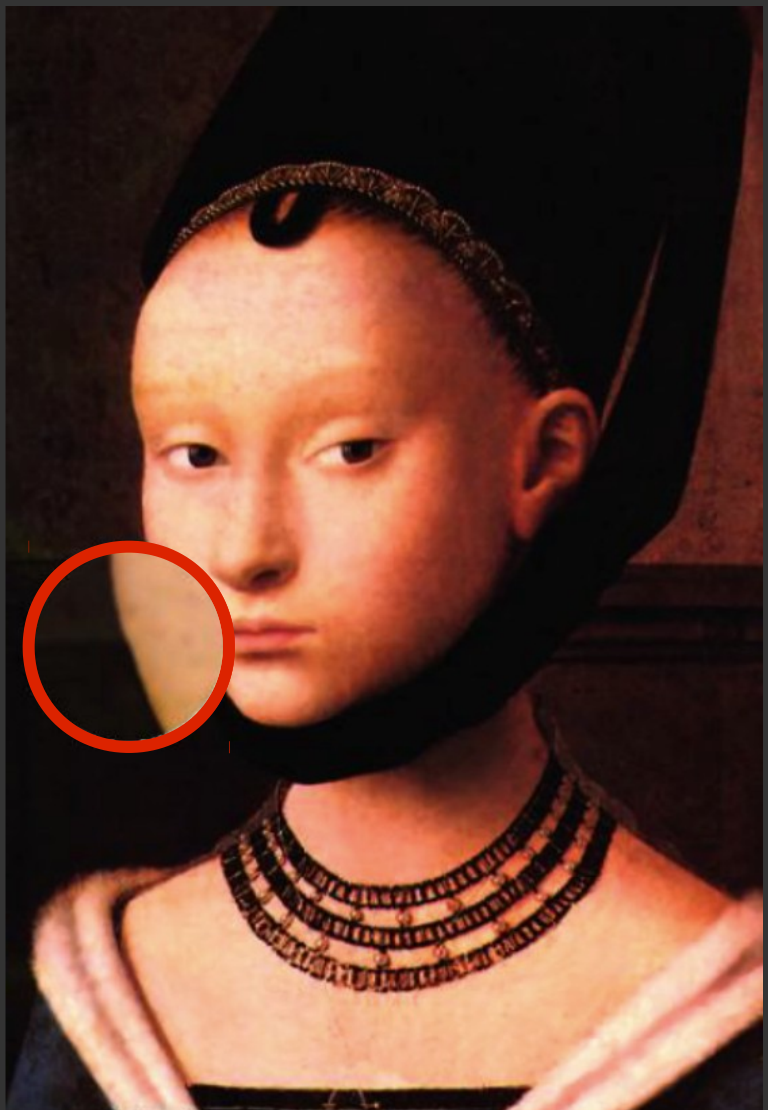
Median szűrő (**k=n/2**)



Median

Median





Egyéb

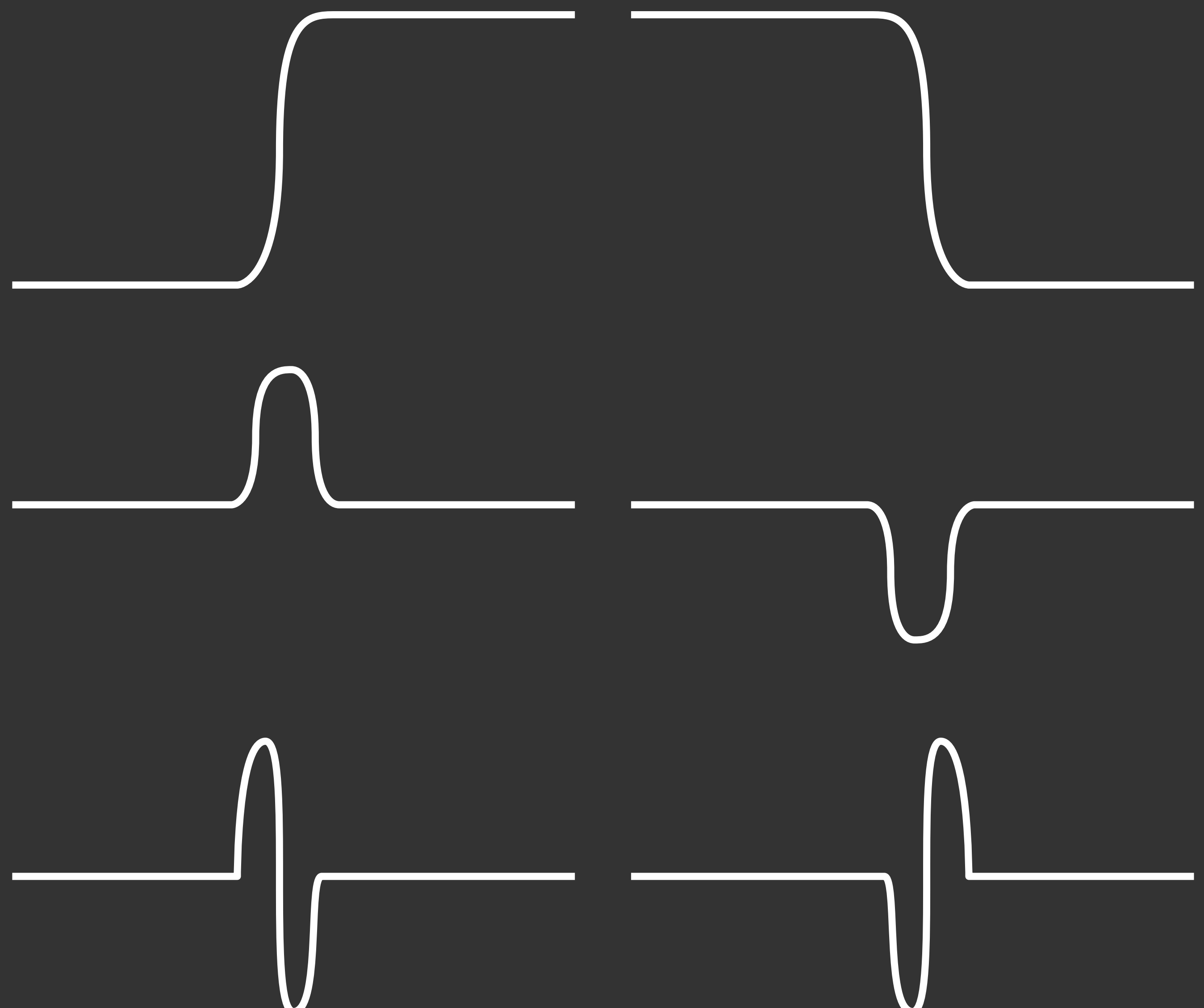
Olimpiai szűrő

Szűrés színtartományban

Kalap-szűrő

Gaussok különbsége (DoG)

Élkeresés deriváltakkal



-1	0	1

-1		
	0	
		1

-1	2	-1

-1		
	2	
		-1

Élkeresés deriváltakkal

1	0	-1
1	0	-1
1	0	-1

1	0	-1
2	0	-2
1	0	-1

1	-1	-1
2	1	-1
1	-1	-1

5	-3	-3
5	0	-3
5	-3	-3

1	1	0
1	0	-1
0	-1	-1

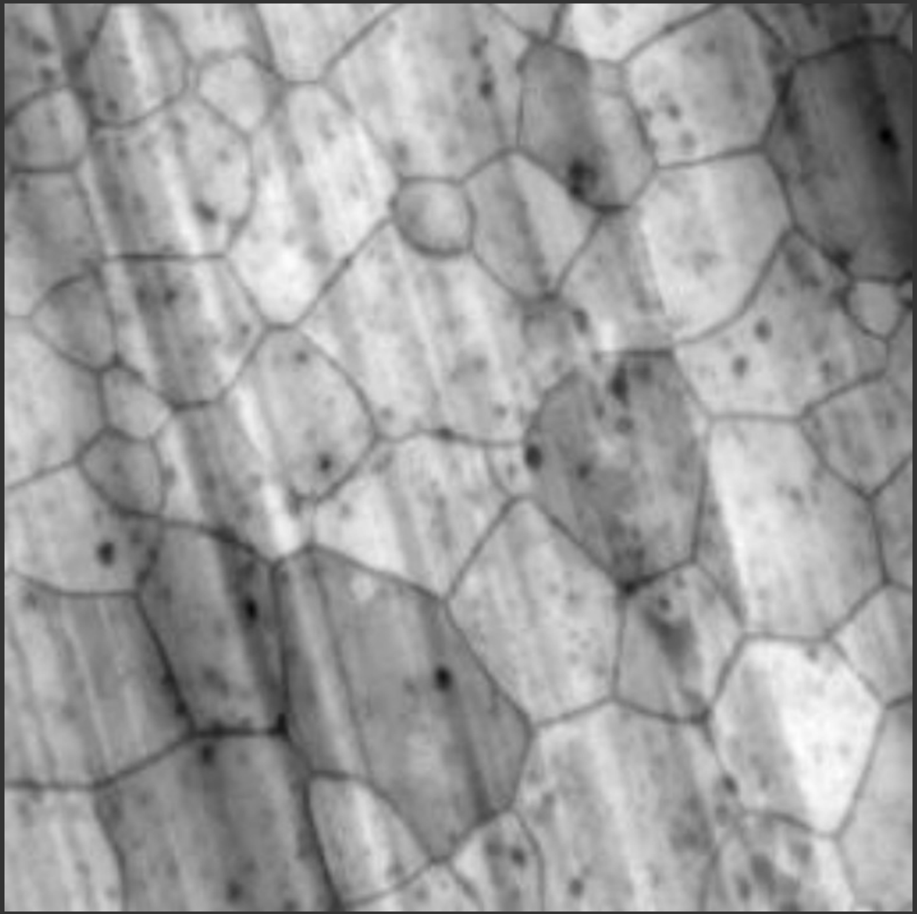
2	1	0
1	0	-1
0	-1	-2

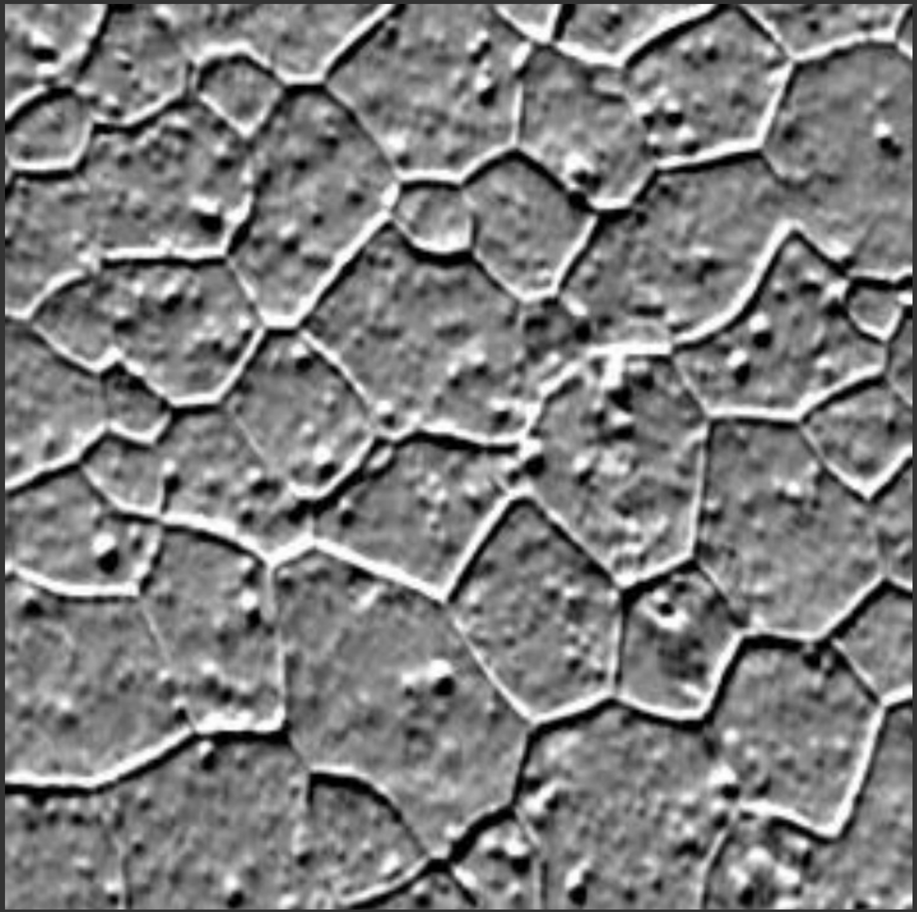
2	1	-1
1	1	-1
-1	-1	-1

5	5	-3
5	0	-3
-3	-3	-3

...

Derivatív szűrő

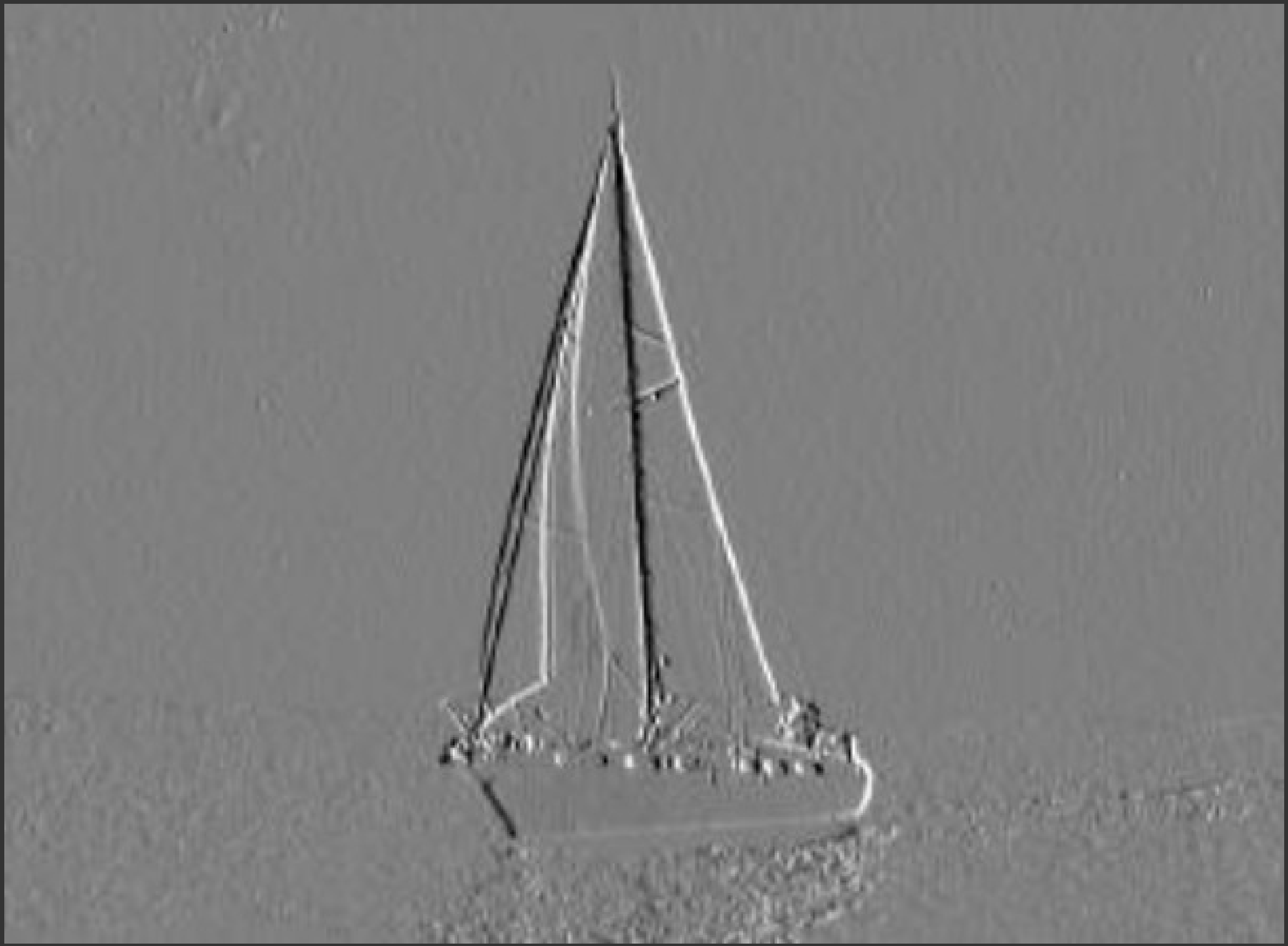




Összetett példa (Sobel)

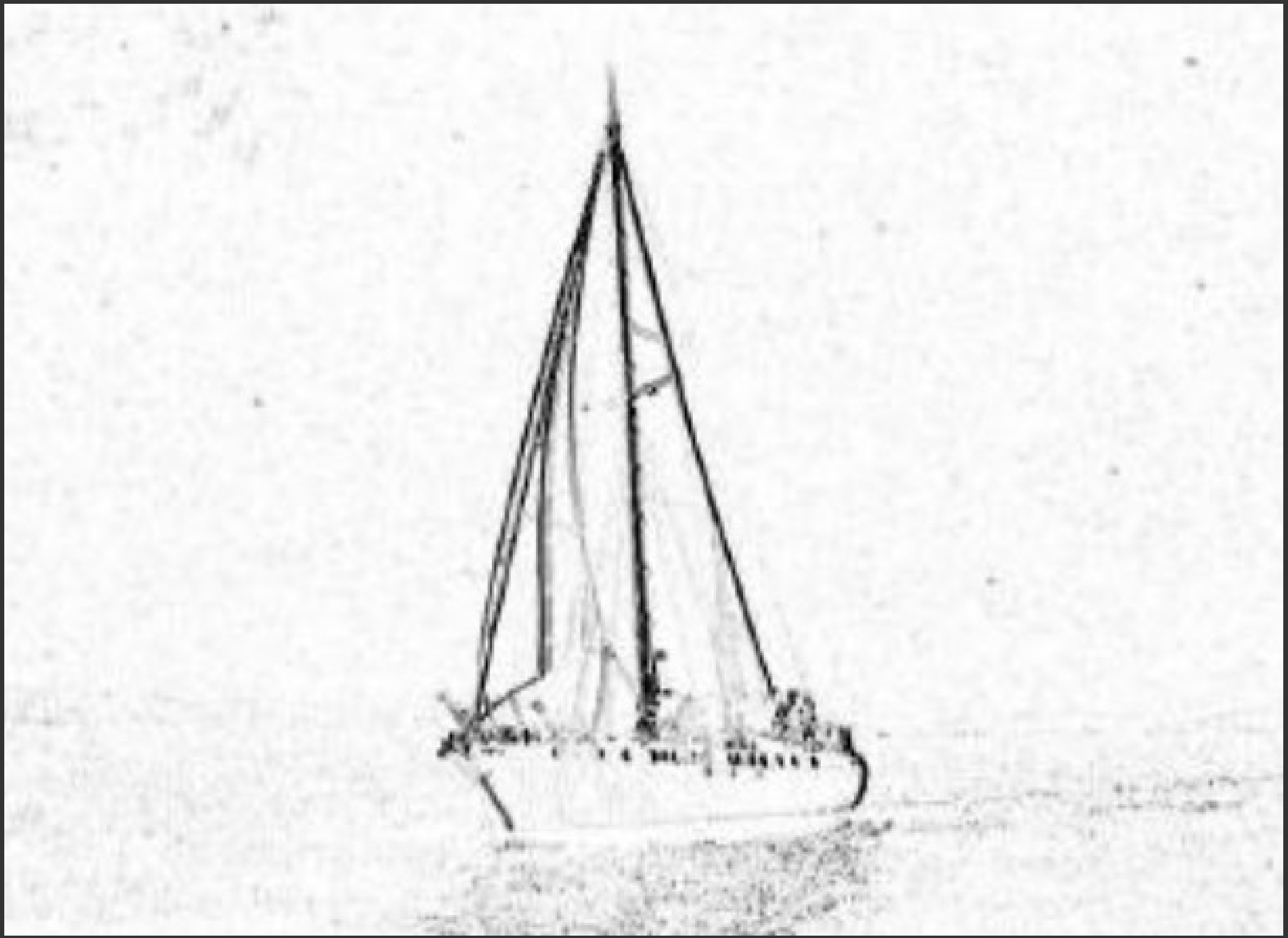
Kiinduló kép

Összetett példa (Sobel)



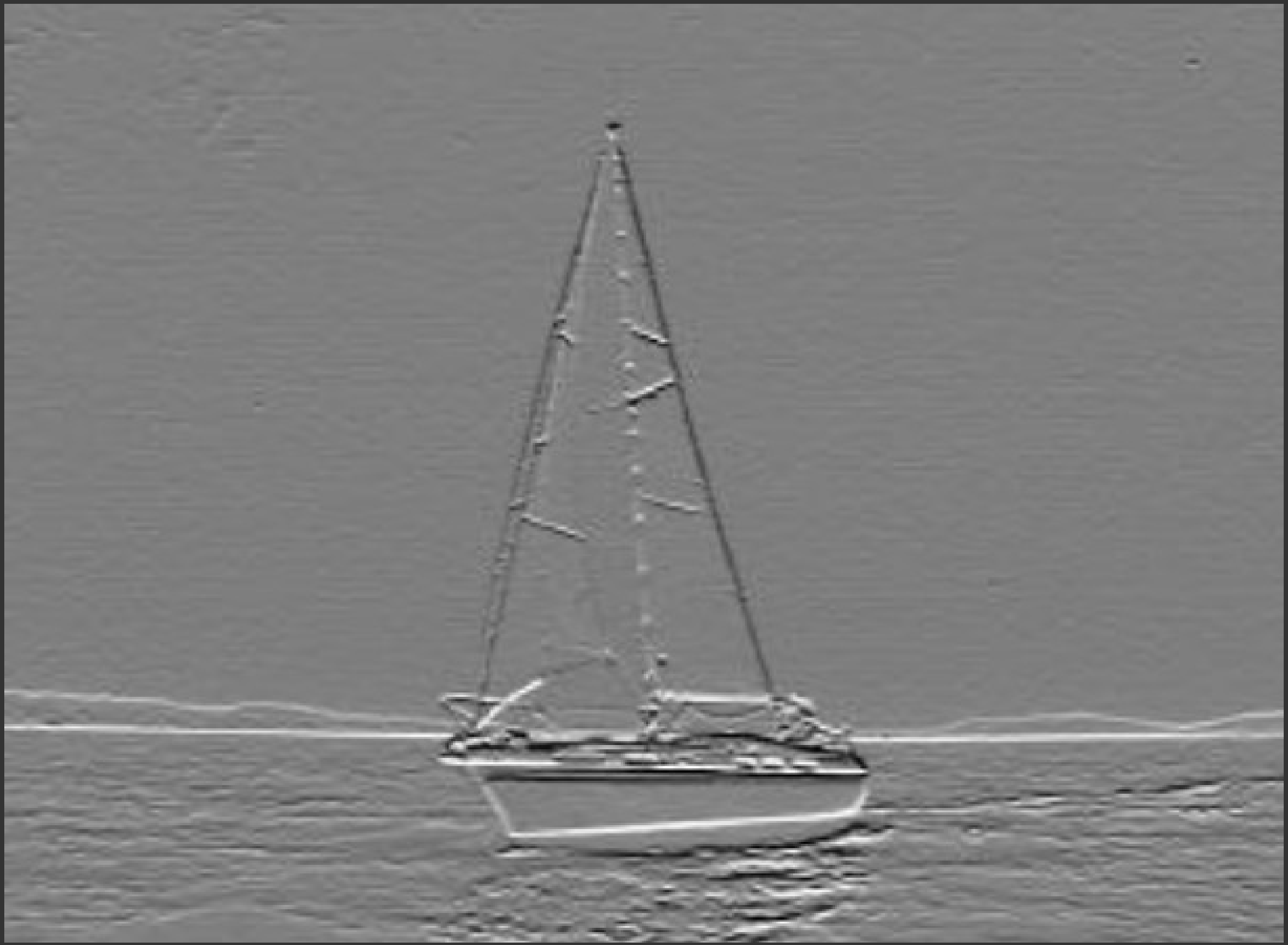
Horizontális derivált

Összetett példa (Sobel)



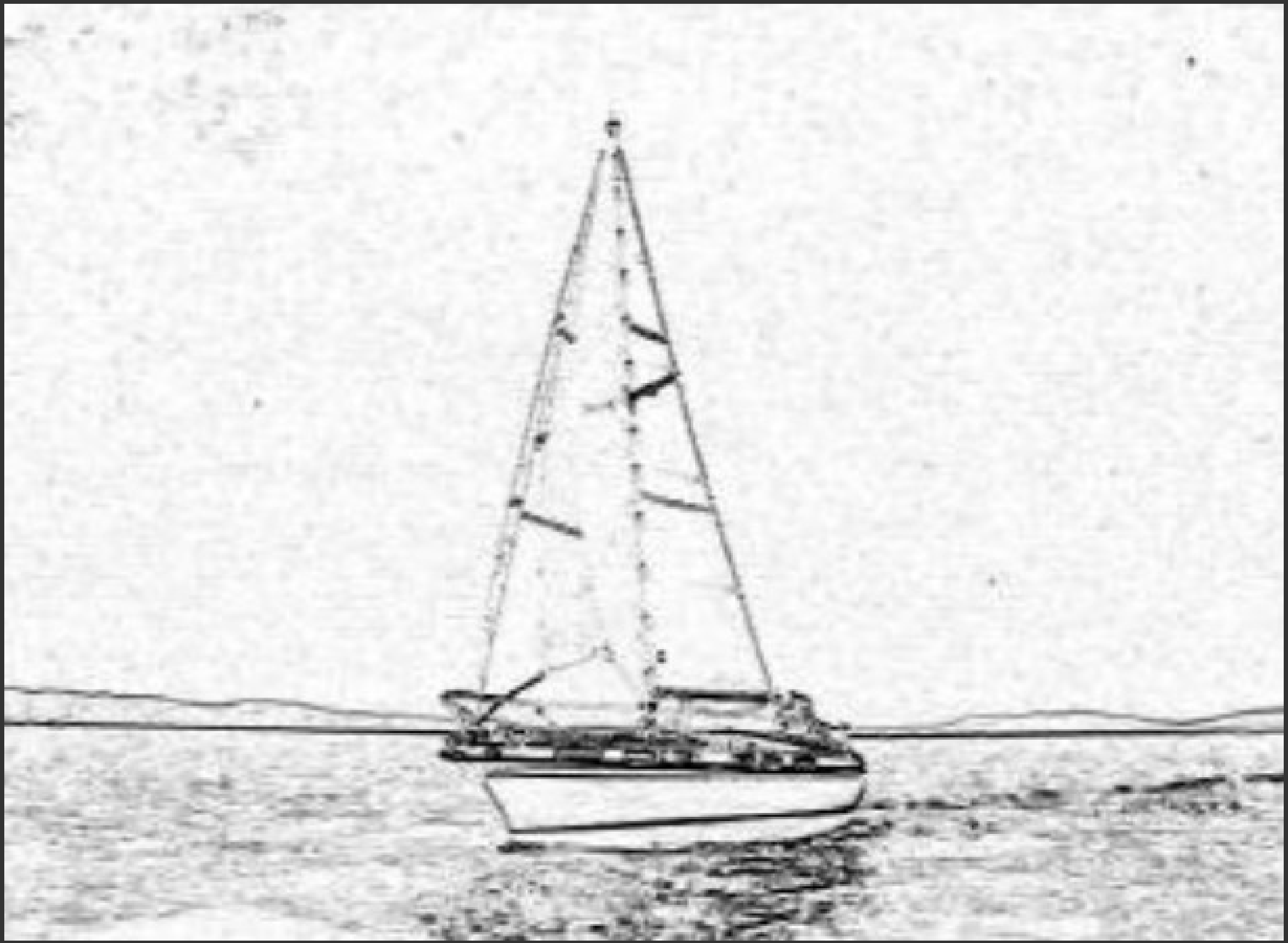
Horizontális derivált abszolút értéke

Összetett példa (Sobel)



Vertikális derivált

Összetett példa (Sobel)

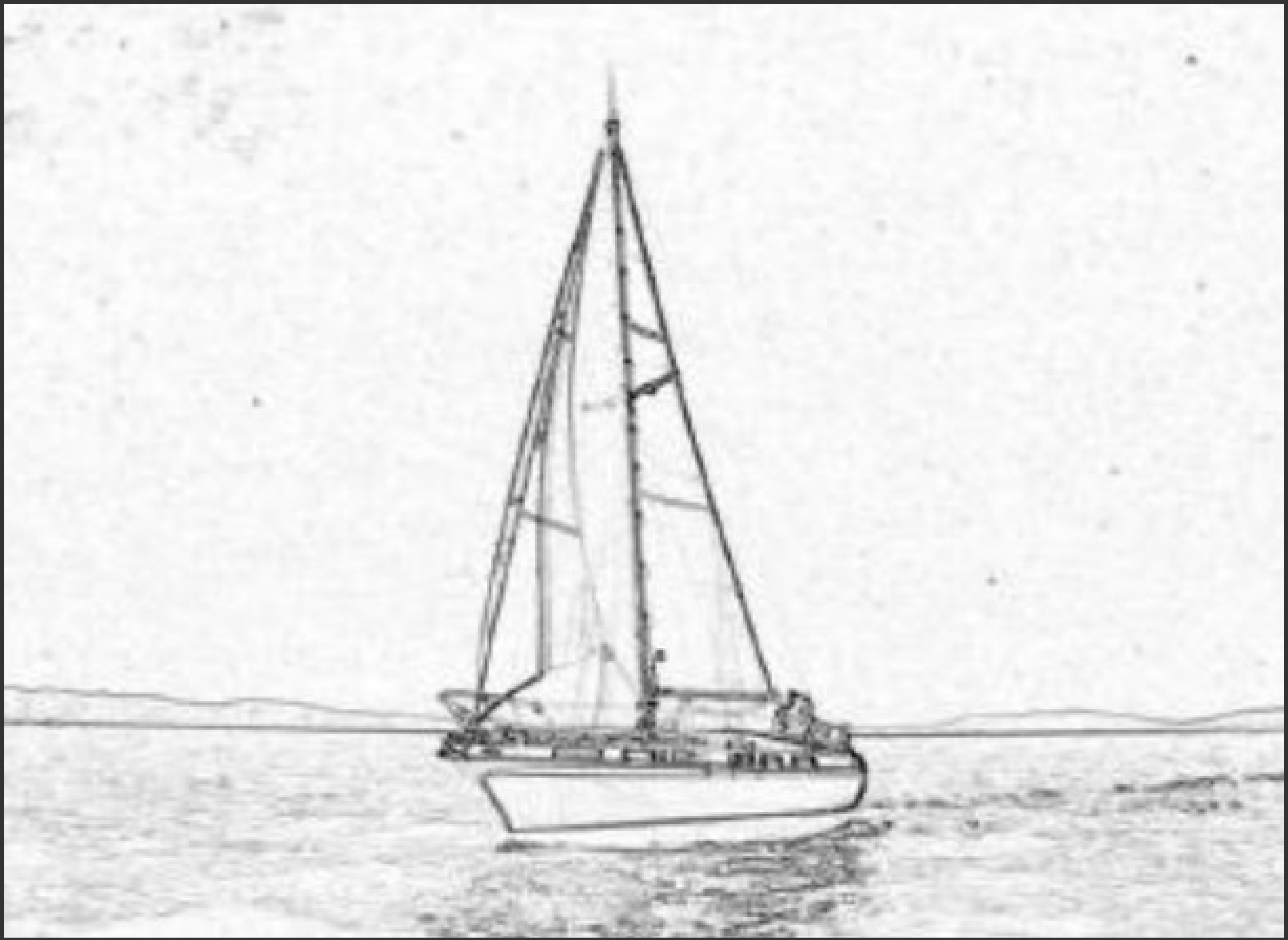


Vertikális derivált abszolút értéke

Összetett példa (Sobel)

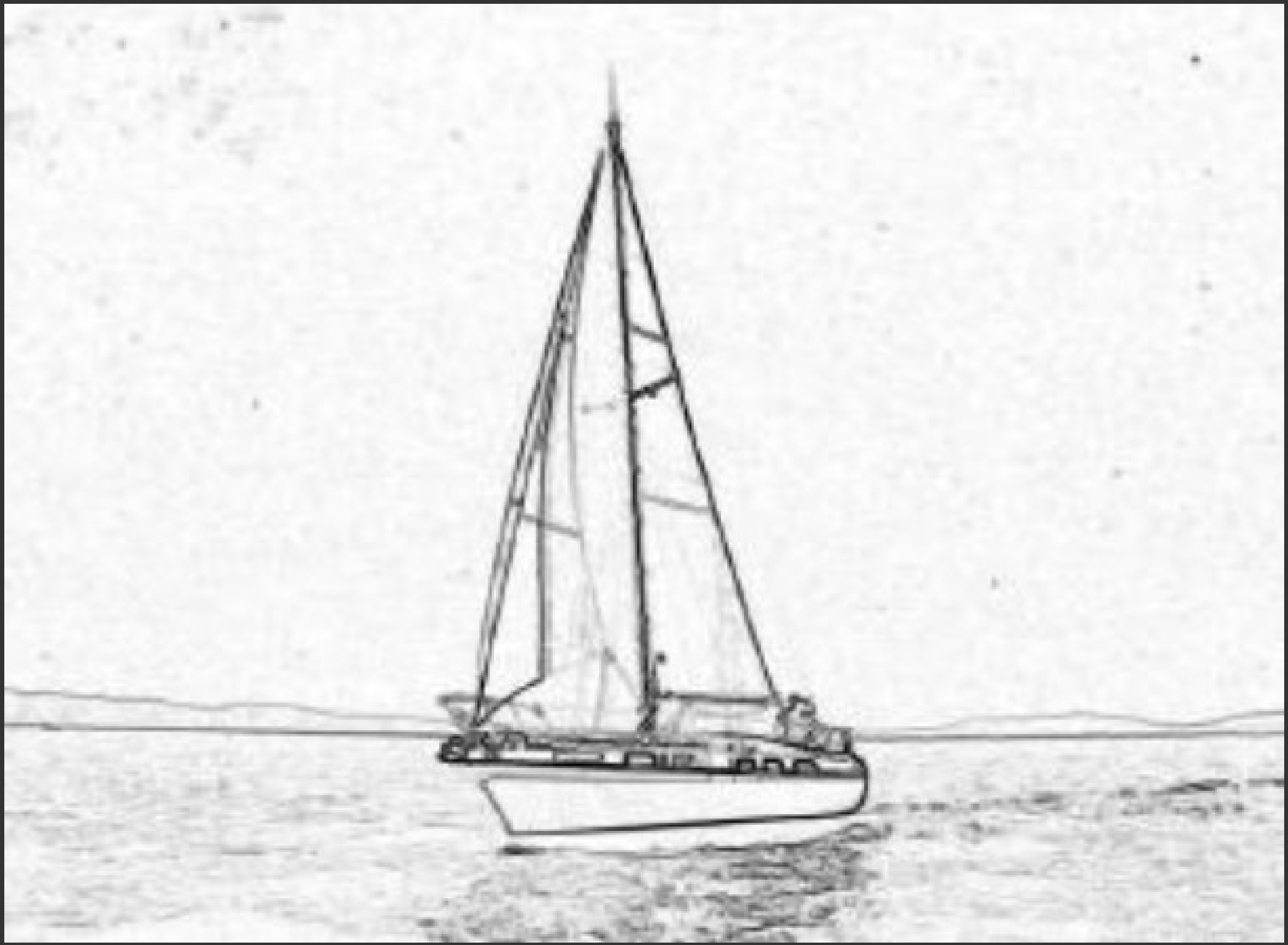
Derivált abszolút értékek maximuma

Összetett példa (Sobel)



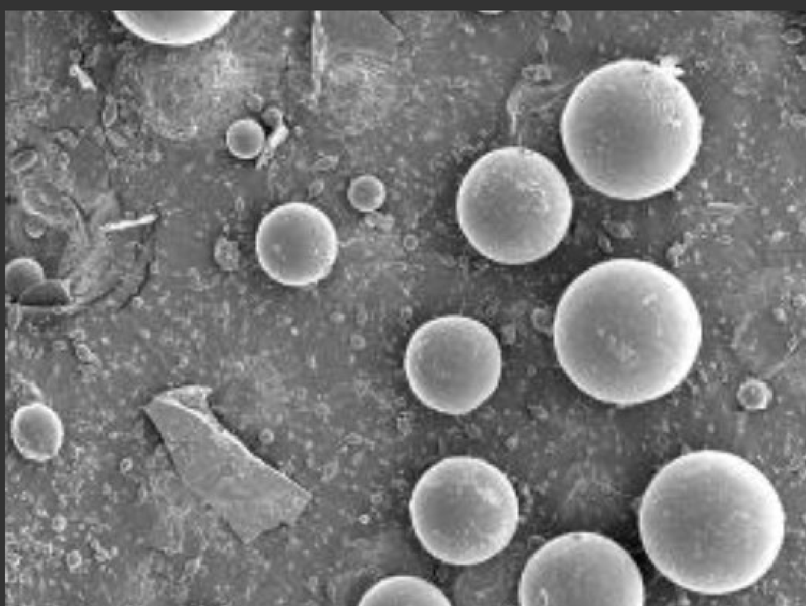
Derivált abszolút értékek összege

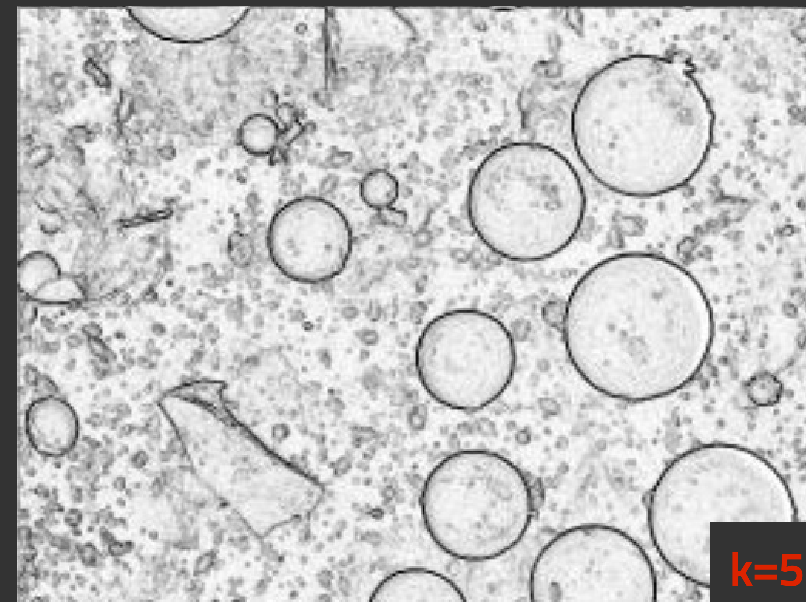
Összetett példa (Sobel)

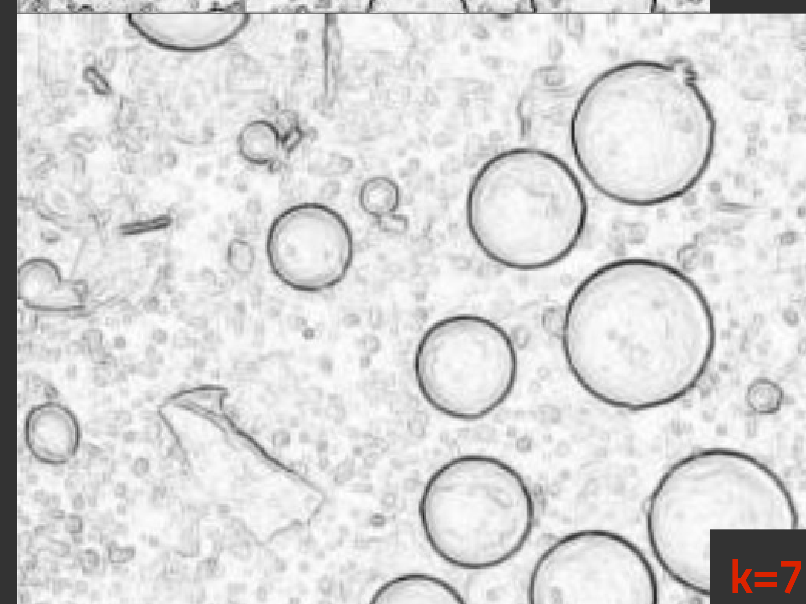


Derivált abszolút értékek négyzetre emelése, összeadása, majd gyökvonás

Kernel méret







Frei & Chen

1	1	1
1	1	1
1	1	1

-1	-√2	-1
0	0	0
1	√2	1

-1	0	1
-√2	0	√2
-1	0	1

0	-1	√2
1	0	-1
-√2	1	0

√2	-1	0
-1	0	1
0	1	-√2

0	1	0
-1	0	1
0	-1	0

-1	0	1
0	0	0
1	0	-1

1	-2	1
-2	4	-2
1	-2	1

-2	1	-2
1	4	1
-2	1	-2

$$I' = \cos\sqrt{\sum_{i=0}^{8} k_i * I}$$

Canny éldetektor

- Gauss szűrés
- Derivatív szűrés két/négy irányban
- Nem-maximumok törlése (gradiens irányban)
- Küszöbözés: erős élek, gyenge élek

Canny éldetektor

Perspektív torzítás

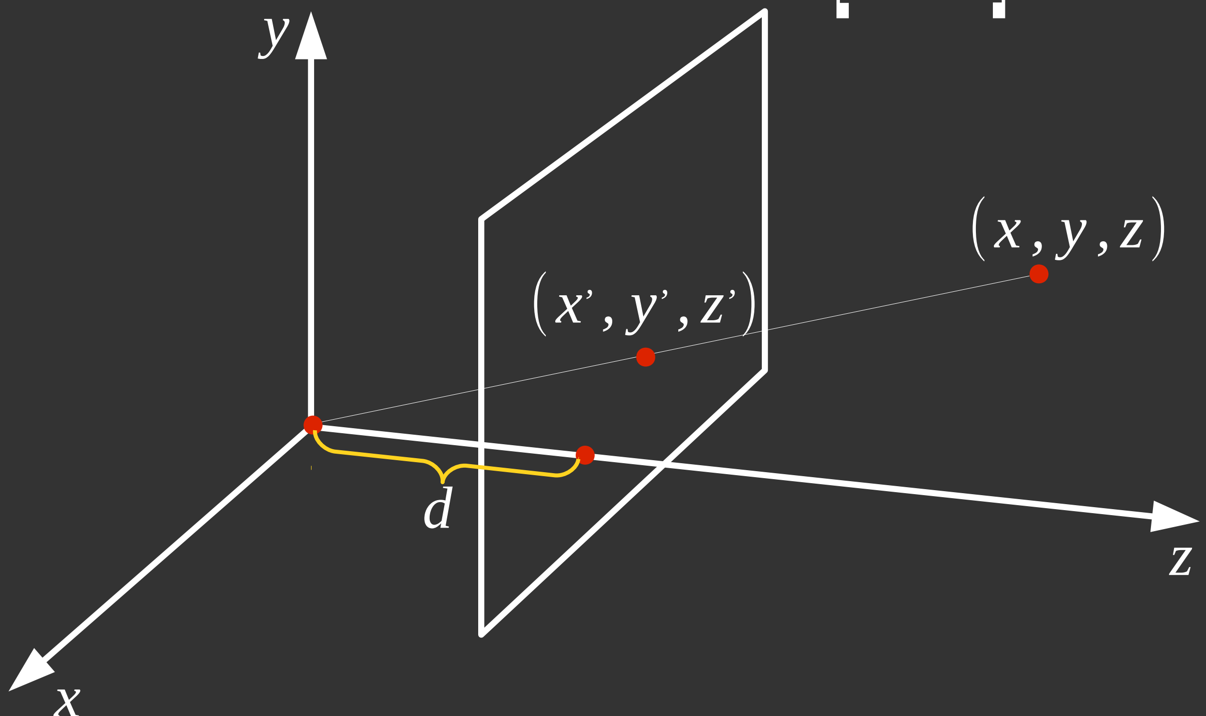
Perspektív torzítás

Perspektív torzítás

Perspektív transzformáció

$$\begin{bmatrix} x' \\ y' \\ z' \\ 1 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & t_x \\ a_{21} & a_{22} & a_{23} & t_y \\ a_{31} & a_{32} & a_{33} & t_z \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} x' \cdot w \\ y' \cdot w \\ z' \cdot w \\ w \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/f & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$



Síkbeli perspektíva

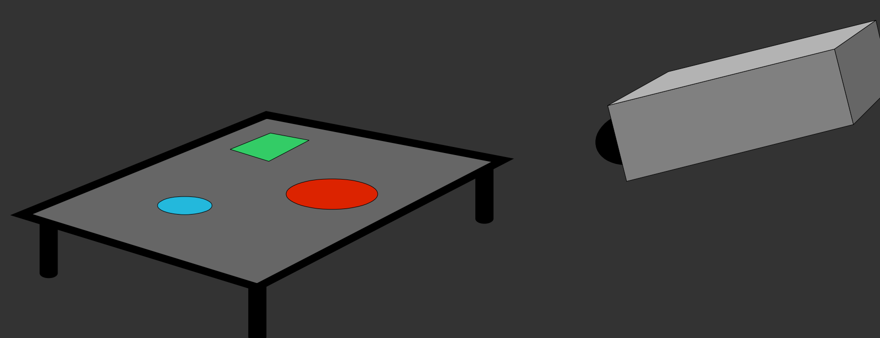
$$\begin{bmatrix} x\cdot w \\ y\cdot w \\ w \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & 1 \end{bmatrix} \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}$$

$$x = \frac{a_{11}\cdot u + a_{12}\cdot v + a_{13}}{a_{31}\cdot u + a_{32}\cdot v + 1}$$

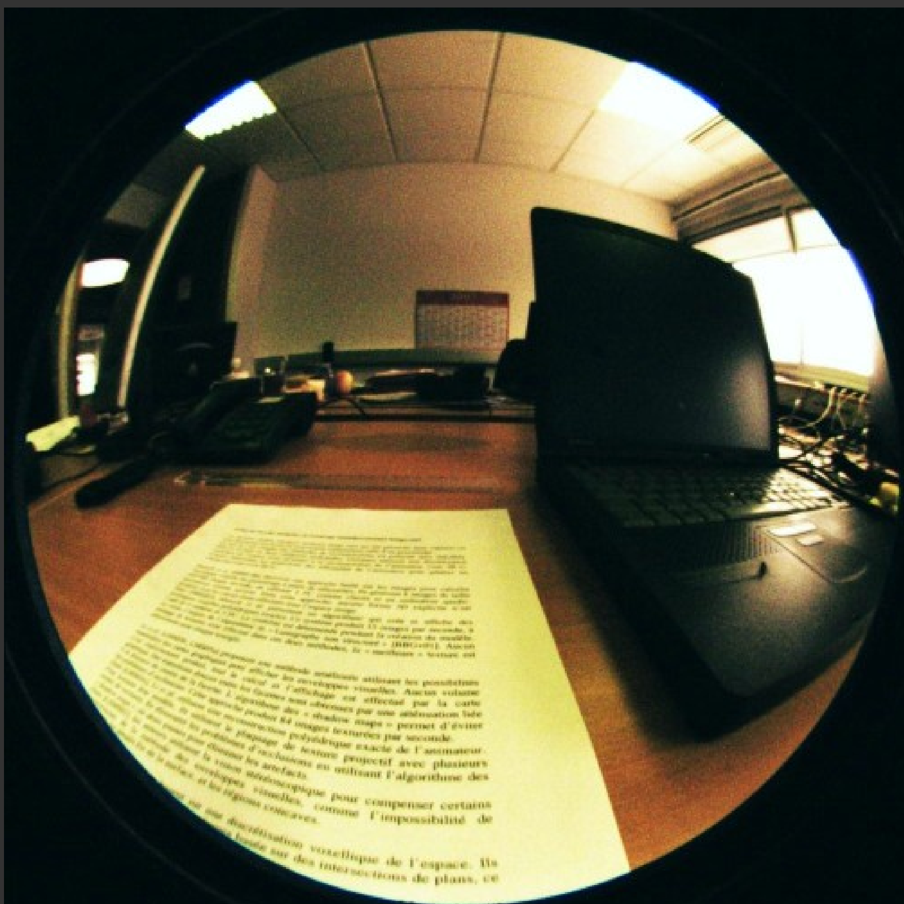
$$y = \frac{a_{21}\cdot u + a_{22}\cdot v + a_{23}}{a_{31}\cdot u + a_{32}\cdot v + 1}$$

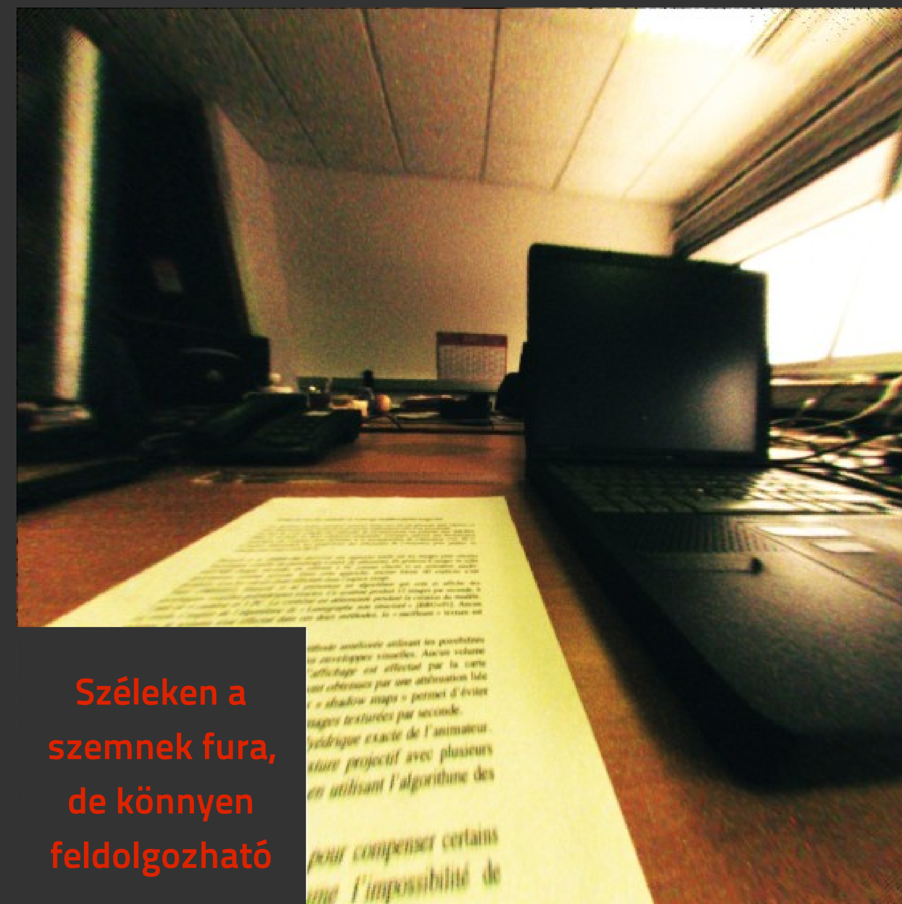
$$\left[(x_i, y_i) \multimap (u_i, v_i)\right] \rightarrow \begin{cases} u_i a_{11} + v_i a_{12} + a_{13} - u_i x_i a_{31} - v_i x_i a_{32} = x_i \\ u_i a_{21} + v_i a_{22} + a_{23} - u_i y_i a_{31} - v_i y_i a_{32} = y_i \end{cases}$$

$$\begin{bmatrix} a_{11} \\ a_{12} \\ a_{13} \\ a_{21} \\ a_{22} \\ a_{23} \\ a_{31} \\ a_{32} \end{bmatrix} = \begin{bmatrix} u_0 & v_0 & 1 & & & & -u_0 x_0 & -v_0 x_0 \\ & & & u_0 & v_0 & 1 & -u_0 y_0 & -v_0 y_0 \\ u_1 & v_1 & 1 & & & & -u_1 x_1 & -v_1 x_1 \\ & & & u_1 & v_1 & 1 & -u_1 y_1 & -v_1 y_1 \\ u_2 & v_2 & 1 & & & & -u_2 x_2 & -v_2 x_2 \\ & & & u_2 & v_2 & 1 & -u_2 y_2 & -v_2 y_2 \\ u_3 & v_3 & 1 & & & & -u_3 x_3 & -v_3 x_3 \\ & & & u_3 & v_3 & 1 & -u_3 y_3 & -v_3 y_3 \end{bmatrix}^{-1} \begin{bmatrix} x_0 \\ y_0 \\ x_1 \\ y_1 \\ x_2 \\ y_2 \\ x_3 \\ y_3 \end{bmatrix}$$



Geometriai torzítás





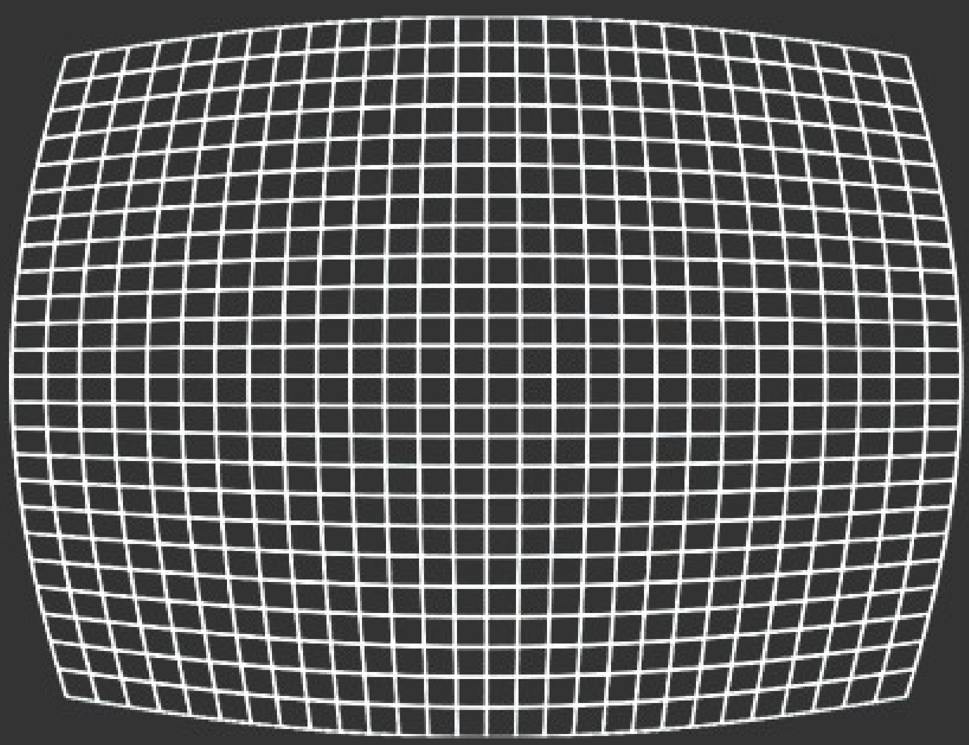
Széleken a szemnek fura, de könnyen feldolgozható

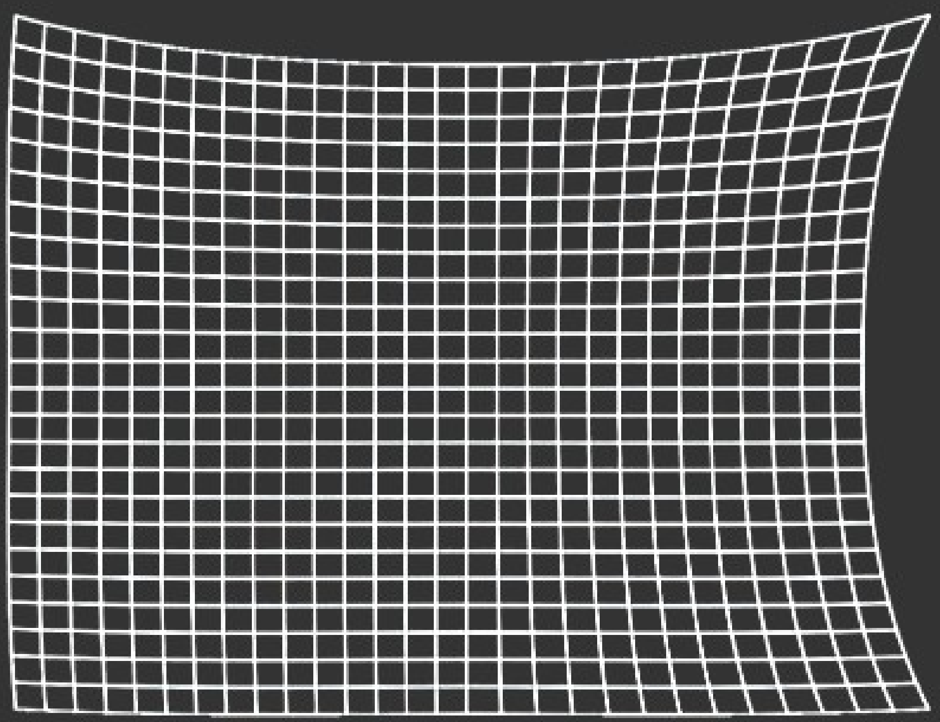
Geometriai torzítás

$$x_d = x_u + x_u \cdot f_{rad} + f_{tang,x} = x_u + x_u(k_1 r^2 + k_2 r^4 + \ldots) + [2 p_1 x_u y_u + p_2(r^2 + 2 x_u^2)](1 + p_3 r^2 + p_4 r^4 + \ldots)$$

$$y_d = y_u + y_u \cdot f_{rad} + f_{tang,y} = y_u + y_u(k_1 r^2 + k_2 r^4 + \ldots) + [2 p_2 x_u y_u + p_1(r^2 + 2 y_u^2)](1 + p_3 r^2 + p_4 r^4 + \ldots)$$

$$r = \sqrt{(x_u - x_c)^2 + (y_u - y_c)^2}$$



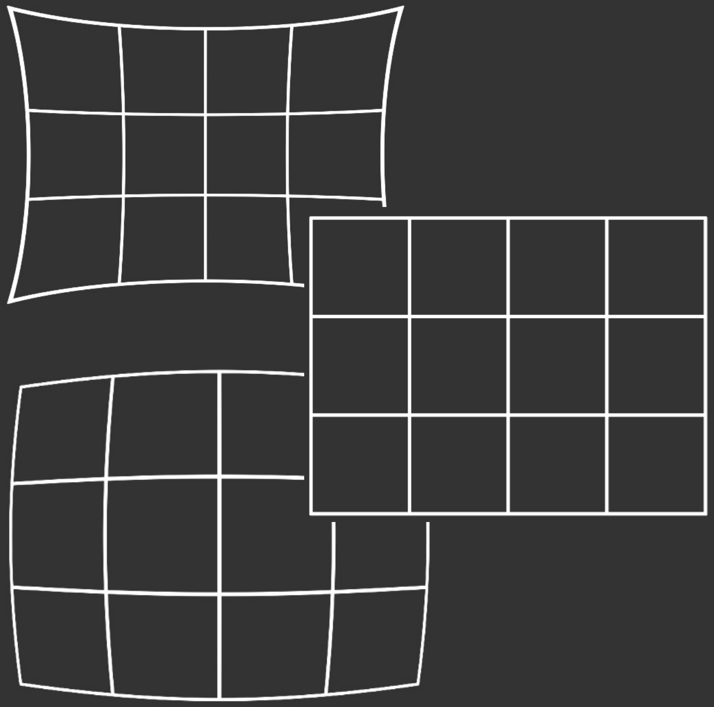


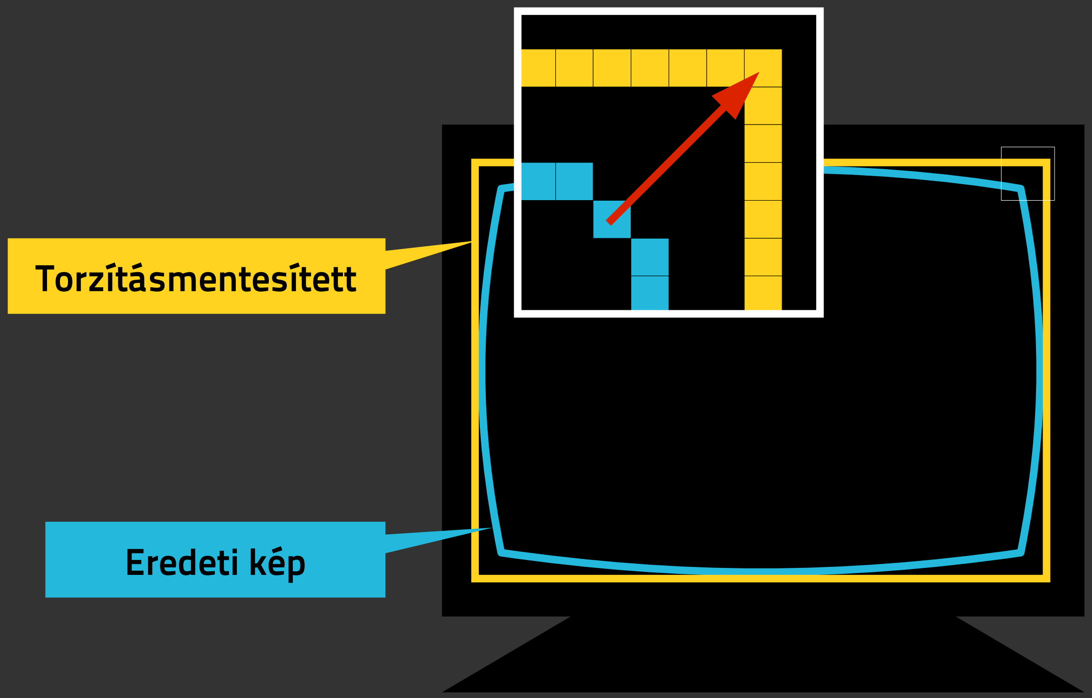
Geometriai torzítás

$$x_d = x_u + x_u \cdot f_{rad} + f_{tang,x} = x_u + x_u(k_1 r^2 + k_2 r^4 + \ldots) + [2p_1 x_u y_u + p_2(r^2 + 2x_u^2)](1 + p_3 r^2 + p_4 r^4 + \ldots)$$

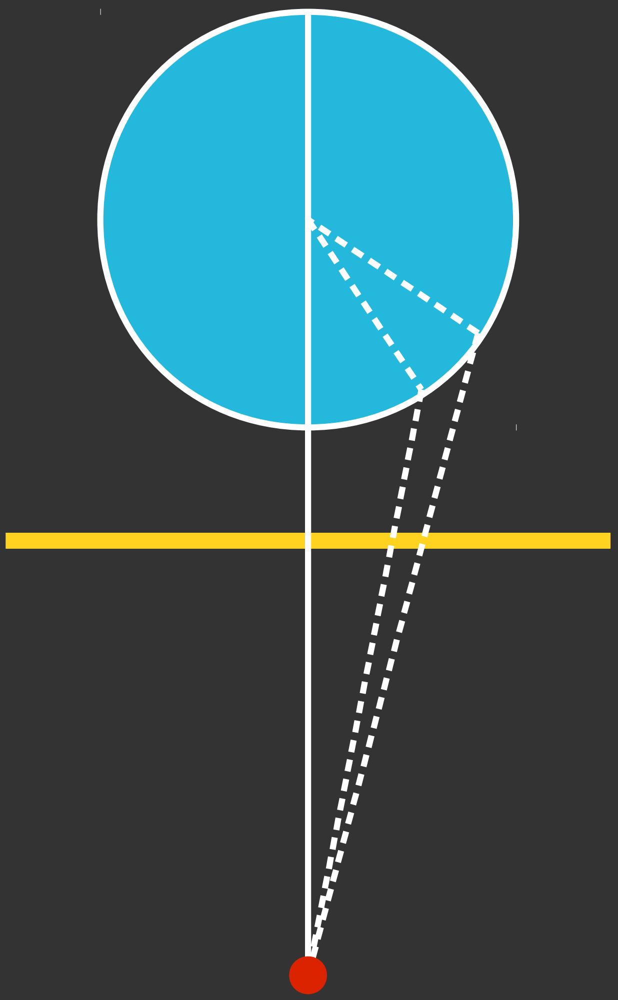
$$y_d = y_u + y_u \cdot f_{rad} + f_{tang,y} = y_u + y_u(k_1 r^2 + k_2 r^4 + \ldots) + [2p_2 x_u y_u + p_1(r^2 + 2y_u^2)](1 + p_3 r^2 + p_4 r^4 + \ldots)$$

$$r = \sqrt{(x_u - x_c)^2 + (y_u - y_c)^2}$$

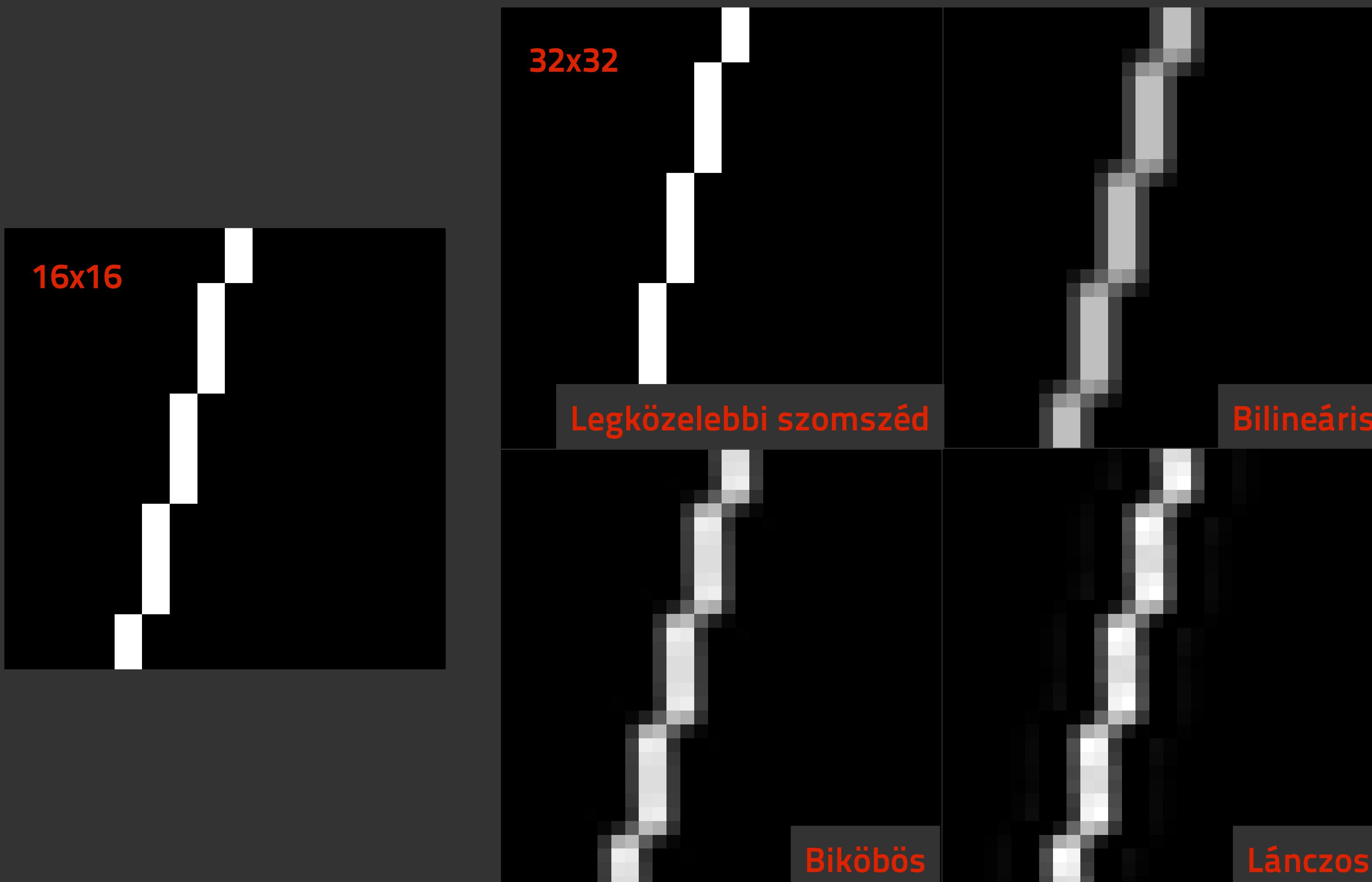




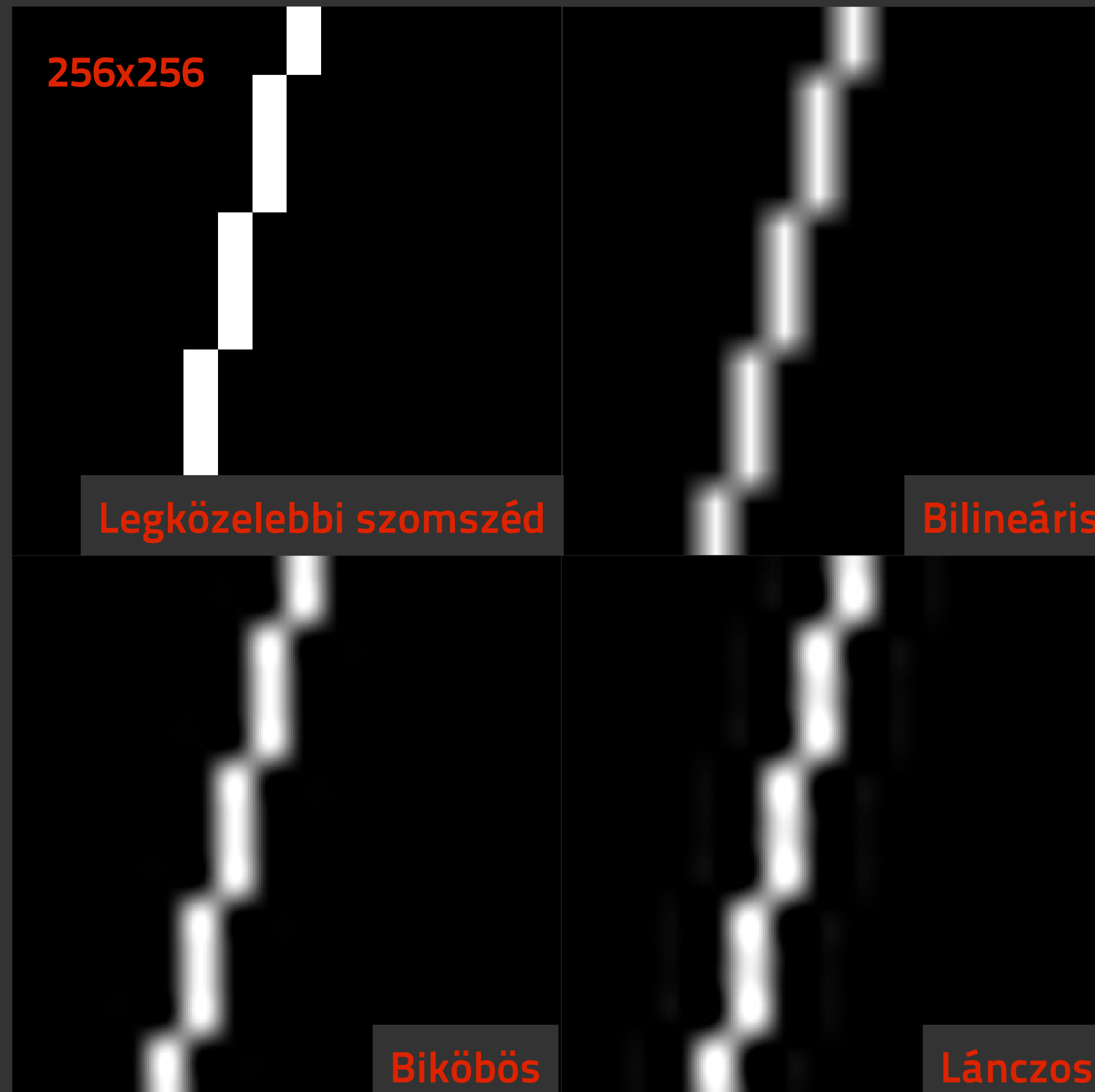
Gömbfelület torzítása



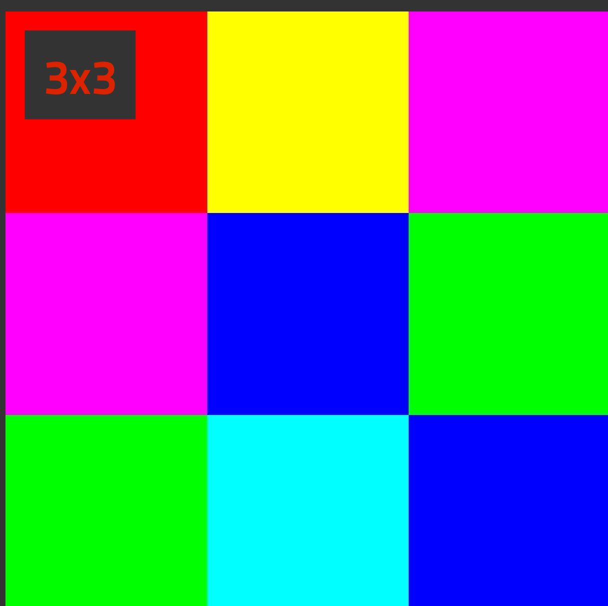
Interpoláció

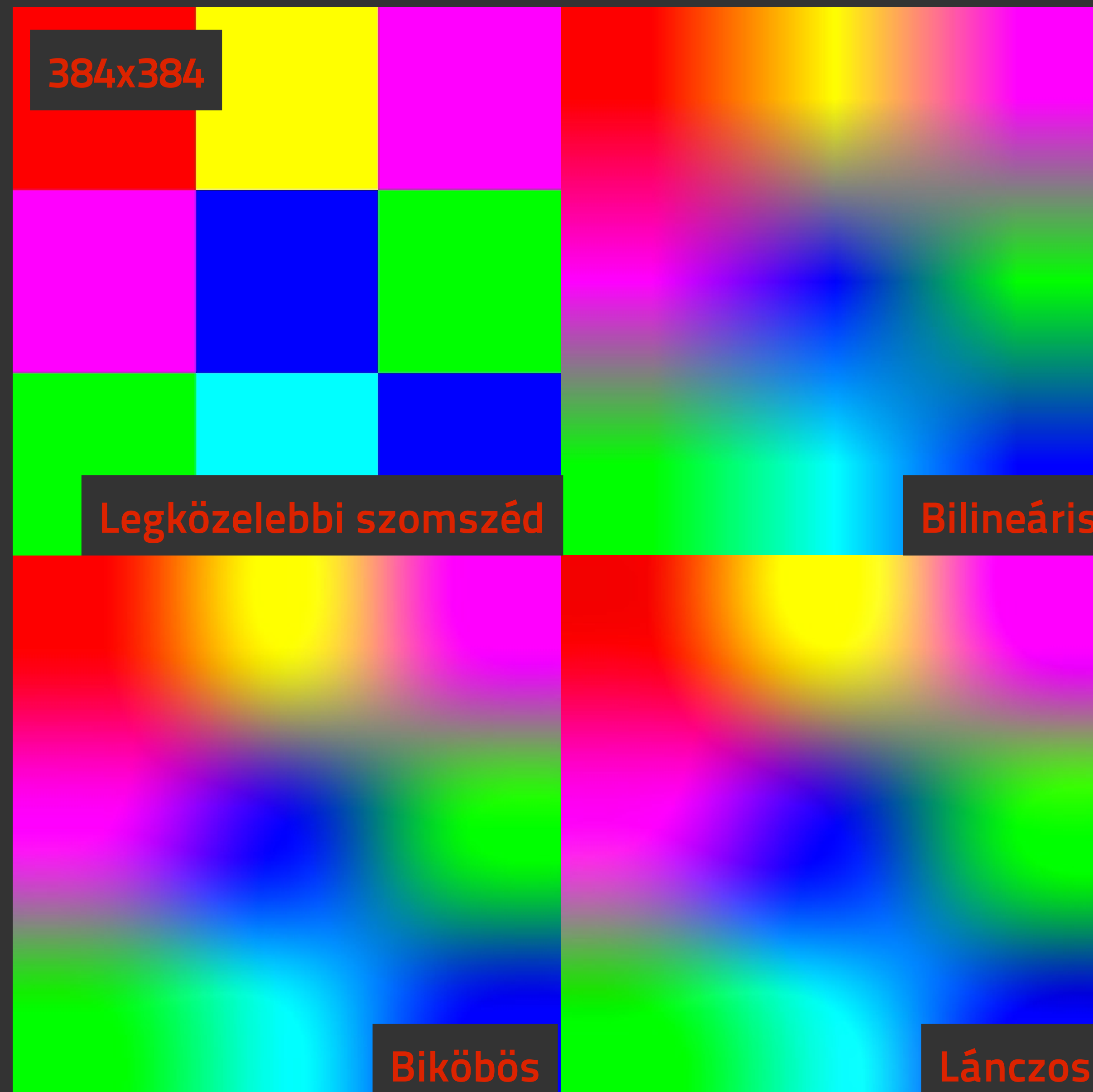


Interpoláció



Interpoláció



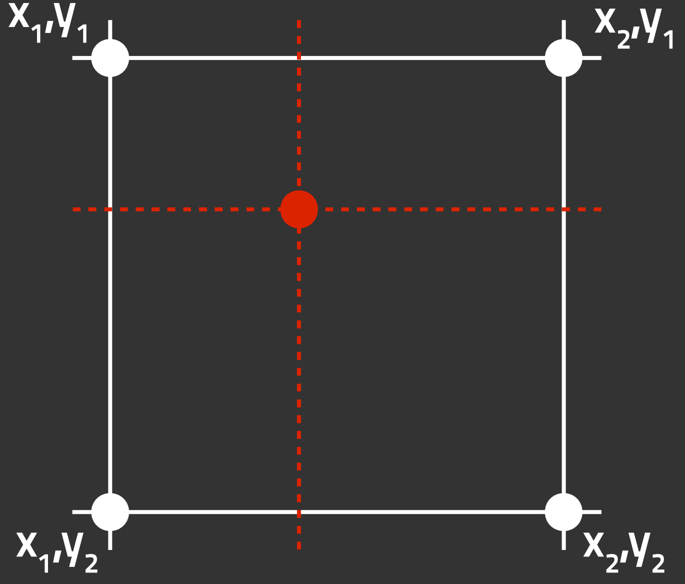


Bilineáris interpoláció

$$f(x,y_1)=\frac{x_2-x}{x_2-x_1}\cdot f(x_1,y_1)+\frac{x-x_1}{x_2-x_1}\cdot f(x_2,y_1)$$

$$f(x,y_2)=\frac{x_2-x}{x_2-x_1}\cdot f(x_1,y_2)+\frac{x-x_1}{x_2-x_1}\cdot f(x_2,y_2)$$

$$f(x,y)=\frac{y_2-y}{y_2-y_1}\cdot f(x,y_1)+\frac{y-y_1}{y_2-y_1}\cdot f(x,y_2)$$



Biköbös interpoláció

$$f(x,y)=\sum_{i=0}^{3}\sum_{j=0}^{3} a_{ij}\,x^{i}\,y^{j}$$

$$\frac{\partial f(x,y)}{\partial x}=\sum_{i=1}^{3}\sum_{j=0}^{3} a_{ij}\,i\,x^{i-1}\,y^{j}$$

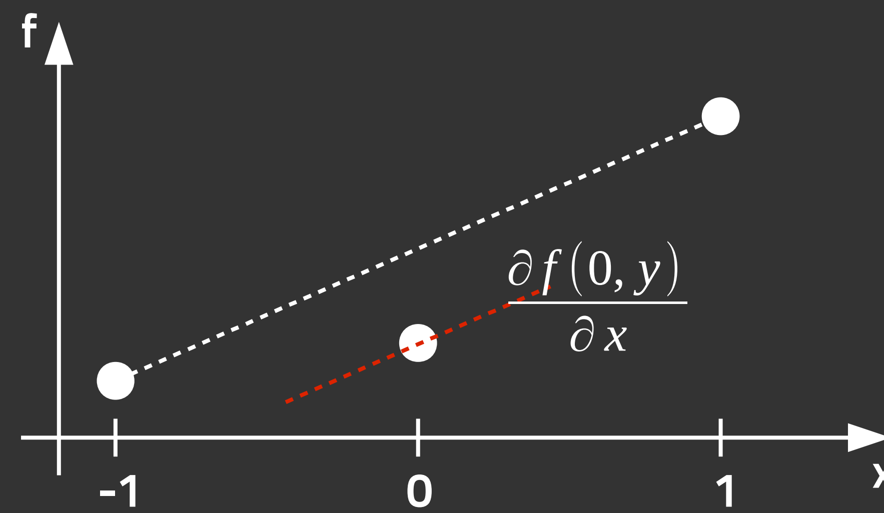
$$\frac{\partial f(x,y)}{\partial y}=\sum_{i=0}^{3}\sum_{j=1}^{3} a_{ij}\,x^{i}\,j\,y^{j-1}$$

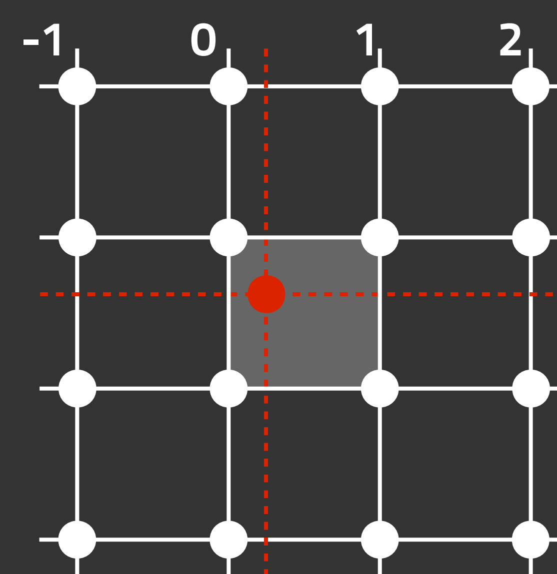
$$\frac{\partial^2 f(x,y)}{\partial x\,\partial y}=\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij}\,i\,x^{i-1}\,j\,y^{j-1}$$

$$\frac{\partial f(x,y)}{\partial x}=\frac{f(x+1,y)-f(x-1,y)}{2}$$

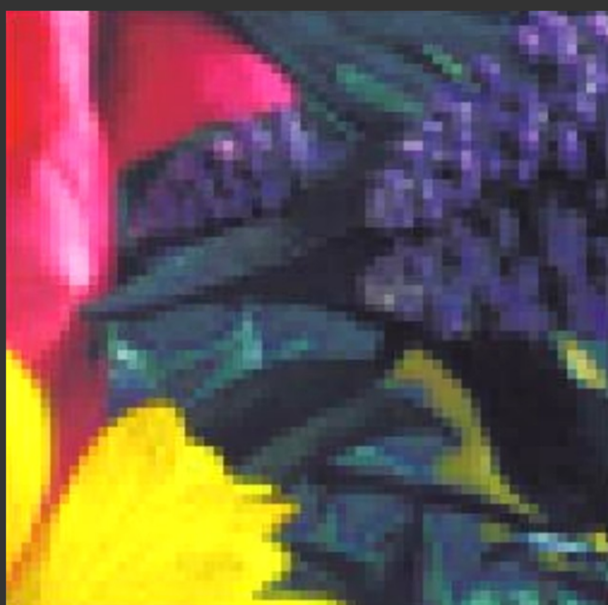
$$\frac{\partial f(x,y)}{\partial y}=\frac{f(x,y+1)-f(x,y-1)}{2}$$

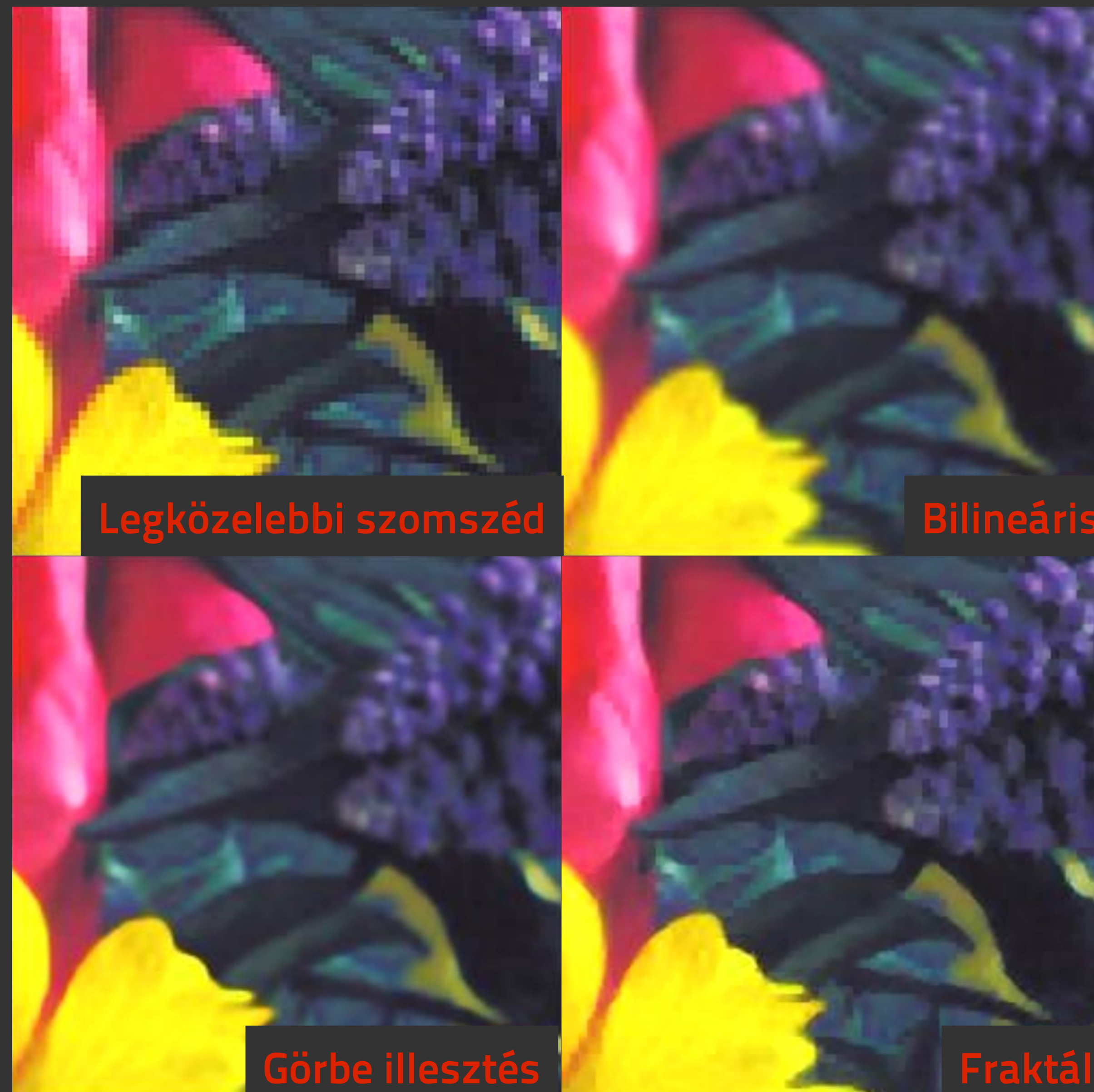
$$\frac{\partial^2 f(x,y)}{\partial x\,\partial y}=\frac{f(x+1,y+1)-f(x-1,y)-f(x,y-1)+f(x,y)}{4}$$



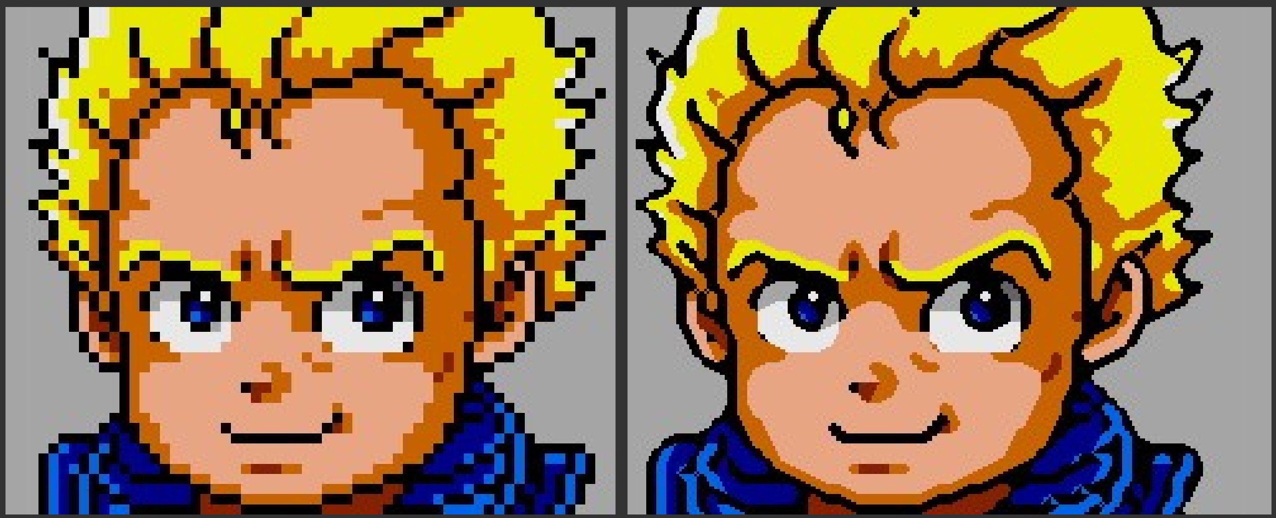


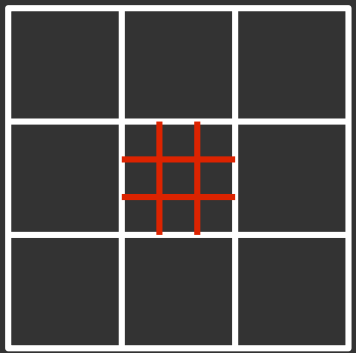
Komplex interpoláció



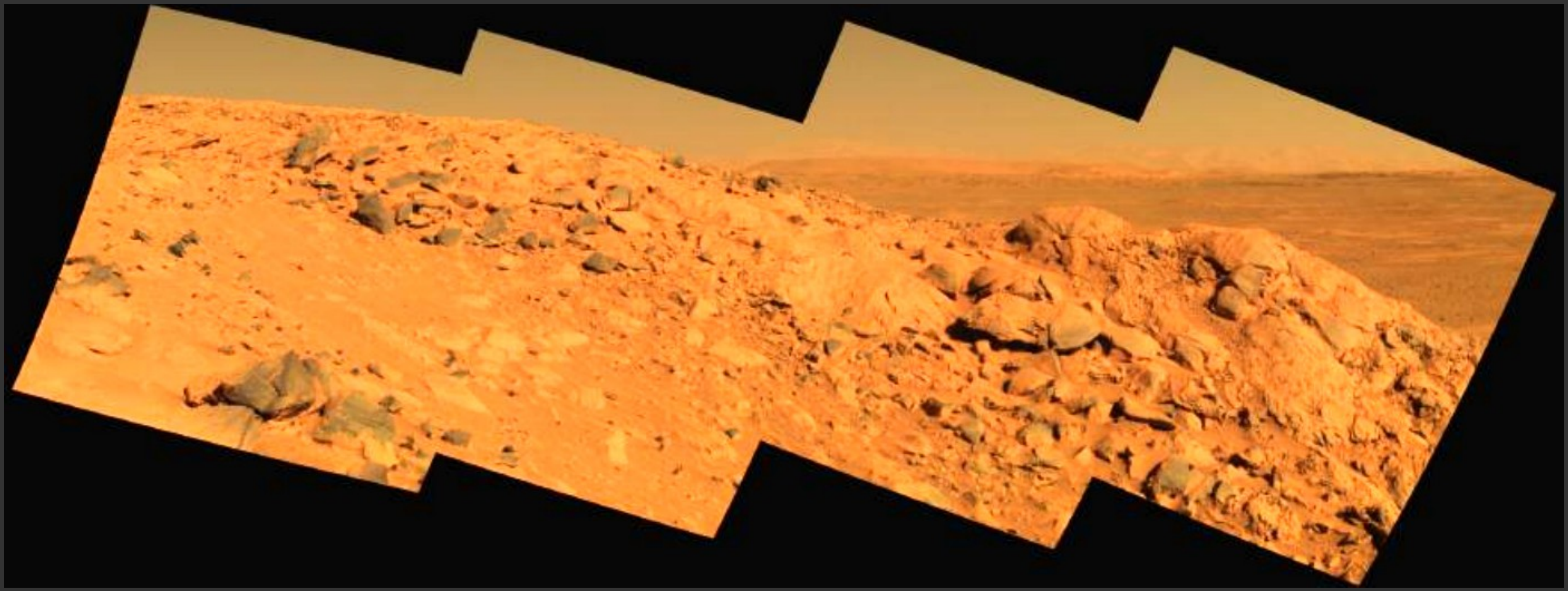


Scale2X, 3X, 4X





Illesztések



Képi matematika

Kép–érték v. **kép–kép**

Összeadás / kivonás / átlagolás

Szorzás / osztás / normalizálás

Maximum / minimum

Logikai műveletek (főleg bináris képek)

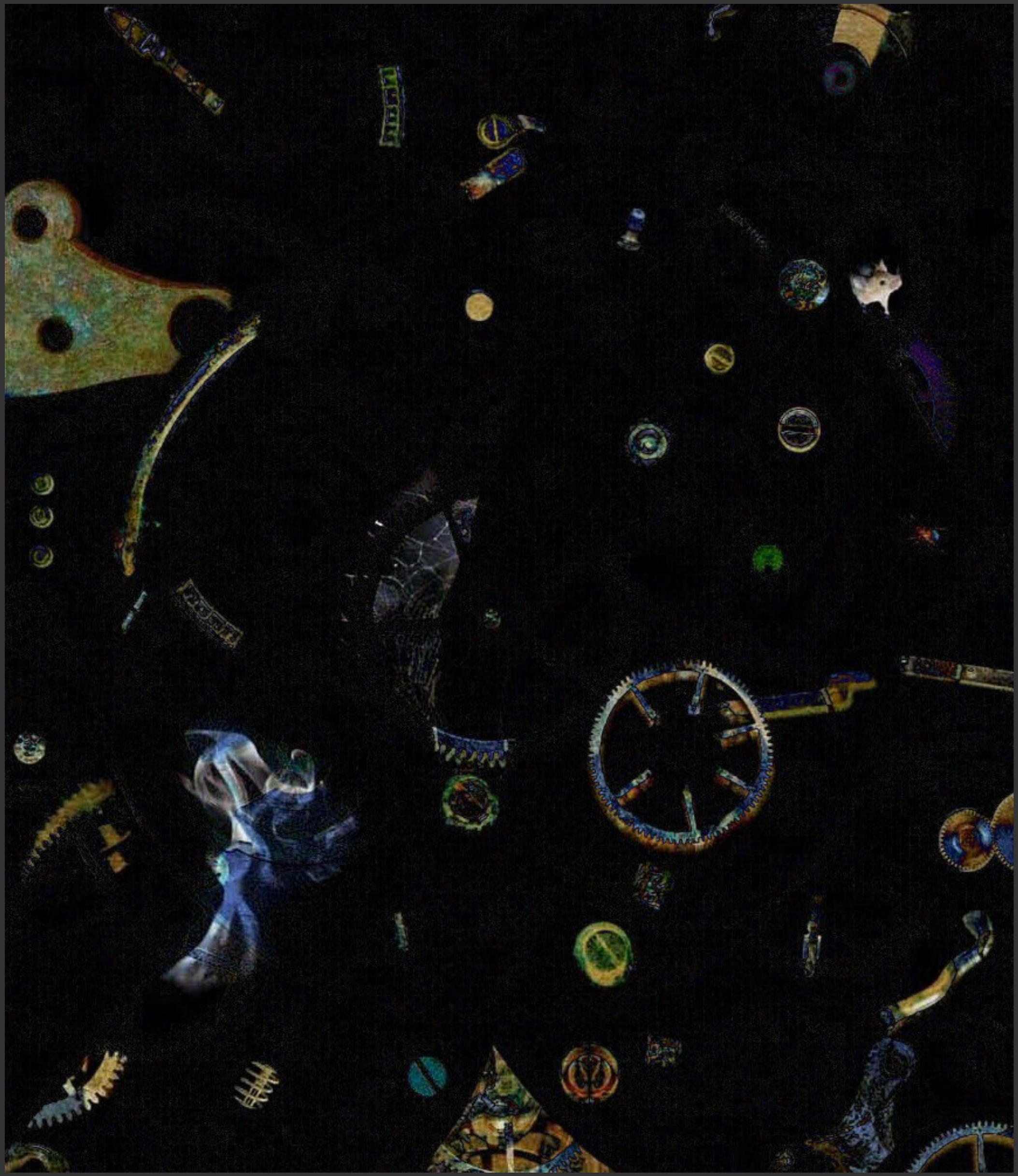
Textúrázás (szorzás)

Különbség

Különbség

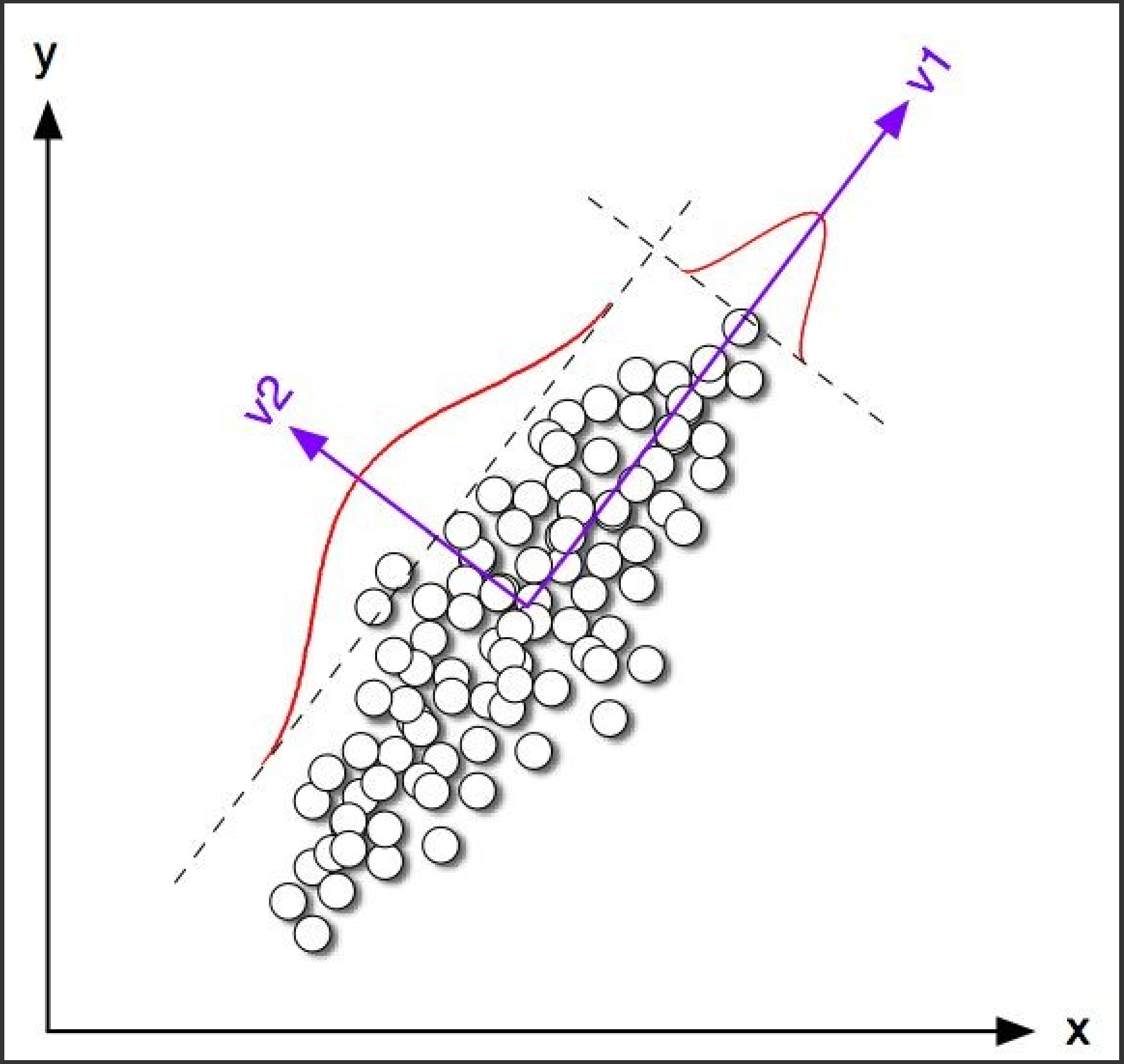
Különbség

Különbség



Háttérleválasztás

Főkomponens-analízis



Főkomponens-elemzés

- Adathalmaz meghatározása (pl. színcsatornák)
- Adatok tömegközéppontja origóba
- Kovariáns-mátrix
- Sajátvektorok, sajátértékek
- Sajátvektorok sorbarendezése
- **Vektor első tengelye legnagyobb szórás irányába**

Főkomponens-elemzés

Főkomponens-elemzés

Kombináció – fókusz

Kombináció – világosság