

# Reprezentace rastrového obrazu

## Počítačová grafika

Mgr. Markéta Trnečková, Ph.D.



Palacký University, Olomouc

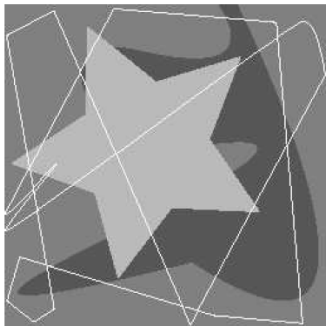
- *černobílý (B/W) – 1 bit/pixel*
- *v odstínech šedi (gray scale) – 1 byte/pixel*
- *s paletou (palleted) – 1 byte/pixel*
- *plně barevný (color) – 3-4 byte/pixel*
- *s vysokým dynamickým rozsahem (HDR) – 6-12 byte/pixel*

- *Relativní redundance dat*

$$R = 1 - \frac{1}{C}$$

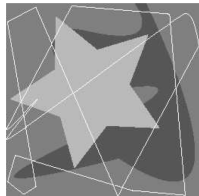
- Kompresní poměr

$$C = \frac{b}{b'}$$

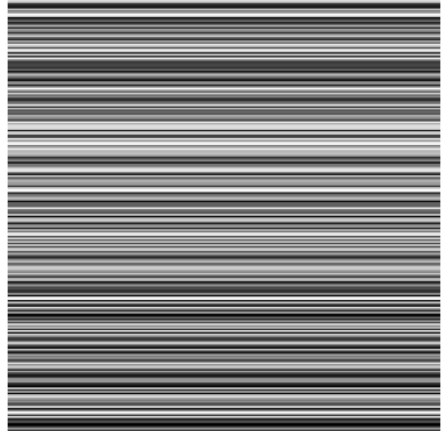
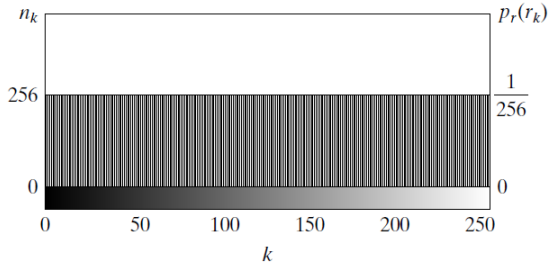


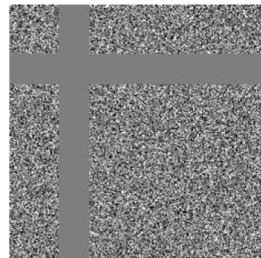
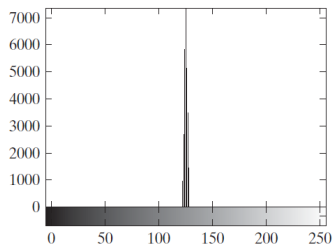
$$p_r(r_k) = \frac{n_k}{MN}, k = 0, 1, \dots, L - 1$$

$$L_{avg} = \sum_{k=0}^{L-1} l(r_k) p_r(r_k)$$



$r_k$	$p_r(r_k)$	Code 1	$l_1(r_k)$	Code 2	$l_2(r_k)$
$r_{87} = 87$	0.25	01010111	8	01	2
$r_{128} = 128$	0.47	10000000	8	1	1
$r_{186} = 186$	0.25	11000100	8	000	3
$r_{255} = 255$	0.03	11111111	8	001	3
$r_k$ for $k \neq 87, 128, 186, 255$	0	—	8	—	0





## Informace

$$I(E) = \log \frac{1}{P(E)} = -\log P(E)$$

## Entropie

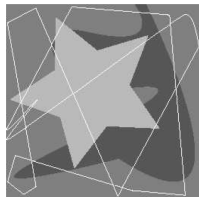
$$H = -\sum_{j=1}^J P(a_j) \log P(a_j)$$

$$\tilde{H} = -\sum_{k=0}^{L-1} p_r(r_k) \log_2 p_r(r_k)$$

$$J = \text{entropy}(I)$$



$r_k$	$p_r(r_k)$
$r_{87} = 87$	0.25
$r_{128} = 128$	0.47
$r_{186} = 186$	0.25
$r_{255} = 255$	0.03
$r_k$ for $k \neq 87, 128, 186, 255$	0



$$e(x, y) = |\hat{f}(x, y) - f(x, y)|$$

## Celková chyba

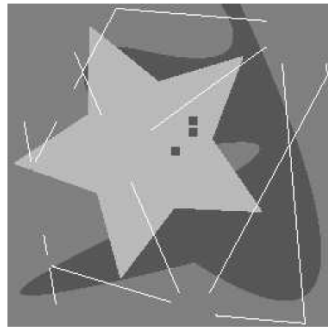
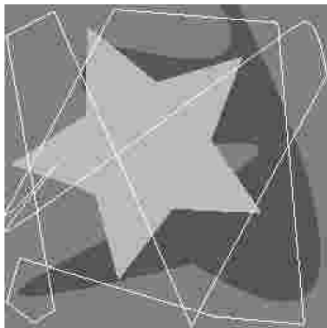
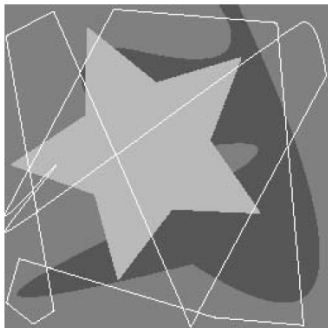
$$\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} |\hat{f}(x, y) - f(x, y)|$$

## root-mean-square error

$$e_{rms} = \left[ \frac{1}{MN} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [\hat{f}(x, y) - f(x, y)]^2 \right]^{\frac{1}{2}}$$

## mean-square signal-to-noise ratio

$$SNR_{ms} = \frac{\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} \hat{f}(x, y)^2}{\sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [\hat{f}(x, y) - f(x, y)]^2}$$



Original source		Source reduction				
Symbol	Probability	1	2	3	4	
$a_2$	0.4	0.4	0.4	0.4	0.6 0.4	
$a_6$	0.3	0.3	0.3	0.3		
$a_1$	0.1	0.1	0.2	0.3		
$a_4$	0.1	0.1				
$a_3$	0.06	0.1	0.1			
$a_5$	0.04					

Original source			Source reduction							
Symbol	Probability	Code	1		2		3		4	
$a_2$	0.4	1	0.4	1	0.4	1	0.4	1	0.6	0
$a_6$	0.3	00	0.3	00	0.3	00	0.3	00	0.4	1
$a_1$	0.1	011	0.1	011	0.2	010	0.3	01		
$a_4$	0.1	0100	0.1	0100	0.1	011				
$a_3$	0.06	01010	0.1	0101						
$a_5$	0.04	01011								

## Vstupní data

<b>139</b>	144	149	153	155	155	155	155
<b>144</b>	151	153	156	159	156	156	156
<b>150</b>	155	160	163	158	156	156	156
<b>159</b>	161	162	160	160	159	159	159
<b>159</b>	160	161	162	162	155	155	155
<b>161</b>	161	161	161	160	157	157	157
<b>162</b>	162	161	163	162	157	157	157
<b>162</b>	162	161	161	163	158	158	158

## DCT (dopředná)

$$F(u, v) = \frac{1}{4}c(u)c(v) \left[ \sum_{x=0}^7 \sum_{y=0}^7 f(x, y) \cos \frac{(2x+1)u\pi}{16} \cos \frac{(2y+1)v\pi}{16} \right]$$

## DCT (zpětná)

$$f(u, v) = \frac{1}{4} \left[ \sum_{u=0}^7 \sum_{v=0}^7 c(u)c(v) F(u, v) \cos \frac{(2x+1)u\pi}{16} \cos \frac{(2y+1)v\pi}{16} \right]$$

$$\begin{aligned} c(u), c(v) &= \frac{1}{\sqrt{2}} \text{ pro } u, v = 0 \\ &= 1 \text{ jinak} \end{aligned}$$

## Koeficienty po DCT

<b>1259.6</b>	-1.0	-12.1	-5.2	2.1	-1.7	-2.7	1.3
-22.6	-17.5	-6.2	-3.2	-2.9	-0.1	0.4	-1.2
-10.9	-9.3	-1.6	1.5	0.2	-0.9	-0.6	-0.1
-7.1	-1.9	0.2	1.5	0.9	-0.1	-0.0	0.3
-0.6	-0.8	1.5	1.6	-0.1	-0.7	0.6	1.3
1.8	-0.2	1.6	-0.3	-0.8	1.5	1.0	-1.0
-1.3	-0.4	-0.3	-1.5	-0.5	1.7	1.1	-0.8
-2.6	1.6	-3.8	-1.8	1.9	1.2	-0.6	-0.4



## Kvantizační tabulka

<b>16</b>	11	10	16	24	40	51	61
<b>12</b>	12	14	19	26	58	60	55
<b>14</b>	13	16	24	40	57	69	56
<b>14</b>	17	22	29	51	87	80	61
<b>18</b>	22	37	56	68	109	103	77
<b>24</b>	35	55	64	81	104	113	92
<b>49</b>	64	78	87	103	121	120	101
<b>72</b>	92	95	98	112	100	103	99

## Kvantované koeficienty

<b>79</b>	0	-1	0	0	0	0	0
-2	-1	0	0	0	0	0	0
-1	-1	0	0	0	0	0	0
-1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

## Expandované koeficienty před IDCT

<b>1264</b>	0	-10	0	0	0	0	0
<b>-24</b>	-12	0	0	0	0	0	0
<b>-14</b>	-13	0	0	0	0	0	0
<b>-14</b>	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

## Rekonstruovaná data

142	144	147	150	152	153	154	154
149	150	153	155	156	157	156	156
157	158	159	161	161	160	159	158
162	162	163	163	162	160	158	157
162	162	162	162	161	158	156	155
160	161	161	161	160	158	156	154
160	160	161	162	161	160	158	157
160	161	163	164	164	163	161	160

Nebudu to zkoušet podrobně, ale je potřeba, abyste to znali.

Přečtěte si něco o obrazových formátech. Zejména rozdíl mezi bitmapovými a vektorovými a mezi ztrátovými a bezztrátovými.

## ■ Rastrové bezztrátové

- BMP
- GIF
- PNG
- RAW
- TIFF

## ■ Rastrové, ztrátové

- JPEG

## ■ Vektorové

- SVG