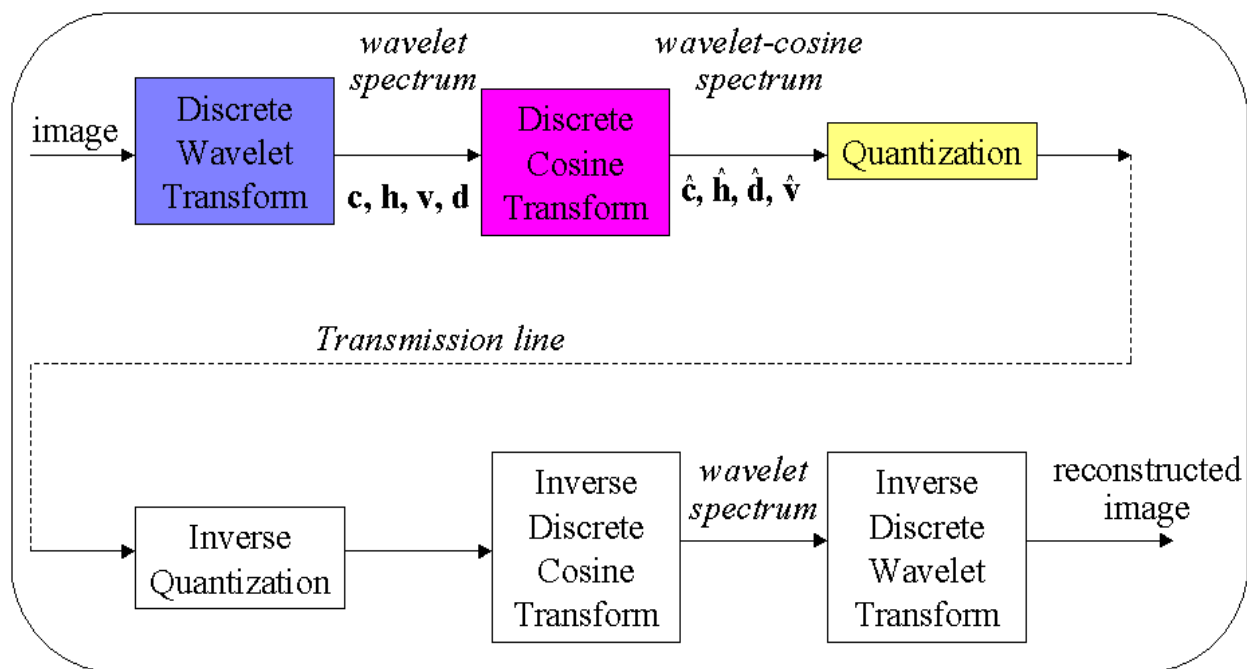


*Przetwarzanie obrazów przy
pomocy złożenia dwóch
transformacji*



Zastosowanie transformacji kosinusowo-falkowej do stratnej kompresji obrazów





Obraz

Original image : 256 X 256



$$\begin{aligned} s_{m+1}(x, y) = & \sum_{n_1} \sum_{n_2} c_{m,n_1,n_2} \phi_{m,n_1,n_2}(x, y) \\ & + \sum_{n_1} \sum_{n_2} h_{m,n_1,n_2} \phi_{m,n_1,n_2}^h(x, y) \\ & + \sum_{n_1} \sum_{n_2} v_{m,n_1,n_2} \phi_{m,n_1,n_2}^v(x, y) \\ & + \sum_{n_1} \sum_{n_2} d_{m,n_1,n_2} \phi_{m,n_1,n_2}^d(x, y) \end{aligned}$$

$$s_{m+1}(x, y) = \sum_{n_1} \sum_{n_2} c_{m+1,n_1,n_2} \phi_{m+1,n_1,n_2}(x, y)$$

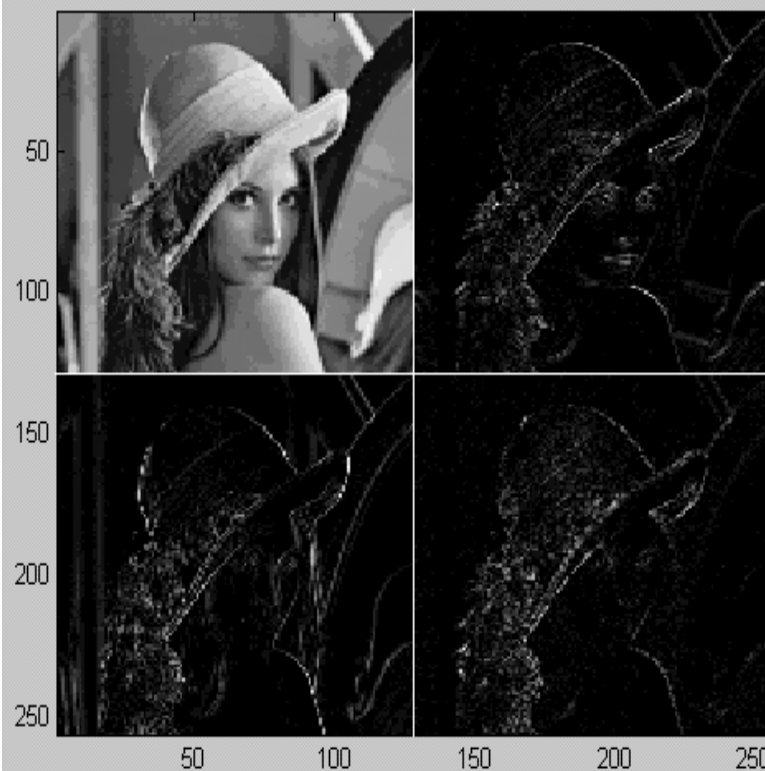


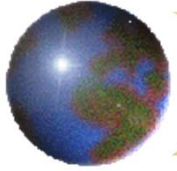
Dekompozycja Leny

Original image : 256 X 256

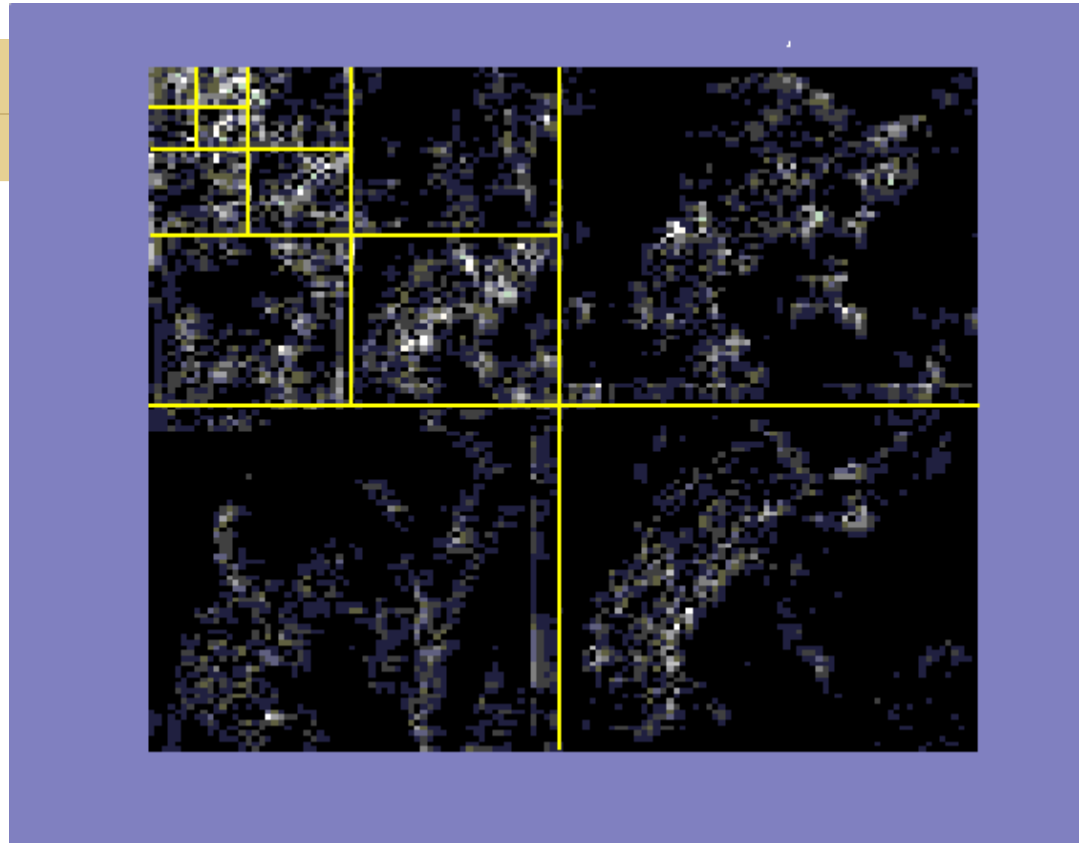


decomposition at level 1 with db1



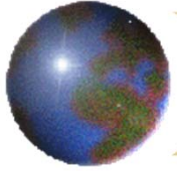


Transformata falkowa



$$WT = \left\{ \left\{ h_{m,n_1,n_2} \right\}_{n_1,n_2}, \left\{ v_{m,n_1,n_2} \right\}_{n_1,n_2}, \right. \\ \left. \left\{ d_{m,n_1,n_2} \right\}_{n_1,n_2}, \left\{ h_{m-1,n_1,n_2} \right\}_{n_1,n_2}, \right. \\ \left. \left\{ v_{m-1,n_1,n_2} \right\}_{n_1,n_2}, \left\{ d_{m-1,n_1,n_2} \right\}_{n_1,n_2}, \right. \\ \left. \dots, \dots, \right. \\ \left. \left\{ h_{m-M,n_1,n_2} \right\}_{n_1,n_2}, \left\{ v_{m-M,n_1,n_2} \right\}_{n_1,n_2}, \right. \\ \left. \left\{ d_{m-M,n_1,n_2} \right\}_{n_1,n_2}, \left\{ c_{m-M,n_1,n_2} \right\}_{n_1,n_2} \right\}$$

Falki Daubechies 12 rzędu



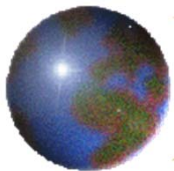
Transformacja kosinusowa

$$\hat{h}_{m,\theta_1,\theta_2,k_1,k_2} = 0.25 a(k_1) a(k_2) \cdot \sum_{\eta_1,\eta_2} h_{m,n_1,n_2} \cos \frac{(2\eta_1 + 1)k_1\pi}{16} \cos \frac{(2\eta_2 + 1)k_2\pi}{16}$$

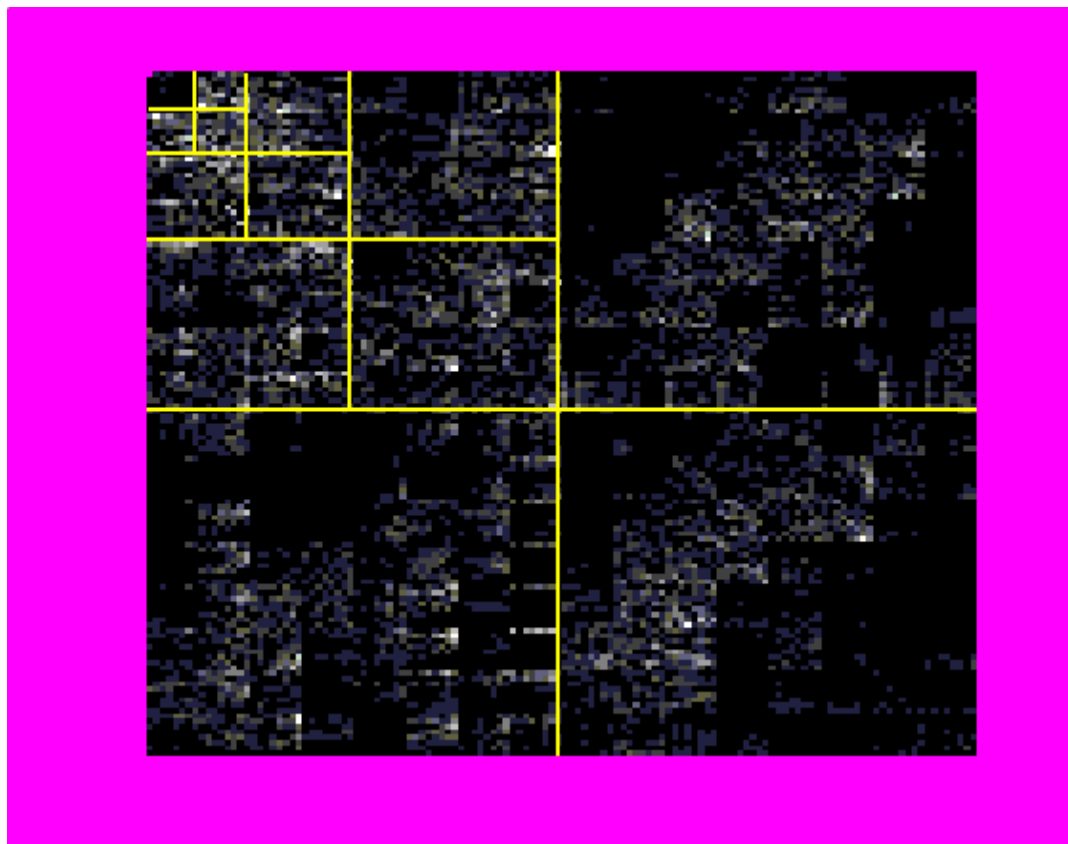
$$a(k) = \begin{cases} 1/\sqrt{2} & \text{if } k = 0 \\ 1 & \text{if } k \neq 0 \end{cases}$$

$$k_1, k_2, \eta_1, \eta_2 = 0, 1, \dots, 7$$

$$n_1 = 8\theta_1 + \eta_1; \quad n_2 = 8\theta_2 + \eta_2$$



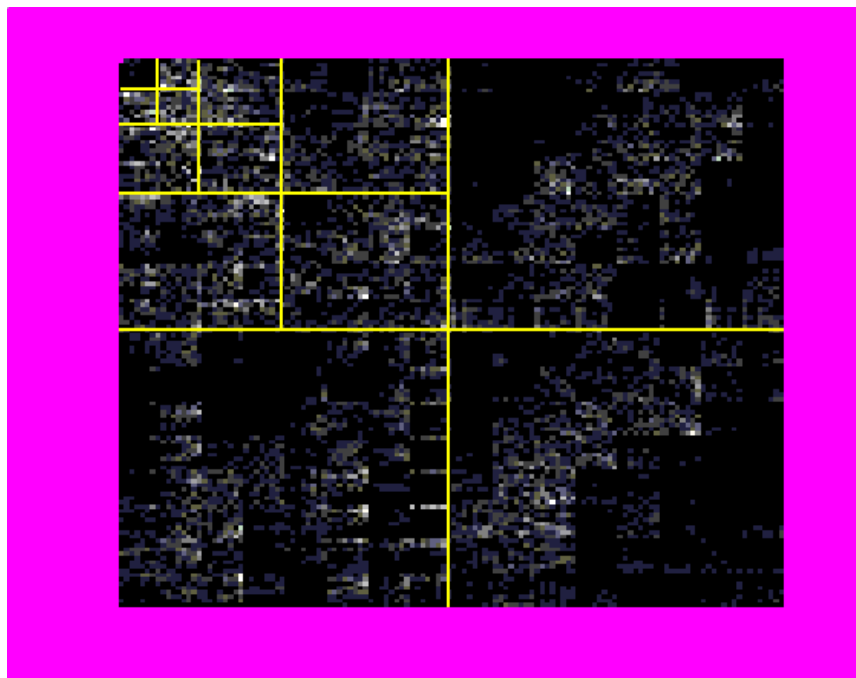
Transformata kosinusowo-falkowa



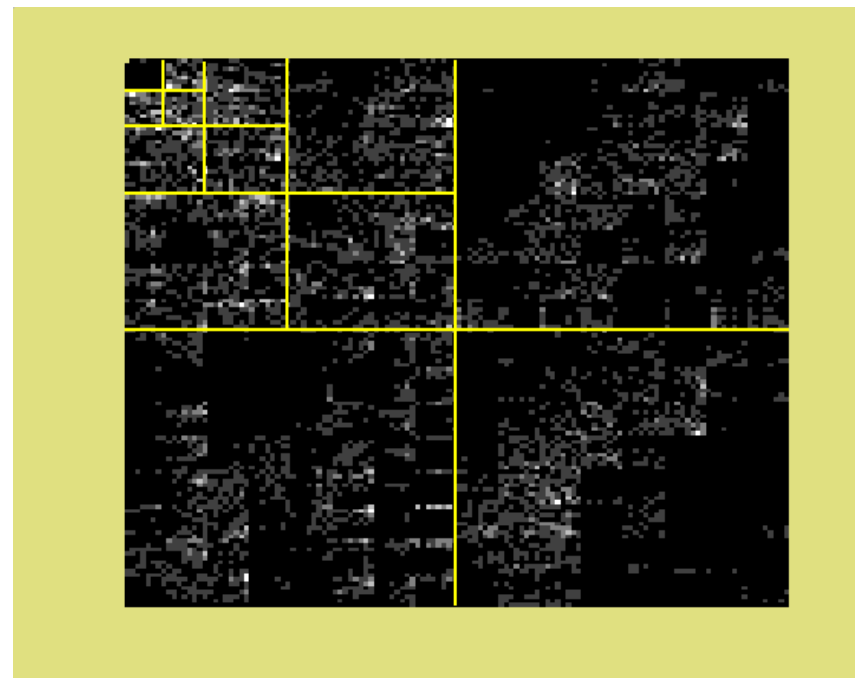
$$WCT = \left\{ \left\{ \left\{ \tilde{h}_{m,\theta_1,\theta_2,k_1,k_2} \right\}_{k_1,k_2} \right\}_{\theta_1,\theta_2}, \right. \\ \left. \left\{ \left\{ \tilde{v}_{m,\theta_1,\theta_2,k_1,k_2} \right\}_{k_1,k_2} \right\}_{\theta_1,\theta_2}, \right. \\ \left. \left\{ \left\{ \tilde{d}_{m,\theta_1,\theta_2,k_1,k_2} \right\}_{k_1,k_2} \right\}_{\theta_1,\theta_2}, \right. \\ \left. \dots, \right. \\ \left. \left\{ \left\{ \tilde{h}_{m-M,\theta_1,\theta_2,k_1,k_2} \right\}_{k_1,k_2} \right\}_{\theta_1,\theta_2}, \right. \\ \left. \left\{ \left\{ \tilde{v}_{m-M,\theta_1,\theta_2,k_1,k_2} \right\}_{k_1,k_2} \right\}_{\theta_1,\theta_2}, \right. \\ \left. \left\{ \left\{ \tilde{d}_{m-M,\theta_1,\theta_2,k_1,k_2} \right\}_{k_1,k_2} \right\}_{\theta_1,\theta_2}, \right. \\ \left. \left\{ \left\{ \tilde{c}_{m-M,\theta_1,\theta_2,k_1,k_2} \right\}_{k_1,k_2} \right\}_{\theta_1,\theta_2} \right\}$$



Kwantyzacja widma CWT



Równomierna kwantyzacja 8-mio bitowa



Zmienna ilość bitów (8 - 7 - 6 - 2)

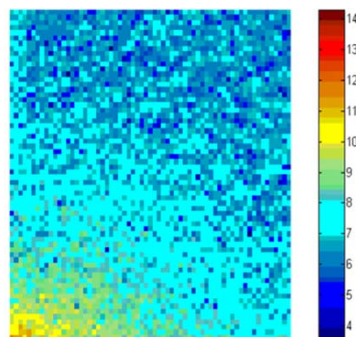
(średnio 3 bity)

Udziały

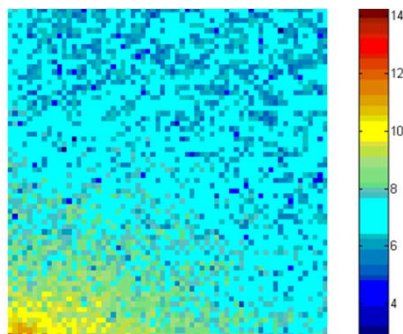
1,03% + 2,72% + 9,31% + 37,26% + 49,68%



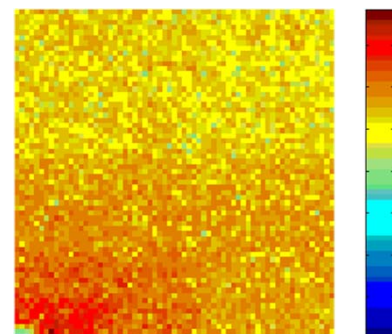
Widma Fouriera



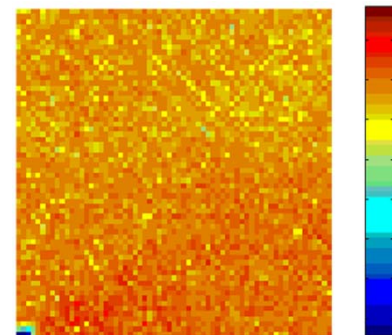
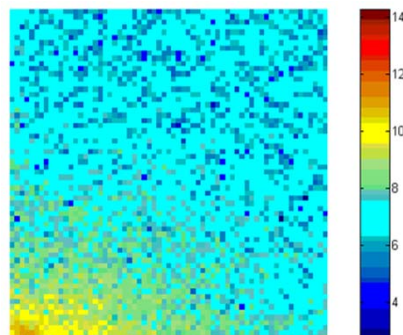
Dla obrazu oryginalnego



Dla obrazów skompresowanych



Kwantyzacja równomierna 3 bity/piksel



Kwantyzacja nierównomierna 3 bity/piksel

Dla różnicy pomiędzy obrazem oryginalnym i skompresowanym