A Grayscale beta Version of Color Image
based on the Color to Gray and Back
Reversible Transformation

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Plan

- The problem.
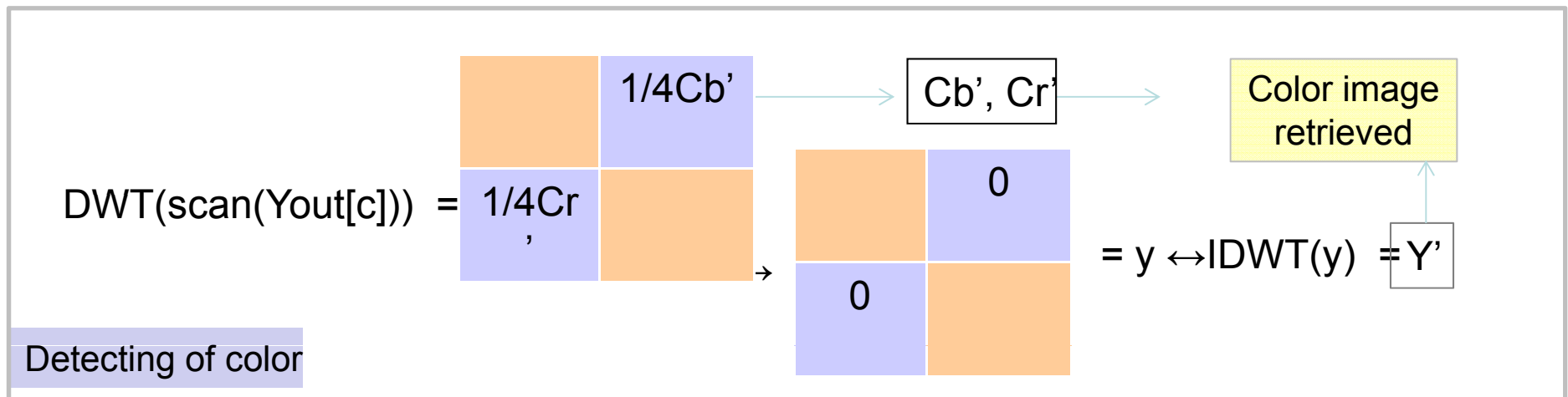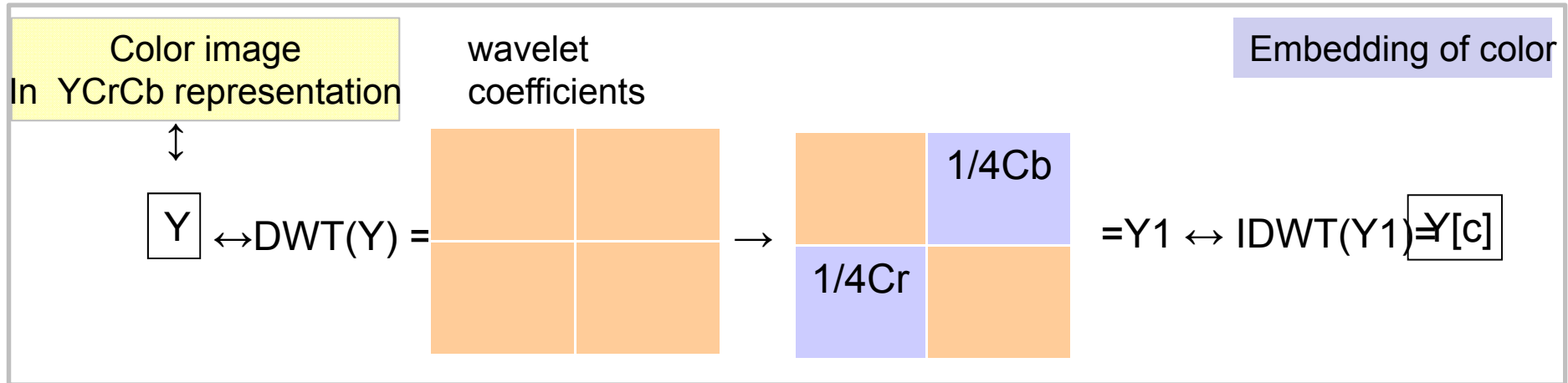- Embedding color with secrete key.
- Distributing of color images.

Color to Gray Transformation

- R, G, B → Y = αR + βG + γB
- 24 bits → 8 bit

Transformation is irreversible.

Possible reversible solution: R. Querioz and
K. Braun, 2005.

Embedding by Discrete Wavelet Transform.

wavelet
coefficients

$Y \leftrightarrow DWT(Y) =$ | 1/4Cb / 1/4Cr | $= Y1 \leftrightarrow IDWT(Y1) = Y[c]$

$PRINT(Y[c]) = Yout[c]$

$DWT(scan(Yout[c])) =$ | 1/4Cb' , 1/4Cr | $\rightarrow$ | 0 / 0 | Cb', Cr' → Color image retrieved

$= y \leftrightarrow IDWT(y) = Y'$

Embedding color with secrete key

- Embedding : $C \otimes M \otimes K \to S$
- $C \approx S$
- Detecting : $C \otimes K \otimes S \to M$
- Blind detecting: $K \otimes S \to M$

- C = cover work
- M = message
- K = secret key
- S = stego work, cover with embedded message

Block embedding algorithm

- RGB → YUV
- M' = (K + M) mod 255, M=U,V

$$d_a = \bigoplus_{x \in Y_{Va}} y[x, h - x]$$

Parity bit of a side diagonal

$$Y_{Va} \to S_{Va} = \begin{cases} Y_{Va}, & if\ d_a \oplus m' = 0, \\ ZY_{Va}, & if\ d_a \oplus m' = 1, \end{cases}$$

Example of block embedding

Block with modified brightness

Side diagonal

$$M = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} \to C = \left[\begin{array}{cc|cc} 0 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 \\ \hline 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 \end{array} \right] ; \quad S = \left[\begin{array}{cc|cc} 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 1 \\ \hline 0 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 \end{array} \right]$$

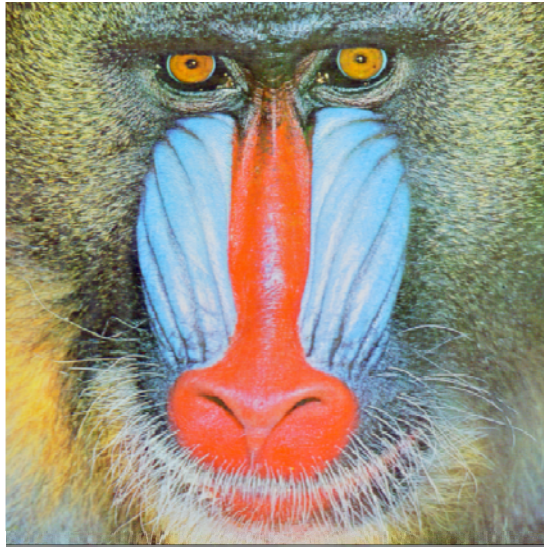message   cover   stego

One block has only changed its brightness after embedding of message
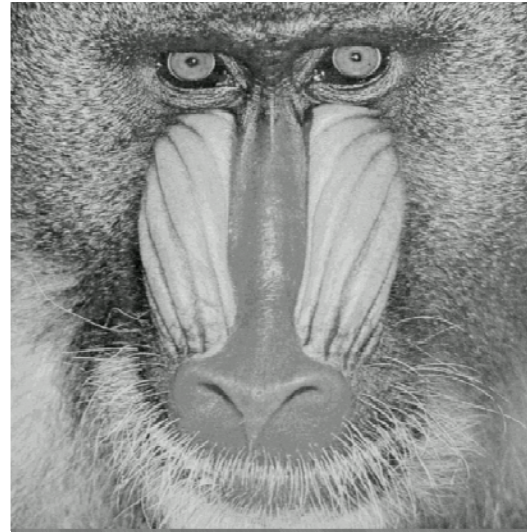
Detecting algorithm

- M = (M' - K + 255) mod (255)
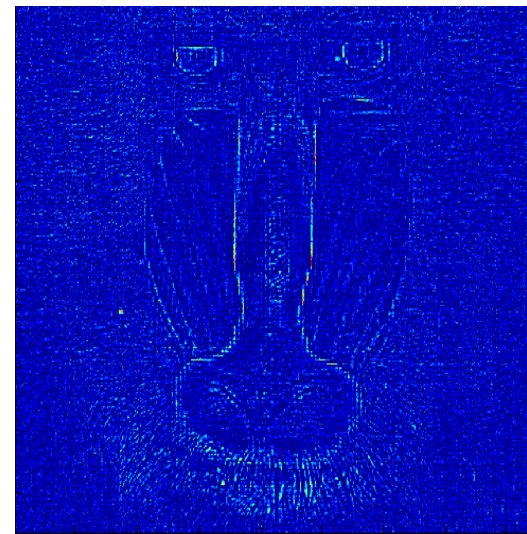
Results

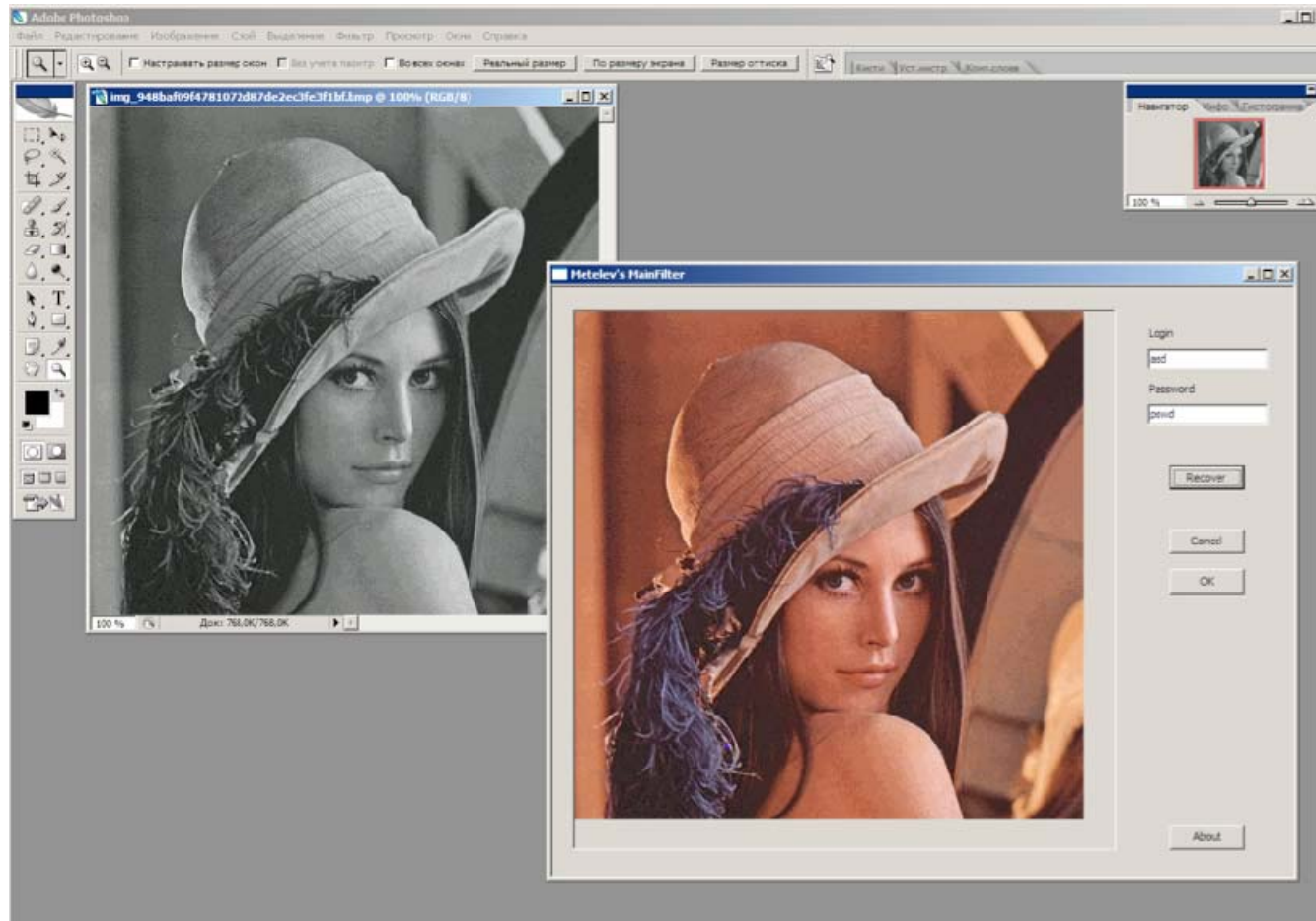original

Grayscale version with hidden color

Color version retrieved from gray

Difference between blue components of original and the retrieved color image
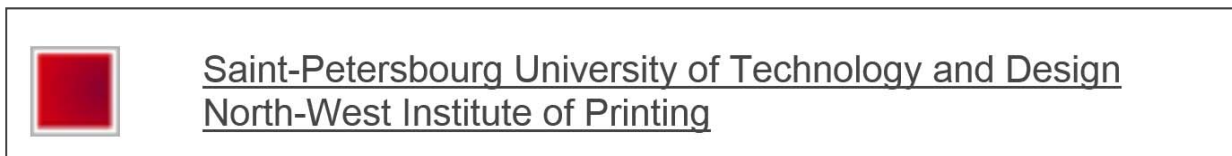
Interface

Beta-version

- Distributing of color images among legitimate users

- <u>Problem.</u> *Alice has a digital color image a and she wishes to sell it. Bob wishes to buy the color image but before he wants to get it to know and Alice distrusts Bob.*

- <u>Solution</u>. Alice sends to Bob a grayscale image b with hidden color instead of the initial color image a.

  After Bob tells his positive decision, Alice sends him the secrete key.

  Bob retrieves the desired color image.

Thank you

Uprint Image Processing Group

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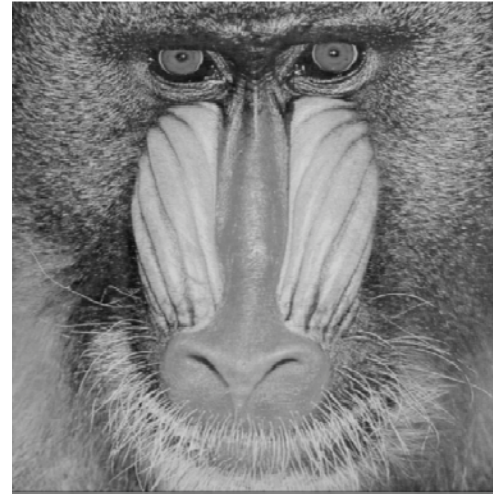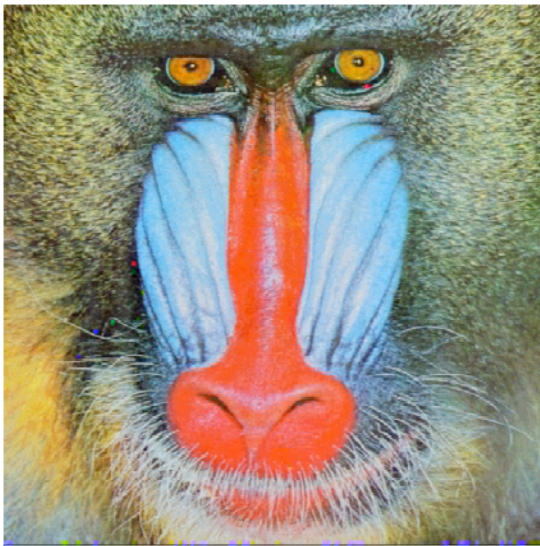North-West Institute of Printing
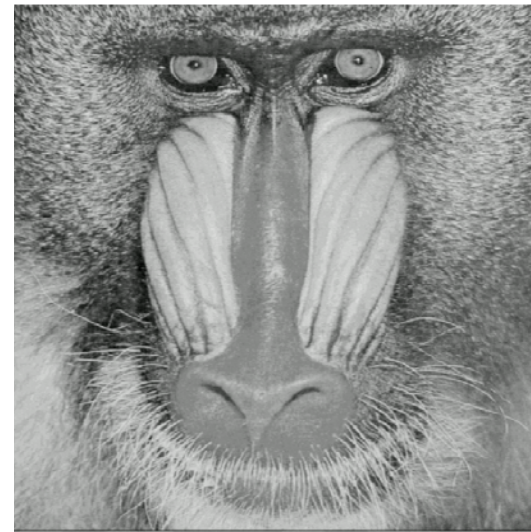
http://uipg.ru/

Results

Initial color image

Y component, luminance

Retrieved color image

Y with hidden color