

A decorative border of various school supplies is scattered around the edges of the slide. At the top left is a blue globe. Next to it are several colorful sticky notes, a blue pen, and a yellow ruler. In the top center are a pair of green scissors and a green pencil. To the right is an orange book, a pair of red scissors, and a yellow triangle ruler. At the top right is a blue backpack. At the bottom left is a blue backpack, a yellow triangle ruler, and a pair of red scissors. In the bottom center are a green pencil and a yellow ruler. At the bottom right is a blue globe, a blue pen, and a yellow ruler.

Image Steganography in Cryptography

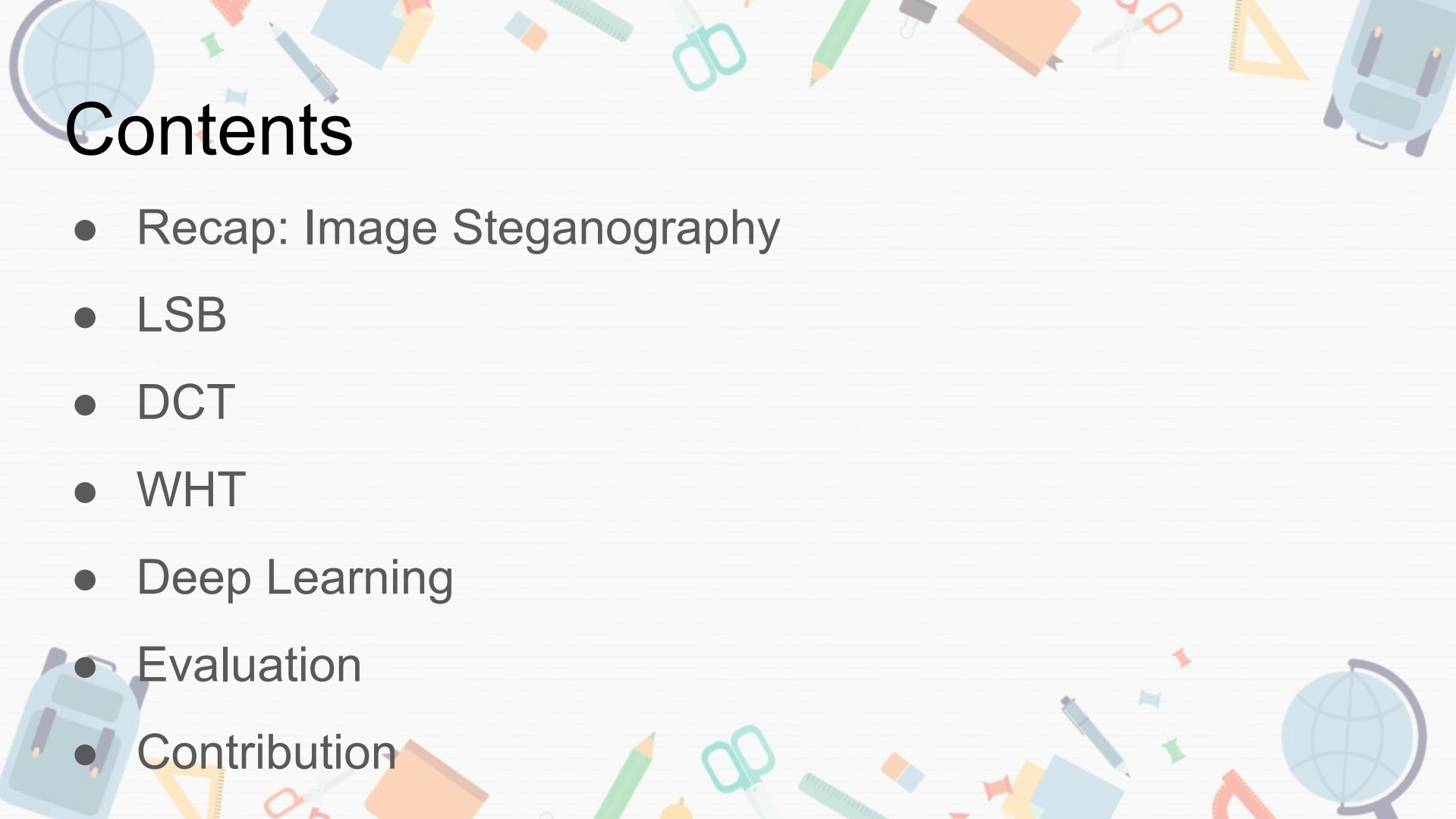
組別: flag_t34m_n4me_1s_3ncrypt3d

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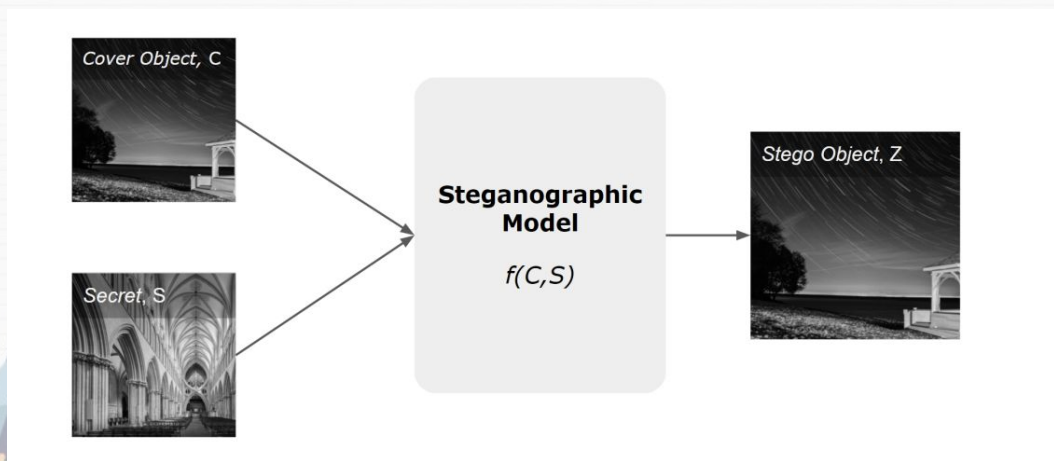
Contents

- Recap: Image Steganography
- LSB
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- Evaluation
 - Contribution
- 
- A decorative banner at the bottom of the slide featuring various school supplies like a blue backpack, pencils, scissors, a ruler, a globe, and colorful paper clips.

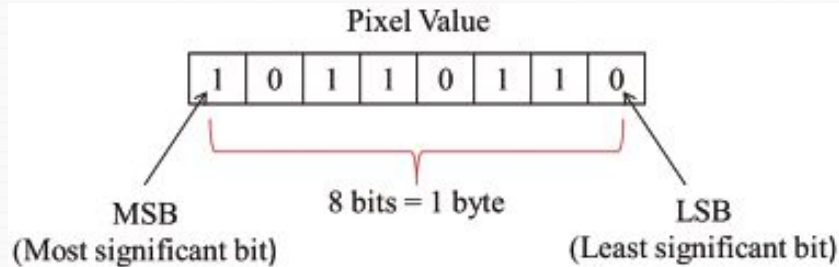
Recap: Image Steganography

- Hiding data behind digital images
- Common example: watermark

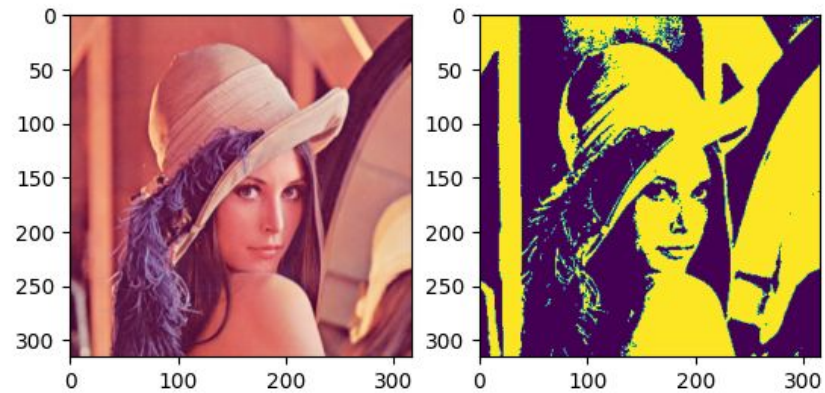


LSB (Least Significant Bits)

- The subtle differences in the image are difficult to detect with the naked eye.
- Color model: RGB、HSV...



LSB (Least Significant Bits)



Cover



Encrypted



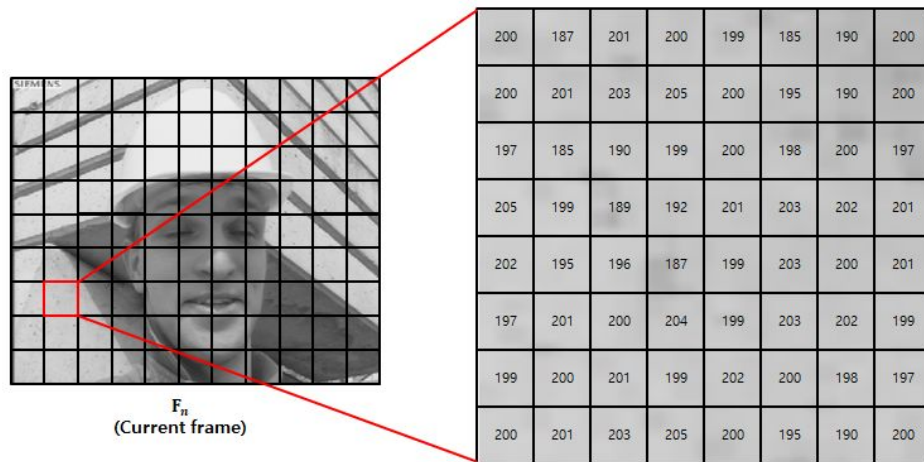
Secret



Extracted



DCT (Discrete Cosine Transform)



8x8 image block(spatial domain)

DCT
→

DC component

987	223	112	12	1	-1	0	0
201	180	101	23	-4	-1	0	0
14	21	9	5	3	-1	0	0
3	-5	-3	3	-1	-1	0	0
-1	2	4	-1	-1	1	0	0
1	1	-1	1	-1	0	0	0
0	0	1	1	1	0	0	0
0	0	0	0	0	0	0	0

AC components

Transformed block(frequency domain)

source: [GitHub - JawThrow/ICSPCodec: Implementation of video codec based on H.261](#)

Two-dimensional DCT & IDCT

$$F(u, v) = \frac{2}{N} C(u) C(v) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} f(x, y) \cos \frac{(2x+1)u\pi}{2N} \cos \frac{(2y+1)v\pi}{2N}$$

$$f(x, y) = \frac{2}{N} \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} C(u) C(v) F(u, v) \cos \frac{(2x+1)u\pi}{2N} \cos \frac{(2y+1)v\pi}{2N}$$

$$\text{Where } C(u), C(v) = \begin{cases} \frac{1}{\sqrt{2}} & \text{for } u, v = 0 \\ 1 & \text{otherwise} \end{cases}$$

$0 \leq x, y, u, v \leq N-1, N^2$: frame size

Cover Image



Encoded Image



Secret Image



Decoded Image



Secret:"Hello"



Secret:an article



Secret:image



Secret:image



Secret:"Hello"

```
Decoded_output > ≡ dct_hidden_text.txt
1 Hello!
```

Secret:an article

```
Decoded_output > ≡ dct_hidden_text.txt
1 In the heart of a bustling ci
2 charming bookstore that stood
3 It was a haven for book lovers
4 with its wooden shelves filled
5 The aroma of freshly brewed co
6 creating an inviting atmospher
7 waiting to be discovered by cu
8 The owner, an elderly man with
9 It was a place where time seen
10 in the magic of reading.
```

A decorative border of various school supplies is scattered around the edges of the slide. At the top left is a blue globe. Next to it are a red paper airplane, a blue pen, a blue notepad, a yellow pencil, a green ruler, a pair of teal scissors, a green pencil, a silver paperclip, an orange book, a pair of red scissors, a yellow ruler, and a blue backpack. At the bottom left is a blue backpack, a yellow ruler, a pair of red scissors, an orange book, a green pencil, a pair of teal scissors, a green ruler, a silver paperclip, a blue notepad, a blue pen, a red paper airplane, and a blue globe. At the top right is a blue backpack. At the bottom right is a blue globe.

DCT(Discrete Cosine Transform)

Summary of failure reasons:

1. Floating-point error

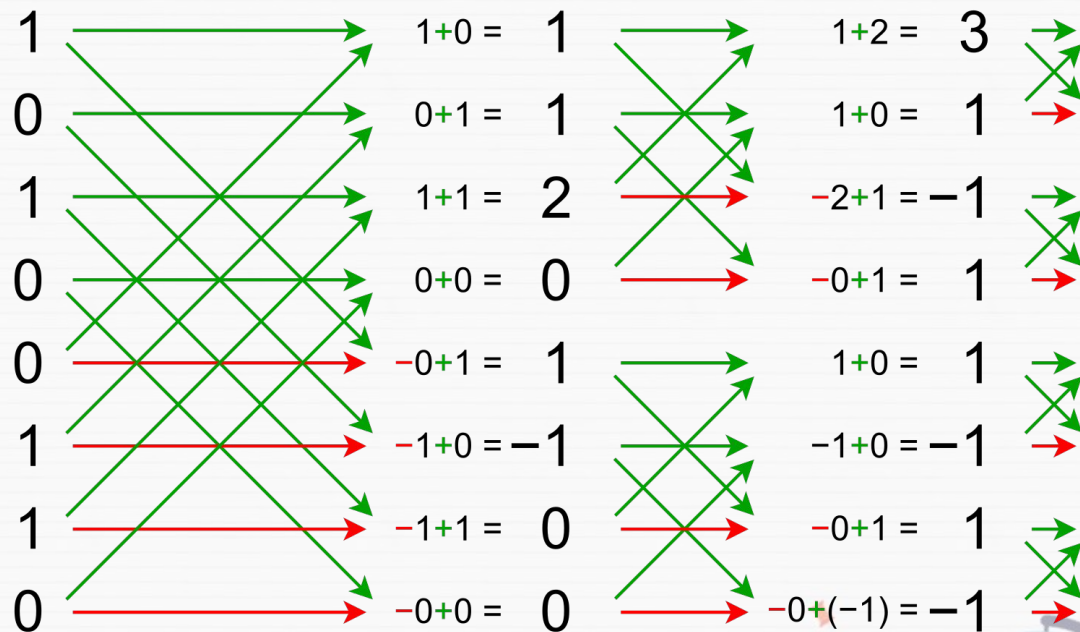
- The volume of text is too large.

2. Boundary effects

- low robustness

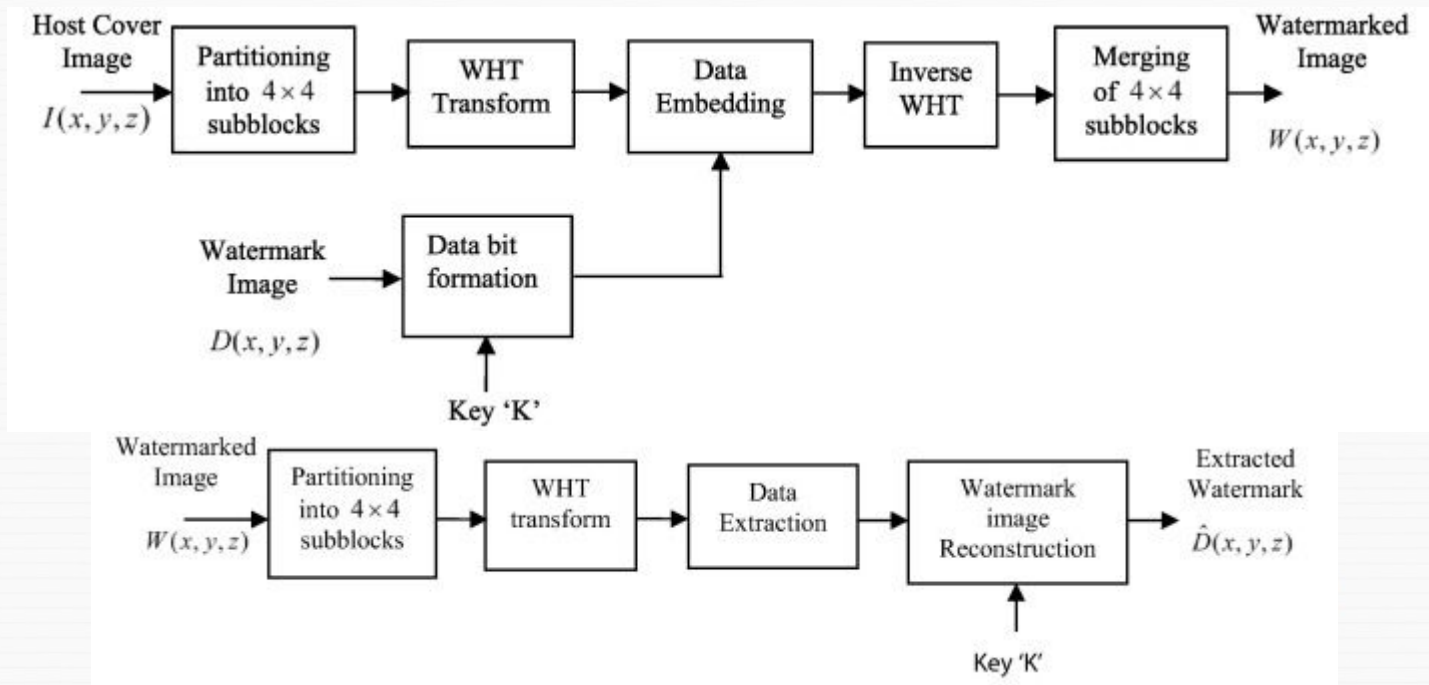
WHT

$$H_m = \frac{1}{\sqrt{2}} \begin{pmatrix} H_{m-1} & H_{m-1} \\ H_{m-1} & -H_{m-1} \end{pmatrix}$$



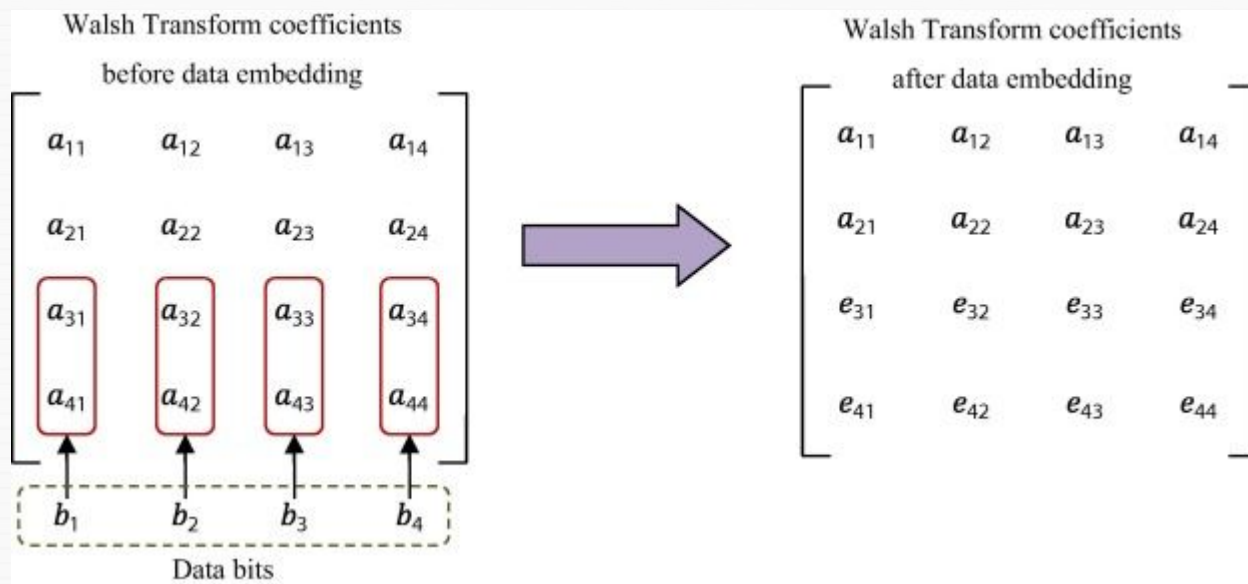
source: https://en.wikipedia.org/wiki/Hadamard_transform

WHT



source: [An effective robust and imperceptible blind color image watermarking using WHT](#)

WHT



WHT

Original Image



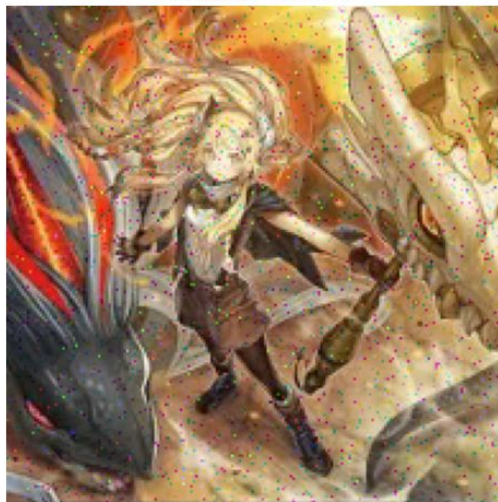
Original Watermark



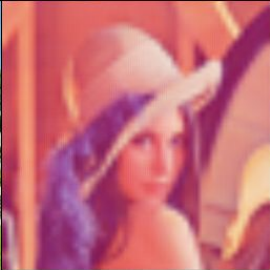
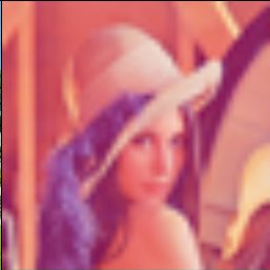
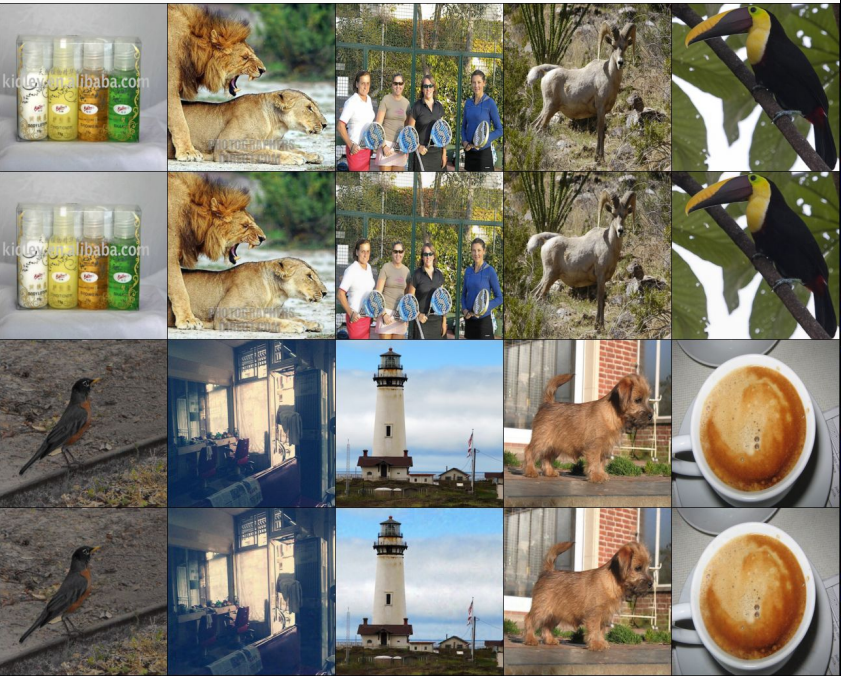
Watermarked Image



Extracted Watermark



Deep Learning



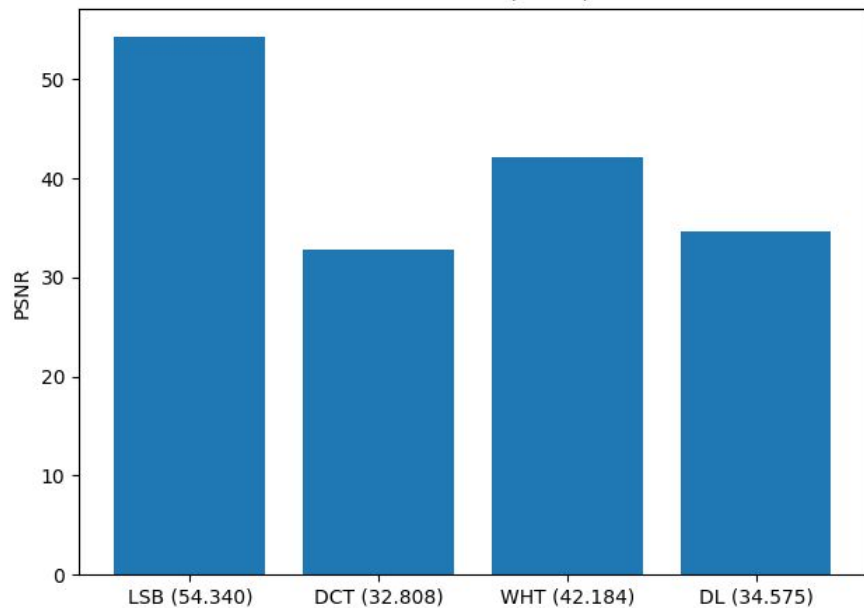
Evaluation

- PSNR

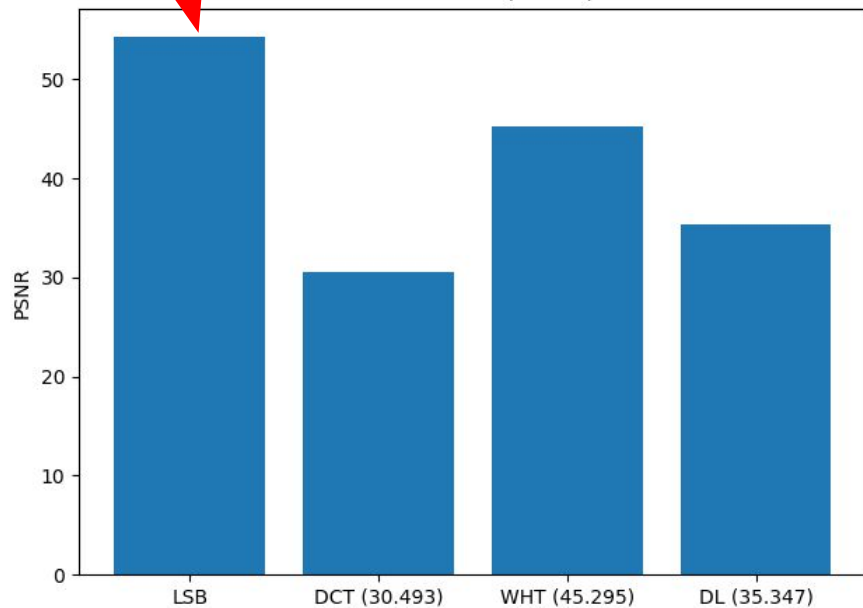
為無限大



PSNR Values (cover)

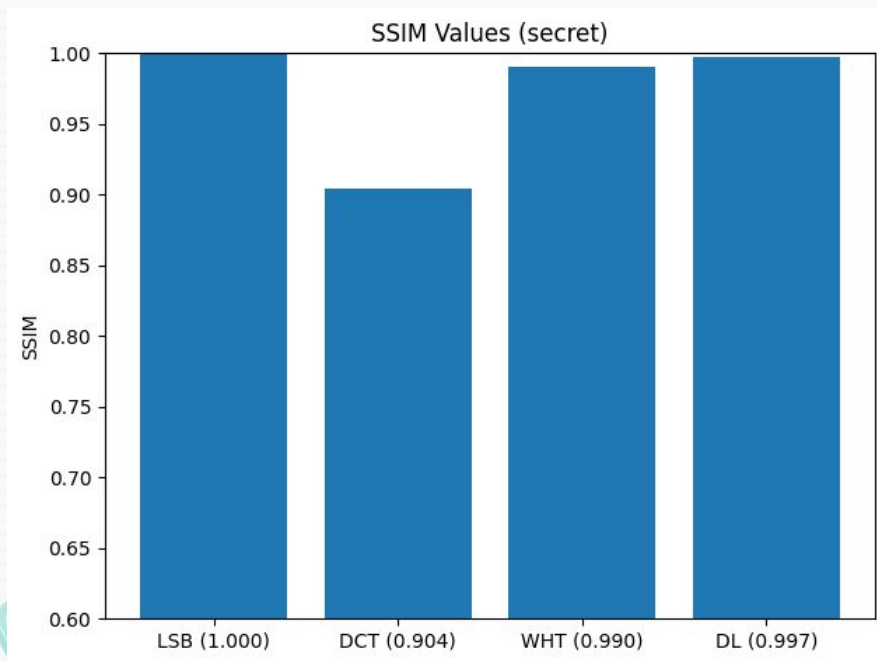
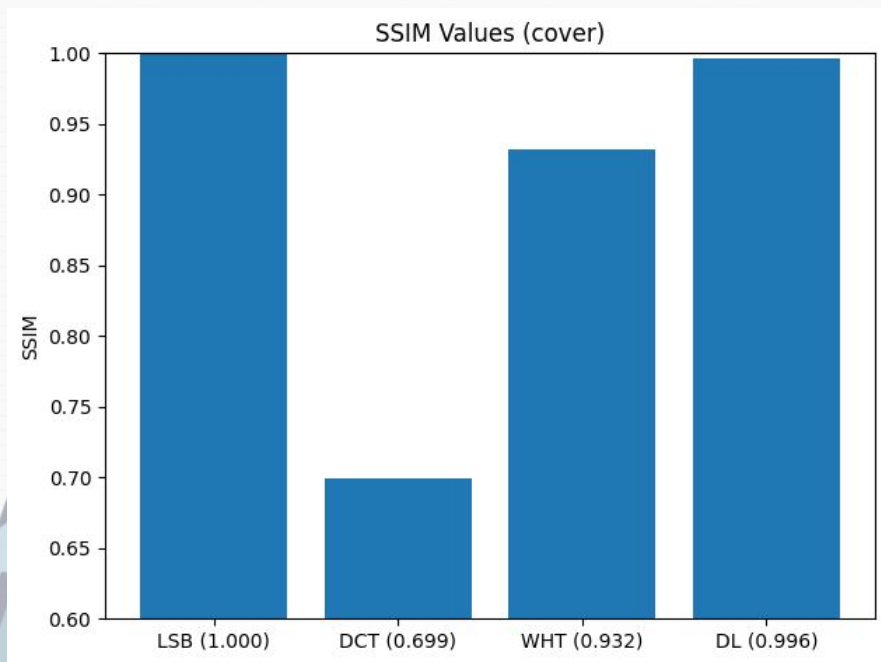


PSNR Values (secret)



Evaluation

- SSIM





Comparison

Pros:

1. LSB方法能無損精確藏入資訊
2. DCT、WHT方法具高隱密性且僅需較低計算量
3. 套用神經網路可以實現各種圖片形式間的圖片隱寫術

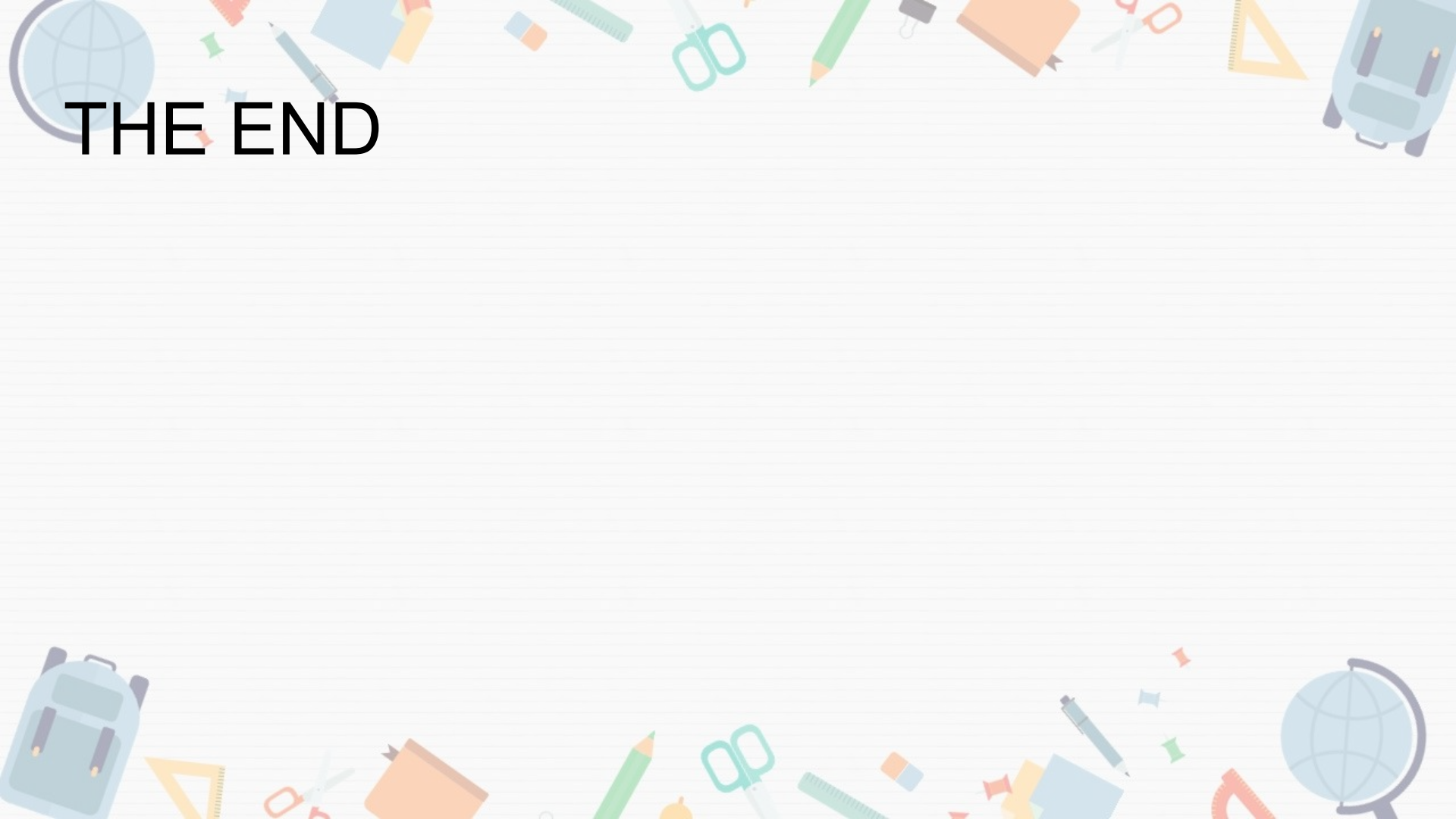
Cons:

1. 若文本量大, 使用DCT方法在Cover藏入資訊後會很明顯
2. WHT方法無法避免誤差
3. 神經網路架構通常會把input、output設為統一大小



Contribution

- 實作一個成功的LSB方法 (可以藏彩色圖片)
- 實作利用DCT並能藏入圖片的方法(但有諸多限制)
- 透過論文記述公式, 重現並實作WHT方法
- 實驗DL方法可以適用多種影像格式
- 對這四種方法進行數值分析並探討差別



THE END