A Novel Technique for Image Authentication in Frequency Domain using Discrete Fourier Transformation Technique (IAFDDFTT)

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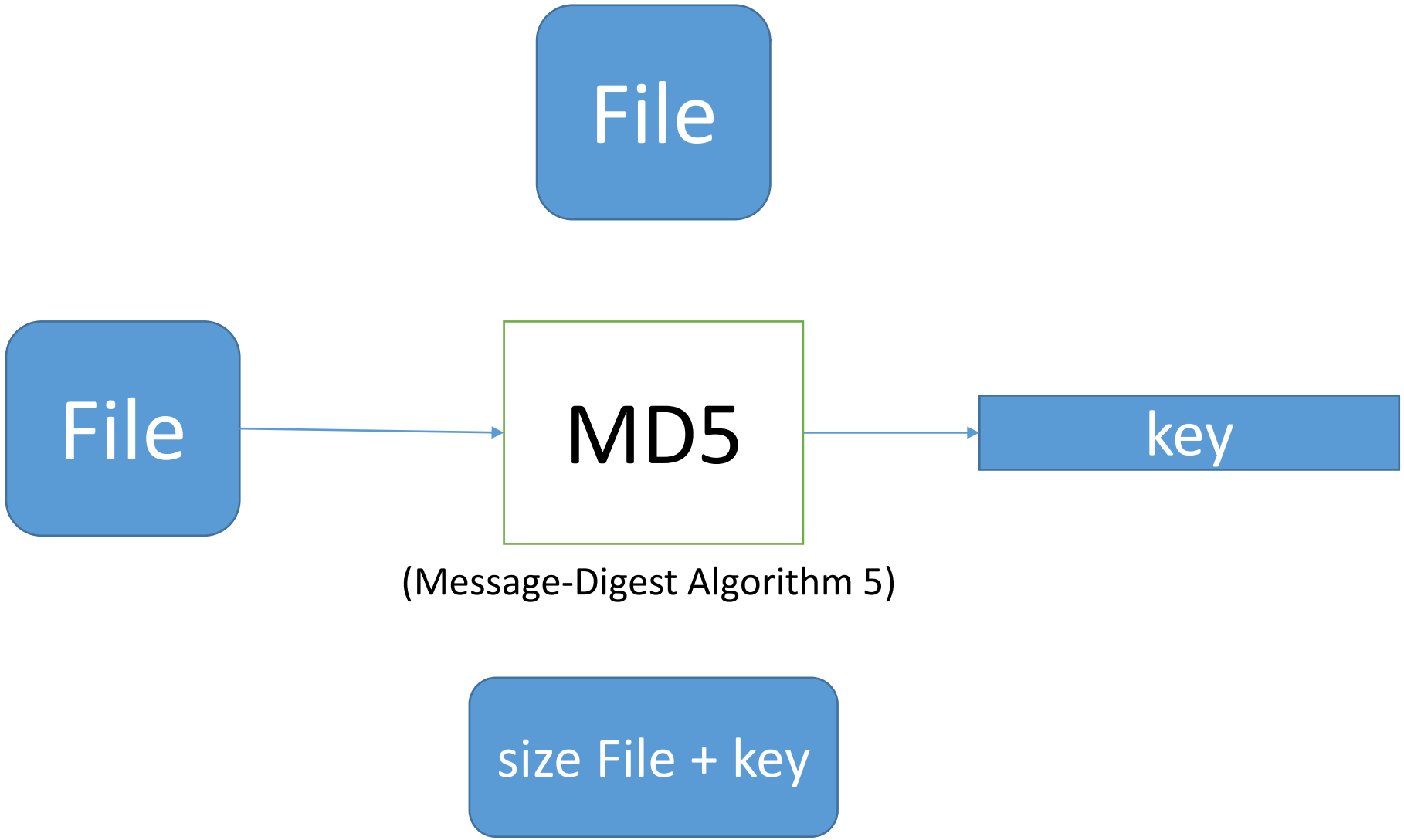
Nabin Ghoshal, Dept. of USIC, University of Kalyani ;

Jyotsna Kumar Mandal, Dept. of Computer Science and Engineering, University of Kalyani

outline

- Algorithm
  - Insertion
  - Extraction
- Analysis
  - Histogram Analysis
  - Noise Analysis
- Conclusions

Insertion



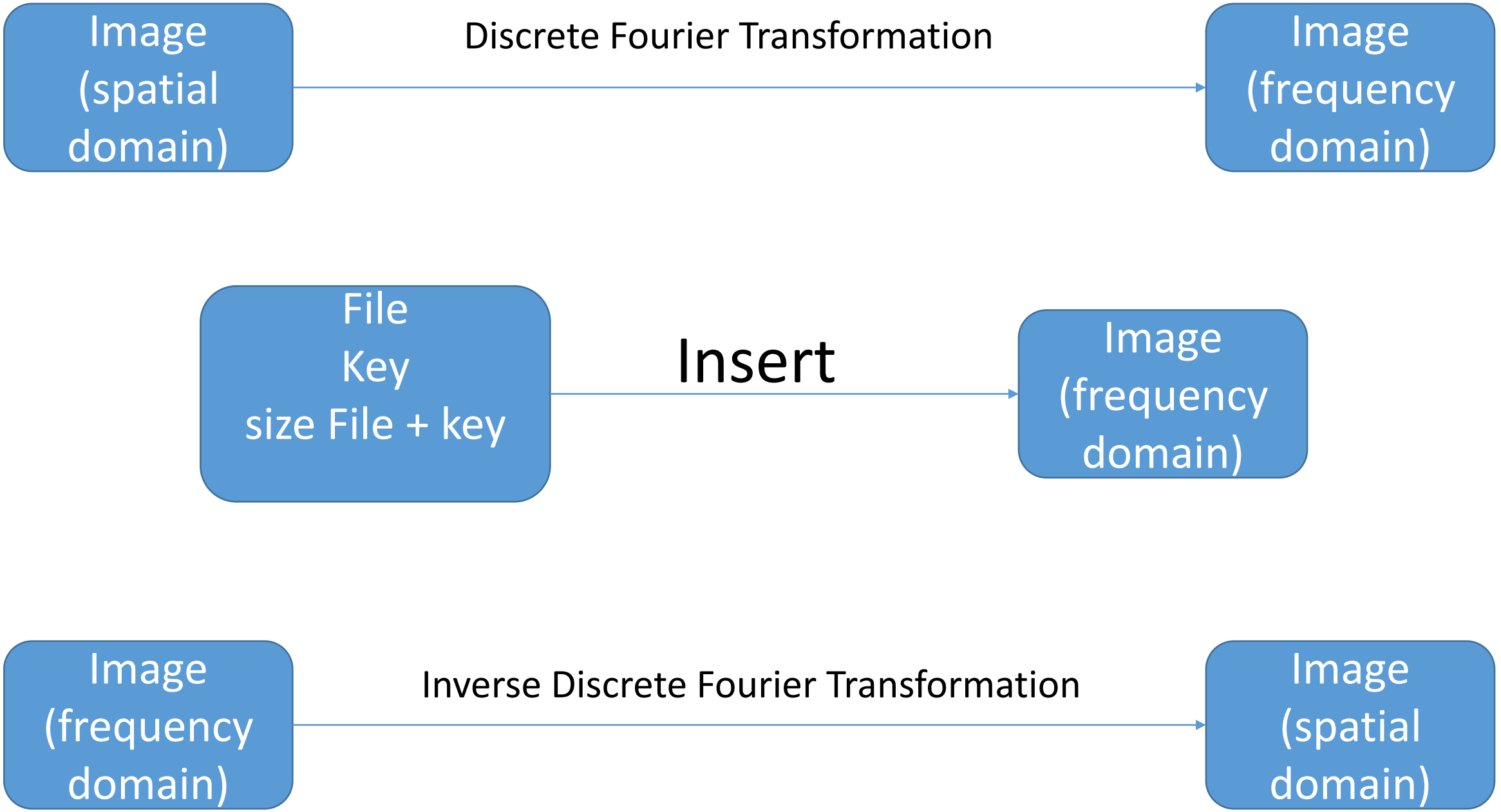


Image (spatial domain)
Discrete Fourier Transformation
Image (frequency domain)
File
Key
size File + key
Insert
Image (frequency domain)
Image (frequency domain)
Inverse Discrete Fourier Transformation
Image (spatial domain)

Discrete Fourier Transformation

$$\text{DFT : } F(u,v) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} [f(x,y)\cos(\frac{2\pi ux}{M}) - i\, f(x,y)\sin(\frac{2\pi vy}{N})]$$

$$\text{IDFT : } f(x,y) = \frac{1}{\sqrt{MN}} \sum_{x=0}^{M-1} \sum_{y=0}^{N-1} F(u,v) \cos\left(\frac{2\pi ux}{M}\right) + F(u,v)\, i \sin(\frac{2\pi vy}{N})$$

Window size (2 X 2)

X	F(0,1)
F(1,0)	F(1,1)

Insert

- F(u,v) = A + Bi　將機密訊息藏入A，其中A為8bit
- 使用者決定藏入s個bit，$1 \le s \le 8$，$s \in N$，則在第 7%(s-1)的bit以LSB藏入s個bit。
- 例：A = 00111001，secret = 10011111，使用者決定藏入3bit，7%3 = 1，A = 0011 001 1

Extraction

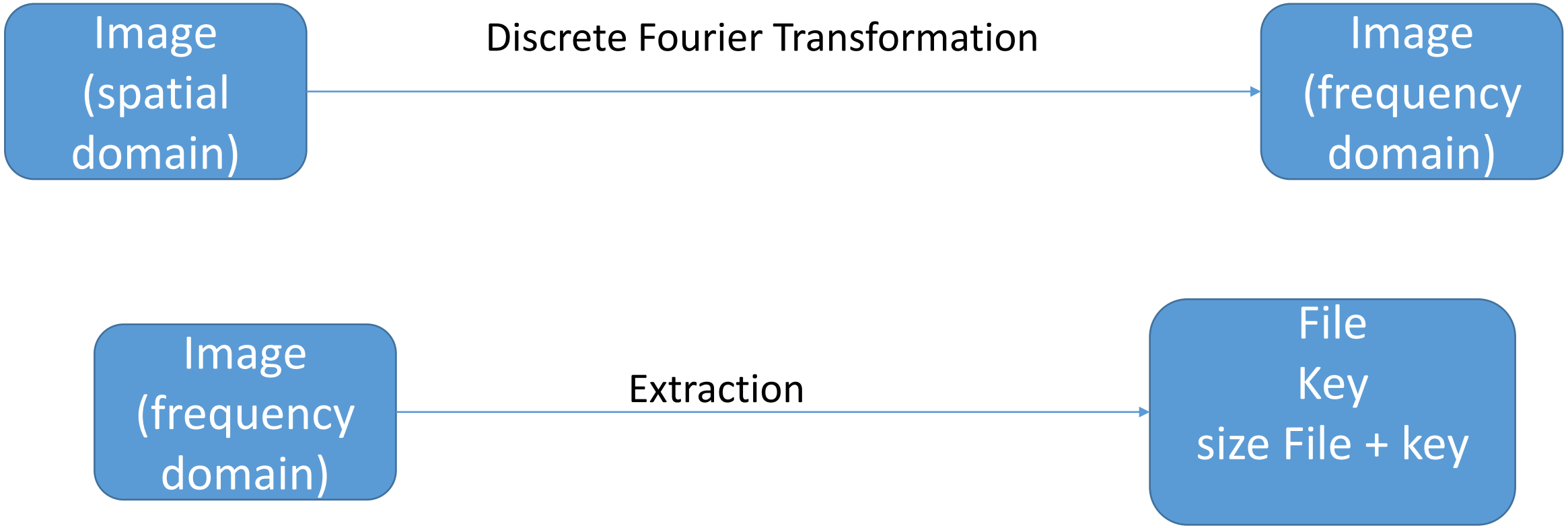


Image (spatial domain)
Discrete Fourier Transformation
Image (frequency domain)
Image (frequency domain)
Extraction
File
Key
size File + key

Authorized

keyA = key → Authorized

keyA ≠ key → Unauthorized

Analysis

80 X 80(Earth) 藏進 250 X 150(Blue-Sky)

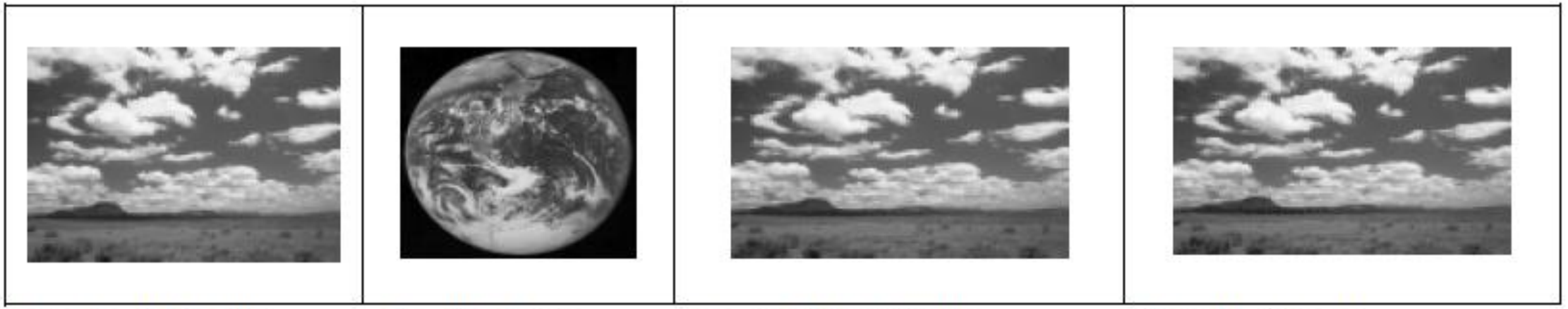


Fig. 2a. Blue-Sky Fig. 2b. Earth Fig. 2c. IAFDDFTT Fig. 2d. S-tools

Fig. 2 : Comparison of visual fidelity in embedding 'Earth' using IAFDDFTT and S-Tools

Histogram Analysis

Frequency Histogram

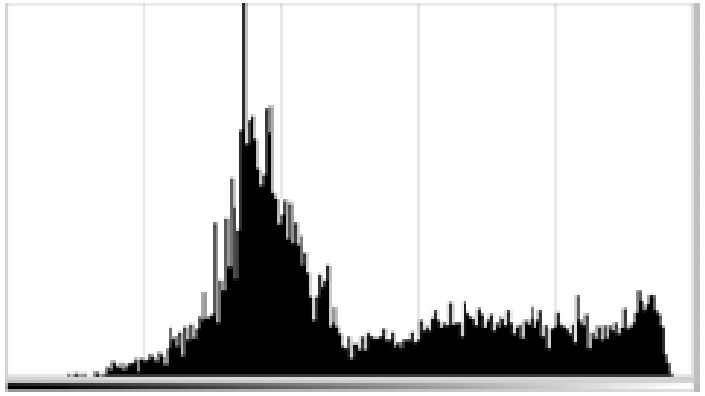


Fig. 4a : ‘Blue-sky’

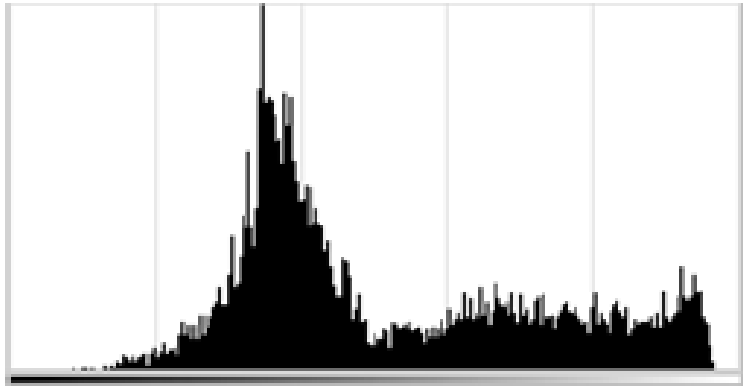


Fig. 4b : IAFDDFTT

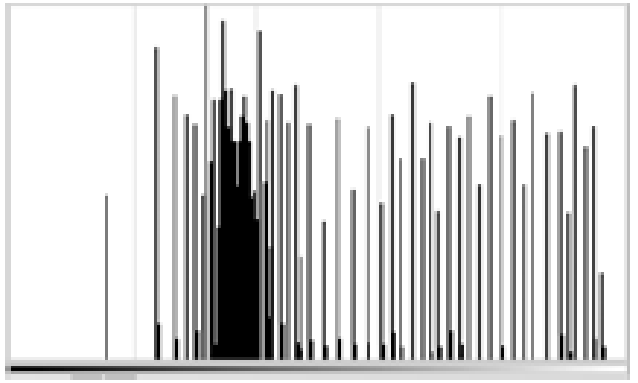
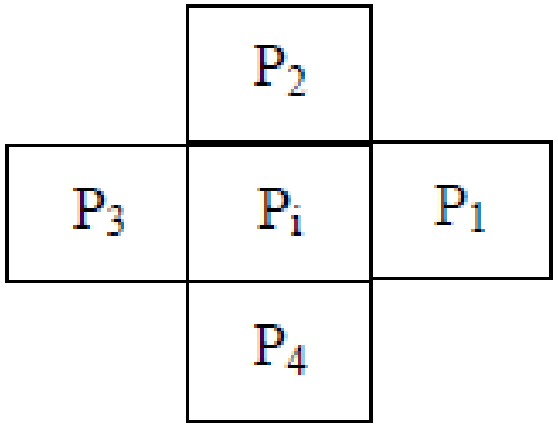


Fig. 4c : S-Tools

Fig. 4: Histogram for image ‘Blue-sky’, embedded ‘Earth’ using IAFDDFTT and S-Tools

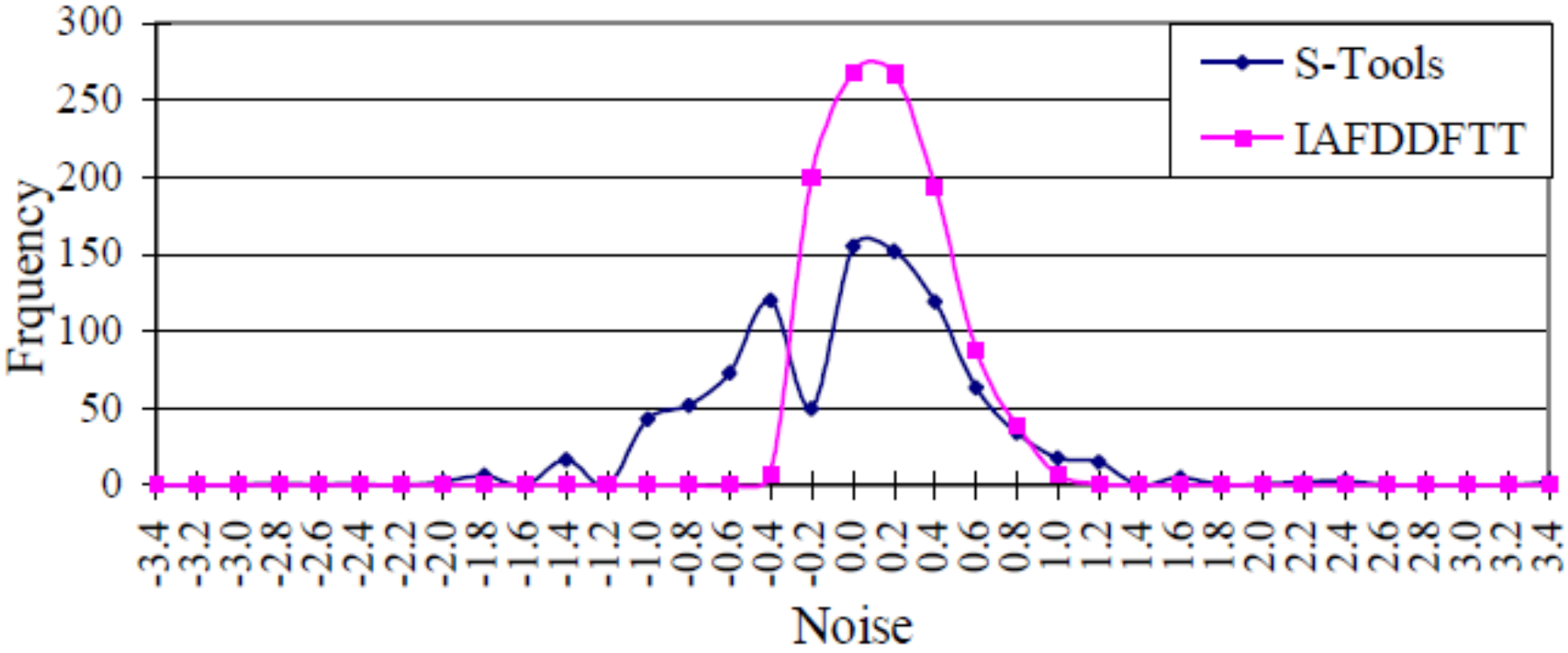
Noise Analysis

$$Noise_{3\times3} = \sum_{i=1}^{m\times n}\left(\left|\frac{p_i^E + \sum_{j=1}^{4} p_j^E}{5}\right| - \left|\frac{p_i^S + \sum_{j=1}^{4} p_j^S}{5}\right|\right)$$



計算方式：將影像切成多個3X3pixel，以最中間那格為基準，計算出相鄰四格與本身的平均。隱藏前(p^S)與隱藏後(p^E)的差值總合。

橫軸為Noise值，縱軸為出現次數



Conclusions

- Author：
  1. As a result the scheme may be more robust against brute force attack.
  2. In IAFDDFTT distortion of image and change of fidelity (like sharpness, brightness etc) is negligible.

- 我的結論：
  1. 作者只用了兩張圖做測試，樣本太少。
  2. S-tool所用的steganography是LSB，比較的結果差異當然明顯。
  3. Noise Analysis這種方式我沒看過，以後分析時多了一項工具。
  4. 在frequency domain下做bit更動是否有問題。
  5. 公式都有問題。

Reference

- Stool and steganographic tools
- Stool download
- Introduction using S-tool
- MD5