Secret Communication

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Steganography

- Data hiding in an original signal for one-to-one secret communication
- In general, a message, an image, and an audio as a carrier signal
- Embedding and extraction of hidden data in a sender and a receiver, respectively
- Detectability of hidden data
- Similar principle of digital watermarking, which creates indelible imprint for ownership, authenticity, integrity of the original signal

Prediction Error Based Data Hiding

- Prediction of a pixel to be embedded or extracted with neighboring pixels
- Embedding and extraction, only if prediction error is equal to predefined values
- Same rule in embedding and extraction processes
- Lossless compression for reversible data hiding
- Other approaches, such as difference and histogram based data hiding

Example of Embedding

- Embedding of hidden data in an even column pixel, only if prediction error is equal to 0
- Prediction from an average of left and right pixels
- Total number of embedding bits = 3 (8 different messages), for example, 000(대기), 001(종료), 010(지상군), 011(잠수함), 100(전투기), 101(핵), 110(후퇴), 111(항복)

Embedding of Hidden Information

Embedding of 011(잠수함)

$m = p + h \,\&\, o = p, if\ e = 0$

100	99	96	96	96
99	99	100	100	95
255	102	99	98	97
255	255	99	99	99
99	255	255	99	98

Original Image

100	99	96	96	96
99	100	100	100	95
255	102	99	99	97
255	255	99	99	99
99	255	255	99	98

Marked Image

Lossless Encoding
(No Quantization)

0	1
1	0
0	1
0	0
0	0

Location Map

Example of Extraction

- Exactly same as the embedding process
- Extraction of hidden data in an even column pixel, only if the location map is equal to 1
- Reconstruction from an average of left and right pixels, based on the location map
- Total number of extraction bits = 3 (8 different messages), for example, 000(대기), 001(종료), 010(지상군), 011(잠수함), 100(전투기), 101(핵), 110(후퇴), 111(항복)

Extraction of Hidden Information

$$h = m - p \;\&\; r = p, if\ e = 0$$

Lossless Decoding

0	1
1	0
0	1
0	0
0	0

Location Map

100	99	96	96	96
99	100	100	100	95
255	99	99	99	97
255	255	99	99	99
99	255	255	99	98

Marked Image

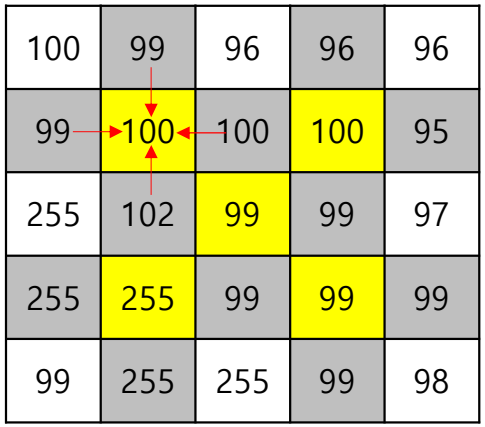
100	99	96	96	96
99	99	100	100	95
255	99	99	98	97
255	255	99	99	99
99	255	255	99	98

Reconstructed Image
(Original Image)

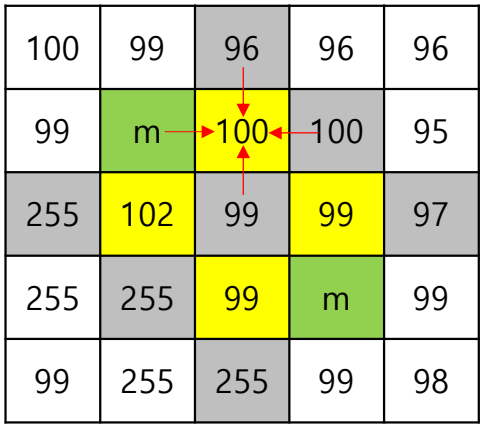
Extraction of 011(잠수함)

Prediction Accuracy

- Embedding of more bits with high accuracy trough advanced prediction
- Adaptive prediction based on characteristics of images or regions



First Prediction



Second Prediction
(if necessary)

Experiment

- Embedding of hidden data into an original image, only if prediction error is equal to 0
- Prediction from neighboring pixels
- Total number of embedding bits = α (2^{α} different messages)
- Lossless compression of the marked image and its location map
- Based on the location map, extraction of the hidden data from the marked image