NSUCRYPTO2024

Problem 3: Steganography and codes

October 21, 2024

Solution

Assume Sam selects an original image where the first two pixels are identical. Sam will encode the message by making subtle changes to the first pixel's bits. The cost for modifying a bit depends on which bit is changed, ensuring the changes are not visually noticeable.

Each pixel in RGB format is represented by 24 bits, split into three colors (red, green, and blue), each using 8 bits for brightness. The costs for changing bits are:

- Modifying bits r_6, r_7, g_6, g_7 or b_6 costs 2 coins.
- Modifying bits r_8, g_8, b_7, or b_8 costs 1 coin.

Based on this, we encode the 16 possible messages with minimal changes to the pixel. Betty can compare the first and second pixels of the image to identify which bits have been modified, and from that, extract the secret message.

Encoding Method (Lookup Table)

Message	Changed Bits	Cost
0	No changes	0
1	r_6	2
2	g_6	2
3	b_6	2
4	r_7	2
5	g_7	2
6	b_7	1
7	r_8	1
8	g_8	1
9	b_8	1
10	b_7, r_8	2
11	b_7, g_8	2
12	b_7, b_8	2
13	r_8, g_8	2
14	r_8, b_8	2
15	g_8, b_8	2

Table 1: Lookup table for encoding messages based on pixel bit changes

Decoding Method for Betty

Betty will download the encoded image and compare the first pixel with the second pixel to check for any differences in the bits. Based on which bits have changed, she can use the table to determine which message Sam encoded. Since Sam makes sure the first two pixels of the original image are identical, any changes will correspond directly to the message Sam wants to send.

This method ensures that the changes are visually imperceptible and cost no more than 2 coins while allowing Sam to encode any of the 16 possible messages.