Least Significant Bit Steganography: Hiding Text, Images, and Files

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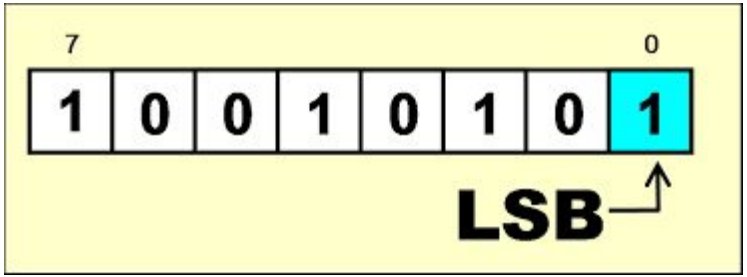
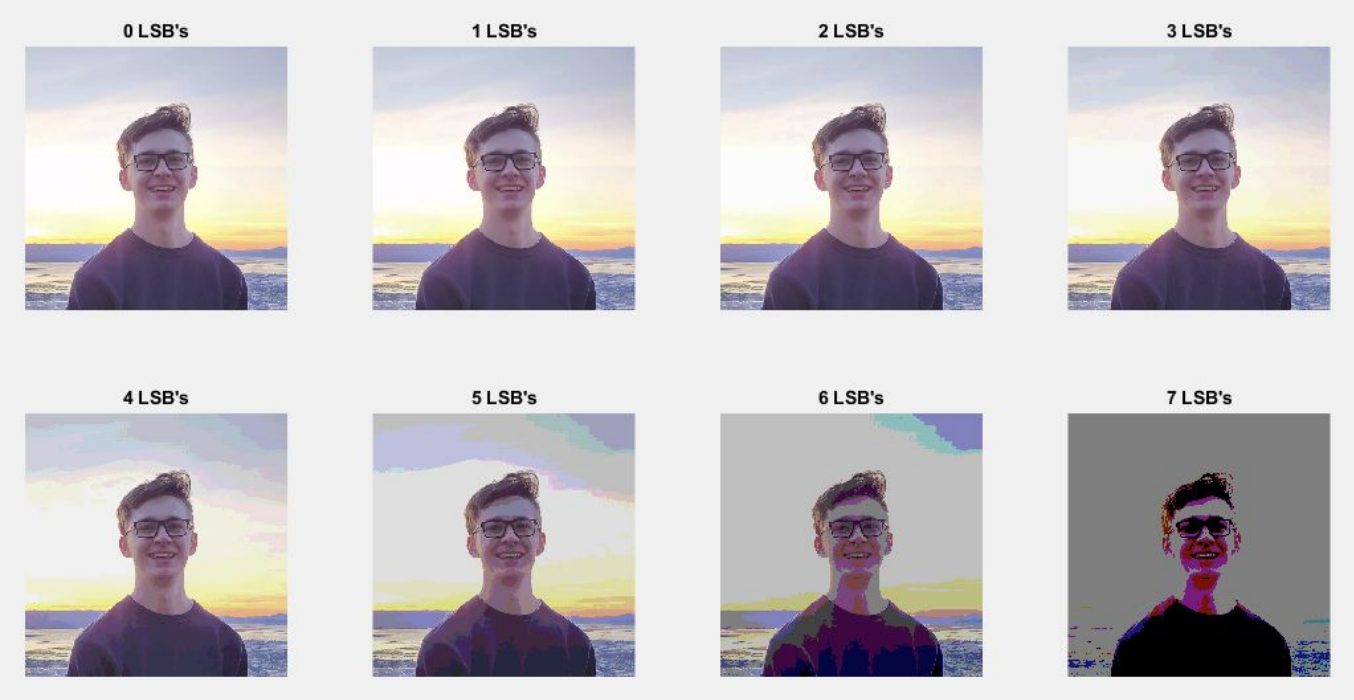
Least Significant Bit Steganography

- Images use 8 bit of resolution for Red, Green, and Blue colors each
- full resolution not needed, can alter lower “least significant bits” without large visual repercussions
- Can be utilized to hide media within 2D images without detection
- Can encrypt more bits of data with more LSB’s, at the loss of image quality

01010010
01000111
01000010



Varying Cleared LSB's Within an Image



MATLAB Solution

Hiding Process

1. Load Original Image to hide data within
2. Load Hidden Data to hide within Original Image
3. Convert Hidden Data to 1D array of bits from original file type
4. Clear N least significant bits from Original Image
5. Set N least significant bits from Original Image to 1D Hidden Data bits, generating Modified Image

MATLAB Solution

Recovery

1. Iterate over every pixel of Modified Image to recover N least significant bits of Hidden Data
2. Convert 1D array of Hidden Data bits into original media type

Analysis

1. Display Original and Modified Image side by side
2. Compare structural similarity index (ssim) of Original and Modified Image

MATLAB Solution

Baseline Image

- Caden, 670 x 673 png file

Media to Hide

- Bee Movie Script (86,091 characters)
- Bee Movie Script 9 Times (774,819 characters)
- Cliffs Image, 256x256 jpeg
- Landscape Image, 616 x 462 jpeg

Hiding Text Within Image

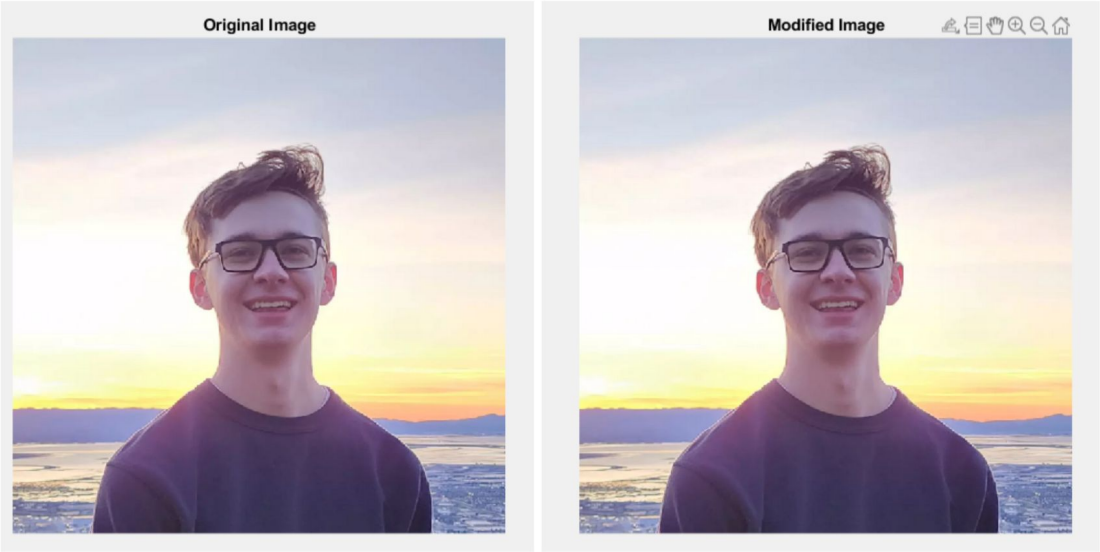


Figure 1. Original Caden Image (Left), Bee Movie Text Embedded into Caden N=1 (Right)

Hiding Text Within Image

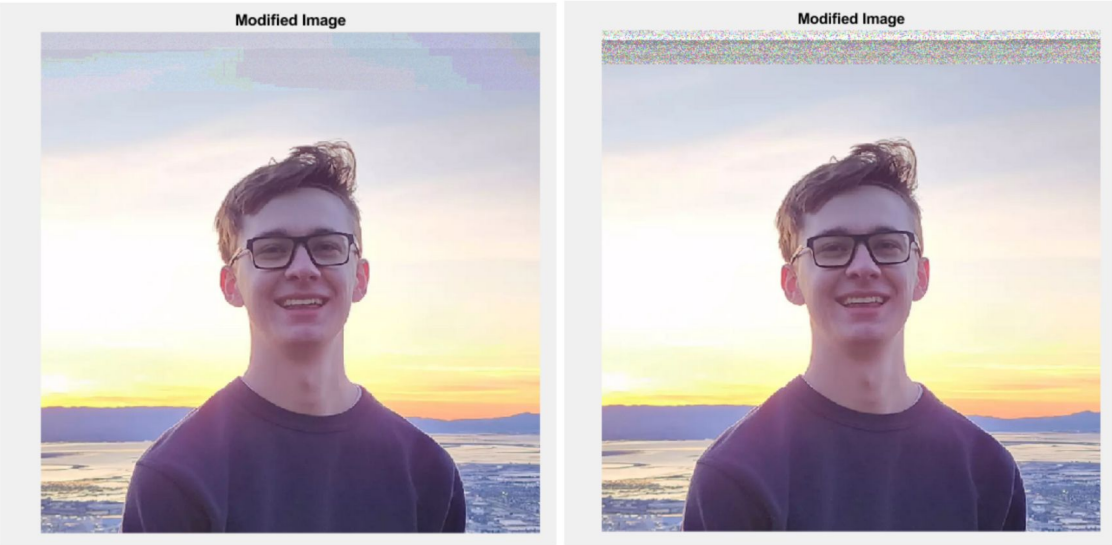


Figure 2. Bee Movie Text Embedded into Caden, N=4 (Left), N=7 (Right)

Hiding Text Within Image

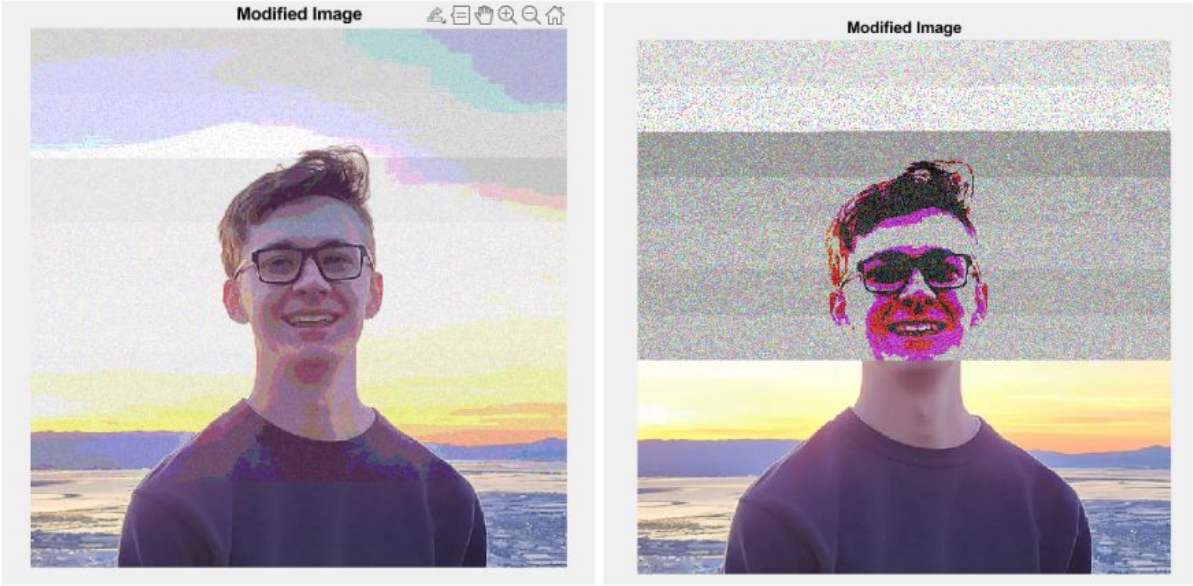


Figure 3. Bee Movie x9 Text Embedded into Caden, N=5 (Left), N=7 (Right)

Hiding Text Within Image

N Bits Hidden	1	2	3	4	5	6	7
SSIM	0.99855	0.99672	0.9937	0.98353	0.95263	0.94069	0.93373

Table 1. Structural Similarity Index for Bee Movie Script into Caden

N Bits Hidden	1	2	3	4	5	6	7
SSIM	Too Small	Too Small	Too Small	Too Small	0.65244	0.46648	0.44219

Table 2. Structural Similarity Index for Bee Movie Script X9 into Caden

Hiding Images Within Images

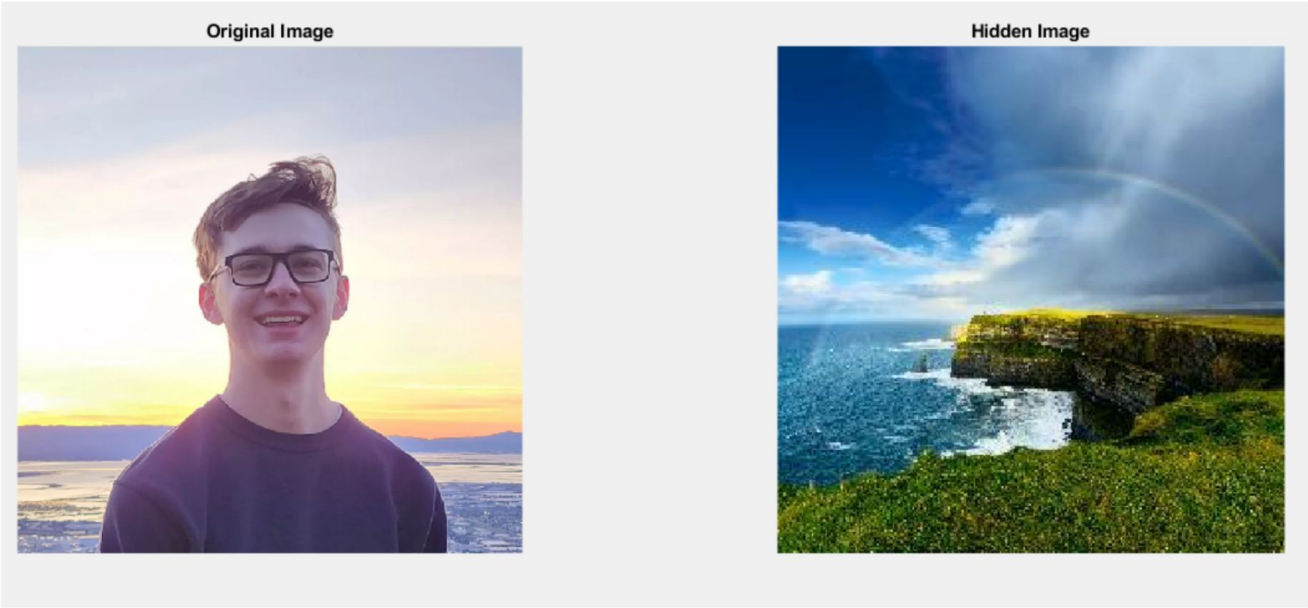


Figure 4. Original Caden with Hidden Image Cliffs

Hiding Images Within Images

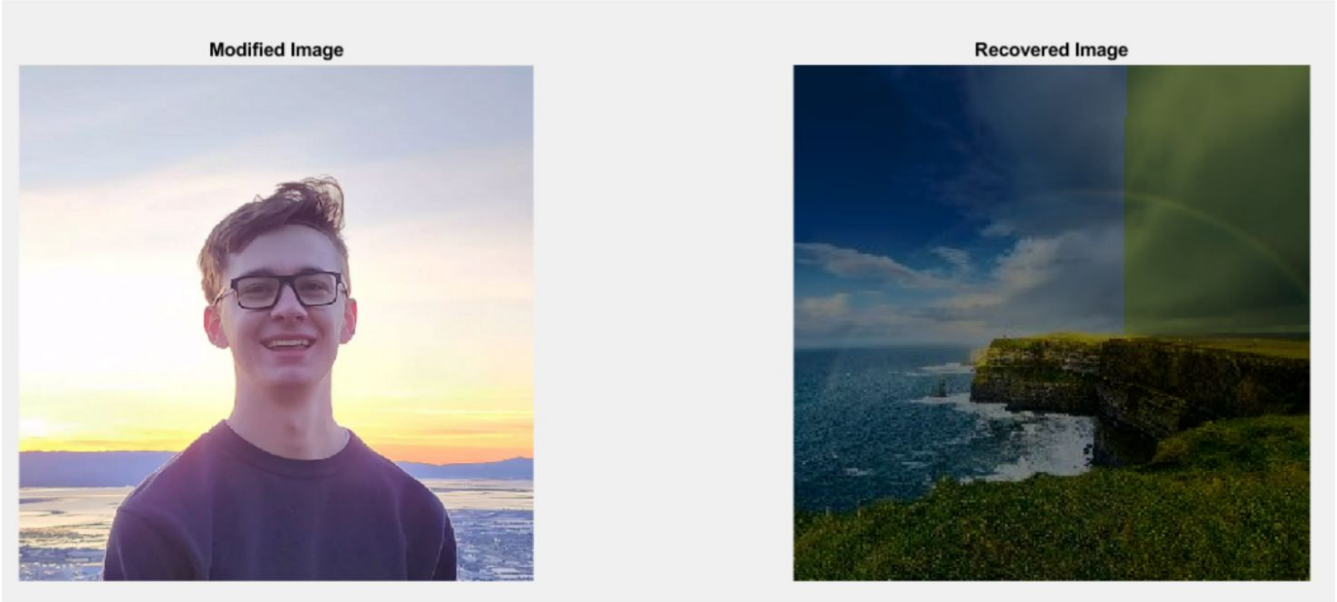


Figure 5. Cliffs Image Embedded into Caden, N=1

Hiding Images Within Images

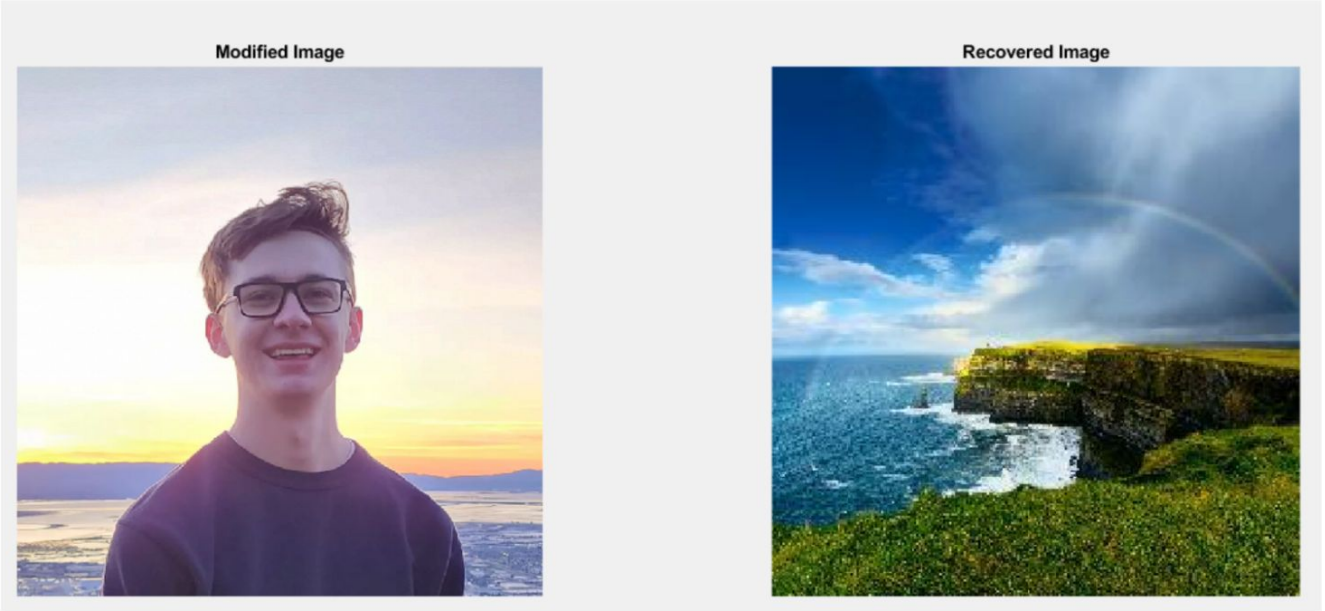


Figure 6. Cliffs Image Embedded into Caden, N=2

Hiding Images Within Images

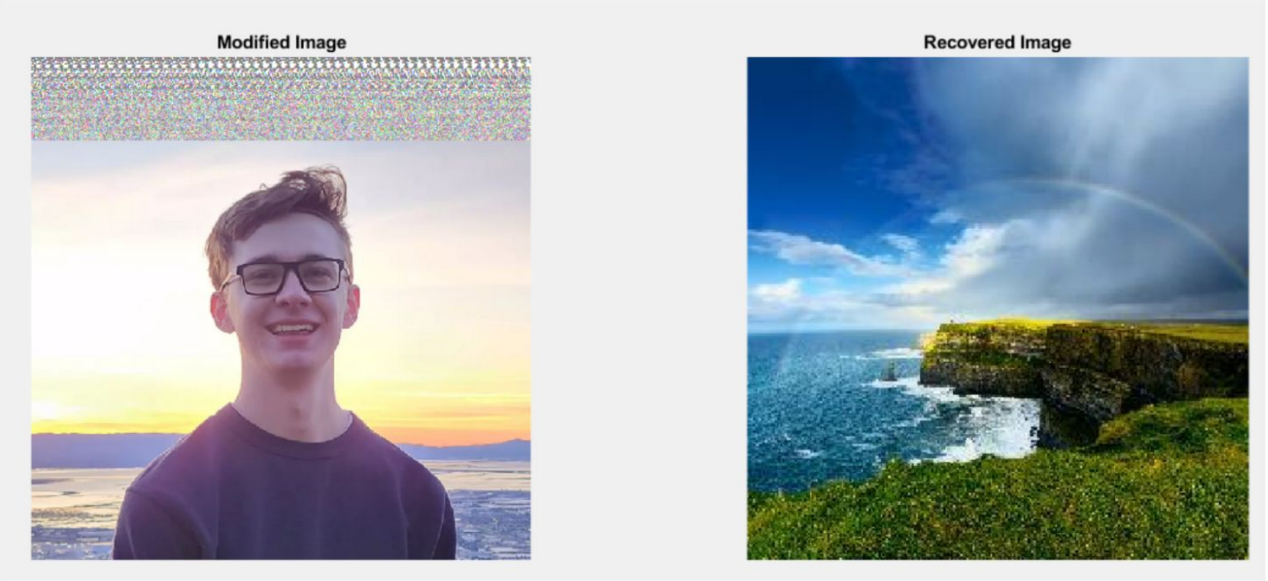


Figure 7. Cliffs Image Embedded into Caden, N=7

Hiding Images Within Images

N Bits Hidden	1	2	3	4	5	6	7
SSIM Original Image	0.99782	0.98949	0.97253	0.93363	0.86951	0.83697	0.83531
SSIM Recovered Image	0.48562	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

Table 3. Structural Similarity Index for Cliffs Image into Caden

Hiding Images Within Images

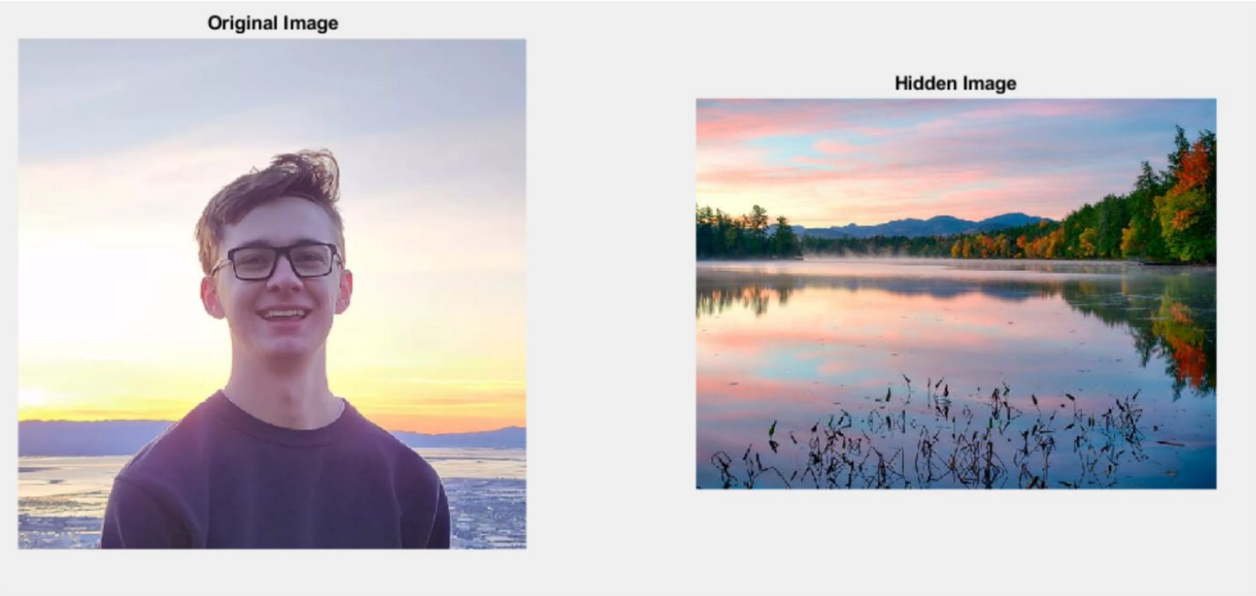


Figure 8. Original Caden with Hidden Landscape

Hiding Images Within Images

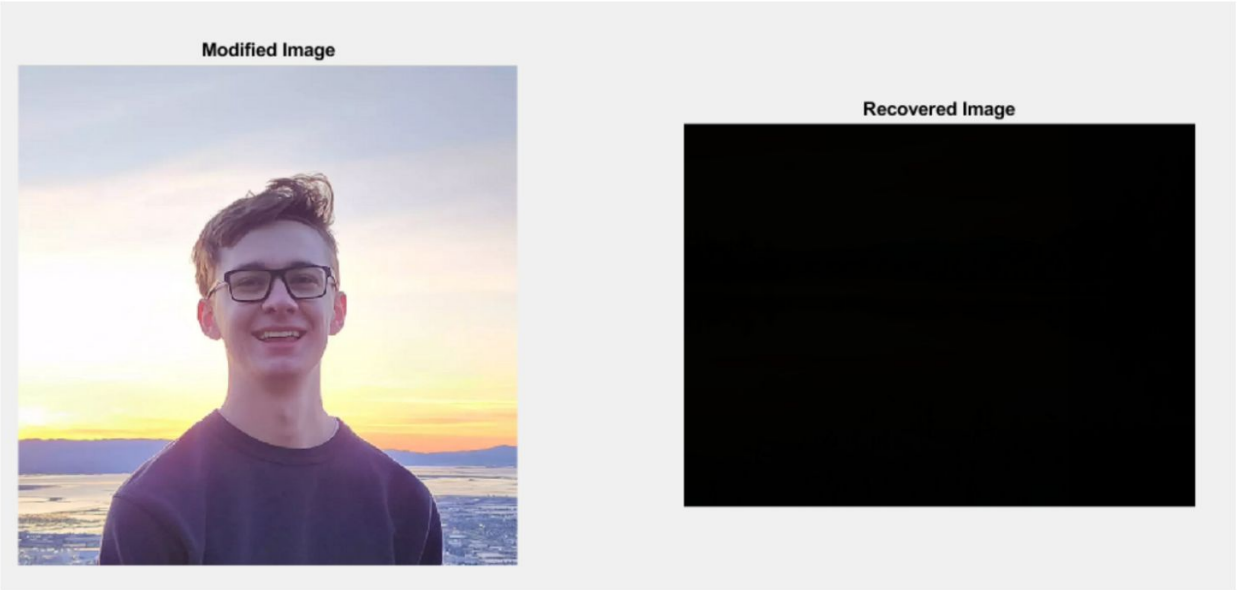


Figure 9. Landscape Image Embedded into Caden, N=1

Hiding Images Within Images

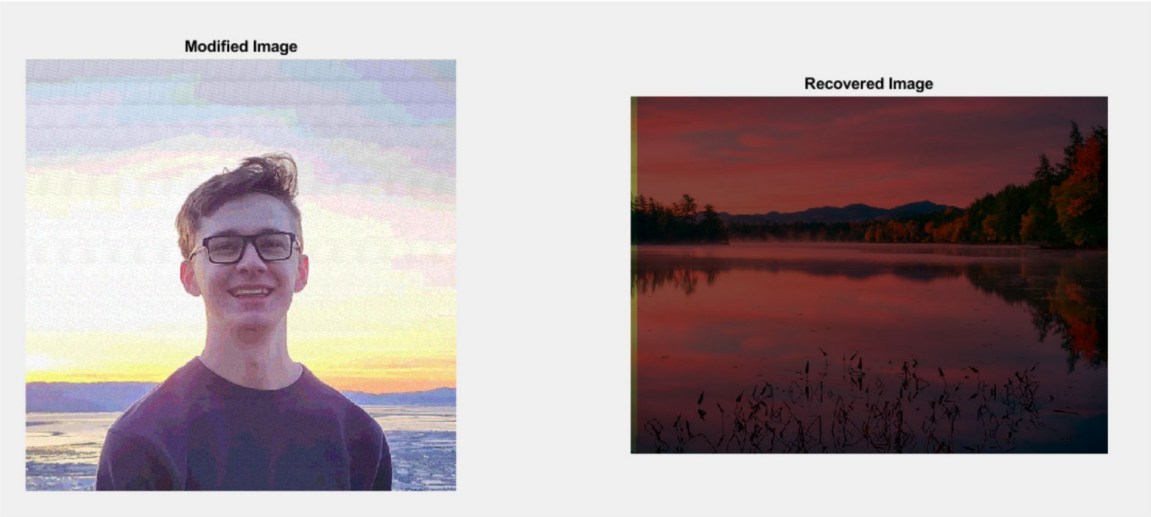


Figure 10. Landscape Image Embedded into Caden, N=4

Hiding Images Within Images

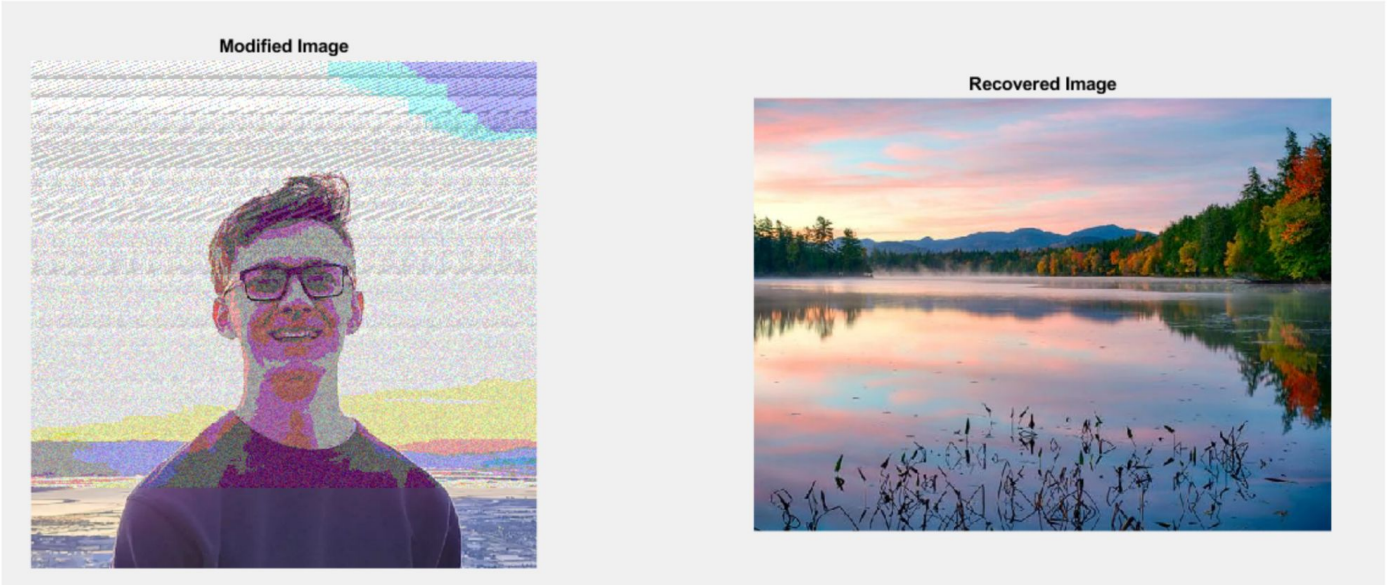


Figure 11. Landscape Image Embedded into Caden, N=6

Hiding Images Within Images

N Bits Hidden	1	2	3	4	5	6	7
SSIM Original Image	0.99804	0.98622	0.94642	0.8089	0.54971	0.36106	0.31908
SSIM Recovered Image	0.00397	0.020648	0.061384	0.25223	0.86167	1.00000	1.00000

Table 4. Structural Similarity Index for Landscape Image into Caden

Hiding Bitstream Within Image

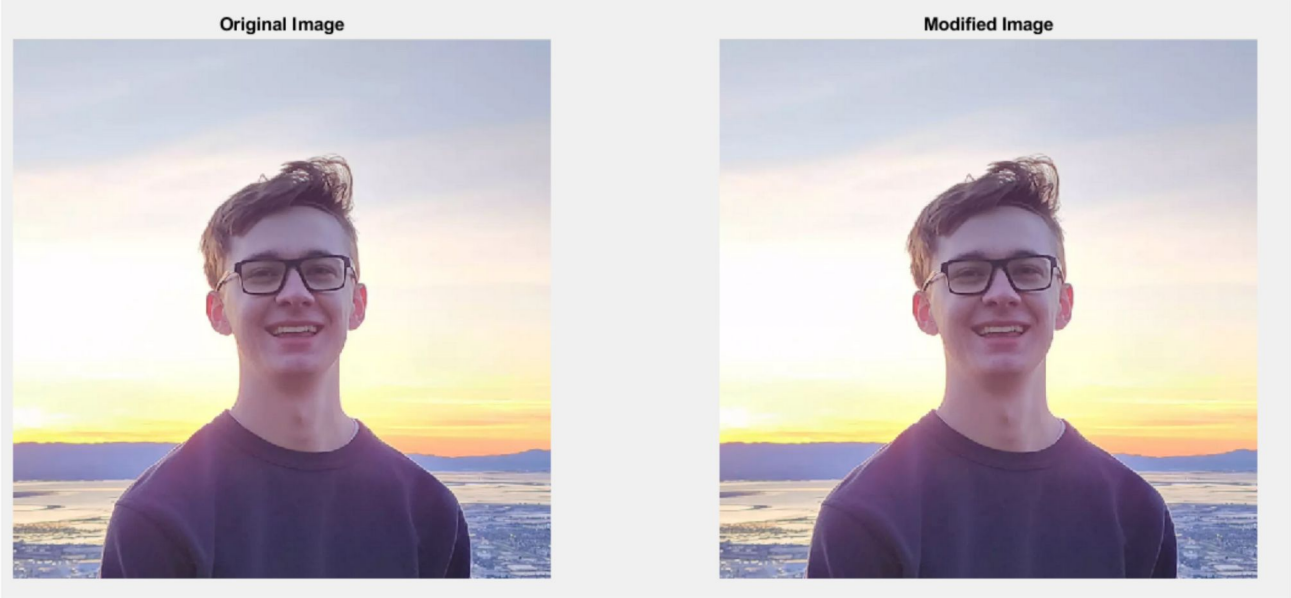


Figure 12. Bee Movie Embedded into Caden, N=1, ssim=0.99828

Hiding Bitstream Within Image

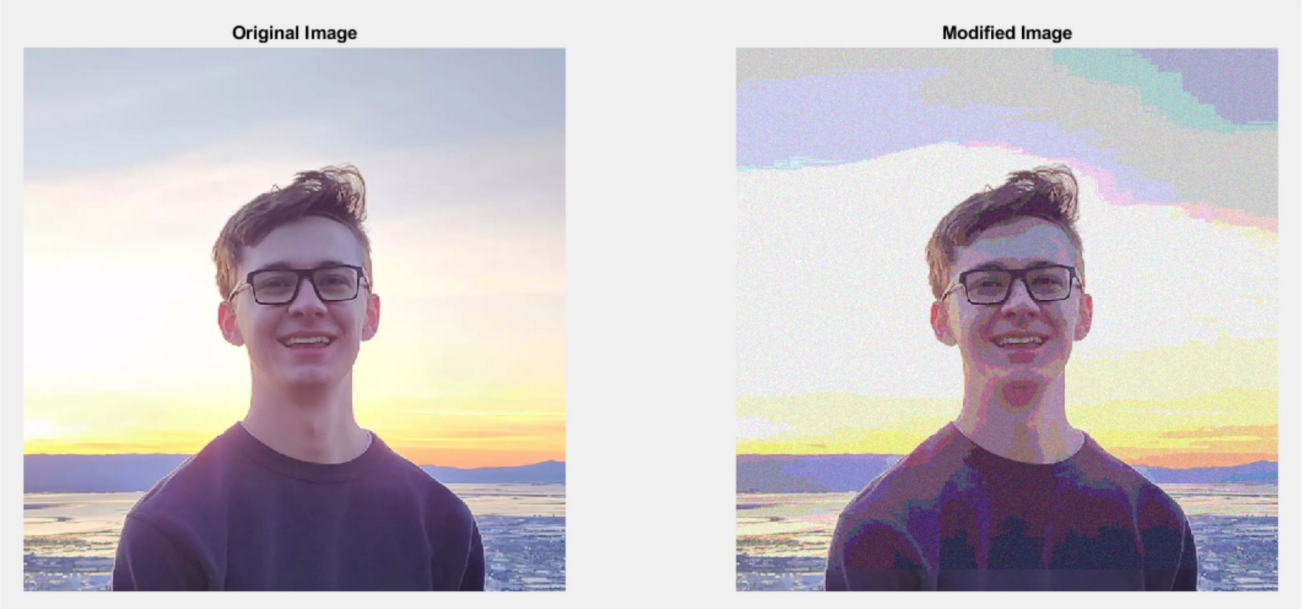


Figure 13. Bee Movie x 9 . Embedded into Caden, N=5, ssim=0.62883

Hiding Bitstream Within Image

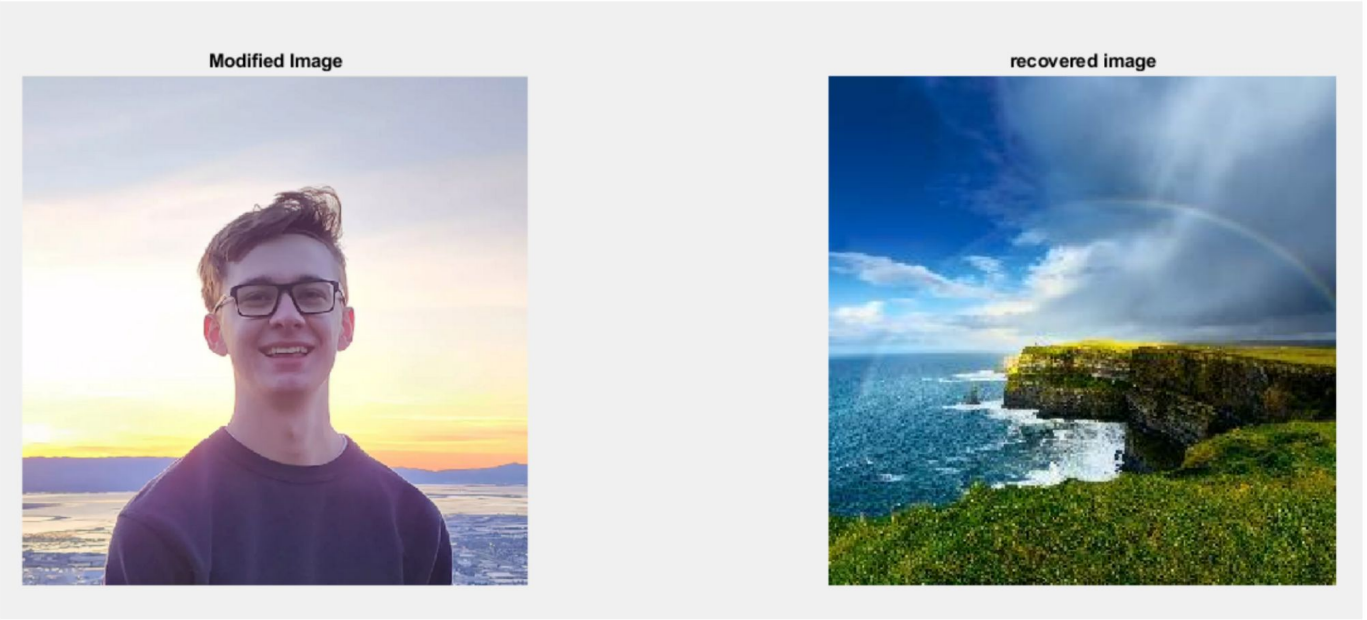


Figure 14. Landscape Embedded into Caden, N=1, ssim=0.99981

Hiding Bitstream Within Image

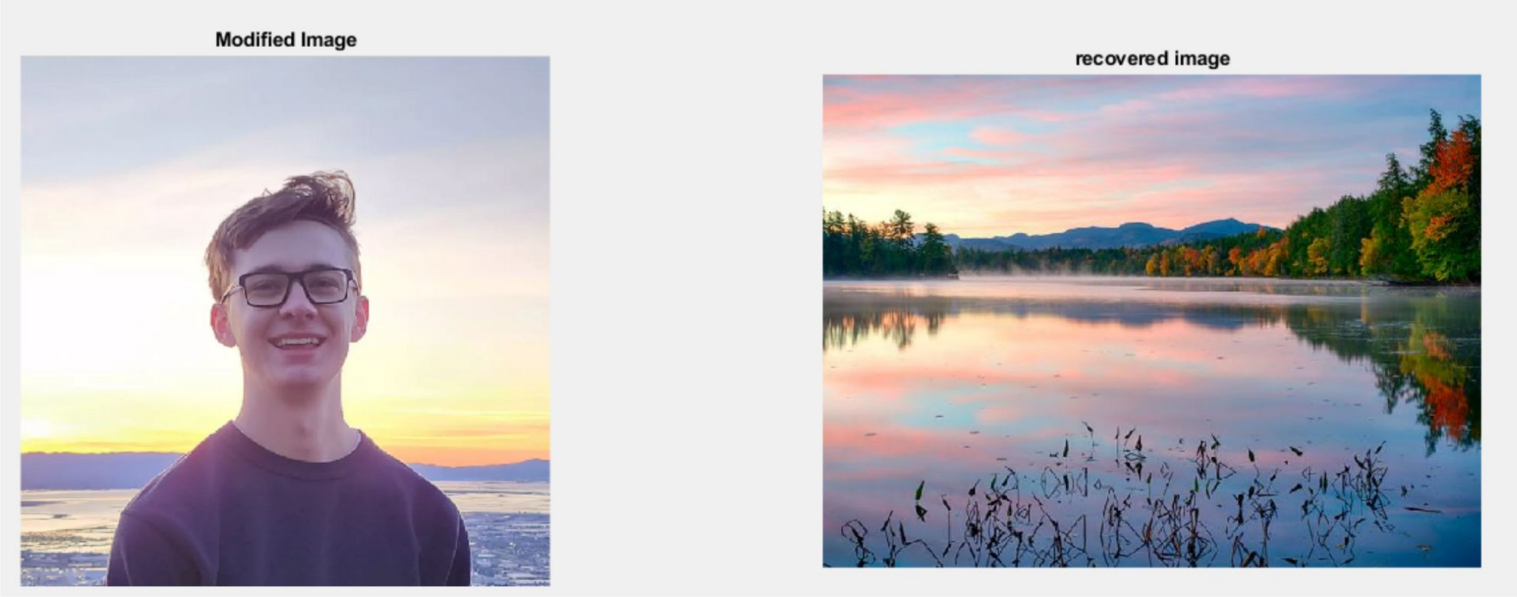


Figure 15. Landscape Embedded into Caden, N=1, ssim=0.99916

Bitstream Comparison

Original Hiding with Landscape, N=6

Bitstream Version with Landscape, N=1

Hiding Bitstream Within Image

File	Bee Movie	Bee Movie x9	Cliffs	Landscape
Original N	1	5	2	6
Bitstream N	1	5	1	1
Original ssim	0.99855	0.65244	0.98949	0.36106
Bitstream ssim	0.99828	0.62883	0.99981	0.99916
SSIM Improvement %	99.973%	96.381%	101.042%	276.729%

Table 5. Bitstream Improvement

Fun With the Bits (Upscaling)

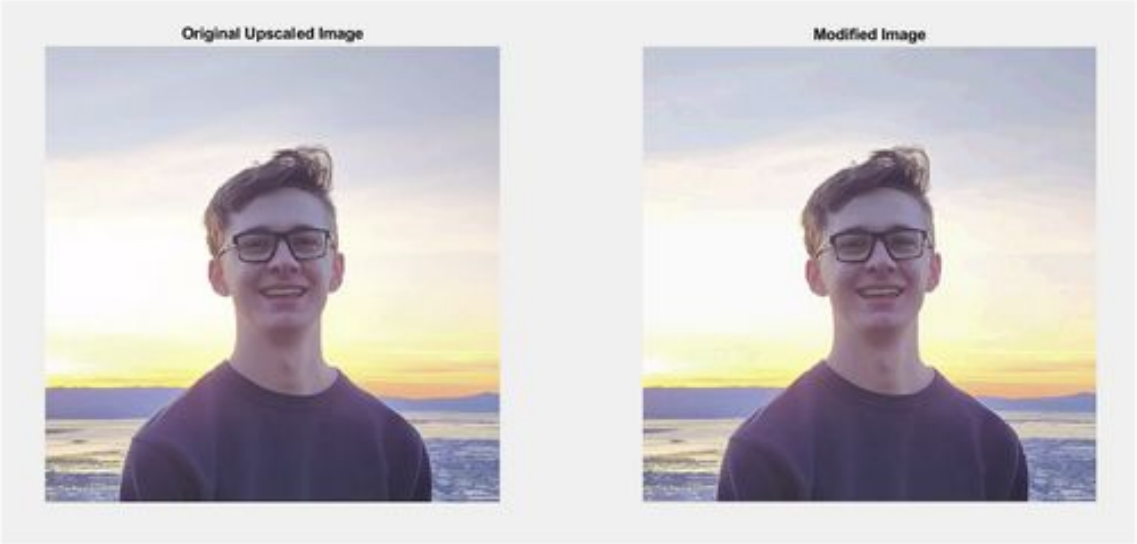
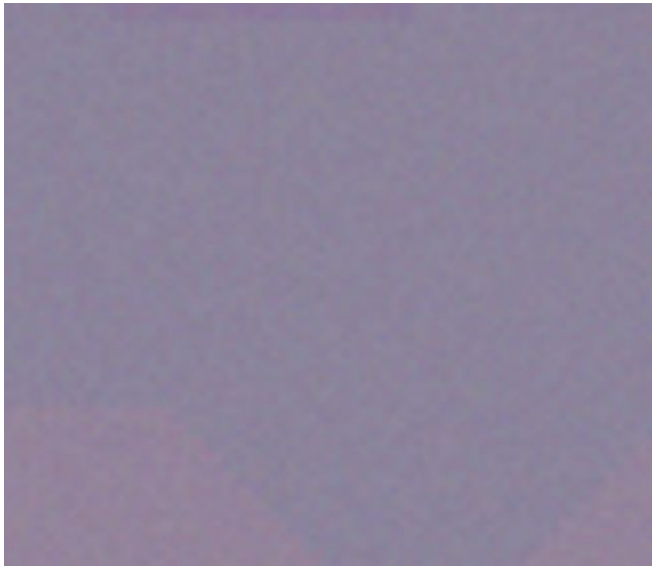


Figure 16. Bee movie film embedded in upscaled Caden, N=2, ssim=0.9621



Cadens Forehead zoomed

Fun with the bits (lossless compression)

Figure 17. Caden image hidden within itself, N=3, ssim=0.95966

Special thanks

- Caden Kraft - Baseline Image
- Jesse Gillingham - Proved we needed zero padding since “88 is not divisible by 5”

References

[1] D. Neeta, K. Snehal and D. Jacobs, "Implementation of LSB Steganography and Its Evaluation for Various Bits," *2006 1st International Conference on Digital Information Management*, Bangalore, India, 2007, pp. 173-178, doi: 10.1109/ICDIM.2007.369349.

[2] https://cadenkraft.com/

Questions