

COMP 3422 Assignment 1 (15% of the Final Score)

Deadline: 23:59 20-Feb-2024

February 7, 2024

WARNING: You may discuss with peer students, but you need to answer all questions independently by yourself. Any cheating or copying detected will result in a 0 score, and all candidates involved will be reported to the department.

1 Basics of Image/Video/Audio (60 marks)

(1) As shown in Figure 1, suppose we have a color image with a resolution of 2×2 pixels. Each pixel has 24 bits representing red (8 bits), green (8 bits) and blue (8 bits) respectively. However, we notice that humans are more sensitive to Red and Green than to Blue - in fact, 1.5 times more sensitive to Red and Green than to Blue.

- a) How could you best make use of the 24 bits available? (10 marks)
- b) Give your new strategy, convert the existing 2×2 image to a new image. Write down the new decimal integers in Figure 2. (10 marks)
- c) Write down the 9th bit plane of two images. The first bit of red color is counted as the 0th plane, and the last bit of blue color is counted as the last plane of the image. (10 marks)

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|------------------------|-------------------------|
| R:32 G:128 B:245 | R:100 G:201 B:15 |
| R:231 G:16 B:80 | R:176 G:143 B:196 |

Figure 1

| | |
|----------------|----------------|
| R: G: B: | R: G: B: |
| R: G: B: | R: G: B: |

Figure 2

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| | |

The 9th bit plane of Figure 1

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| | |

The 9th bit plane of Figure 2

(2) Suppose we have an audio signal $x(t) = 5 + \sum_{k=6}^{10} k * \sin(2\pi(k-5)^2 * t + \pi/2)$, where t represents time in seconds.

- a) What is the highest frequency in the signal? (10 marks)
- b) What is the lowest frequency in the signal? (10 marks)
- c) What is the Nyquist rate of the signal? (10 marks)

2 Implementation (40 marks)

(3) Given the example image used in Tutorial 3, please visualize the 0^{th} and 5^{th} bit planes of red color, the 3^{rd} and 7^{th} bit planes of blue color. (20 marks)

(4) Plot the audio signal $x(t) = 5 + \sum_{k=1}^{10} k * \sin(2\pi(k-5)^2 * t + \pi/2)$ from $t = 0$ to $t=100$. (20 marks)

Note: For question Section 1, detailed steps need to be provided. If you only show the final numbers, the majority of marks will be deducted. For question Section 2, you need to submit both python code and visualization results with brief descriptions.