# CS435 Assignment 1 - Pixel Operations

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## 1 Theory Questions

1. Given: $(x, y, z) = (3, 5, 10)$ and $z' = 10$
   Recall: $(x', y') = \frac{z'}{z}(x, y)$
   Substitute: $(x', y') = \frac{10}{20}(3, 5)$
   Simplify: $(x', y') = \frac{1}{2}(3, 5)$
   $\boxed{\text{Solution: } (x', y') = (1.5, 2.5)}$

2. Given: $D = 5$ and $f = 10$
   Recall: $\tan\frac{\theta}{2f} = \frac{D}{2f}$
   Simplify: $\tan\frac{\theta}{2} = \frac{1}{4}$
   $\theta = 2 \cdot \arctan\frac{1}{4}$
   $\boxed{\text{Solution: } \theta = 28.07^\circ}$

3. Given a pixel in RGB color space with the values $R = 100$, $B = 10$, $G = 200$
   R' = $\frac{100}{255}$= 0.3921, G' = $\frac{200}{255}$= 0.7843, B' = $\frac{10}{255}$= 0.0392
   $\Delta = max(R', G', B') - min(R', G', B')$
   $\Delta = 0.7843 - 0.0392 = 0.7451$

$$H = \begin{cases} 0^\circ & \text{if } \Delta = 0 \\ 60^\circ(\frac{(0.7843-0.0392)}{0.7451}) & \text{if } 0.7843 = 0.3923 \\ 120^\circ + 60^\circ(\frac{(0.0392-0.3921)}{0.7451}) & \text{if } \boxed{0.7843 = 0.7843} \\ 240^\circ + 60^\circ(\frac{(0.3921-0.7843)}{0.7451}) & otherwise \end{cases} = 91.58^\circ$$

$$S = \frac{0.7451}{0.7843} \cdot 100 = 95.00\%$$

$$V = 0.7843 \cdot 100 = 78.43\%$$

$\boxed{\text{Solution: } H = 91.58^\circ, S = 95.00\%, V = 78.43\%}$

4. (a)

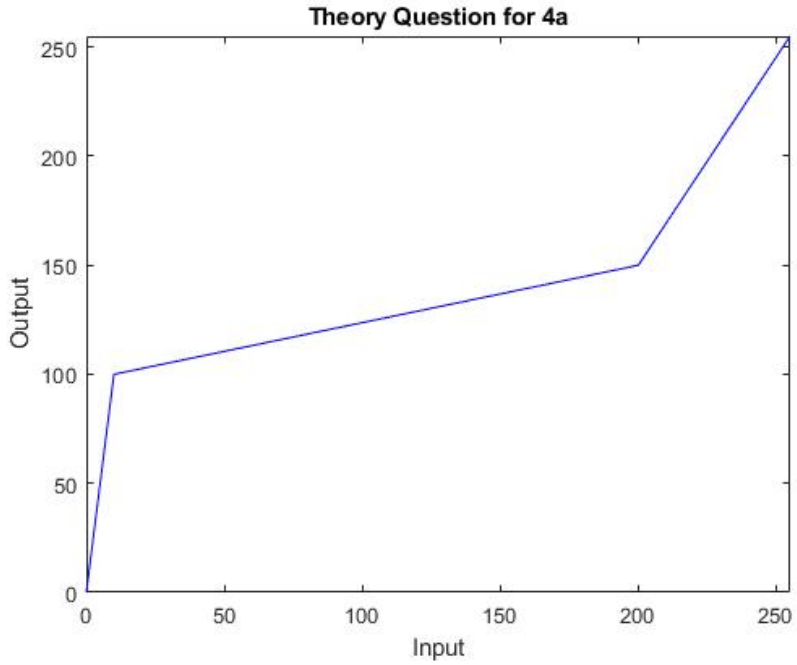


Figure 1: 2D Graph of Mapped Values

(b)

$$\begin{cases} 10r & 0 \leq r \leq 10 \\ \frac{5}{19}(r-10)+100 & 10 < r \leq 200 \\ \frac{21}{11}(r-200)+150 & 200 < r \leq 255 \end{cases}$$

(c) Given r = 50
Use the Second Piecewise Function: $\frac{5}{19}(r-10)+100$
Substitute: $\frac{5}{19}(50-10)+100$
Simplify: $\frac{5}{19}(40)+100$
Solution: 110.526

(d) Contrast stretching tries to improve contrast by stretching the intensity values of an image to fill the entire dynamic range. The goal is to get a relatively flat uniformed distribution which can be done by using piecewise equations. These piecewise accepts a normal pixel value and remaps it to a different scale, which in turn, expands or compress the region so the values are more spread out. For the mappings in **part b**:

If a pixel is between the scale from 0 to 10, the **first piecewise** equation will be used, which will remap the pixel to a scale from 0 to 100.

If a pixel is between the scale from 10 to 200, the **second piecewise** equation will be used, which will remap the pixel to a scale from 100 to 150.

If a pixel is between the scale from 200 to 255, the **third piecewise** equation will be used, which will remap the pixel to a scale from 150 to 255.

## 2 RGB → Grayscale

Figure 2: Original RGB Image

Figure 3: Grayscale Image

# 3 RGB → Binary

Figure 4: Original RGB Image

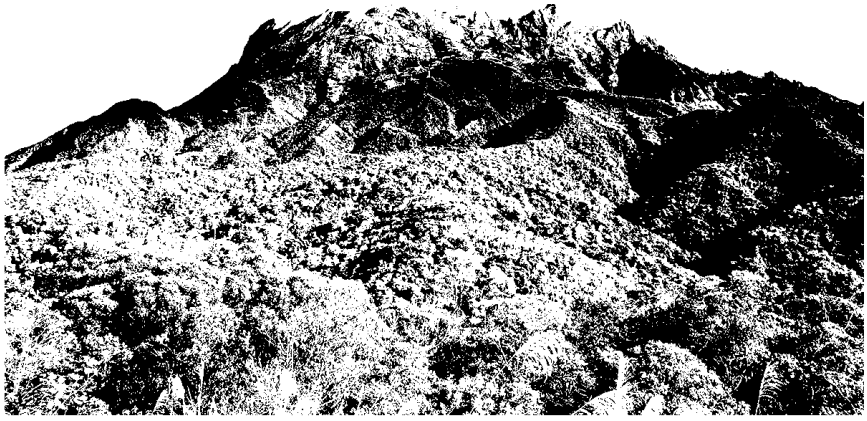

Figure 5: Grayscale Image converted to Binary with Threshold of 25%

Figure 6: Grayscale Image converted to Binary with Threshold of 50%

Figure 7: Grayscale Image converted to Binary with Threshold of 75%

# 4 Gamma Correction

Figure 8: Original RGB Image

Figure 9: Gamma Correction Image with Gamma of 0.2

Figure 10: Gamma Correction Image with Gamma of 1

Figure 11: Gamma Correction Image with Gamma of 50

# 5 Changing Hue

Figure 12: Original RGB Image

Figure 13: Original Image with Hue increased by 50

# 6 Histograms

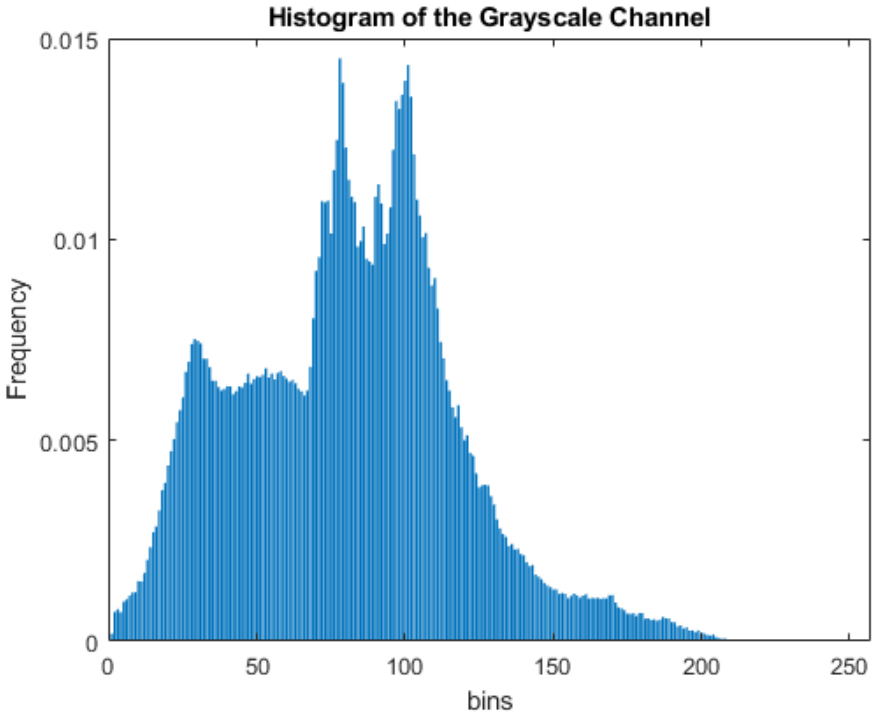


Figure 14: Grayscale Histogram

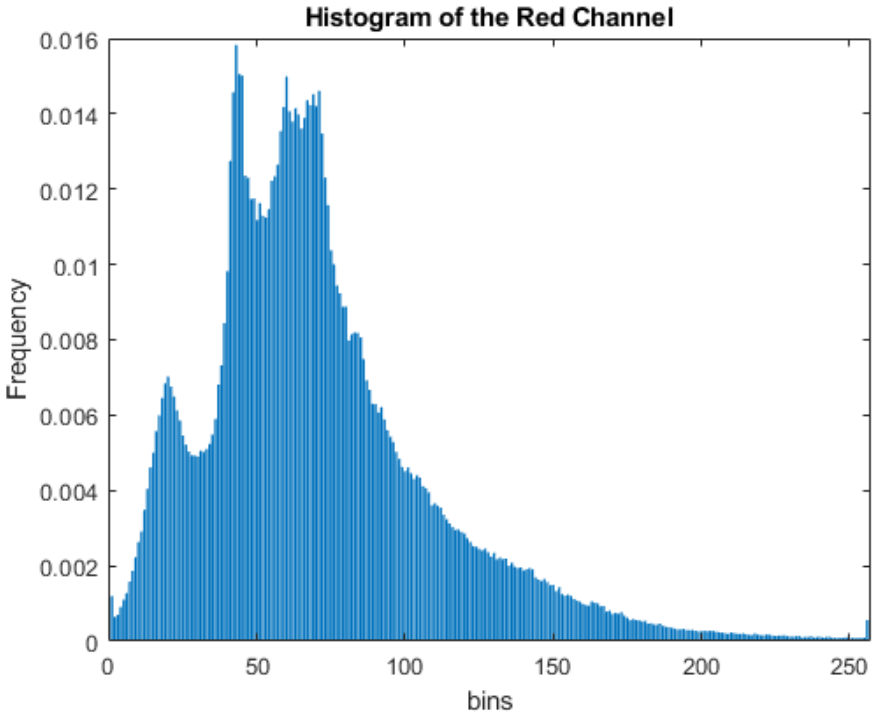


Figure 15: Histogram of the Red Channel

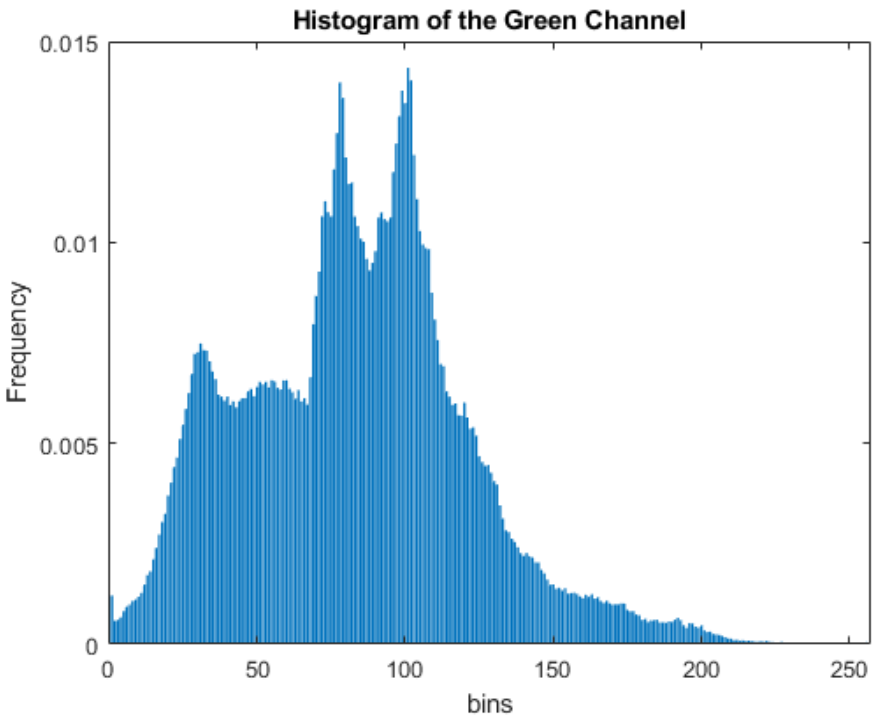


Figure 16: Histogram of the Green Channel

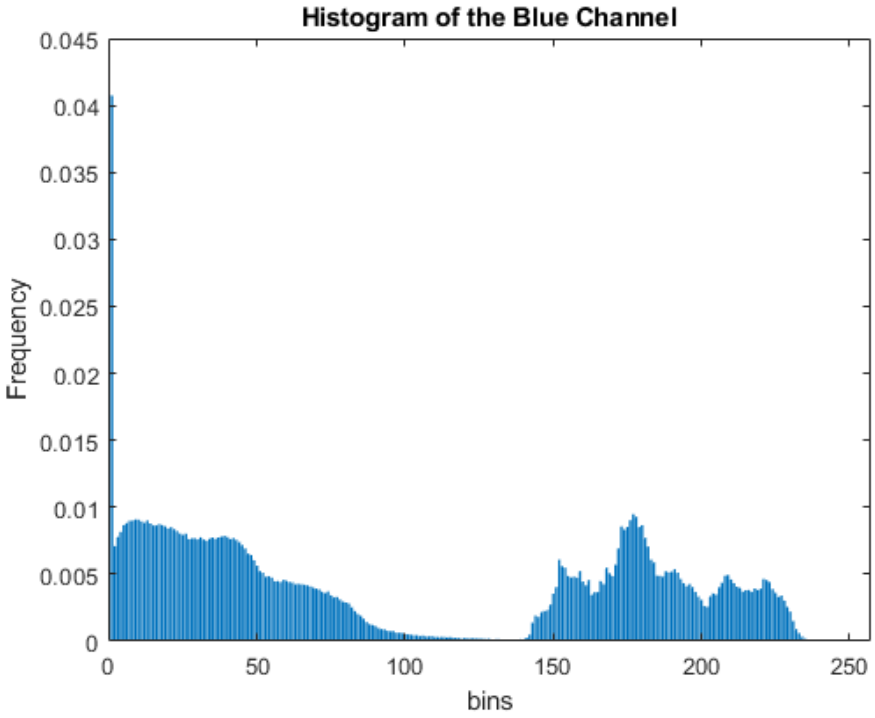


Figure 17: Histogram of the Blue Channel