



EE 583 - Digital Image Processing Final Exam Tutorial

QUESTIONS

1. Given a 5x5 pixel image and respective pixel values (8-bit code for each pixel) below,
- Calculate the respective Huffman Codes for each symbol (each pixel value) of the given image.
 - What is the compression ratio achieved by employing Huffman Coding instead of 8-bit fixed-length coding.
 - Calculate the relative data redundancy of the given 8-bit image and comment on the type of the redundancy used by Huffman coding.
 - Calculate the entropy and the *bpp*(bits per pixel) of the image after Huffman Coding.



- $p(110) = 5/25 = 0.2$
 $p(120) = 7/25 = 0.28$
 $p(140) = 5/25 = 0.2$
 $p(160) = 4/25 = 0.16$
 $p(170) = 3/25 = 0.12$
 $p(180) = 1/25 = 0.04$

Symbol	Prob	Code								
120	0.28	01	0.28	01	0.32	00	0.40	1	0.60	0
110	0.2	10	0.2	10	0.28	01	0.32	00	0.40	1
140	0.2	11	0.2	11	0.2	10	0.28	01		
160	0.16	000	0.16	000	0.2	11				
170	0.12	0010	0.16	001						
180	0.04	0011								

Huffman Codes for the respective symbols

$$b) L_{avg} = \sum_{i=1}^L l(r_i) P_i(r_i) \Rightarrow L_{avg} = 0.28(2) + 0.2(2) + 0.2(2) + 0.16(3) + 0.12(4) + 0.04(4) = 2.48 \text{ (bits/symbol)}$$

$$\text{Compression Ratio, } C = \frac{5 \times 8}{2.48} = 3.2258$$

$$c) \text{ Relative Data Redundancy, } R = 1 - \frac{1}{C} = 1 - \frac{1}{3.2258} = 0.69 \Rightarrow 69\%$$

$$d) \text{ Entropy, } H = - \sum_{i=1}^L P_i(r_i) \log_2 P_i(r_i) \Rightarrow$$

$$H = -(0.04 * \log_2(0.04) + 0.12 * \log_2(0.12) + 0.16 * \log_2(0.16) + 0.2 * \log_2(0.2) + 0.2 * \log_2(0.2) + 0.28 * \log_2(0.28)) = 2.4188 \text{ bpps (bits/pixels)}$$

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