Multimedia Systems and Applications

Final Exam

June 25, 2018

1. **(15%)** In Arithmetic Coding, suppose the alphabet is [A, I, H, R, T, O, $], in which $ is a special symbol used to terminate the message, and the known probability distribution is shown in the following table.

Symbol	Probability	Range
A	0.2	[0, 0.2)
I	0.1	[0.2, 0.3)
H	0.2	[0.3, 0.5)
R	0.05	[0.5, 0.55)
T	0.3	[0.55, 0.85)
O	0.05	[0.85, 0.9)
$	0.1	[0.9, 1.0)

What is the generated binary code word for the string of symbols ARITH$ after Arithmetic Coding?

2. **(15%)** The Huffman coding algorithm requires prior statistical knowledge about the information source and such information is often not available. The solution is to use Adaptive Huffman coding algorithm. Let's assume the initial code assignment for both the encoder and decoder as follows.

Initial	***Code***
NEW:	0
A:	00001
B:	00010
C:	00011
D:	00100
:	:

For the symbol string ABBCC, please provide the Huffman tree after each step using the Adaptive Huffman coding algorithm.

3. **(15%)** Given a very simple dictionary, initially containing only three characters, with the codes as follows:

Code	String
1	A
2	B
3	C

Now if the input string is BAABBACCA, what is the output code based on the LZW compression algorithm. Please show how the LZW works.

4. (10%) Consider the Haar Wavelet Transform that replace the original sequence with its pairwise average $x_{n\text{-}1,i}$ and difference $d_{n\text{-}1,i}$ defined as follows.

$$x_{n-1,i} = \frac{x_{n,2i} + x_{n,2i+1}}{2}, \qquad d_{n-1,i} = \frac{x_{n,2i} - x_{n,2i+1}}{2}$$

For the following input image, what is the output of the first level of the 2D Haar Wavelet Transform?

0	**0**	**0**	**0**	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**
0	**0**	**160**	**80**	**80**	**160**	**0**	**0**
0	**0**	**80**	**200**	**200**	**80**	**0**	**0**
0	**0**	**80**	**200**	**200**	**80**	**0**	**0**
0	**0**	**160**	**80**	**80**	**160**	**0**	**0**
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**
0	**0**	**0**	**0**	**0**	**0**	**0**	**0**

5. (10%) Considering the effect of Frequency Masking, which descriptions are **correct** for the general situation in regard to masking? (多選題)

( ) 1. A lower tone can effectively mask (make us unable to hear) a higher tone

( ) 2. At the same power level, a higher tone can also mask a lower tone well

( ) 3. A masking tone with greater power can mask the tone which is widely separated from the masking tone.

6. (15%) For the coefficients of a three-stage wavelet transform shown in the following figure, we attempt to code the coefficients using the EZW algorithm.

62	-44	39	-42	3	7	9	10
-30	30	17	35	8	2	1	6
12	6	15	13	9	-4	2	3
18	26	-7	9	-7	14	12	-9
12	15	43	20	-2	3	1	0
0	7	2	4	4	-1	1	1
4	1	10	3	2	0	1	0
5	6	0	0	3	1	2	1

(a) What is the list of coefficients visited, in the order of the scan?

(b) What is the dominant pass outputs D_0?

(c) What is the subordinate pass output S_0**?**

7. (20%) Suppose that a 3-bit image (L=8) of size 64x64 pixels has the intensity distributions as follows.

r_k	n_k	$P_r(r_k)=n_k/MN$
$r_0=0$	860	0.21
$r_1=1$	81	0.02
$r_2=2$	780	0.19
$r_3=3$	1023	0.25
$r_4=4$	122	0.03
$r_5=5$	245	0.06
$r_6=6$	656	0.16
$r_7=7$	329	0.08

What is the intensity distribution S_0~S_7 after histogram equalization?