

# UNIVERSITY OF RUHUNA

## Faculty of Engineering

End-Semester 8 Examination in Engineering: December 2015

Module Number: EE8160

Module Name: Video Compression and  
Communication

[Three Hours]

[Answer all questions, each question carries 100 marks. However, total marks of the paper will be mapped to 50 marks accordingly thus each question carries 12.5 marks]

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- Q1 a) A user wants to download a 100 minutes HD (High Definition) quality movie (1920 × 1080; 4:4:4) over the Internet with a connection speed of 50 Mbits/sec. The frame rate is 30 frames/sec and each pixel is encoded using 8 bits/pixel.
- Calculate the raw video data rate.  
[15 Marks]
  - Calculate the minimum compression ratio that is for the sequence to be transmitted as live content over the Internet. Assume that there is no network congestion.  
[15 Marks]
  - It is decided to store the content in a Blu Ray disk. The capacity of the disc is 25 GB. What is the minimum compression ratio to store the complete movie?  
[15 Marks]
- b) List the four types of redundancies considered in video coding and briefly explain how they are exploited.  
[40 Marks]
- c) List the three metrics that are used in measuring the quality of a video.  
[15 Marks]
- Q2 a) The video resilience and concealment are very important in video transmissions specially in error prone channels.
- Explain the purpose of error resilience and error concealment techniques in video transmissions.  
[30 Marks]
  - List the most common error resilience techniques that are used in current video systems.  
[10 Marks]

b) Suppose a video content is transmitted in an error prone channel after HEVC (High Efficiency Video Coding) encoding and decoded by the HEVC decoder which is capable of concealing errors with the frame copy concealment technique. Consider the following two scenarios where one slice is dropped. Figure 1 and Figure 2 present the original images and the images concealed by the decoder. The left hand images [Figure 1 (a) and Figure 2 (a)] show where the slice is dropped by the channel. The right hand images [Figure 1 (b) and Figure 2 (b)] show where the affected areas are concealed by the decoder.

i) Comment on the decoder ability to conceal errors in both scenarios and explain why different image qualities are resulted for image 156. You may assume that the video camera is fixed and no camera operations such as zooming, tilting is involved with the capturing the contents.

[20 Marks]

ii) Comment on the image qualities of the images 160, 161 and 162 assuming that there is no any slices are dropped after frame 155.

[20 Marks]

iii) Suggest a suitable error resilience method to minimize this problem, if there is any quality degradation in the decoded images are expected.

[20 Marks]

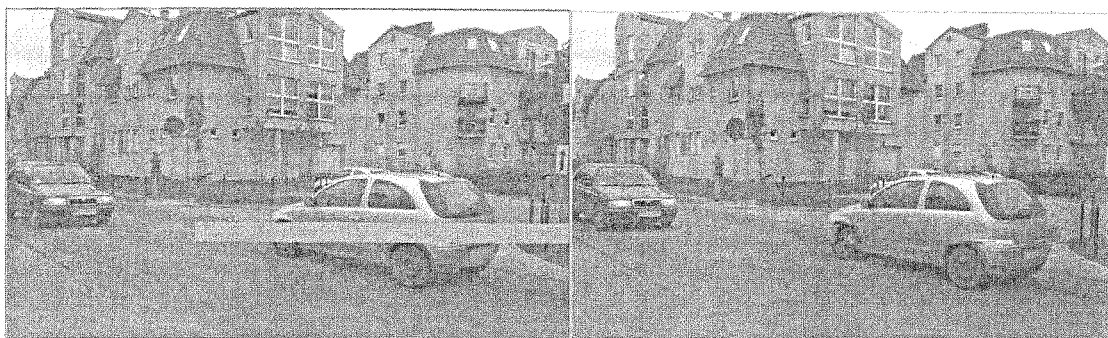
<b>Frame</b>	154	155	156	157	158	159	160	161	162
<b>Type</b>	P	P	P	P	P	P	P	I	P
<b>Slice dropped</b>	No	Yes	No	No	No	No	No	No	No



(a) One slice is dropped (frame 155) (b) Concealed frame by the decoder (frame 156)

Figure 1 : Scenario 1

Frame	154	155	156	157	158	159	160	161	162
Type	P	P	P	P	P	P	P	I	P
Slice dropped	No	Yes	No	No	No	No	No	No	No



(a) One slice is dropped (frame 155)      (b) Concealed frame by the decoder (frame 156)

Figure 2 : Scenario 2

- Q3 a) Identify the four important features in the HEVC video coding standard compared to MPEG - 1/2 (Moving Picture Experts Group) and briefly explain them. [40 Marks]
- b) Alan is a professional video content producer in a company. The company wants to produce a video content for a 90 minutes movie. It has two options (HD - High-Definition or UHD - Ultra High Definition) to consider in producing the content as shown in Table 1. Suggest the best option for the company to maximize its profit. You may use reasonable assumptions when making your decision.

Table 1

Parameter	HD	UHD
Spatial Resolution	1920 x 1080	3840 x 2160
Bits per Pixel	8	8
Frame Rate (frames per second)	100	150
Video Format	4:2:2	4:2:2
Compression Ratio	100	220
Production Cost (per Giga bit cost)	£ 500.00	£2,750.00
Selling Price (per movie)	£15.00	£18.00
Number of movies to sell (predicted)	10 Million	12 Million

[60 Marks]

- Q4 a) Determine the motion vector for the block shown in Figure 3 using the block-matching algorithm with a mean absolute difference error function. The search area is shown in Figure 4 and the search positions are restricted to positions (0,0), (0,1), (-1,0) and (1,-1). The search (0,0) position is indicated by a bold square. The positive displacements are towards the right-hand side and towards the bottom.

120	121	125	119
120	120	118	117
122	121	117	118
122	122	120	120

Figure 3

120	120	120	121	122	119
119	<b>119</b>	120	120	120	118
122	121	122	120	120	120
118	118	120	120	120	119
120	120	120	119	118	119
119	120	120	120	118	119

Figure 4

[50 Marks]

- b) The DCT (Discrete Cosine Transform) coefficients of the above (4 × 4) block is shown in Figure 5.

480.5	3.8	-1.5	0
-0.1	-1.8	-2.7	2.7
4	-2.3	-2	2
1.1	0.2	0	0.3

Figure 5

- i) Assuming the QP size of 2 used for the quantization, generate the quantized coefficients for this block.
 

[10 Marks]
  - ii) Based on part i) and a pixel is encoded using 8 bits/pixel or 10 bits/DCT coefficient, calculate the compression ratio for this block. Assume the block is INTRA coded.
 

[10 Marks]
  - iii) Suggest a method to improve the compression further, if the reference frames are used.
 

[10 Marks]
- c) Explain the advantages and disadvantages of a colour-depth video compared to the stereoscopic video capturing and compression.

[20 Marks]