COMUNICAÇÃO DE ÁUDIO E VÍDEO

INSTITUTO SUPERIOR TÉCNICO

Year 2015/2016 – 1st Semester, Responsible: Prof. Fernando Pereira

2nd Exam – 25th January 2016, 8am (Monday)

The marks should be out before **26th January (Tuesday), 8pm** at the CAV Web page and the exam checking session will be on the **27th January (Wednesday), 10am** in room LT4.

The exam is **3 hours long**. Answer all the questions in a detailed way, including all the computations performed and justifying well your answers.

Don't get 'trapped' by any question; move forward to another question and return later. ***Good luck !***

I (1.0 + 0.5 + 1.0 + 1.0 + 0.5 val. = 4.0 val.)

Consider the JPEG standard to code photographic images with a 576×720 luminance resolution, 4:2:0 color subsampling and 8 bit/sample.

a) How many times would the number of luminance blocks increase if the color subsampling is changed to 4:2:2 ? And the total number of chrominance blocks for the same change ? (R: No change for the luminance, doubling for the chrominance)

b) Determine the average number of bits per luminance sample that has to be spent to code this type of image if a codec with a luminance compression factor of 20 and a chrominances compression factor of 10 is used. (R: 0.4 bit/sample)

c) Determine the maximum number of DCT coefficients that may be coded for each luminance block of an image if each coefficient costs, on average, 4 bits for the luminance and 3 bits for the chrominance and a maximum total number of bits of 300000 is desired; consider that luminance blocks always code 2 coefficients more that each chrominance block and additionally consider that the EOB (End of Block) word costs 3 bits. (R. 8 bits)

d) Indicate 2 architectural elements of a JPEG baseline encoder that are responsible for this type of coding being lossy. Explain why. (R: Quantizer and DCT)

e) Why is it reasonable to ask that an ideal transform for image compression compacts the information/signal energy as much as possible ?

II (0.5 + 0.5 + 0.5 + 0.5 + 2.0 val. = 4.0 val.)

Consider a videotelephony communication using Recommendation ITU-T H.261. The video sequence is coded with a CIF spatial resolution and a frame rate of 12.5 Hz at a rate of 64 kbit/s.

The video content to code is horizontally divided into two equal parts; however, while the bottom part is fixed, the top part is moving. Since the encoder processes sequentially the macroblocks, it is observed that all bits are uniformly generated in the first half of the time interval that the encoder usually dedicates to encode each image. At the encoder, the bits wait for transmission in an output buffer.

Knowing that the first image has used 7680 bits, the second image 10240 bit, and the third image 5120 bits, determine:

a) The time instants at which the sender acquires the first, second and fourth images. (R: 0, 80 and 240 ms)

b) The time instants at which the sender finishes to produce the bits for the first, second and fourth images. (R: 80, 120 and 280 ms)

c) The time instants at which the sender finishes to send the bits for the first, second and third images. (R: 120, 280 and 360 ms)

d) The time instants at which the receiver finishes to receive the bits for the first, second and third images. (R: 120, 280 and 360 ms)

e) The time instants at which the display should show the first, third and fifth images assuming that the minimum acceptable acquisition-visualization delay is applied and the minimum acceptable buffer size is used. (R: 240, 400 and 560 ms)

III (0.5 + 2.0 + 0.5 = 3.0 val.)

Suppose that you are contacted by a company to design a digital storage system for short multimedia clips. The company requires editing flexibility with a maximum access time per image below 200 ms and needs to store the largest number of 1.5 minutes clips in a disk with 500 GBytes of capacity. The maximum access speed to the disk is 20 Mbit/s. The clips have HDTV resolution, this means 1920×1152 (Y) and 960×1152 (Cr, Cb) at 25 Hz. Assuming that you have at your disposal providing the required video quality:

1. a JPEG coding solution with a compression factor of 25 for both the luminance and chrominances
2. a MPEG-2 Video coding solution with the following compression factors when M=3 is used:

· I frames: 20 and 25 for the luminance and chrominances, respectively

· P frames: 40 and 50 for the luminance and chrominances, respectively

· B frames: 50 and 60 for the luminance and chrominances, respectively

a) Considering its native features, which of these two coding solutions is more suitable for editing purposes? Why ? (R: JPEG)

b) Determine, justifying, which coding solution should be proposed to your client ? Identify a major limitation of this proposed solution. (R: MPEG-2 Video; does not allow real-time playing)

c) How many full video clips would you be able to store in the disk with the two coding solutions above. (R: 1255 and 1845)

IV (0.5 + 0.5 + 0.5 + 0.5 + 1.0 = 3.0 val.)

Consider the DVB standards.

a) Why are QPSK and 8-PSK typically used for television in DVB-S2 knowing that this standard accepts other modulations for satellite transmission.

b) Considering that DVC-2 should not have to accommodate multipath effects, why does DVC-C2 recommend COFDM as the modulation ?

c) What is the advantage for DVB-T2 of accepting a larger set of OFDM modes in terms of the number of carriers ?

d) Why is it normal to have a simulcasting period when introducing digital TV in a country which already has analogue TV ?

e) Knowing that a DVB solution may initially ‘insert’ 20 Mbit/s of source rate in a 8 MHz bandwidth channel using a channel coding ratio of 1/2, what is the transmitted source rate if all the system parameters stay the same with the exception of the modulation that goes from 16-QAM to 8-PSK. (R: 15 Mbit/s)

V (1.0 + 1.0 + 0.5 + 0.5 = 3.0 val.)

Consider the development of an application similar to YouTube including also a paid premium service.

a) List 2 main technologies required for this application excluding those related to the multimedia content representation ? For each of these technologies, define its main objective.

b) Considering the rate budget, provide reasonable estimates of the rate percentages that would you allocate to the 2 main technologies related to the free access multimedia content representation assuming video with standard definition and stereo audio ? Justify your numbers.

c) Considering the video media component, what codecs would you support on the uploading side and on the streaming side for the case of live broadcasting. Justify your choices.

d) Considering the video media component, what codecs would you support on the uploading side and on the streaming side for the case of *a posteriori* streaming. Justify your choices.

VI (1.0 + 1.0 + 0.5 + 0.5 = 3.0 val.)

Consider the emerging HEVC video coding standard.

a) This standard has abandoned the macroblock concept used for decades in video coding. Indicate two drawbacks of this concept, especially considering an Ultra HD context.

b) Which two main concepts have substituted the macroblock in HEVC and with what advantages ?

c) Why did HEVC introduce a new transform, this means the DST ?

d) What is the advantage of increasing the number of Intra prediction modes regarding the previous H.264/AVC coding standard ?