Multimedia Technologies
Spring Term, 2021
Final Project (Total Marks: 100)

Student No.:
Student Name:

Instructions:

1. There are four questions in part 1 and three questions in part 2. Answer all questions in part 1 and any one question in part 2.
2. Complete neatly with your name and student number on the first page.
3. Turnitin is enabled for this assessment. Please submit your answer file in word format. PDF format, JPEG images are not allowed.
4. Upload your answer file to
5. Submission Deadline: 23:59 12 Jun 2021 (Sat). (You are recommended to complete it as early as you can and reserve sufficient time to submit your work)
6. Question 2 and question 4 contain variables (W, X, Y and Z) whose values depend on your student number. W, X, Y and Z are the 5^{th}, 6^{th}, 7^{th} and 8^{th} digits of your student number. For example, student number "0281", W = 0, X = 2, Y = 8 and Z = 1.
7. Marks will be deducted if you do not follow the instructions.

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Part 1 (70%): Answer all questions in this part.

[**12 Marks**] **Question 1:** Determine the MIDI message (in hex) for each of the below actions.

1. Pan the stereo of Channel 6 to absolute right
2. Change the instrument on Channel 6 to Rhodes Piano
3. Play the A4 note using ***mf*** loudness on Channel 6
4. Turn off the note played in action 3.
5. System reset

Note: refer to the MIDI message format and GM instrument patch map in the lecture notes and tutorial notes

[**24 Marks**] **Question 2:** Consider a completely new musical instrument Q. The lowest frequency played by Q is 32.703 Hz. The frequency range of Q is U octaves plus V semitones, where U = 8+1, V = 1+1.

Note: Y = 8, Z = 1 and U = 9, V = 2.

(a) What is the highest frequency that Q can sound? Show your steps clearly. **(4 marks)**

(b) Given that the frequency of middle C (note name C4) is 261.63 Hz, find the name of the highest frequency note sounded by Q. Show your steps clearly. **(4 marks)**

(c) You are going to record a 5 minutes solo performance of Q.

(i) Suggest a suitable sampling rate for the recording. **(2 marks)**

(ii) Instead of mono, stereo is preferred for the recording. Suggest a reason to support the decision. **(2 marks)**

(iii) Compute the raw data size (in bytes) for the recording if the sampling size is 24-bit. Show your steps clearly. **(4 marks)**

(d) You just learn how to play Q. Although your solo performance in (c) was bad, you would like to share your first solo to your friends. However, you find that the raw data size in (c)(iii) is too big for sharing. You consider to re-record it in MIDI format or compress it using MP3 technology.

(i) Describe two disadvantages for choosing MIDI format for (c). **(4 marks)**

(ii) Describe two disadvantages for choosing MP3 format for (c). **(4 marks)**

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[16 Marks] Question 3: Consider the following decoding order of a sequence of frames of a MPEG-1 Video:

Frame ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Frame Type	I	P	B	B	B	P	B	B	B	I	B	B	B	I	P	B	P

(a) What is the display order of the frames? **(6 marks)**

(b) Suppose there is an error in decoding frame ID R, which of the other frames may possibly suffer from error directly? **(6 marks)**

(i) R = 6

(ii) R = 15

(c) Compare the below two designs of frame structures:

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Design U: I B B P B B I B B P B B I
Design V: I B B B B B B B B B B B I
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(i) Describe an advantage of choosing design U. **(2 marks)**

(ii) Describe an advantage of choosing design V. **(2 marks)**

[18 marks] Question 4: Consider a video with frame size of 6 x 6 and macroblock size of 2 x 2. The luma values in the reference frame (left) and current frame (right) are given as follows:

7	1	7	9	6	0
7	4	1	4	2	4
8	0	6	0	8	5
8	5	7	5	3	1
3	0	3	1	2	7
7	6	5	9	4	3

#	#	#	#	#	#
#	#	#	0	2	#
#	#	#	8	1	#
#	#	#	#	#	#
#	#	#	#	#	#
#	#	#	#	#	#

(a) Find the motion vector of the highlighted macroblock using window search with search range ± 1 pixel. Show your steps clearly. **(10 marks)**

(b) Having computed the motion vector, determine the residual to be coded after motion compensation. **(4 marks)**

(c) Having computed the residual, explain whether intra mode or inter mode coding should be used for this macroblock. **(4 marks)**

Part 2 (30%): Answer any one question in this part

To answer the questions in this part, you may use the Internet as a source of information. However, you should digest the content and use your own words to write the reports. You are also required to indicate the total number of words and the sources of information in your reports. Marks will be deducted if you do not follow the instructions.

[30 Marks] Question 5: JPEGsnoop (https://www.impulseadventure.com/photo/jpeg-snoop.html) is a digital forensics software that able to tell whether a JPEG image was likely an original photo taken by a camera or had been edited using photo-editing software (e.g. Photoshop). In your own words, write a report in 300 to 400 words with appropriate diagrams to explain its digital forensics mechanism, its technical weakness, and explain whether the digital forensics mechanism can apply to MPEG videos or not.

[30 marks] Question 6: Steganography refers to techniques which hide secret information in a way that nobody but the sender and the intended recipient knows about the existence of the message. It is different from watermarking, which is a kind of digital signature to protect information against removal or modification. In your own words, write a report in 300 to 400 words with appropriate diagrams to describe how to apply steganography in images, videos and audio data, respectively. (You need to describe one method for hiding information in images, one method for videos, and one method for audio data.)

[30 marks] Question 7: FLAC (Free Lossless Audio Codec) is a non-proprietary lossless compression format for audio. FLAC performs better than classical lossless compression schemes for audio data and is able to reduce the size up to 50%. In your own words, write a report in 300 to 400 words with appropriate diagrams to describe the target applications, technical standards of FLAC, and explain why FLAC can achieve high compression rate for audio data.

[End of Final Project]