Sample Midterm for Multimedia Systems Course, Fall 2023

Definitions (7 points)

Q. State what is the Entropy of a random process, and write an equation for the entropy of an N-valued random process.

Q. Describe what is meant by the time and the frequency resolutions in the discrete Fourier transform.

Q. Briefly state what is meant by non-stationary and stationary signal processes, and give an example of each type of process.

Q. Enumerate two reasons on why we need to transfer color from RGB space to other color space (e.g., YUV color space).

Q. When using less colors (8 bits) to show true color images (24 bits), what’s the most popular mechanism used to handle this problem?

Standards (7 points)

Q. MPEG
  a) What is MPEG an acronym of?
  b) List the different versions of MPEG coders.
  c) What is meant by the term “open standard coder”?
  d) State the function and the applications of each version of MPEG coder.

Q. Enucleate major steps of the JPEG compression mechanism (which is supported by all JPEG decoders)?

System Design (7 points)

Q. Enumerate major steps to construct a content-based audio information retrieval system.

Q. Explain with the aid of diagrams how an invisible complete watermark can be inserted in an image and extracted from an image.

Think and Compute (7 points)

Q. (Sampling Theorem, Quantization)
  a) Suppose the audio signal from a microphone is first pre-filtered with a low-pass filter, then sampled with a sampling period equal to \( \frac{1000}{2} \) ms (milliseconds), then
subsampling by a factor of $\frac{1}{4}$ (meaning that only one out of four samples is retained). What is the maximum band $B$ of the pre-filter in order to avoid aliasing?

b) Suppose we quantize the resulting samples (in part a) over the intensity interval $[-V, V]$, with $V = \cdot,^\wedge \text{Volt}$, and with quantization step equal to $\cdot,^\wedge m\text{Volts}$, how many bits should be used to encode each sample? what’s the resulting bit rate of the signal?

Q. (Speech Encoding, Entropy)

Speech is based on the use of about $\cdot$ basic acoustic symbols, known as phonemes (or phonetic units), these are used to construct words, sentences etc. Assuming that all phonetic units are equi-probable, and that the average speaking rate is $\cdot$ words per minute, and that the average word had $\cdot$ phonemes/word, calculate the minimum number of bits per second required to encode speech at the average speaking rate.