Hall Ticket No | | | | | | | | | | | Question Paper Code:ACAC05

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
(Dundigal-500043, Hyderabad)

B.Tech V SEMESTER END EXAMINATIONS (REGULAR) - DECEMBER 2022
Regulation:UG20
IMAGE AND SPEECH PROCESSING

Time: 3 Hours (ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING) **Max Marks: 70**

Answer ALL questions in Module I and II
Answer ONE out of two questions in Modules III, IV and V
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

MODULE – I

1. (a) Describe the fundamental steps in digital image processing. Write the image acquisition using linear strip and circular strips. [BL: Understand| CO: 1|Marks: 7]

   (b) The pixel values of the following 5x5 matrix representation of an image are represented by 8-bit integers. Determine f with a gray-level resolution of 2k for i) k=5 ii) k=3.

$$F=\begin{bmatrix} 123 & 162 & 200 & 147 & 93 \\ 137 & 157 & 165 & 232 & 189 \\ 151 & 155 & 152 & 141 & 130 \\ 205 & 101 & 100 & 193 & 115 \\ 250 & 50 & 75 & 88 & 100 \end{bmatrix}$$

[BL: Apply| CO: 1|Marks: 7]

MODULE – II

2. (a) How an image is compressed using JPEG image compression standard? Differentiate lossless and lossy compression. [BL: Understand| CO: 2|Marks: 7]

   (b) Using the following probability mass function perform the Huffman coding and calculate the coding efficiency

$$\begin{bmatrix} \frac{1}{2} & \frac{1}{8} & \frac{1}{8} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} & \frac{1}{16} \end{bmatrix}$$

[BL: Apply| CO: 2|Marks: 7]

MODULE – III

3. (a) Summarize the human speech production system with the help of a schematic representation of vocal tract. [BL: Understand| CO: 3|Marks: 7]

   (b) The waveform plot in Figure 1 shows a 500 msec section (100 msec/line) of a speech waveform. Indicate the regions of voiced, un-voiced speech and silence (or background signal). For the voiced regions estimate the pitch period on a period-by-period basis and plot the pitch period versus time for this section of speech.(let the period be indicated as zero during unvoiced and silence intervals)

[BL: Apply| CO: 3|Marks: 7]

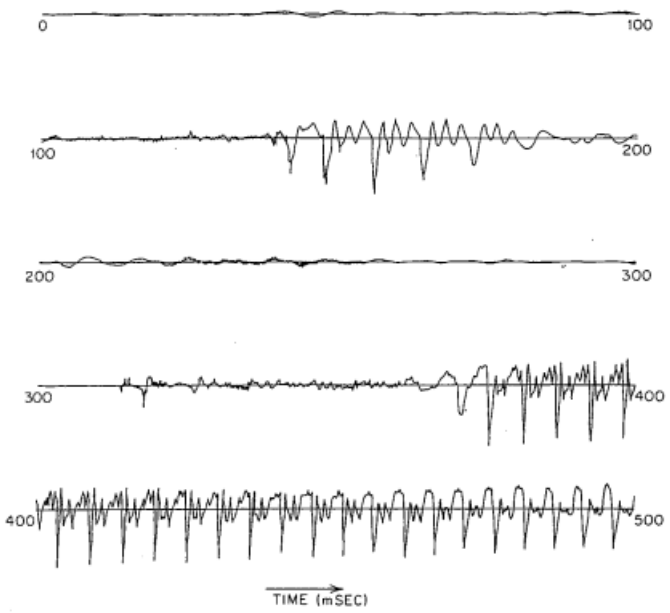

Figure 1

4. (a) Outline the excitation network for voiced fricatives. Briefly describe the inherent properties speech signal. [BL: Understand| CO: 4|Marks: 7]

   (b) The reflection coefficients for the junction of two lossless acoustic tubes of areas A_k and A_{k+1} can be written as either

   $$r_k = \frac{\frac{A_{k+1}}{A_k} - 1}{\frac{A_{k+1}}{A_k} + 1} \text{ or } r_k = \frac{1 - \frac{A_{k+1}}{A_k}}{\frac{1 + A_{k+1}}{A_k}}$$

   i) Show that since both A_k and A_{k+1} are positive, $-1 <= r_k <= 1$.

   ii) Show that if $0 < A_k < \infty$ and $0 < A_{k+1} < \infty$, then $-1 < r_k < 1$ [BL: Apply| CO: 4|Marks: 7]

MODULE – IV

5. (a) Infer the working of center clipping auto correlator with the help of block diagram. Enlist the advantages of using three level clipper. [BL: Understand| CO: 5|Marks: 7]

   (b) Explain the term short time magnitude with related equations. How do you distinguish voiced and unvoiced segments based on this parameter? [BL: Apply| CO: 5|Marks: 7]

6. (a) Illustrate the term autocorelation function with relevant diagram. Draw the block diagram representation of short-time zero-crossings. [BL: Understand| CO: 5|Marks: 7]

   (b) Calculate the autocorrelation function, $R_n(k)$ using rectangular window for periodic impulse train.
   i) How would the result change if the window is Hamming window
   ii) Find and sketch the modified short time autocorrelation function.
   [BL: Apply| CO: 5|Marks: 7]

MODULE – V

7. (a) Comment on the model of frequency-domain processing of speech via STFA and STFS methods. [BL: Understand| CO: 6|Marks: 7]

   (b) A filter bank with N filters has the following specifications:

   - the center frequencies of the bands are ω_k
   - the bands are symmetric around $\omega = \pi$, i.e., $\omega_k = 2\pi - \omega_{N-k}$, $P_k = P^*_{N-K}$ $\omega_k[\mathrm{n}] = \omega_{N-k}[\mathrm{n}]$
   - a channel exists for ω_k=0. For both N even and N odd:

   i) Sketch the locations of the N filter bands;

   ii) Determine an expression for the composite impulse response of the filter bank in terms of $\omega_k[\mathrm{n}]$, ω_k, P_k, and N. [BL: Apply| CO: 6|Marks: 7]

8. (a) Show the lossless tube model terminated in infinitely long tube and its corresponding signal flow graph for infinite glottal impedance. [BL: Understand| CO: 6|Marks: 7]

   (b) Determine the second-order linear prediction inverse filter, A(z), for which the two LSF are 666.67 Hz and 2000 Hz, when Fs = 8000 samples/sec. [BL: Apply| CO: 6|Marks: 7]

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