2024 Master's Program, Graduate School of Design (General Entrance Examination) Achievement Test Question Sheets

Examination Subject
Media Engineering

[Compulsory Question] Answer Question below.

Select six of the following 22 technical terms in Media Engineering field, and explain each. [60 points, 10 points each]

(1) Edge preserving smoothing
(2) Hough transform
(3) Histogram equalization
(4) Fourier transform
(5) Gaussian filter
(6) Error diffusion
(7) Photometric stereo
(8) Large Language Model (LLM)
(9) Vector space model
(10) PageRank Algorithm
(11) Avatar
(12) Metaverse
(13) Social touch
(14) Rendering equation
(15) Particle system
(16) BRDF (Bidirectional Reflectance Distribution Function)
(17) Morphing
(18) Fluid simulation
(19) Boids-algorithm
(20) Perspective projection
(21) Geodesic
(22) Principle of virtual work

[Elective Questions] Choose and answer two questions from the following question 1 through 6.

Question 1 [70 points]

[1] Figure 1 shows the process of transformation from an analog image to a digital image. Answer the following questions based on the figure. [50 points]

(1) About the process A. (30 points)
   a) What is the process A generally called?
   b) Explain how the input $f_a(x,y)$ is different from the output $f_a(i,j)$ by A.
   c) Describe how to perform A appropriately.

(2) About the process B. (20 points)
   a) What is the process B generally called?
   b) Explain how the input $f_a(i,j)$ to B is different from the output $f(i,j)$ by B.

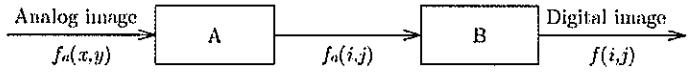


Figure 1: Transformation from an analog image to a digital image.

[2] The signal $g(t)$ is obtained by convolving the signal $f(t)$ with the function $h(t)$. Let $F(\omega)$, $G(\omega)$ and $H(\omega)$ be the functions obtained by Fourier transforming $f(t)$, $g(t)$ and $h(t)$ and expressing them in the frequency domain, respectively (where $\omega = 2\pi f$ is the angular frequency). Answer the following questions. [20points]

(1) Show the relational equation that is valid for $F(\omega)$, $G(\omega)$ and $H(\omega)$. (10 points)

(2) Given the signals $f(t)$ and $h(t)$, explain how to obtain the signal $g(t)$ by processing in frequency space. (10 points)

Question 2 [70 points]

[1] Describe a sphere of radius r using the generalized cylindrical (conical) method. The coordinate system may be set arbitrarily. [35 points]

[2] Two trees were lined up in front of it on the left and right, and a person was standing still in the center of the front. On the other side, car A was driving slowly from right to left, and another car B was driving fast from right to left, passing car A on the other side. Illustrate a spatio-temporal cross-sectional image of such a scene. [35 points]

[Elective Questions] Choose and answer two questions from the following question 1 through 6.

Question 3 [70 points]

[1] Recommendation Systems [40 points]

(1) Describe collaborative filtering and content-based filtering and explain the advantages and disadvantages of each. (10 points)

(2) Consider collaborative filtering using Matrix Factorization.

(a) If given a "user-feature matrix" and an "item-feature matrix", explain how to calculate the user's evaluation value for each item, with examples. (10 points)

(b) Explain how to compute the "user-feature matrix" and the "item-feature matrix" using the user's evaluation values for items when not all users evaluate all items. (10 points)

(3) Explain how to evaluate the performance of a recommendation algorithm by cross-validation, using a concrete example, and describe the advantages of using cross-validation. (10 points)

[2] AI Applications [30 points]

(1) Explain the inference mechanism of a recurrent neural network (RNN) with illustrations. (10 points)

(2) Explain the basic mechanism and features of the seq2seq model. (10 points)

(3) Using the seq2seq model, determine whether the given Japanese sentence "Anata ha onaka ga suite imasuka?" into the English sentence "Are you hungry?" (10 points)

Question 4 [70 points]

[1] Please list the four fundamental elements for creating a VR experience. Draw a diagram to illustrate the relationships among them and provide an explanation for each of these elements. [35 points]

[2] AIP Cube is an evaluation metric used for VR systems, allowing for comparisons between VR systems and other media. List the three axes of the AIP Cube and provide an explanation for the meaning of each axis. [20 points]

[3] VR sickness is a condition that occurs when using virtual reality (VR) technology. It is characterized by symptoms such as nausea, dizziness, disorientation, and discomfort. Please explain the cause of VR sickness and describe what kind of hardware improvement that can reduce VR sickness [15 points]

Question 5 Read the following passage and answer questions 1-4. [70 points]

Computer animation is expressed as a sequence of pictures divided chronologically. The basic frame (picture) is called (1), and the method of automatically interpolating the pictures between (1) to generate animation is called (1) animation. The interpolated elements include orientation, size, color, and camera parameters.

If the shape is interpolated, (1) animation can be created by specifying each vertex's start and end positions, etc. However, this is very time-consuming when the number of vertices is large. Therefore, when creating animations of humans and animals, virtual support is applied to the position between joints, and the vertices are calculated according to the (2) movement. This is called (2) animation.

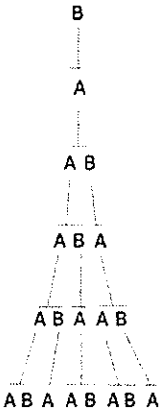
On the other hand, in addition to (1) animation, there is procedural animation, which simulates physical laws or generates motion according to set rules. In procedural animation, for example, animation is automatically generated by providing environmental parameters such as gravity, frictional force, and annual growth, as well as physical parameters such as the initial velocity of the moving object. Below, we describe a method for representing the growth process of plants.

There are several growth models that apply the L-system as a modeling method for plants. Growth simulation is performed by considering environmental factors such as the amount of light received and vegetation (e.g., if there are large obstacles in the surrounding area, the branching will worsen due to reduced light reception, etc.) The following is an example of describing algae growth with the L-system. Graphics can be created by replacing the resulting string with graphics.

variables	:	A, B
constants	:	nothing
Start, axiom	:	A
Production rules	:	(A → AB), (B → A)

Which produces:

n = 0 : A
n = 1 : AB
n = 2 : ABA
n = 3 : ABAAB
n = 4 : ABAABABA



String growth chart of the algae example

[1] Answer the words that apply to (1) and (2). [10 points]

[2] Answer the underlined "elements to be interpolated" other than those listed in the text. [10 points]

[3] Explain what a recursive function is, using pseudo code to show specific usage scenarios. In addition, describe its relationship to the L-system. [20 points]

[4] Answer the following questions about the L-system. [30 points]

1) Describe the features and algorithms of the L-system. (15 points)
2) List possible CG representations other than trees and fractals using the L system, and explain your ideas on how to calculate them, including diagrams. (15 points)

Question 6 [70 points]

[1] Two smooth slopes A and B, each with an inclination from the horizontal of α and β, respectively, are placed as shown in Fig. 6-1. A straight bar of uniform material of length L and mass M is placed on these slopes, and the two ends of the bar rest on each slope at an inclination of γ from the horizontal. The motion of the bar is assumed to take place only on the surface of the paper. Based on this condition, answer the following questions. Define and use any quantities other than the letters in the question. [35 points]

(1) Find the inclination of the bar γ based on the forces acting on the bar and the moment of equilibrium of the forces. (15 points)

(2) Find the slope of the bar γ based on the gravitational potential of the bar. (15 points)

(3) Determine the static stability of the bar at the slope γ. (5 points)

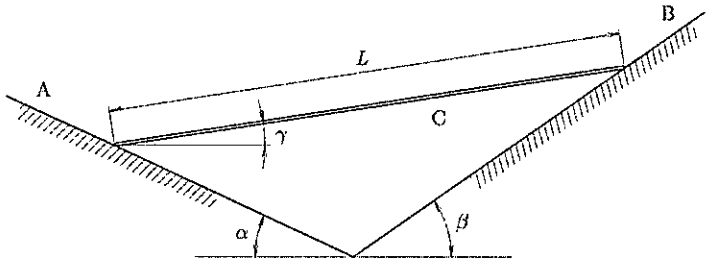
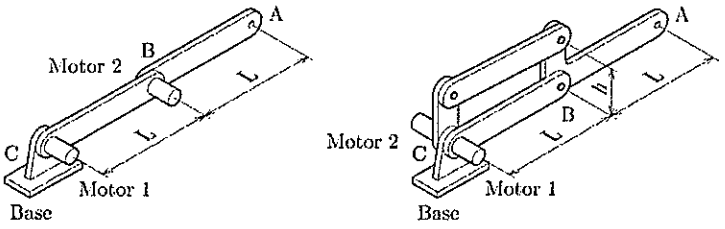


Fig. 6-1

[2] Figure 6-2 shows two planar links of 2-degree-of-freedom, (a) serial link and (b) parallel link, which are driven by two motors 1 and 2, respectively. The lengths of the main links are all the same L. Answer the following questions. [25 points]

(1) Find the torque required for each motor to hold the arm horizontal in the position shown in Fig. 6-2, when load P acts vertically on A at the tip of the arm. Define and use any necessary quantities for the calculation. (15 points)

(2) Explain the advantages of the parallel link arm in (b) over the serial link arm in (a) from several perspectives. (10 points)



(a) Serial link arm (b) Parallel link arm

Fig. 6-2

[3] There are two point masses A and B. After A, which was in motion with velocity **U**, elastically collided with B, which was at rest, their respective velocities **u** and **v** formed an angle of $\pi/2$. In this situation, explain by solving the motion what is known about the point masses A and B. Clearly distinguish between scalars and vectors in your answer. [10 points]