2025 Master's Program, Graduate School of Design (General Entrance Examination) Achievement Test Question Sheets

Examination Subject
Media Engineering

[Compulsory Question] Answer the Question below.

The following are terms used in the field of Media Engineering (Image Information Processing, Image Analysis Technology, Web Informatics, Computer Graphics, Virtual Reality, and Mechanics Design).
Select six of the following 20 technical terms in the field of Media Engineering, and explain each.
[60 points, 10 points each]

(1) Image binarization
(2) Hough transform
(3) Histogram equalization
(4) Lowpass filter
(5) Bilateral filter
(6) Error diffusion
(7) Visual hull
(8) Fine-tuning
(9) Cosine Similarity
(10) Hypertext
(11) Avatar
(12) Metaverse
(13) Social touch
(14) Ray tracing
(15) Style transfer
(16) Digital fabrication
(17) Octree
(18) Projection of 3D body onto 2D plane
(19) Developable surface
(20) Gravitational Potential and Stability

[Elective questions]

Choose and answer two questions from the following questions 1 through 6.

Elective Question 1 [70 points]

[1] Answer the following questions about what can be done by using Fourier transforming an image and representing it in the frequency space. [40 points]

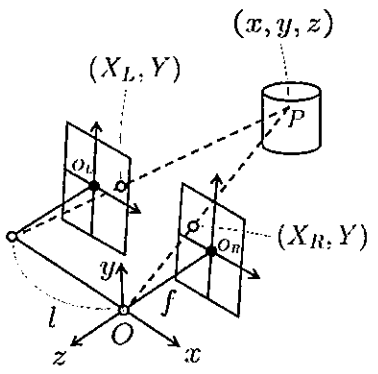
1. Explain what features of the image can be examined by representing the image in the frequency space. (20 points)
2. Suppose that a digital image f_{ij} $(i=0,1,\cdots,N\ ;j=0,1,\cdots,N)$ is masked (convolved) by a linear filter h_{ij} and the resulting image g_{ij} is obtained. Show how this process is expressed in the frequency space by a mathematical expression. Let F_{kl}, H_{kl}, and G_{kl} denote the Fourier transforms of f_{ij}, h_{ij}, and g_{ij}, respectively. (10 points)
3. Explain the advantages of performing the linear masking in the frequency space. (10 points)

[2] Answer the following questions about the transformation from an analog image to a digital image. [30 points]

1. The transformation from an analog image to a digital image is realized by two processes. Answer the names of each of these two processes. (10 points)
2. Explain the advantages of performing the linear masking in the frequency space. (20 points)

Elective Question 2 [70 points]

[1] A camera with the focal length f is used to capture perspective images of a 3D object, as shown in the figure below. Assume that the camera is placed in parallel orientation such that the optical axes are parallel and distant by l from each other to capture two images from different locations. Assume that a surface point P with the coordinates (x, y, z) in the world coordinate system O-xyz is projected to (X_L, Y) in the left image coordinate system O_L-$X_L Y_L$ and is projected to (X_R, Y) in the right image coordinate system O_R-$X_R Y_R$. Express x, y, and z using X_L, X_R, Y, l and f. [35 points]

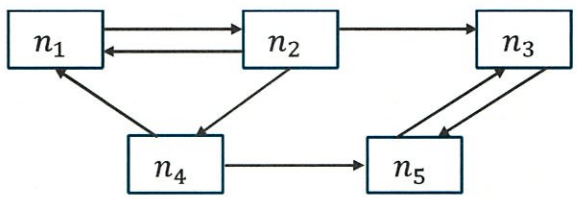


[2] When using the photometric stereo method to recover the surface orientation of an object with uniform reflectance, determine how many images must be captured under varying illumination directions. Also provide a reason for your answer. [35 points]

Elective Question 3 [70 points]

[1] Web Page Search [40 points]

In the following figure, rectangles n_1 to n_5 represent web pages, and arrows between the rectangles represent links between the web pages. Based on the web page structure shown in the figure, answer the following questions:



1. Show the transition probability matrix E for the link structure shown in the figure. (10 points)
2. Consider the transition of web pages based on the random surfer model without considering the damping factor. Using the transition probability matrix E obtained above, find the vector $\boldsymbol{v}_2 = (p_1^2, p_2^2, p_3^2, p_4^2, p_5^2)^{\mathrm{T}}$ that represents the probabilities of a user, who is browsing page n_1 at time 0, browsing each web page at time 2 (after 2 steps). Here, p_i^t represents the probability of browsing web page n_i at time t. The elements of vector $\boldsymbol{v}_2$ can be expressed as fractions. (20 points)
3. Explain the idea of web page ranking by the PageRank algorithm using the random surfer model. (10 points)

[2] AI Applications [30 points]

1. Explain the distributed representation of words in natural language processing. (10 points)
2. Explain the differences between BERT and GPT, which are representative neural language models. (10 points)
3. Explain hallucinations in large language models (LLM). (10 points)

Elective Question 4 [70 points]

[1] Read the following texts and answer the questions 1 to 4. [40 points]

In physics-based animation, collision detection between objects is essential. Relatively simple shapes are used for collision detection, while a combination of these simple shapes approximates complex shapes. The simplest shape is a sphere because it can judge efficiently simply by calculating the distance from the positions of the center of a sphere. There is also a very efficient collision determination method using a rectangular object called an Axis-Aligned Bounding Box, as shown in the center figure. Also, as shown in the right figure, additionally, there is a method to quickly detect collisions between convex polyhedrons by "covering an object with any minimum convex polyhedron."

The above is a collision detection method for stationary objects. In the case of moving objects, it is sufficient to perform the above collision detection process for them whose positions and orientations are determined at certain time intervals. However, for fast-moving objects, there is a possibility of "missing collision detection."

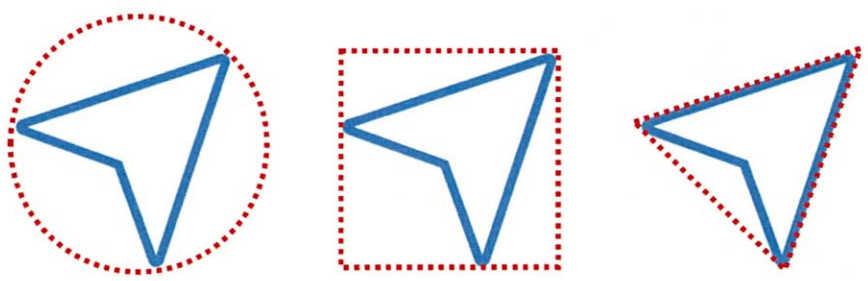


Figure An Example of collision detection primitives. The solid polygons are the objects, and the dotted lines are the shapes for collision detection.

1. Answer the common name for an "Axis-Aligned Bounding Box." (10 points)
2. Describe a concrete example of how to calculate "a very efficient collision detection method using a rectangular body called an Axis-Aligned Bounding Box, as shown in the center of the figure," using diagrams, text, or pseudo code. (10 points)
3. Describe what kind of incident the "missing collision detection" refers to. You can draw a diagram. (10 points)
4. In relation to collision detection, describe what "collision response" is. (10 points)

[2] Describe the following CG words in as much detail as possible using CG terms and method names. [30 points]

1. Non-photorealistic rendering (10 points)
2. Global illumination (10 points)
3. Triangulation (10 points)

Elective Question 5 [70 points]

[1] One common definition of "Reality" in VR is that it is a sensory experience created by the brain based on sensory information from the five senses. Consider the stages of sensory information processing when experiencing virtual reality (VR), which artificially replicates sensory information. Draw a diagram illustrating each stage from sensory input to subjective experience and explain the elements of each stage. [40 points]

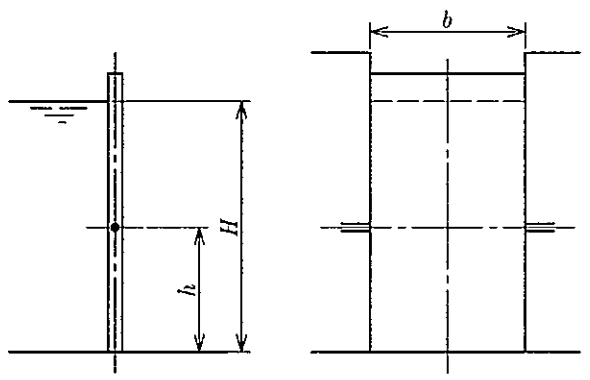
[2] In Social VR and Metaverse, avatars facilitate nonverbal communication through expressions and gestures. Avatars also offer various possibilities for self-expression, freeing individuals from the constraints of their physical bodies and allowing them to become their ideal selves. Additionally, avatars provide new forms of embodiment, such as transformation, alter ego, and fusion. Answer the following questions regarding these new forms of embodiment: [30 points]

A. Explain the specific meanings of "transformation," "alter ego," and "fusion" in the context of avatars. [15 points]

B. Provide one example each of "transformation," "alter ego," and "fusion" using avatars, and describe how each example functions. [15 points]

Elective Question 6 [70 points]

[1] A sluice is installed in a channel with rectangular section of width B with no gap between the sluice and the channel. When the channel is filled with water on only one side of the sluice to a height of H from the bottom of the channel, answer each of the following questions. The z-axis is vertically upward, and the origin is at the bottom of the channel. The x-axis is perpendicular to the sluice face, and the y-axis is parallel to the surface of the sluice with respect to the z-axis and the origin. Let the atmospheric pressure be p_a, the density of water be ρ, and the acceleration of gravity be g, and answer the following questions. The change in atmospheric pressure in the direction of height due to air density can be ignored. [40 points]



1. Set up Euler's equation of equilibrium on the water side of the sluice gate with p as the pressure. (5 points)
2. Based on Euler's equation of equilibrium in (1), derive an expression for the pressure in the water on the water-filled side of the sluice gate. (10 points)
3. Find the horizontal force F on the sluice. (10 points)
4. When a horizontal axis of rotation is attached to a sluice so that it can rotate freely, find the height h of the axis of rotation at which the sluice does not rotate due to water pressure. Assume that there is no friction between the sluice and the channel wall and no water leakage. (15 points)

[2] Answer the following questions regarding the modeling of three-dimensional shapes. You may use graphical or equation-based explanations if necessary. [30 points]

1. Describe what you know about the conditions for obtaining good geometry data and the means and methods for achieving them when acquiring 3D geometry through 3D scanning using a laser beam. (10 points)
2. Explain the standard procedure for converting point cloud data obtained by 3D scanning using a laser beam into CAD data. (10 points)
3. Explain what the G0, G1, and G2 connections of faces are in CAD modeling of faces, and describe the relationship between these connections of faces and the zebra mapping. (10 points)

2025 Master's Program, Graduate School of Design (General Entrance Examination) Achievement Test

Examination Subject Media Engineering

Answer Sheets

Examinee's number

Compulsory Question (State your choice of words and their numbers in your answer.)

No. _____ technical term _____

No. _____ technical term _____

No. _____ technical term _____

Do not write on the back side of the answer sheet. Your answers not being scored.

Examination Subject
Media Engineering

Answer Sheets

Examinee's number

Compulsory Question (State your choice of words and their numbers in your answer.)

No. _____ technical term _____

No. _____ technical term _____

No. _____ technical term _____

Do not write on the back side of the answer sheet. Your answers not being scored.

2025 Master's Program, Graduate School of Design (General Entrance Examination) Achievement Test

Examination Subject Media Engineering

Answer Sheets

Examinee's number

Elective Question [Question No. :]

Do not write on the back side of the answer sheet. Your answers not being scored.

2025 Master's Program, Graduate School of Design (General Entrance Examination) Achievement Test

Examination Subject Media Engineering

Answer Sheets

Examinee's number

Elective Question [Question No. :]

Do not write on the back side of the answer sheet. Your answers not being scored.