CS 5330 Week 6 Homework

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Questions

1. Dichromatic Reflection Model Speed Round:

True or False: body reflection depends on the viewer's location. *True*

True or False: surface reflection depends on the viewer's location. *True*

True or False: Surface reflection is usually highly directional and depends on the viewer's location. *True*

True or False: the intensity of Lambertian reflection is proportional to the dot product of the surface normal and the viewing direction. *False*

True or False: metals do not exhibit body reflection. *True*

True or False: body reflection is caused by photons penetrating the surface and interacting with pigment particles inside the material. *True*

True or False: velvet looks different because of quantum interactions in the material. *False*

True or False: velvet looks different because the surface normals of the fibers are perpendicular to the overall surface normal. *True*

2. How do you find the primary orientation of a 2-D shape (axis of least central moment)? What are the steps and what theoretical property of the pixels in the region corresponds to the orientation?

Answer:
To find the primary orientation of a 2D shape, follow these steps:

1.Compute the second-order moments:Calculate the covariance matrix using image moments: Mxx,Myy,Mxy

2.Find the eigenvectors of the covariance matrix:The eigenvectors give the principal axes of the shape.

The eigenvector corresponding to the smallest eigenvalue is the axis of least moment, meaning the direction where the shape is least spread out.

3.Extract the orientation:The angle θ of the axis is given by

$$\theta = \frac{1}{2}\tan^{-1}\left(\frac{2M_{xy}}{M_{xx} - M_{yy}}\right)$$

This gives the dominant orientation of the shape.

Key Property:

The eigenvectors of the covariance matrix describe the spread of pixel intensities in different directions. The least central moment direction is where the shape has the least variance.

3. What is the purpose of the grassfire transform algorithm? Describe the inputs and outputs.

Answer:

The Grassfire Transform (also called the Distance Transform) helps find the skeleton (or medial axis) of a shape by simulating how a fire would spread from the shape's boundary inward.

Input: A binary image (foreground = 1, background = 0).

Output: A distance map where each pixel stores its shortest distance to the nearest boundary.

4. When is it more efficient to grow or shrink using the grassfire transform compared to using a standard morphological filter?

Answer:

Grassfire Transform is more efficient than standard morphological operations (dilation/erosion) when you need to grow or shrink a shape by a large number of pixels.

When to Use Grassfire?

A. Fast large-scale dilation/erosion (e.g., expanding/shrinking by 100+ pixels).
B. Extracting skeletons or finding medial axes efficiently.
C. Fast distance-based segmentation (e.g., "Keep all pixels within X distance from the edge").

5. What does top-down versus bottom-up mean when applied to segmentation? Give one example of each type of segmentation algorithm.

Answer:

Top-Down: Start with the whole image and break it into meaningful parts.

Example: Region Splitting & Merging – Start with the full image, split it into smaller regions based on some criteria (e.g., color similarity), then merge similar ones.

Think of it like cutting a pizza into slices!

Bottom-Up: Start with small pieces (pixels or regions) and gradually group them into larger meaningful regions.

Example: Watershed Algorithm – Treat the image like a topographic map where low-intensity areas (valleys) are flooded first, and regions grow until they meet.

Think of it like water filling valleys and forming lakes!