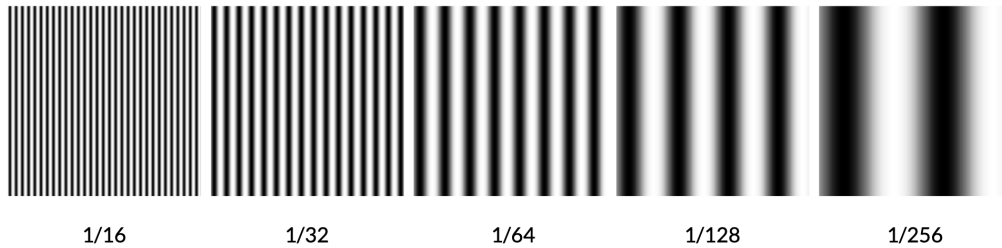


SAMPLING AND TEXTURE MAPPING 3

CS 184: FOUNDATIONS OF COMPUTER GRAPHICS

1 Nyquist Theorem

1. We have five examples of spatial frequencies in cycles per pixel (given by the number below the image). What frequency should each image be sampled at to avoid aliasing?



2. We have two wheels that rotate at different speeds with different numbers of spokes that we want to record with our camera.

- **Wheel A** has 4 spokes and rotates at a rate of 6 rotations per second.
- **Wheel B** has 6 spokes and rotates at a rate of 5 rotations per second.

What frame rate (in frames per second) would our camera need to avoid aliasing effects?

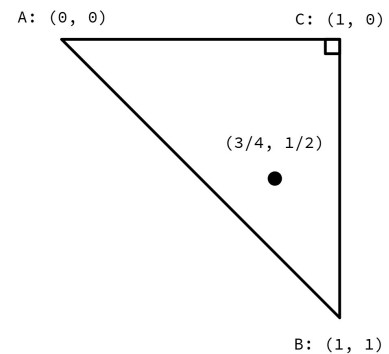
2 Ashley vs. Helicopter

1. Ashley's video camera records at 128 frames per second. The helicopter she is filming has eight blades that rotate. At what rotation rate(s) of the helicopter rotor will Ashley's video suffer from aliasing effects? Give your answer in rotations per second.

3 Barycentric Coordinates

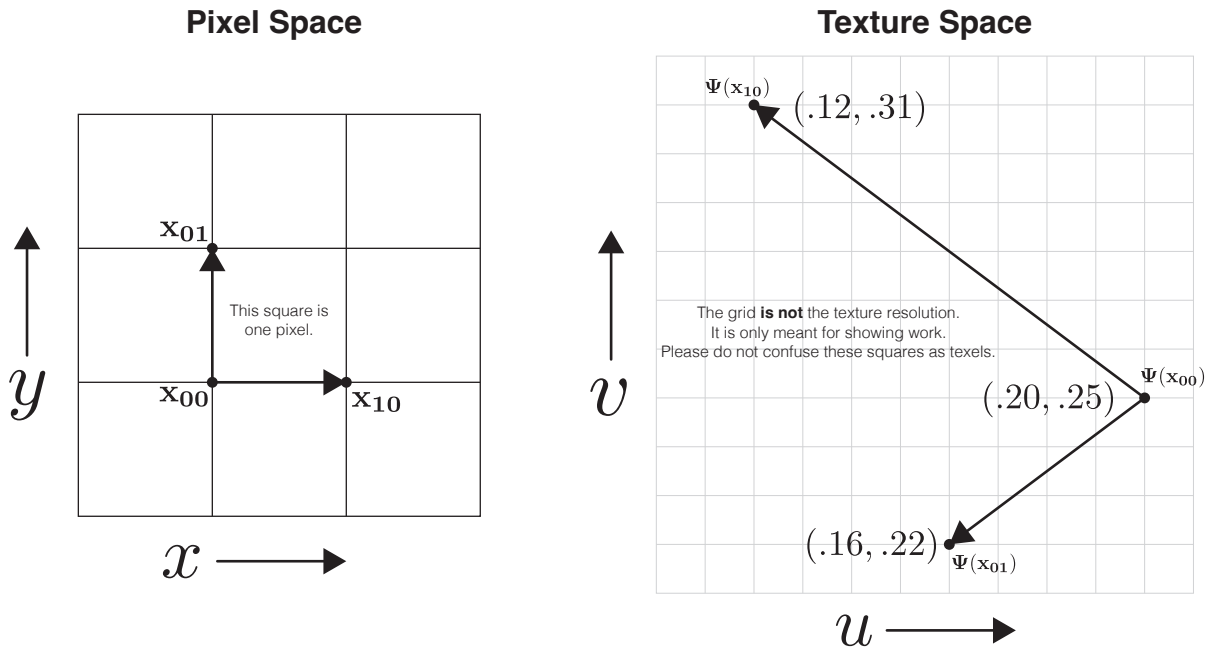
The first step in mapping a texture onto a triangle is to convert the screen pixel to barycentric coordinates. These coordinates (α, β, γ) can be thought of as the weights assigned to each vertex. The weighted average of the vertices is a screen-space coordinate: $(x, y) = \alpha A + \beta B + \gamma C$.

1. What happens if α , β , or γ is less than zero?
2. What is the range of (x, y) if $\alpha + \beta + \gamma = 1$ and $\alpha = 0$?
3. What is the range of (x, y) if $\alpha + \beta + \gamma = 1$ and $\alpha < 0$?
4. What are the barycentric coordinates of the point corresponding to the screen-space coordinates $(x, y) = (\frac{3}{4}, \frac{1}{2})$ in the following diagram? (Hint: Use the definition of barycentric coordinates, not the closed-form solution.)



5. If the RGB values of A, B, C are $(1, 0, 0), (0, 1, 0), (0, 0, 1)$, respectively, then what is the interpolated color at the selected point above?

3. We are given pixel point $\mathbf{x}_{00} = (x, y)$, as well as \mathbf{x}_{01} and \mathbf{x}_{10} , each 1-pixel away from \mathbf{x}_{00} . These three points are mapped to their corresponding locations in texture space by the mapping $\Psi(\mathbf{x})$. Note that the mapping uses barycentric coordinates! The texel space is in the range $[0, 1]$. At what mipmap level, L , should we sample to retrieve the texture for point \mathbf{x}_{00} ?



4. For mipmap levels 0 through 5, the texture value at $\Psi(x_{00})$ is given by:

$$T_0 = 0.38, \quad T_1 = 0.42, \quad T_2 = 0.36, \quad T_3 = 0.40, \quad T_4 = 0.39, \quad T_5 = 0.37.$$

Given our answer to the previous question, what texture value should we use?

5. How can we combine values from two neighboring mipmap levels to get an even smoother result?