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CS 415

Mini Project 4

Q1.

-Invariance: image is transformed and corner locations do not change

-Equivariance: if we have two transformed versions of the same image, features should be detected in corresponding locations

-Translation: Corner location is equivariant w.r.t. image translation. The image pixels may be translated in up/down or left/right directions, meaning the corner locations have also shifted with the pixels.

-Rotation: Corner location is equivariant w.r.t. image rotation. Similarly to translation, a rotated image means all the pixels have been rotated about some point, meaning the corner locations will have also rotated with respect to the pixels.

-Horizontal flipping: Corner location is equivariant w.r.t. image horizontally flipped. The pixels in a horizontally flipped image are reflected across the center of the image. This results in the corners corresponding to those pixels also being flipped. Therefore, the locations change, but all the corners will still be detected, albeit flipped.

-Scaling: Neither invariant nor equivariant to scaling. If the image size is increased, the Harris corner detector cannot guarantee that the same corners will be detected. For example, if an image is a line which is detected as a corner, increasing the size of the image may lead to points on the

line being classified as edges. This operation cannot guarantee the location or preservation of corners of the original image.

-Adding a constant to every pixel intensity (ignoring overflow): Invariant to additive changes in intensity. Adding a constant value to each pixel will result in the image maintaining the same relative brightness with respect to each pixel. Therefore, the corners will still be detected in the same locations.

Q2.

Image gradients: The use of image gradients allow the features to be invariant to absolute intensity values.

Color histogram: Allows for invariance with respect to changes in scale and rotation.

Cells: Can retain general spatial layout, and allows for some invariance to deformations.

Q3.

a.) Shift to the right by 100 pixels:

1	0	100
0	1	0
0	0	1

b.) Rotate around the origin in the clockwise direction by 45 degrees:

cos(45)	-sin(45)	0
sin(45)	cos(45)	0
0	0	1

c.) Rotate around the point (20, 20) in the counterclockwise direction by 90 degrees:

First, apply translation:

1	0	-20
0	1	-20
0	0	1

Then, apply rotation about origin by 90 degrees counterclockwise:

cos(-90)	-sin(90)	0
sin(-90)	cos(-90)	0
0	0	1

Lastly, apply translation back:

1	0	20
0	1	20
0	0	1