Computer Vision Feature Detectors

Gail Carmichael

PhD Student, School of Computer Science, Carleton University
http://www.gailcarmichael.com

What is a feature?

It's interesting.

-Wikipedia puts it well (http://en.wikipedia.org/wiki/Feature_detection_%28computer_vision%29):

> -"There is no universal or exact definition of what constitutes a feature, and the exact definition often depends on the problem or the type of application. Given that, a feature is defined as an "interesting" part of an image, and features are used as a starting point for many computer vision algorithms."

For example...

Edges Blobs

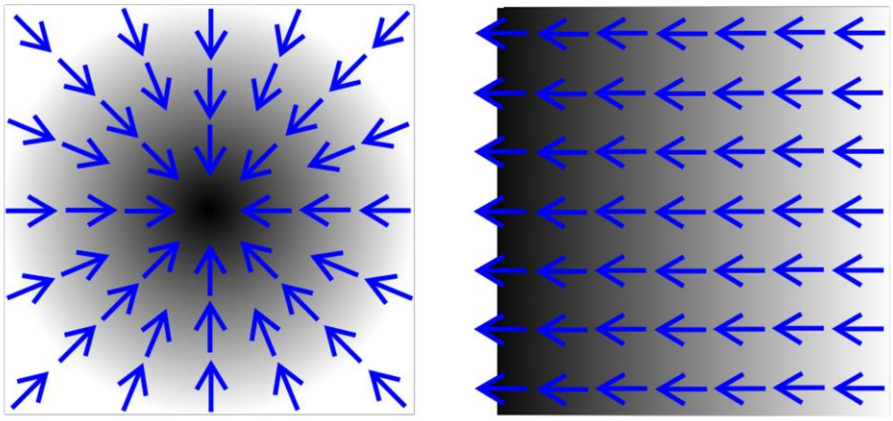
Corners Ridges

-Edges:

-Boundary between two image regions

-Points with a strong gradient magnitude

Image Gradient



-The gradient of a single point in the image is a 2D vector whose components are given by the derivatives in the horizontal and vertical directions

-Image from Wikipedia

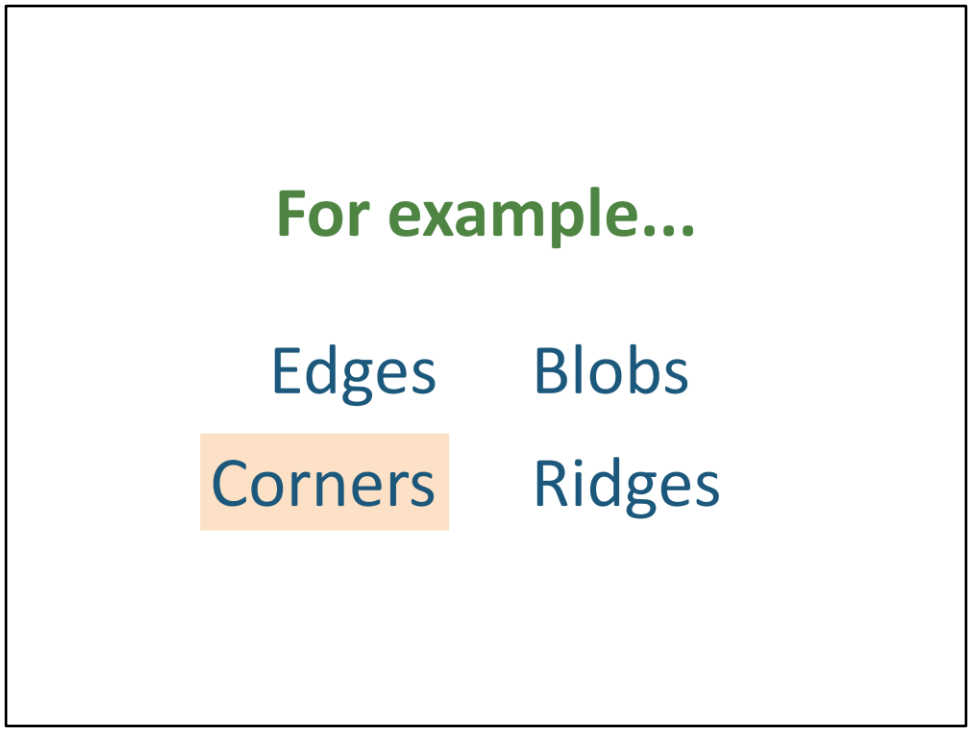
-http://en.wikipedia.org/wiki/File:Gradient2.svg

-We find an approximate/discrete version of the derivate of the image intensity
-Use a kernel convolution over the image (for example, the Sobel operator)
-If this is the before image...

-Images from Wikipedia
-http://en.wikipedia.org/wiki/File:Bikesgray.jpg

-...this is the normalized Sobel gradient image
-The whitest values can be taken as edges

-Image from Wikipedia:
-http://en.wikipedia.org/wiki/File:Bikesgraysobel.jpg



-Corners:

-Term used interchangeably with ‘interest points’

-Points detected aren’t always on corners as we understand them

-Harris corners, shown in previous talk, a good example of ‘true’ corners

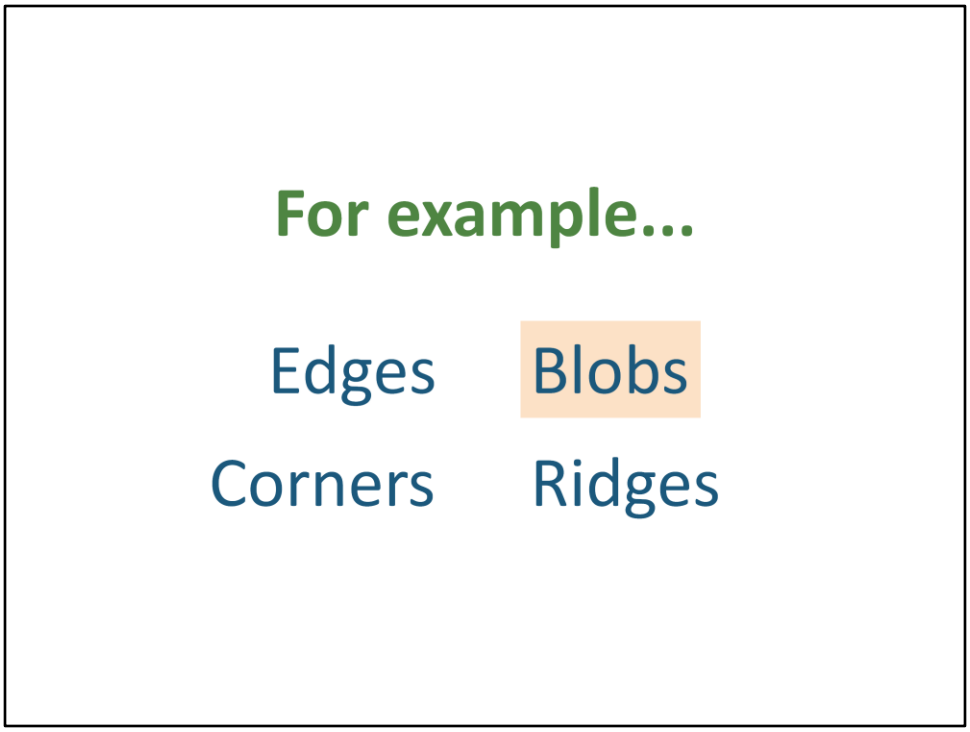
-Example of one interest point detector is SIFT
-First step is Difference of Gaussians (DoG), an image enhancement algorithm that works on greyscale images
    -(so above image would be converted to greyscale first)
-Convolve the image with two Gaussian kernels and subtract them....

-Image:
    -http://en.wikipedia.org/wiki/File:Flowers_before_difference_of_gaussians.jpg

Difference of Gaussians

-....to get this result
-For SIFT, various DoG results obtained over several successive scales
-Local minima/maxima of these results that occur at several scales become the keypoints
-Further processing is done, but SIFT will be discussed in the next talk so we'll leave it at that

-Image:
-http://en.wikipedia.org/wiki/File:Flowers_after_difference_of_gaussians_grayscale.jpg



-Blob detection

-We look for regions (or points) that are darker or brighter than the surrounding regions

-Closely related to corners, since they often contain a preferred point

-Some methods in corner detection, including DoG, are also used here

-Maximally Stable Extremal Regions (MSER)

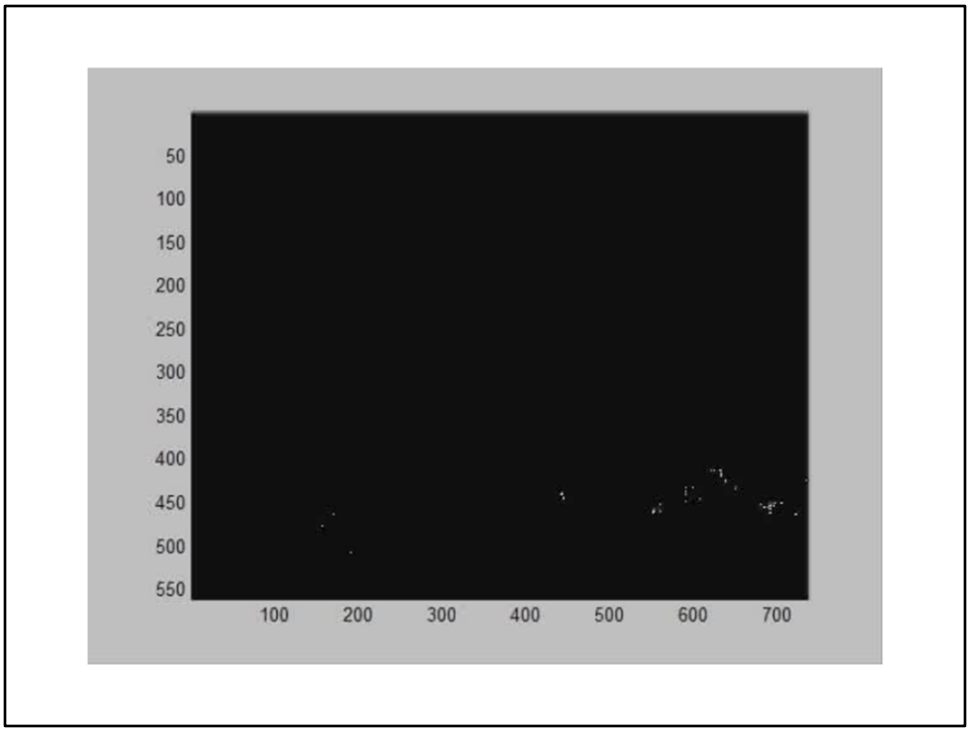
-An example of a blob detector that addresses the issue of changing viewpoints

-Imagine your image is actually a topographic map

-In other words, you are looking at a terrain from a bird's eye view

-The image intensities represent how high a point on the terrain is (with, say, white being the highest)

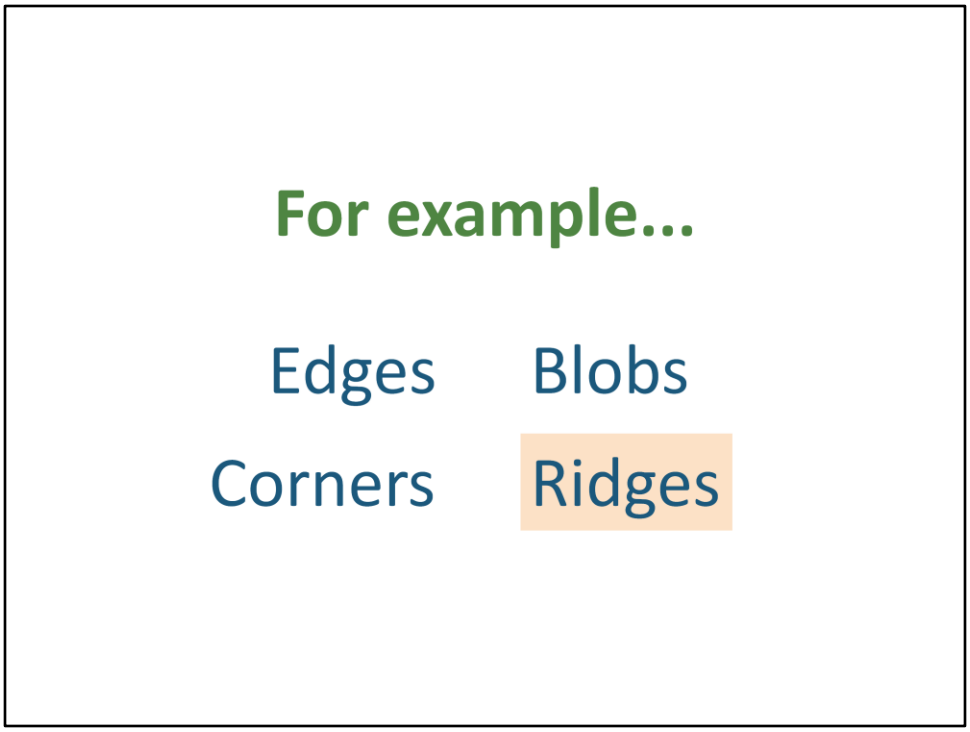
-Now imagine filling up the terrain with water...



-...the lowest regions fill with water first
-Some regions keep the same shape for some time
-It is these regions that will become MSERs
-(Note: The above is a movie that you may not be able to view online. Basically, it was drawing all pixels with 0 intensity white in the first frame, adding those with intensity 1 in the next frame, intensity 2 in the next, and so on, until the whole image is white.)

-The MSER regions found in the detection process are all superimposed in this image as white regions

- Here's the same example with the bounding ellipses of the MSER regions shown in blue, and centers of gravity of the regions shown as red crosses



-Ridges

-"From a practical viewpoint, a ridge can be thought of as a one-dimensional curve that represents an axis of symmetry, and in addition has an attribute of local ridge width associated with each ridge point." (Wikipedia)

-Harder to compute

-Not used a lot, but can be seen in road and blood vessel detection

Now what?

Feature description.

-Once you have detected your features, you need a unique way to describe them.

-Then you can match them between images, use them to build 3D scenes, find similar objects from a database, etc...

-But that's another story. ☺