

In this assignment you will write a procedure to carry out the Hough transform for disks in 2D images and apply it to both computer generated test images and images of the real world.

1. Write a procedure that takes a 2D image in and the following parameters, including a disk radius, and produces the center positions (x,y) of disks with that radius in the image.

Parameters

A disk radius in pixels

The intensity polarity of the desired disk (light on dark or dark on light)

Parzen standard deviation, controlling the smoothing of the accumulator function.

Gradient magnitude threshold, controlling which pixels are boundary-like enough to vote.

The mean and standard deviation of a sigmoid function mapping gradient magnitude to vote strength. A sigmoid function is a cumulative Gaussian. You will find it easier to compute or obtain a lookup table in which to interpolate when evaluating this function.

The scale (Gaussian standard deviation) at which the intensity gradient is calculated.

The method should produce a 2D accumulator (feature space) array indexed by (x,y) center values as well as a list of voting pixel locations together with the feature space positions they voted for. The method should deliver the accumulator position with the most votes and display, superimposed over the image data, the disk chosen. Also, upon a command from the user the method should remove the votes to the accumulator arrays from voters who voted the winning position, thus producing new accumulator array values from which the disk with the most votes will be selected.

The method should produce votes by applying a gradient of a Gaussian operator to the image at each pixel, thresholding the magnitude of the result, and if the threshold is passed, voting for centers along the gradient direction, according to the radius value and the sense of the gradient direction relative to the desired intensity polarity. After the votes are collected, the accumulator array should be blurred by a Gaussian in the (x,y) directions according to the Parzen standard deviation, before the maximum is found.

2. You should write a program that, given the discrete disk radius and a list of possible disk intensities and a number of disks in a specified image position range, generates test images with randomly positioned disks. Moreover, given blurring levels and intensity noise levels it will apply the blurring and produce random Gaussian distributed noise with the given intensity noise standard deviation. You are requested to apply your Hough disk program to a variety of images so generated and to report the effect of blurring, of noise level, and of disk overlap on the ability to extract the disks. Your report should use good English and should be as scientifically valid as you can make it.
3. Locate on the web some images including disks. Apply your program to these after measuring by hand the disk sizes in those images. Comment on the success of your program and on the parameter values you used. Also, comment on the sensitivity of the selection to the value of the radius given, i.e., how close the actual radius needs to be to cause the disk to be selected.

What you should pass in

The programs for image generation and for disk discovery. Some sample images and next to them the images with selected disks indicated by a superimposed circle. Your comments; see items 2 and 3.