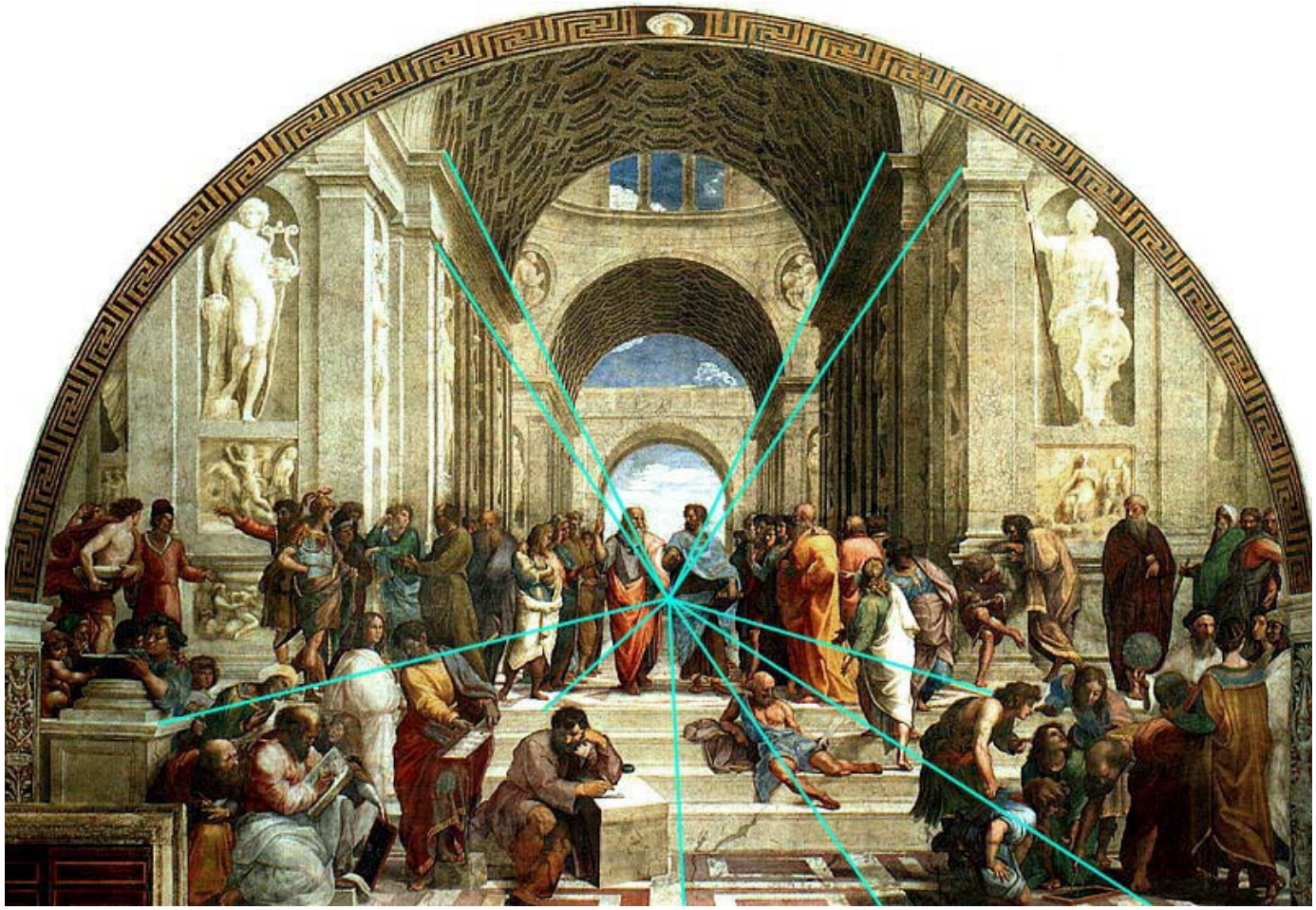
Hough Transform

COMP 4900D

Winter 2006

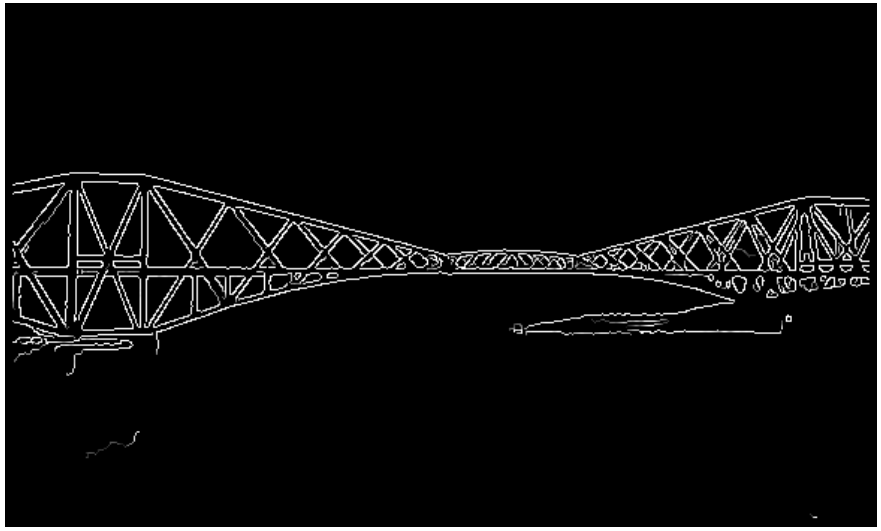
Lines

Lines



Rafael, The School of Athens (1518)

Line Detection



The problem:

- How many lines?
- Find the lines.

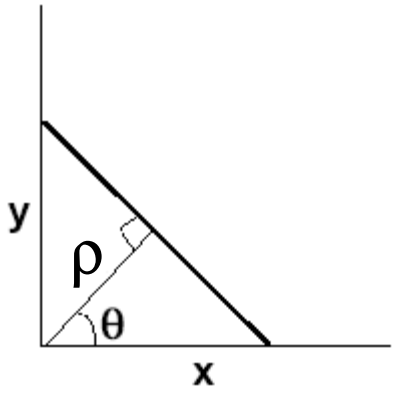
Equations for Lines

The slope-intercept equation of line

$$y = ax + b$$

What happens when the line is vertical? The slope a goes to infinity.

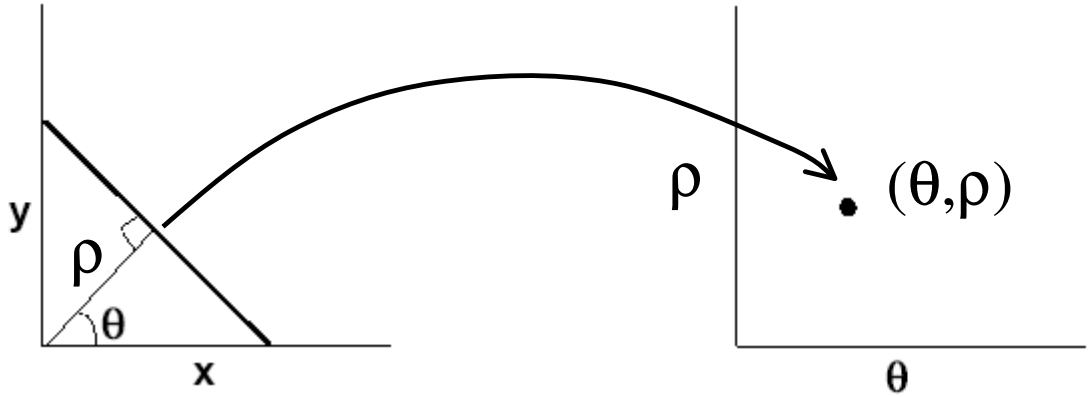
A better representation – the polar representation



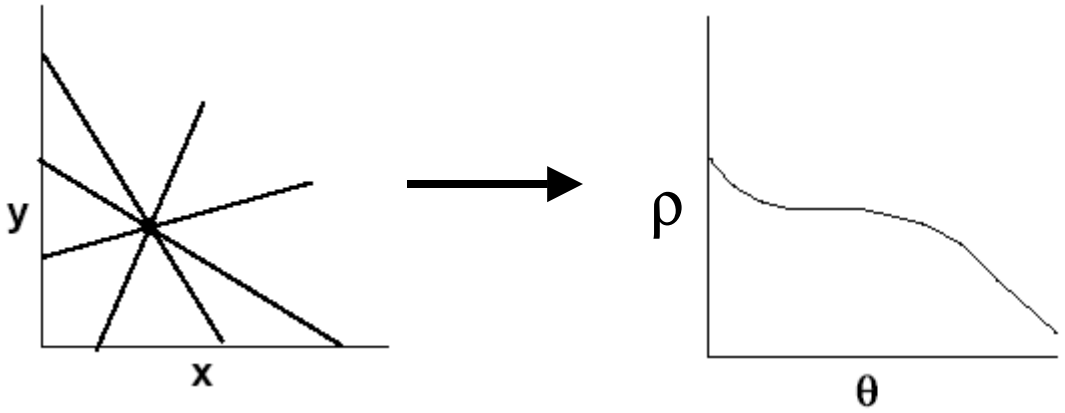
$$\rho = x\cos\theta + y\sin\theta$$

Hough Transform: line-parameter mapping

A line in the plane maps to a point in the θ-ρ space.

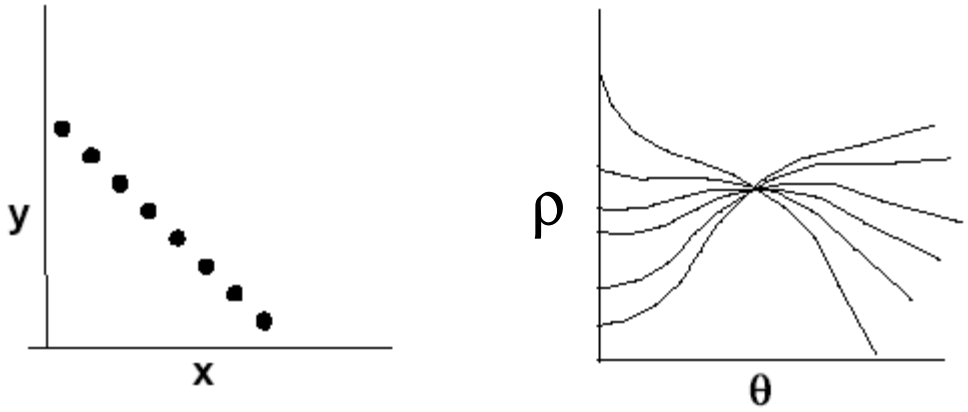


All lines passing through a point map to a sinusoidal curve in the θ-ρ (parameter) space.



$$\rho = x\cos\theta + y\sin\theta$$

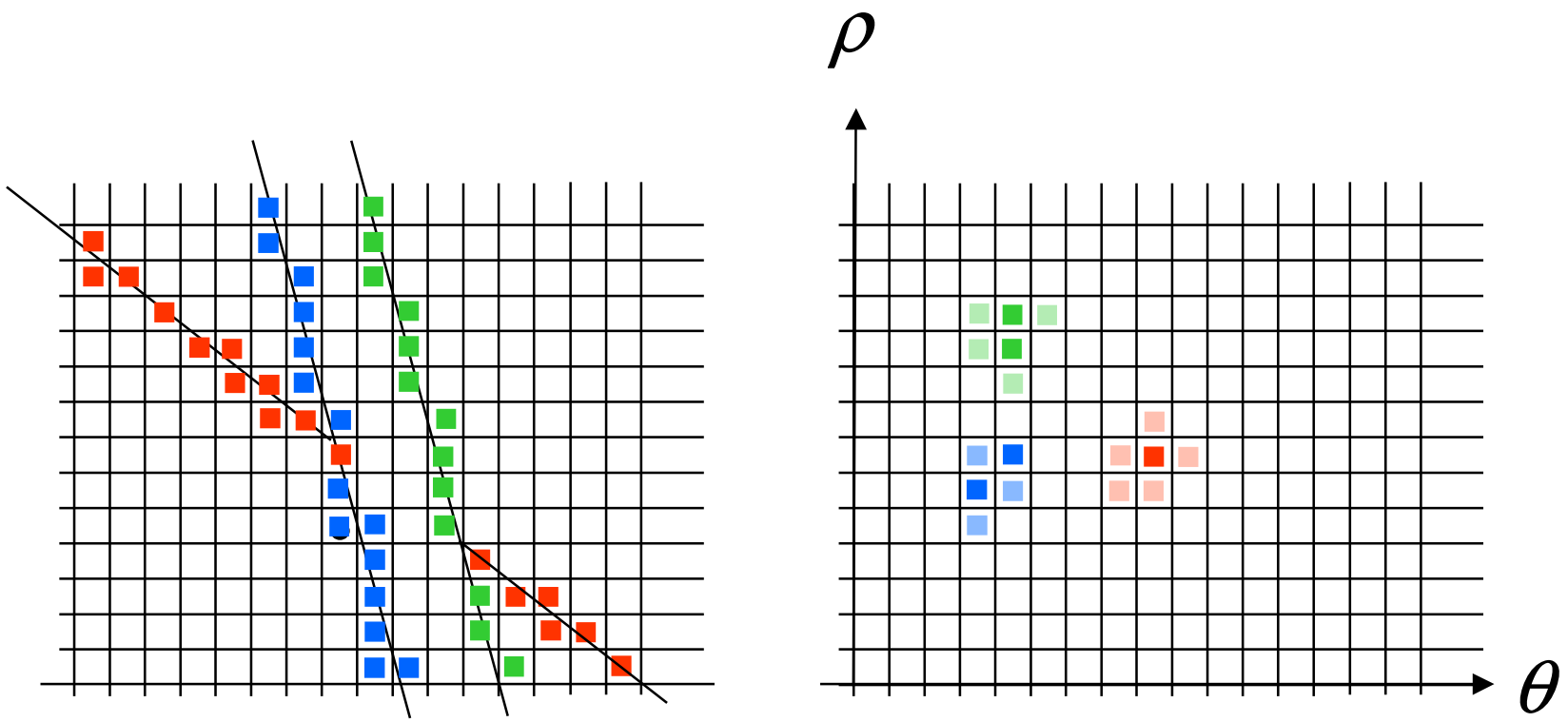
Mapping of points on a line



Points on the same line define curves in the parameter space that pass through a single point.

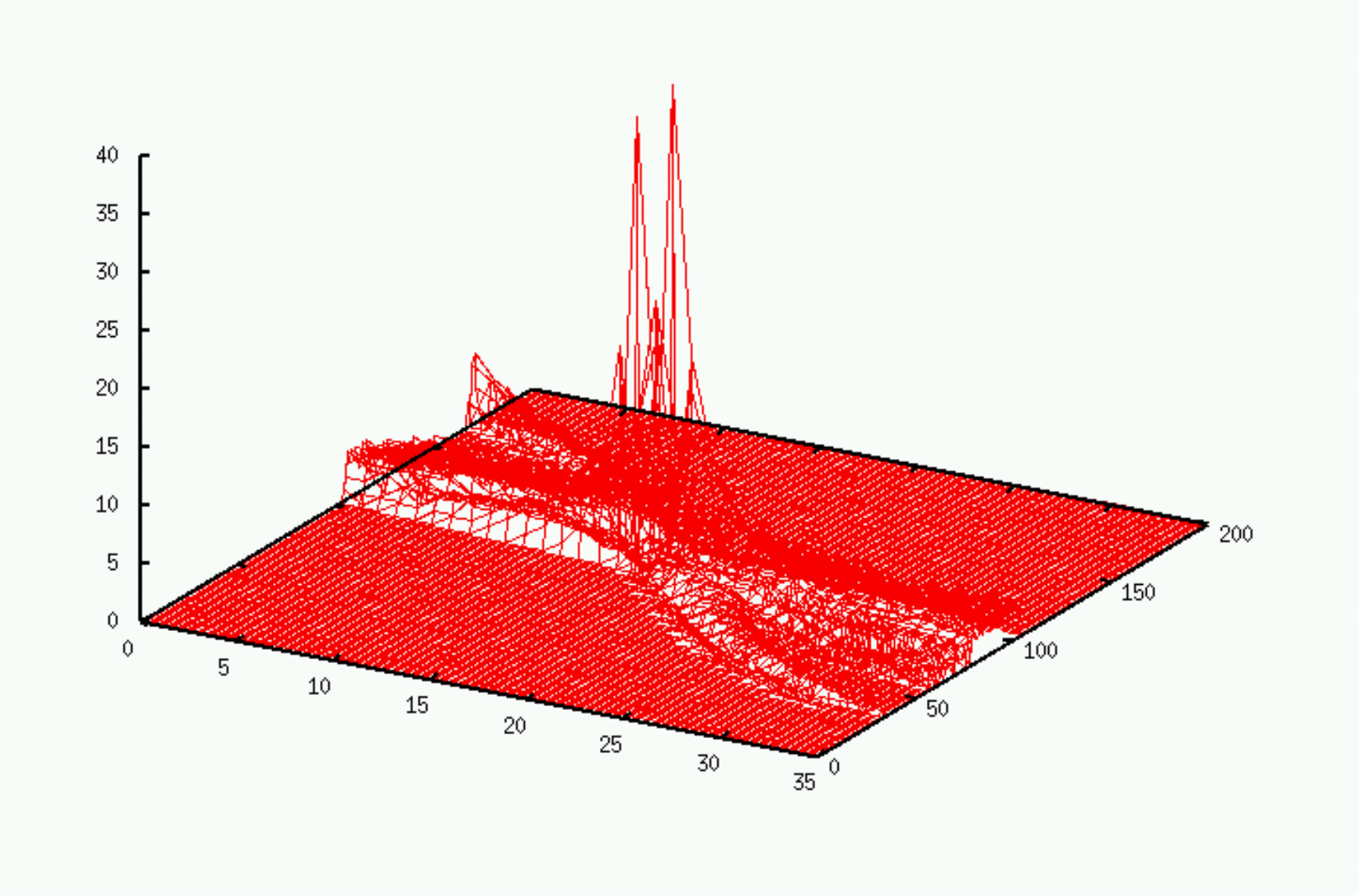
Main idea: transform edge points in *x*-*y* plane to curves in the parameter space. Then find the points in the parameter space that has many curves passing through.

Quantize Parameter Space

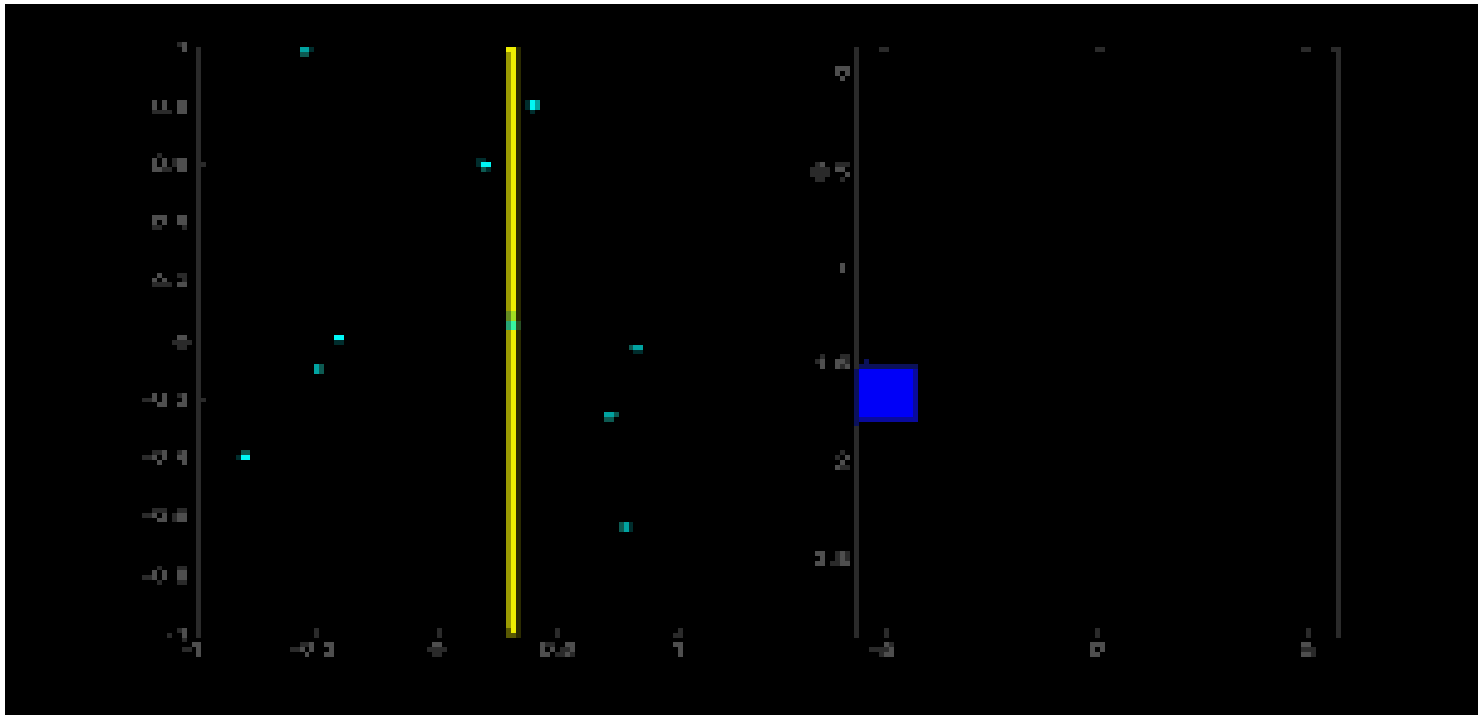


Detecting Lines by finding maxima / clustering in parameter space.

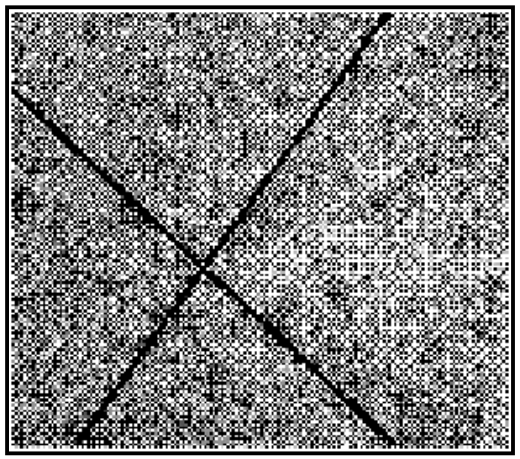
Parameter space – 3D view



A Voting Scheme

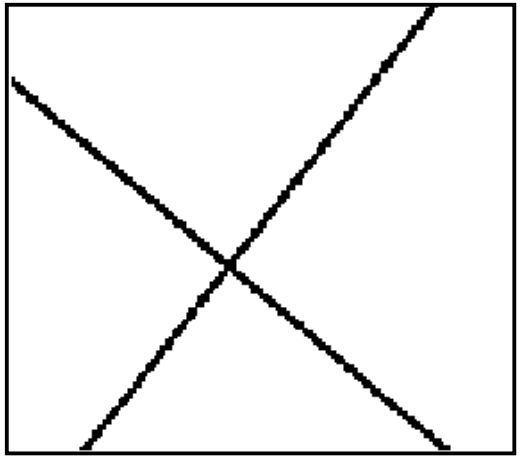


Examples



Image

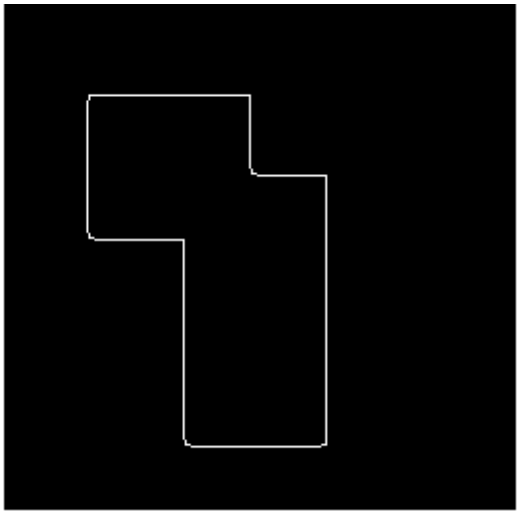
Edge detection



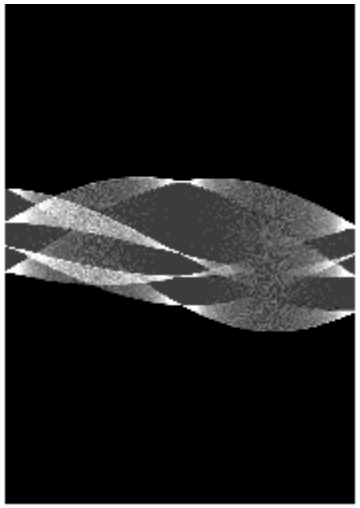
Hough Transform

Examples

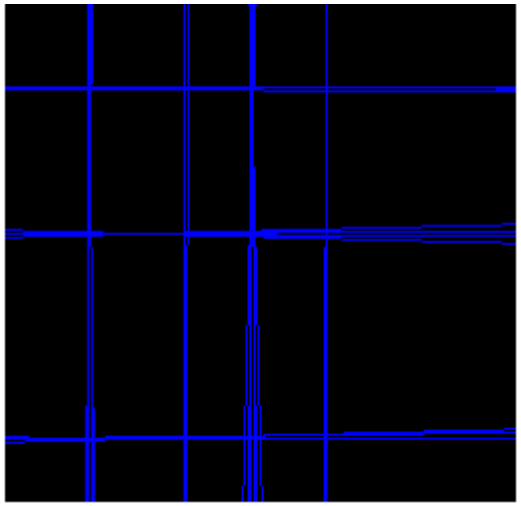
input image

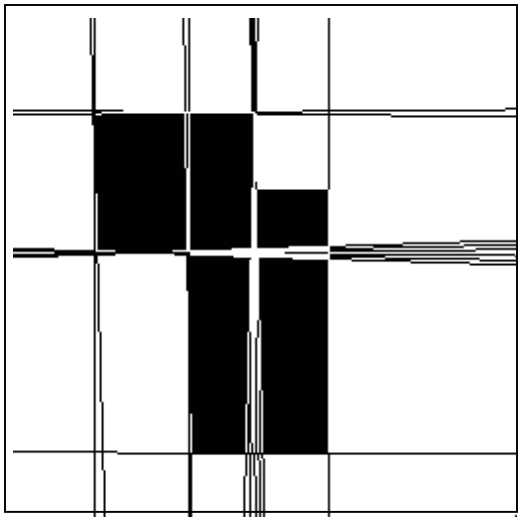


Hough space



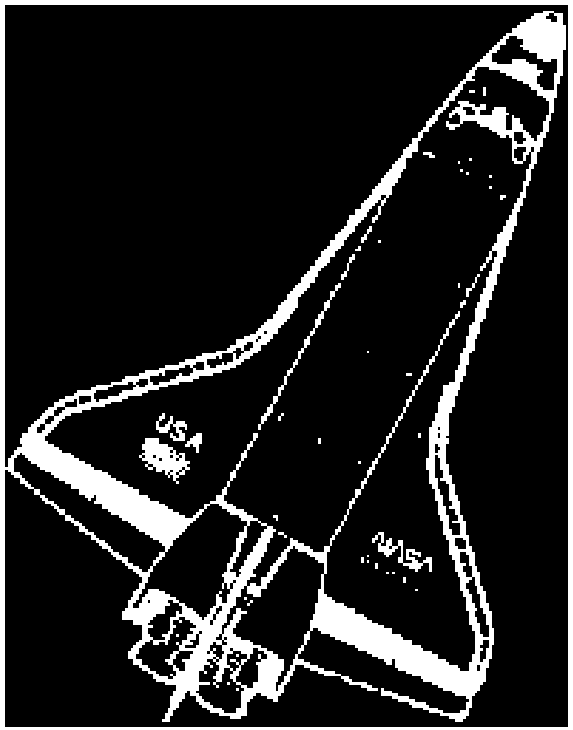
lines detected



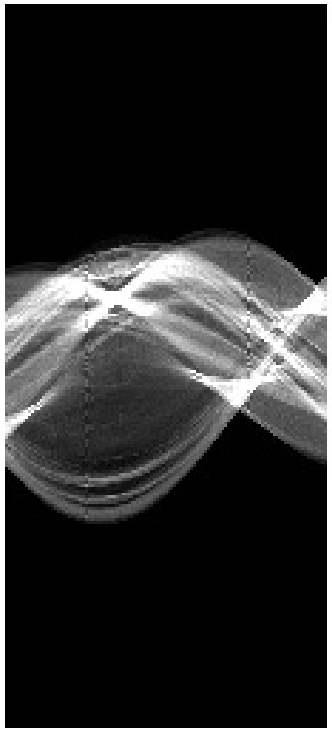


Examples

input image



Hough space



lines detected

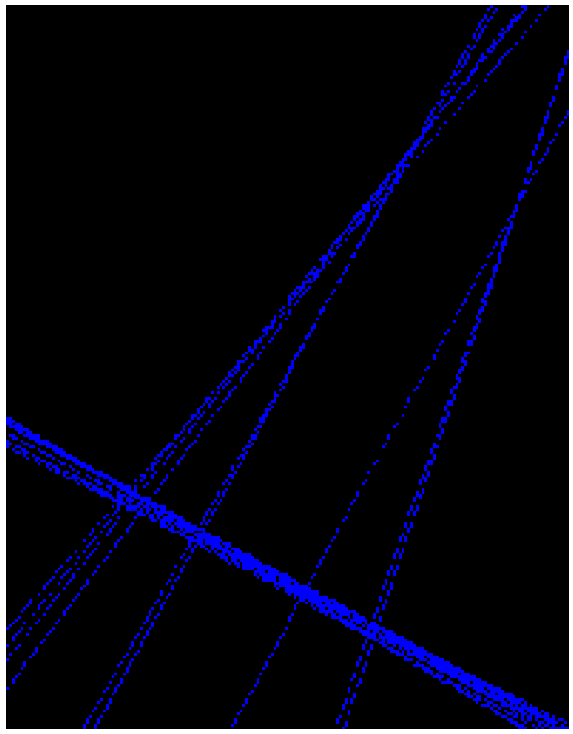


Image credit: NASA Dryden Research Aircraft Photo Archive

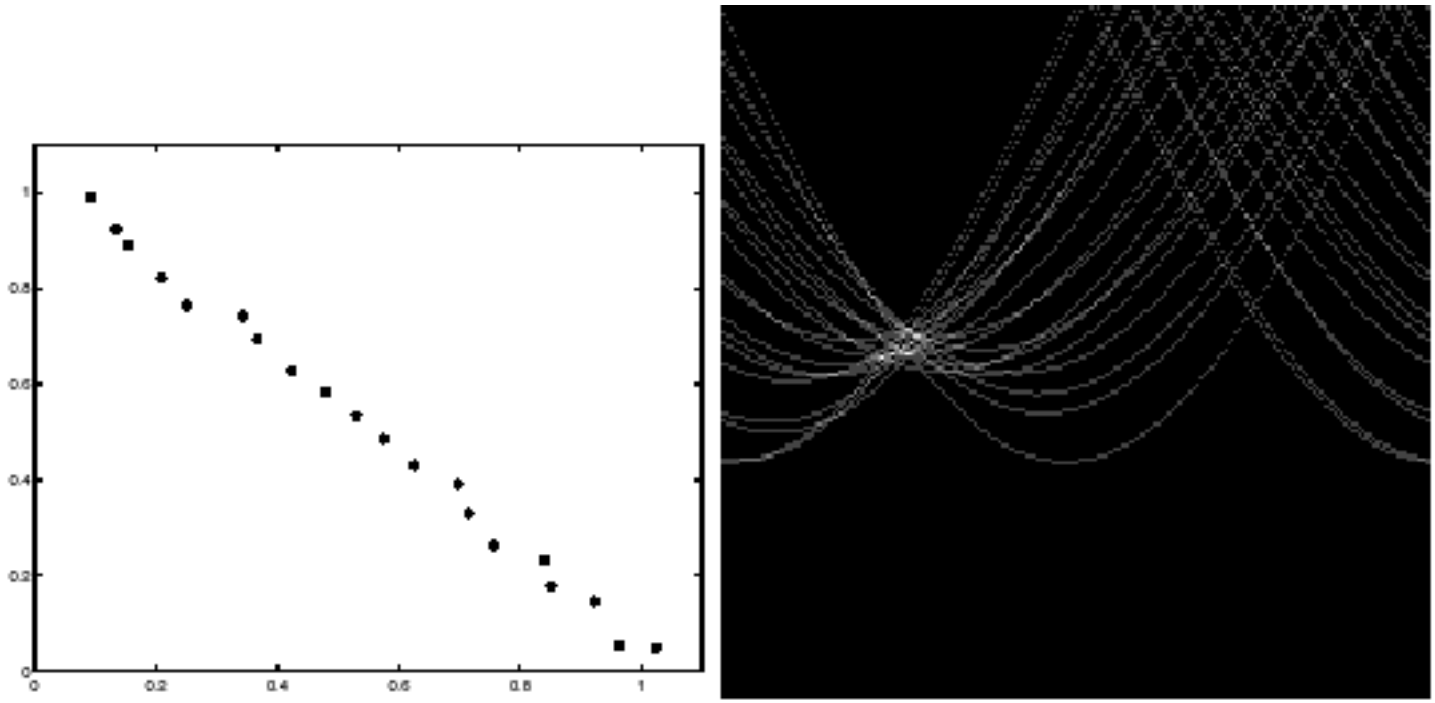
Algorithm

1. Quantize the parameter space
   int P[0, ρ_{max}][0, θ_{max}]; // accumulators

2. For each edge point (x, y) {
   For ($\theta = 0$; $\theta <= \theta_{max}$; $\theta = \theta + \Delta\theta$) {
   $\rho = x\cos\theta + y\sin\theta$ // round off to integer
   (P[ρ][θ])++;
   }
   }

3. Find the peaks in P[ρ][θ].

Cell Size



Choose the parameter cell size such that the algorithm is robust to noise.