HW – 1 (16-720)

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Q4 Test Cases

Image 1

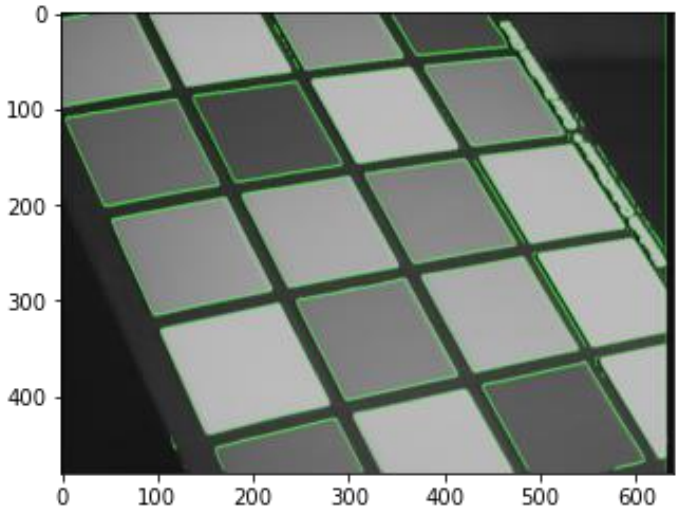


Image 2

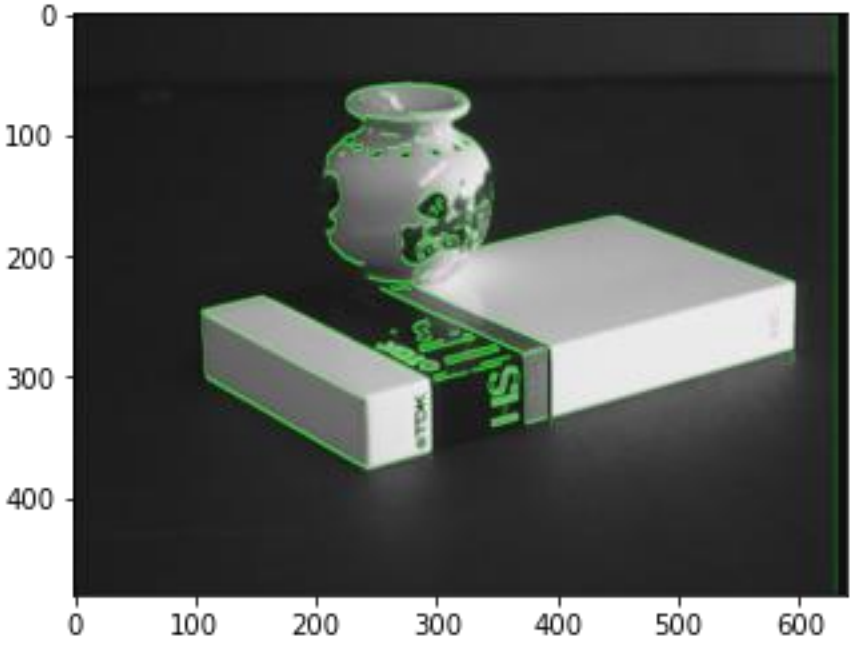


Image 3

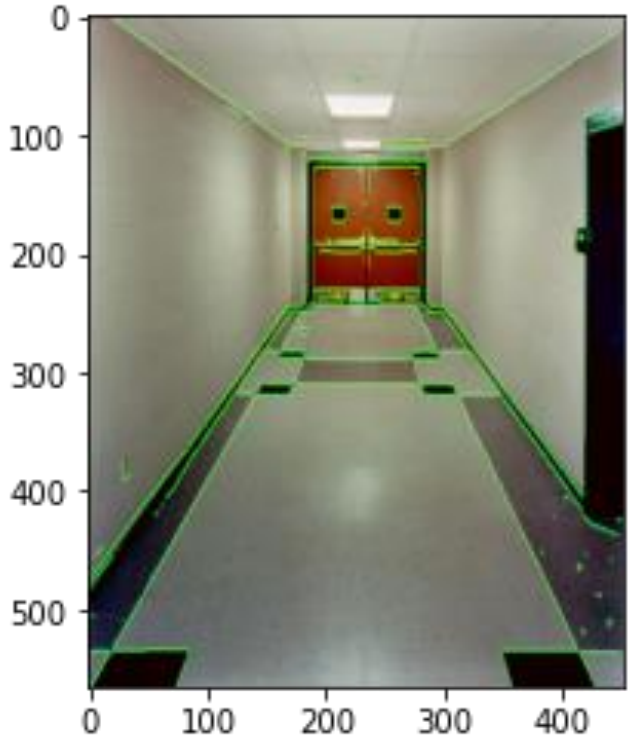


Image 4

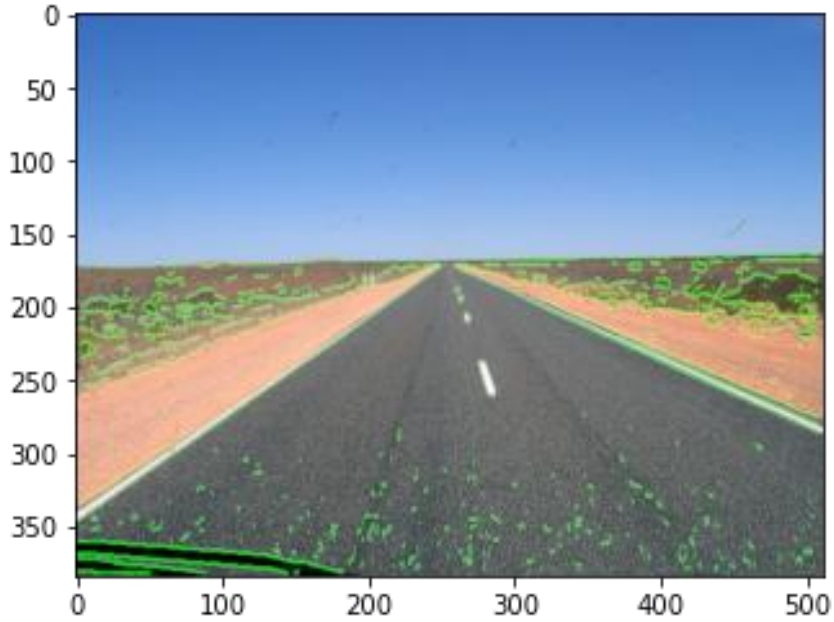


Image 5

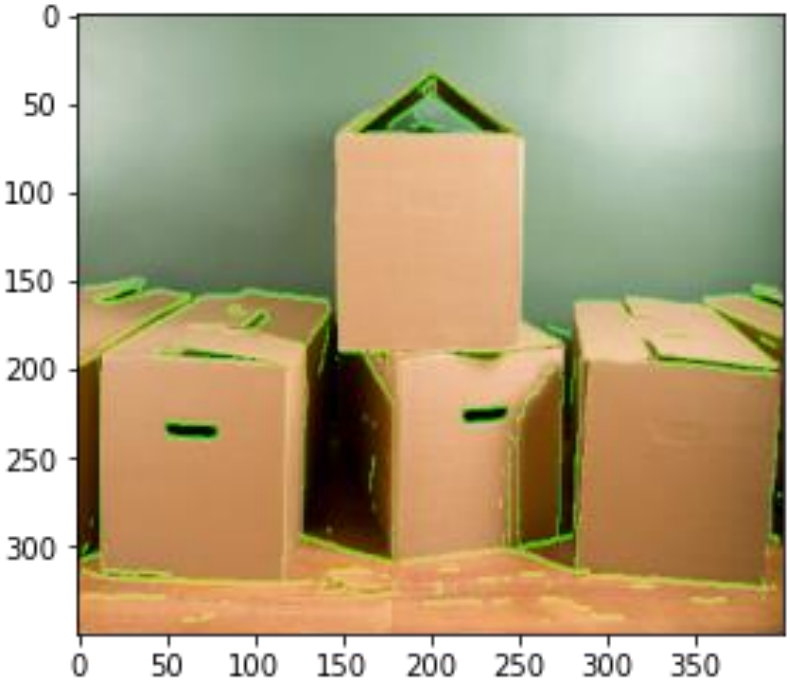


Image 6

Image 7

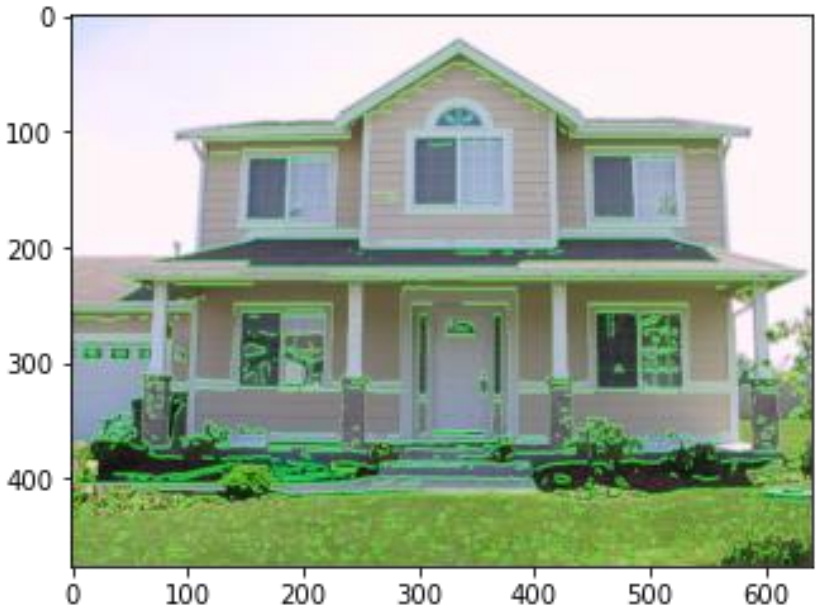


Image 8

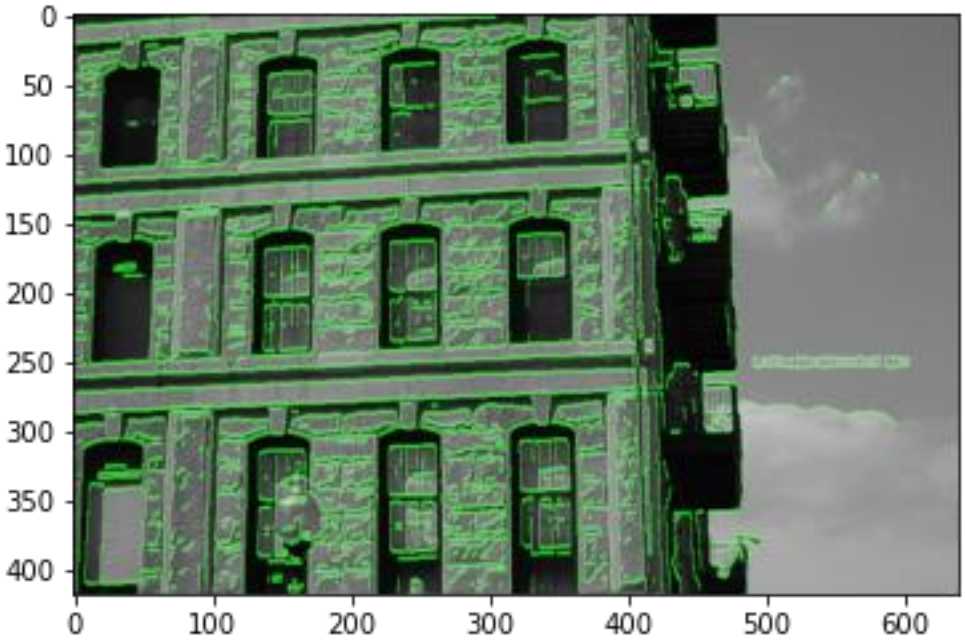


Image 9

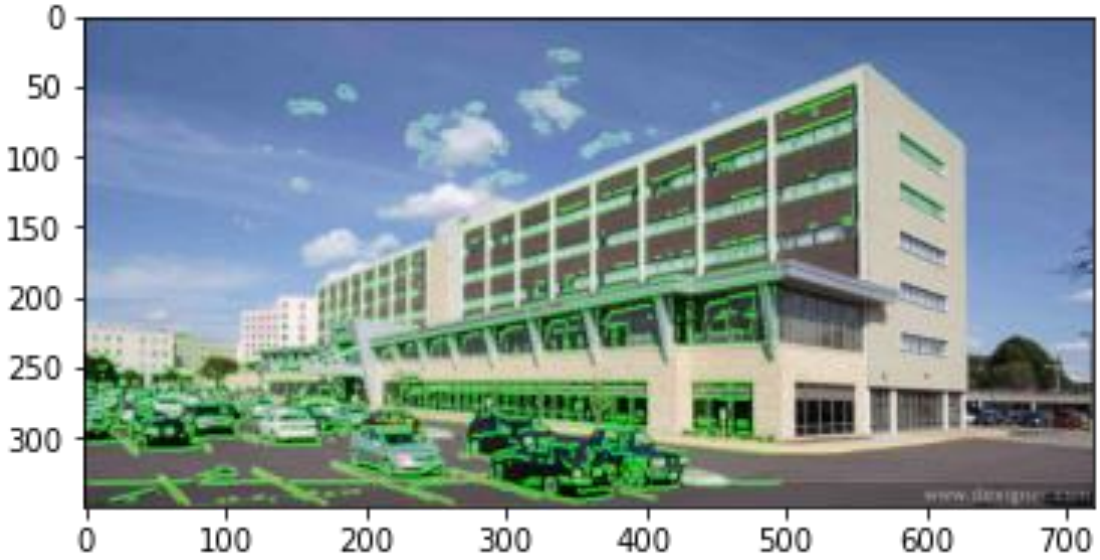
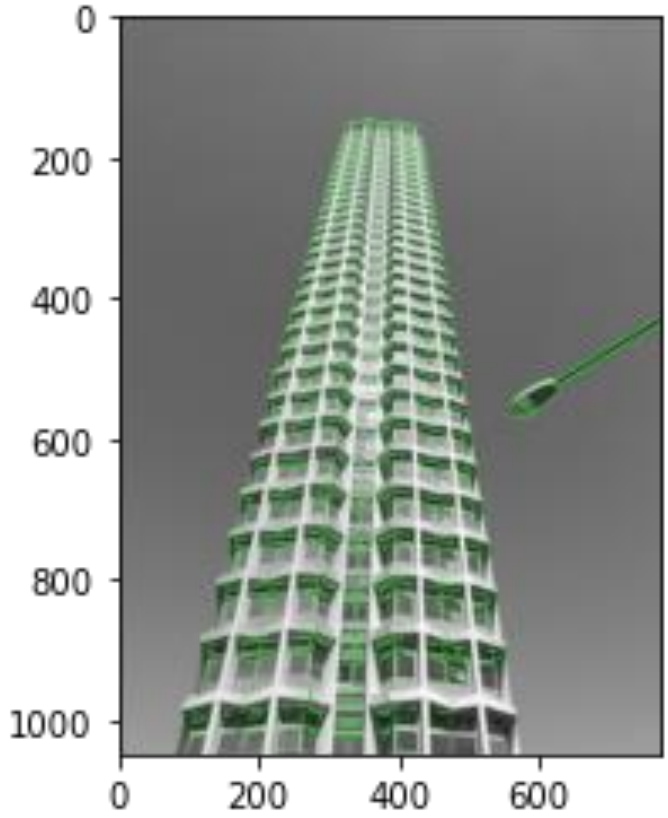


Image 10



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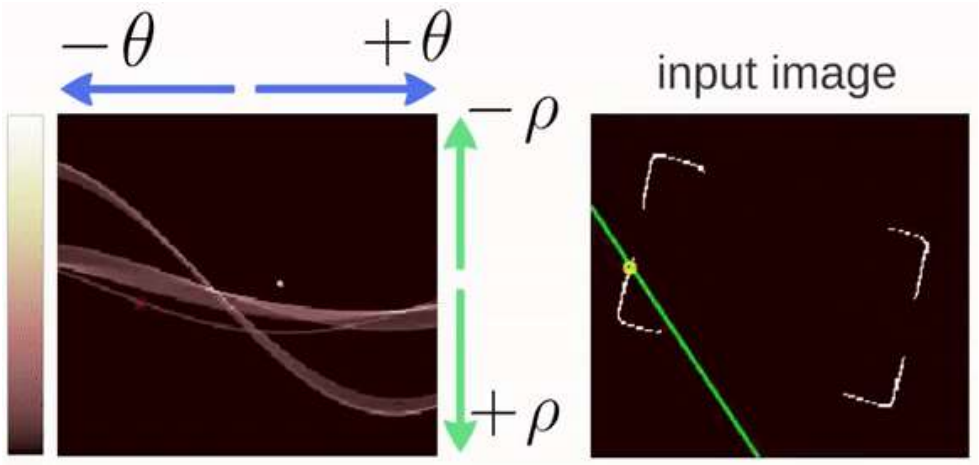
Hough Transform - Assignment 1

Instructor: Kris TAs: Arka, Jinkun, Rawal, Rohan, Sheng-Yu

In this assignment you will be implementing a Hough Transform based line detector.



Theory Questions (25 points)

Grading:

- Each question is 5 points.
- Please add your answers to the writeup. Insert images whenever necessary.
- Show all your work to obtain full credit.

Q1: Show that using $x\cos\theta + y\sin\theta - \rho = 0$, each image point (x, y) results in a sinsuoid in (ρ, θ) hough space.

Use the formulation, $a \sin\theta + b \cos\theta = A \sin(\theta + \phi)$ for the sinusoid.
Write the amplitude A and phase ϕ of the sinusoid as a function of (x, y).

Answer

Let the point of a pixel in the image space be (x,y)

x$cos\theta$ + $y$sinθ = ρ

multiplying the equation by (1/sqrt(x^2 + y^2))

sqrt(x^2 + y^2) is the geometric distance of the point from the origin So, (x/sqrt(x^2 + y^2)) = sinϕ and, (y/sqrt(x^2 + y^2)) = cosϕ

sin$\phi$$cos\theta$ + $cos\phi$sinθ = ρ

sqrt(x^2 + y^2)*sin(θ+ϕ) = ρ

Amplitude A = sqrt(x^2 + y^2)

Phase angle ϕ = arcsin(x/sqrt(x^2 + y^2))

Hence, any point (x,y) results in a sinsuoid in (ρ,θ) hough space

Q2: Why do we parameterize the line in terms of ρ, θ instead of slope and intercept (m, c)?
Also write the slope m and intercept c as a function of ρ and θ.

Answer

We parameterize the line in terms of ρ and θ because -

1. The value of slope becomes infinite as the line becomes verticle. This is because the value of tan θ goes to infinite.
2. The space of C is huge
3. Where as if we use ρ and θ, the values are confined between 0 and 2PI for θ and 0 to ρmax.

m = -cosθ/sinθ

b = ρ/sinθ

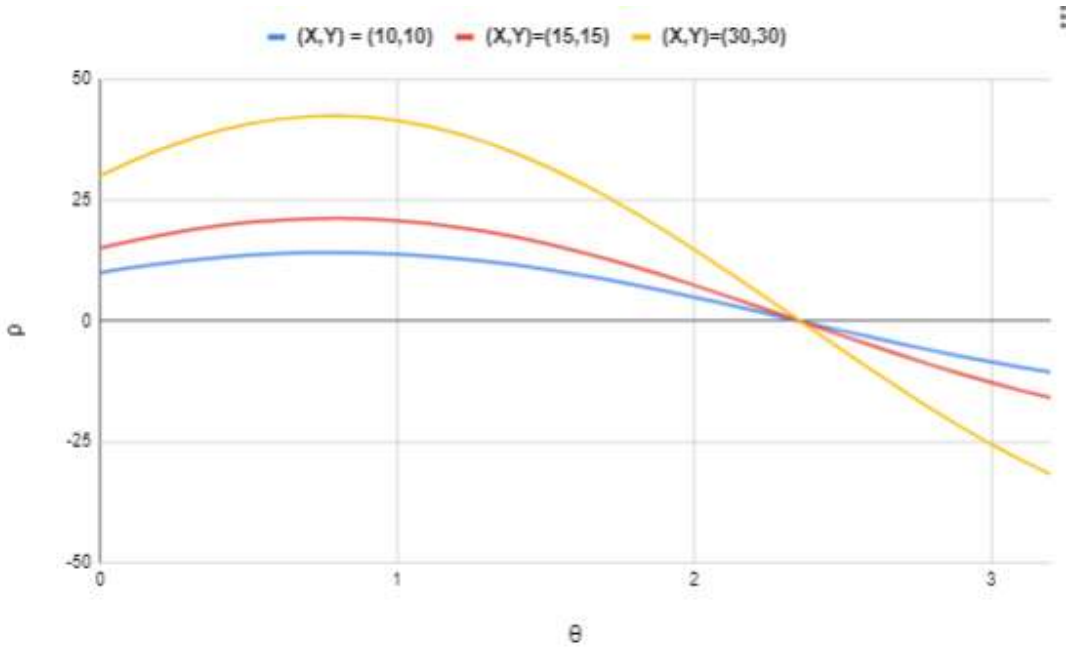
Q3: Assume the image points (x, y) are in an image of width W and height H,
$x \in [1, W], y \in [1, H]$.
What is the maximum absolute value of ρ and what is the range of θ?

Answer

Maximum (ρ) distance is the diagonal length of the image which is (W^2 + H^2)^0.5

θ ranges from 0 to 2*pi

Q4: For points $(10, 10)$, $(15, 15)$ and $(30, 30)$ in the image, plot the corresponding sinusoid waves in Hough space (ρ, θ).
Also visualize how their intersection point defines the line (what is (m, c) for this line?).
Please add the plot as image.**Answer**



Answer

The graphs intersect at (ρ,θ) = (0,2.355)

m = tan(2.355)

= 1.002

c = 0

Q5: How does the dimension of parameter space affects Hough Transform method? What would you do when the parameter space is high, i.e., 3D or 4D instead of 2D? Briefly explain your

method.

Answer

The dimensions of the parameter space affects the Hough Transform as if the parameter space is very small there may be the loss of features while if the parameter space is way too big the computational complexity increases. When the parameter space is high we can change the shape of the accumulator bin into a shape such as of a cube. Also, using a hashmap for storing rho and theta instead of initialising the accumulator array is another method

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