DATA.ML.300 Computer Vision Exercise 4

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1.

a)

The cartesian coordinates can be drawn as follows:

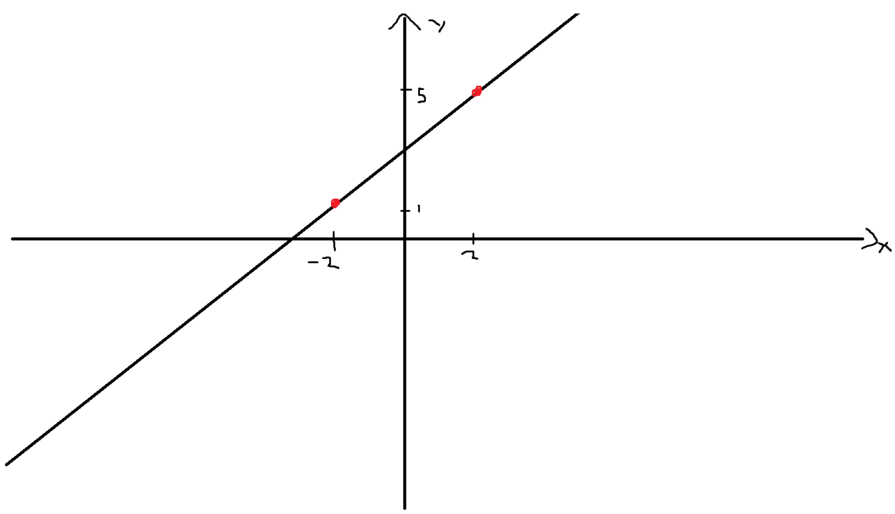

Figure 1: Points x_0 and x_1 in Cartesian coordinates

From here we can also calculate the line's equation, which is

$$m = \frac{\Delta Y}{\Delta X} = \frac{5-1}{2-(-2)} = \frac{4}{4} = 1 \tag{1}$$

We know know the m part of the equation, which results in

$$y = m \cdot x + b \tag{2}$$

and to calculate the value of b we can use one of the points

$$y - 5 = m \cdot (x - 2) \rightarrow y = x + 3 \tag{3}$$

thus the point is $(1, 3)$.

b)

These coordinates can be calculated from comparing the distance between the two points in polar coordinate form, so we get

$$x_0 \cdot cos(\theta) + y_0 \cdot sin(\theta) = x_1 \cdot cos(\theta) + y_1 \cdot cos(\theta)$$

With the values this is

$$-2 \cdot cos(\theta) + sin(\theta) = 2 \cdot cos(\theta) + 5 \cdot sin(\theta)$$

this simplifies to

$$-4 \cdot sin(\theta) - 4 \cdot cos(\theta) = 0$$

and this further simplifies to

$$-4 \cdot (sin(\theta) + cos(\theta)) = 0$$

and thus we get

$$\theta = \frac{3\pi}{4} + \pi n$$

And this has to be in the window, so $n = -1$ gives

$$\theta = \frac{3\pi}{4} - \pi = -\frac{\pi}{4}$$

Rho can be calculated with one of the points

$$\rho = 2 \cdot cos\left(-\frac{\pi}{4}\right) + 5 \cdot sin\left(-\frac{\pi}{4}\right) = -\frac{3\sqrt{2}}{2}$$

And this means that the coordinates are $(-\frac{\pi}{4}, -\frac{3\sqrt{2}}{2})$

This plot can be drawn with the angle going negative $\frac{\pi}{4}$ radians, and then as the ρ is negative, the line moves towards the $\frac{3\pi}{4}$ direction.

c)

Certain benefits can be found in mapping etc. but for computer vision the relevant part is the need for only a single integration when wanting to access an area.The parameter domain is also unbounded, and vertical lines require infinite m.

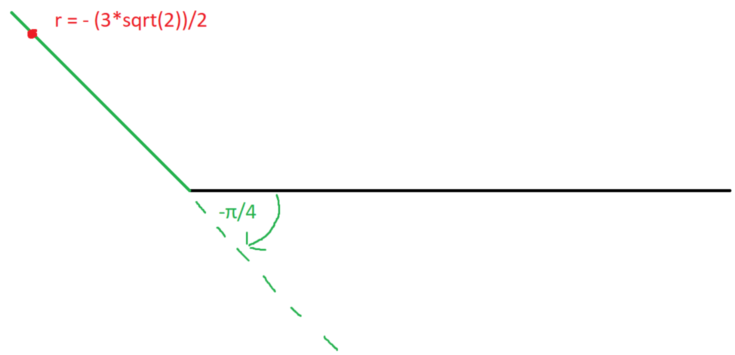

Figure 2: Polar coordinates

3b)

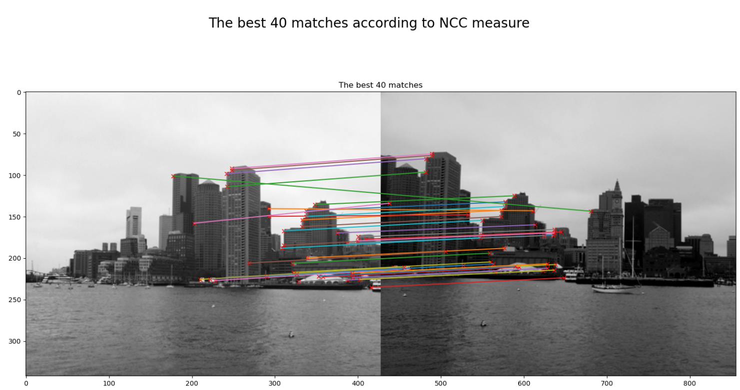

Figure 3: Best 40 matches according to NCC

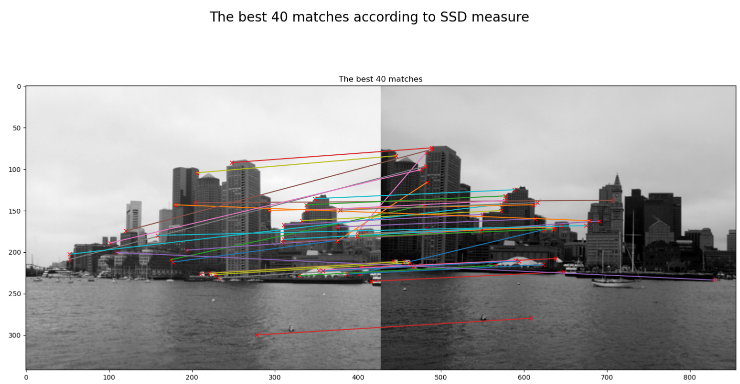

Figure 4: Best 40 matches according to SSD

Much can't be seen here, but with full screen images the NCC is clearly better, as the tracking lines are more straight, which means that the points are followed properly, and the locations do not change between pictures. NCC performs better, because it also takes into account if the environment changes. With this, it's able to not only use grayscale likeness, but also to take into account if the lightning changes.

4b)

SURF regions are better when the scale of the image changes, whereas SURF regions are capable of finding neighbors even in different sized pictures. The Harris corners suffer when the size of the image changes. SURF regions can deal with rotation, but in extreme cases it fails, and then the Harris corners are better. This is because the Harris corner takes into account only the moment and derivative of the image, whereas the SURF region does the same, but with window sizes. With this SURF is more resistant to size changes.