



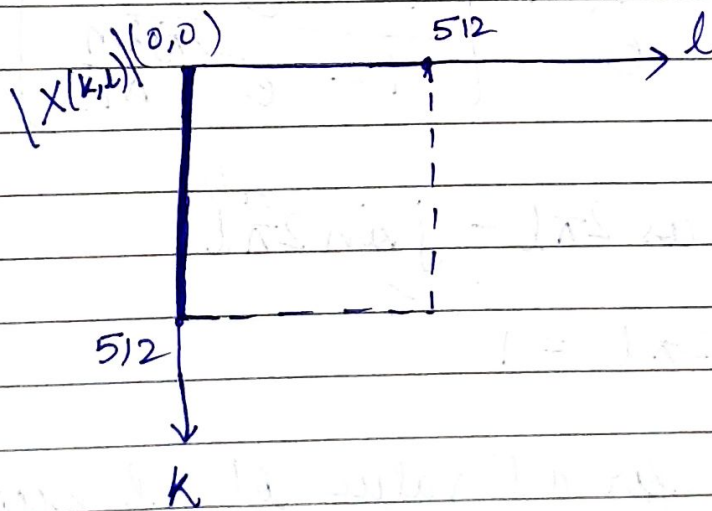
Q2. Given dimension of image = ~~511~~ 512 x 512

Line is at $n = 256$

⇒ Non-zero frequency component is at $n = 256$.

As we move horizontally over the image, there is no change in frequency. At ~~$n = 256$~~ $n = 256$, horizontally also there is no change in the frequency even if the intensity is 1.

However, as we move vertically, there is a spike in the frequency at $n = 256$. Thus, for all k till 512 we will have non-zero component at $l = 0$.



2d DFT.

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$$X(k, l) = \sum_{n=0}^{N-1} \sum_{m=0}^{M-1} x(n, m) e^{-j2\pi \left(\frac{kn}{N} + \frac{lm}{M} \right)}$$

$$N = 512, M = 512$$

The only intensity is at $n=256$, the summation breaks down to

$$X(k, l) = \sum_{m=0}^{M-1} e^{-j\pi k - \frac{2\pi j l m}{M}}$$

$$= e^{-j\pi k} \sum_{m=0}^{M-1} e^{-\frac{2\pi j l m}{M}}$$

This becomes a G.P.

$$= e^{-j\pi k} \left[\frac{1 - e^{-2\pi j l}}{1 - e^{-\frac{2\pi j l m}{M}}} \right]$$

$$e^{-2\pi j l} = \cos 2\pi l - j \sin 2\pi l$$

$$\text{Also, } \cos 2\pi l = 1$$

$\Rightarrow X(k, l) = 0$ for all values of l except 0 as at $l=0$ it takes indeterminate form.

For $l=0$

$$X(k, 0) = e^{-j\pi k} \sum_{m=0}^{M-1} e^{-\frac{2\pi j l m}{M}}$$

$$= e^{-j\pi k} \sum_{m=0}^{M-1} 1$$

$$= M e^{-j\pi k}$$

$$= M \cos(\pi k)$$

$$= M(-1)^k$$

The magnitude is same.

So it is either ± 512 $\forall k$