Assignment - 1

1/ "Image digitization implies that a digital image is an approximation of a real scene" - explain with example.

Answer: Let's first draw a figure of capturing a real image.

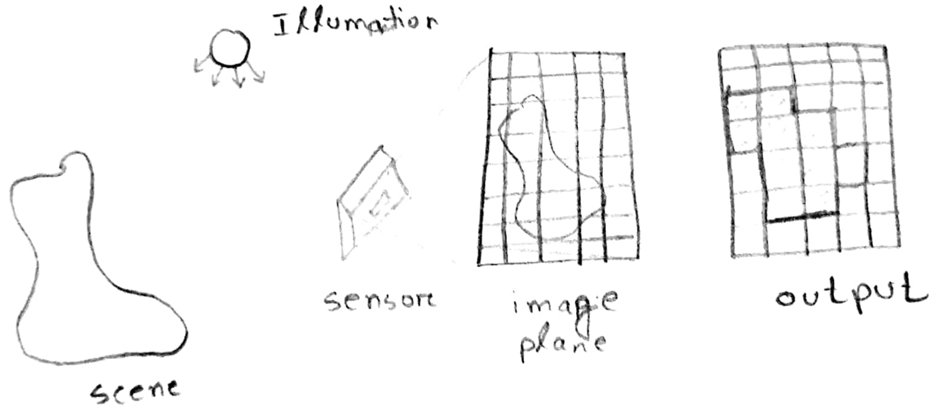


Figure 1

In figure-1 real scene (image) absorbe some illumination and reflect other left energy which is seneed by image sensor. Then comes the digitization part.

We digitize image through 2 process ing sampling & quantization. those

<u>Sampling:</u> If we think rowwise in an image as a signal then we read the analogue signal value after a fixed period ly of time called sampling. So here we 'n loose data in the interval.

<u>Quantization:</u> Now each sample value need to be represent in binary value and the binary length is fixed for storing purpose. So if we increase length' more accurete value can be stored but still there will be approximation.

For example: if voltage = 3.257 out of 8

Now 3 bit representation, 3.25 will be stored as 011 = 3 but if 4 bit then stored as 0110 = 3.5 and if 5 bit then stored as 01101 = 3.25 time to time more accurate.

n

But the loose value in both process.
thats why we know that image digitization is an approximation of the real scene.

2) There are 4 types of resolution,

i) spatial
ii) temporal
iii) spectral
iv) radiometric /intensity

spatial resolution: spatial resolution is the smallest discernable detail in an image.

Temporal resolution: Temporal resolution is the smallest discernable time to record same feature twice.

spectral resolution: spectral resolution is the portion of electromagnetic spectrum in an image band.

Radiometric/Intensity resolution: Intensity resolution is the smallest discernible change in an image.

Spatial resolution limit: In our bare-eye we cannot see bacteria but if we look through microscope we see details of bacteria. So there is no smallest discernable detail limit. Neither upper limit as an image can contain atom to galaxy.

Temporal limit: A frame response persist in human brain for 0.1 sec so less then this time gap we cannot process more frame change but many computer can so there is no lower or upper limit temporal resolution.

same thing apply for the next two resolution so there is no lower or upper bound for any image resolution.

3/ Derivative based edge detection determines the rate of change of intensity. So both 1st & 2nd derivative give response to noise. And 2nd derivative is much sensitive to noise.

Lets examine it in 1 dimension value,

6	6	5	4	3	2	1	6	6	6	2	4

1s derivative	0	-1	-1	-1	-1	-1	5	0	0	-4	2

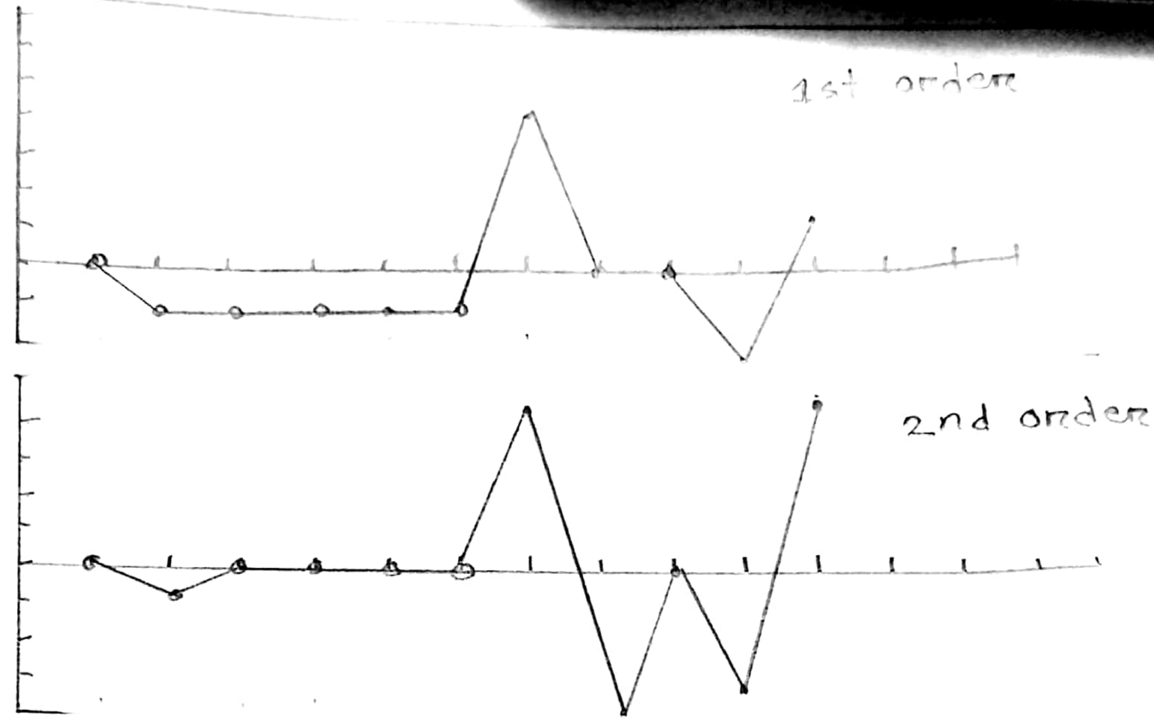
2nd derivative	0	-1	0	0	0	0	6	-5	0	-4	6

which is aquired, $f'(x) = f(x) - f(x-1)$

$$f''(x) = f(x+1) + f(x-1) - 2f(x)$$

So its clear that 2nd derivative are more sensative to sudden change. Which can be more understandable if we plot those values in figures.

P.t.o



so we can see that sudden changes are too sensitive to 2nd order. Now we know that noise are sudden change in the image intensity.

That's why if we use derivatives to find edge first we need to smoothen the image so noise vanishes from the image.

1

Assignment 2

1) If a figure is mirrored according to some reference point / line then those figure is called symmetry.

In case of matrix or more preciesly filters of image. If the filter is symmetry according to there diagonal then it's calleed symmetry filter otherwise called asymmetric filter.

0	1	0
1	-4	1
0	1	0

Symmetry

-1	-1	-1
6	0	0
1	1	1

Asymmetry

Spatial domain v/s frequency domain.

Any filtering can be done in both domain. We generally do filtering to remove noise. There is some major difference beteween these domain.

Time-complexity: If image size is M,N and filter size is m,n then spatial domain filtering will take $O(MNmn)$ time to do the job. Where in frequency domain it takes $O(2MN \log_2 MN)$ time only.

Periodicity: random noise is best handled in spatial domain. But if the noise is periodic it is best handled in fre-quency domain.

In spatial domain we perform neighbourhood processing in beteween image pixel intensity and filter intensity.

Where we use fast - fourier transformation to transform spatial domain to frequency domain. Then we do point wise multiplication of the kernel's transformed form. To reverse the process to its spatial form. And in these approach we filter any image.

2/ Jean Baptiste Joseph Fourier stated that " any functionally that periodically repeats itself can be expressed as a sum of sines and cosines of different frequencies each multiplied by some coefficient".

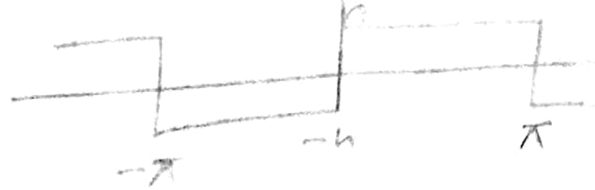
The sinusoid series is,

$$f(x) = a_0 \sum_{n=1}^{\alpha} a_n \cos\left(nx + \frac{\pi}{L}\right) + \sum_{n=1}^{\alpha} b_n \sin\left(nx - \frac{\pi}{L}\right)$$

L = half of the period.

$a_0 \cdots a_n, b_0 \cdots b_n$ are coefficient.

now let the square wave,



$L = \pi$

we get below values,

a_0 is average of net area, $= 0$

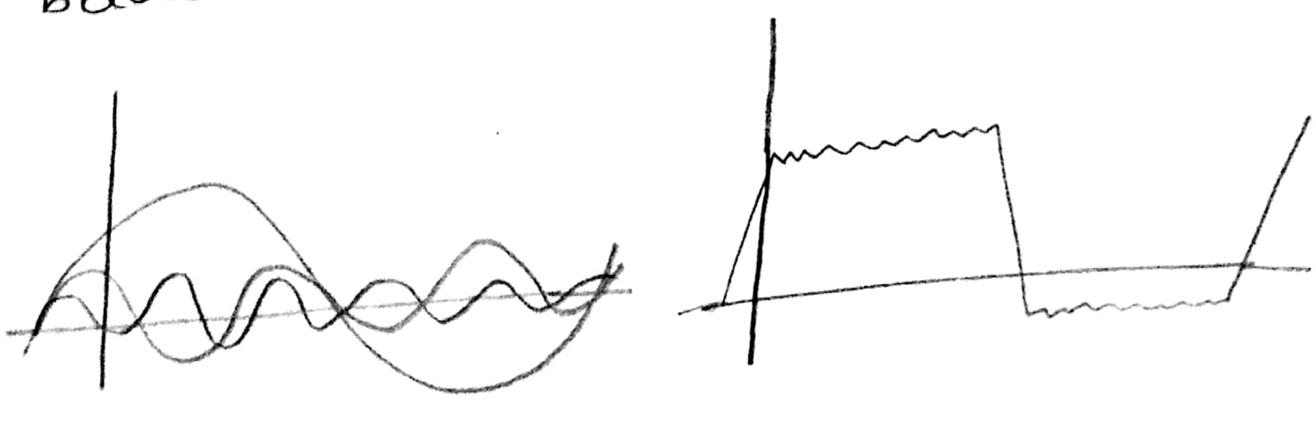
$a_n = 0$

$$b_n = \begin{cases} 0 & \text{- if } n \text{ is even} \\ \frac{4h}{n\pi} & \text{- if } n \text{ is odd} \end{cases}$$

$$f(x) = \frac{4h}{\pi} \sum_{n=1}^{\infty} \frac{\sin(2n-1)}{2n-1}$$

so it's infinite sum of sine wave

below is the representation



the more we add sine wave of $\frac{\sin(2n-1)}{2n-1}$

the more get a perfect wave

form of any square.

3/ "Adaptive thresholding is a generalized thresholding approach of image segmentation"

Adaptive thresholding: Adaptive filters changes depending on the characteristics of the image inside the filter region.

In image segmentation means partitioning image in multiple part's or region. And adaptive thresholding partition image into ~~two~~ multiple parts. But it's better than other thresholding.

Let we want to segement background and object. If we ~~give~~ threshold every kernel area with same methodology some object may vanish or some background maybe considered as object which is much reduced in adaptive

6/

Let's we divide the image into pxq block.

Now we will generate different threshold values for each block. Now we decide how many part we want to split it.

If in three part one way can be sorting all value in the block then take the value of 33percentile and 66 percentile. to divide them in 3 part if 33 percentile is equal to 66 percentilie means this block only contains two or one part.

Lets give an example diagram for 2 partition of an image.

First Divide it in 9 block

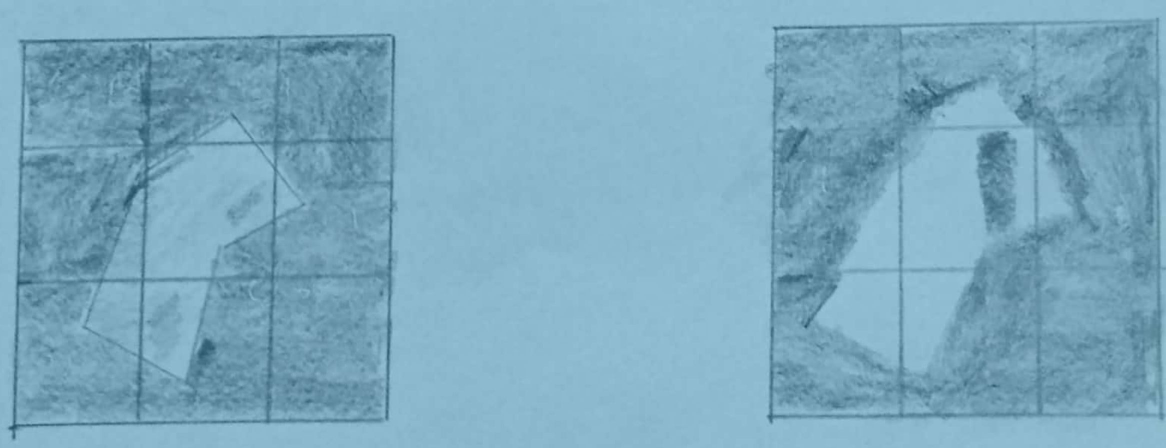


Fig-1

Noew let's do it in 16 block.

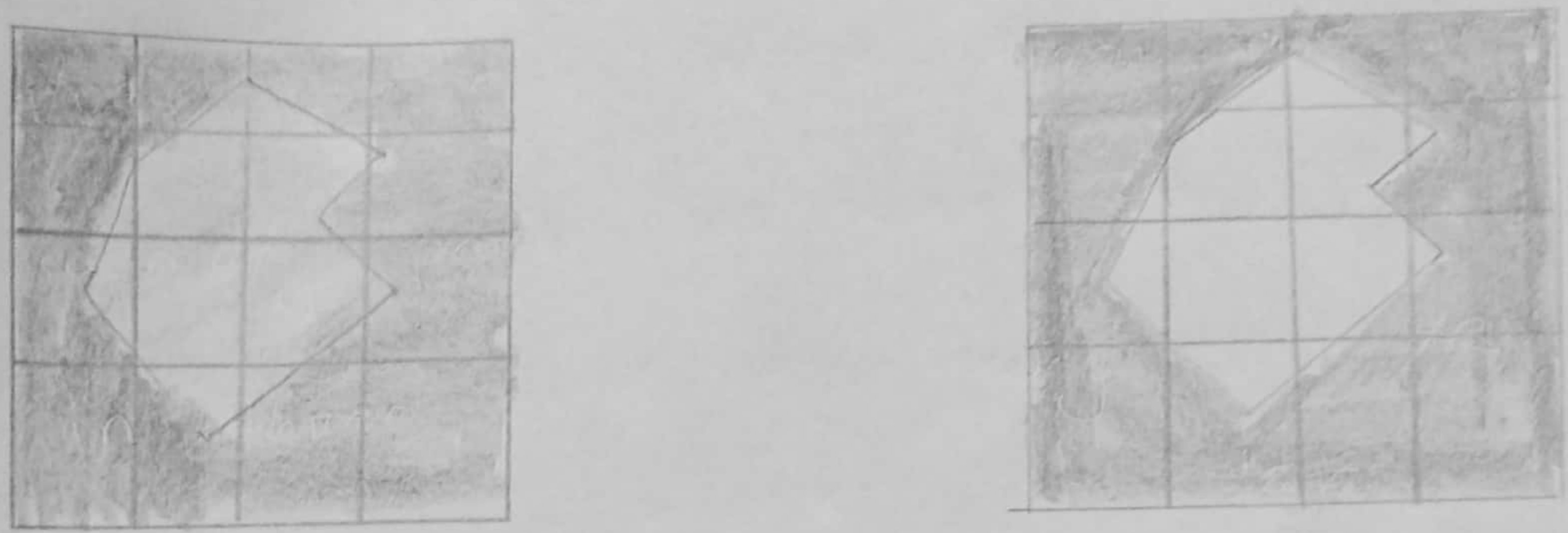


Fig - 2