AIM: Perform a C/C++ program on sampling of an analog CT signal and find its maximum frequency, Nyquist frequency and digital frequency. Analyse the number of digital samples/cycle and comment on your results for oversampling and undersampling. Plot your results on graph paper.

THEORY:

Sampling, Quantization and coding are the basic processes to convert continuous time (CT), continuous amplitude analog signal to discrete time (DT) discrete amplitude digital form. Sampling is a process which converts continuous time, continuous amplitude discrete signal.

Quantization: Convert from distance-time continuous valued signal to discrete time discrete valued signal.

Coding- It is a process to assign binary PCM codes to the quantised levels.

Sampling theorem for Baseband Signal:

A Baseband signal having no frequency components higher than fm Hz may be completely recovered from the knowledge of its samples taken at a rate of at samples per second, that is sampling frequency $f_s \geq 2f_m$.

Sampling interval is the time that separates sampling points if the signal is slowly varying, then fewer samples per second will be required than if the waveform is rapidly varying. So, the optimum sampling rate depends on the signal.

Advantages of Digital Transmission:

Noise immunity ~~or~~ error detection and correction ease of multiplexing integration of analog and digital data use of signal regenerators data integrity and security. Ease of evaluation and measurements. More suitable for processing.

Disadvantages of Digital Transmission:

More bandwidth requirement. Need of precise time synchronization. Additional hardware for ~~ado~~ encoding/decoding Integration of analog and digital data Sudden degradation in Incompatible with existing analog facilities of Digital Transmission More bandwidth requirements need of precise time synchronization Additional hardware for encoding/decoding Integration of analog and digital data Sudden degradation in DoS.

CONCLUSION:

Thus, we implement a C/C++ program successfully.

FOR EDUCATIONAL USE

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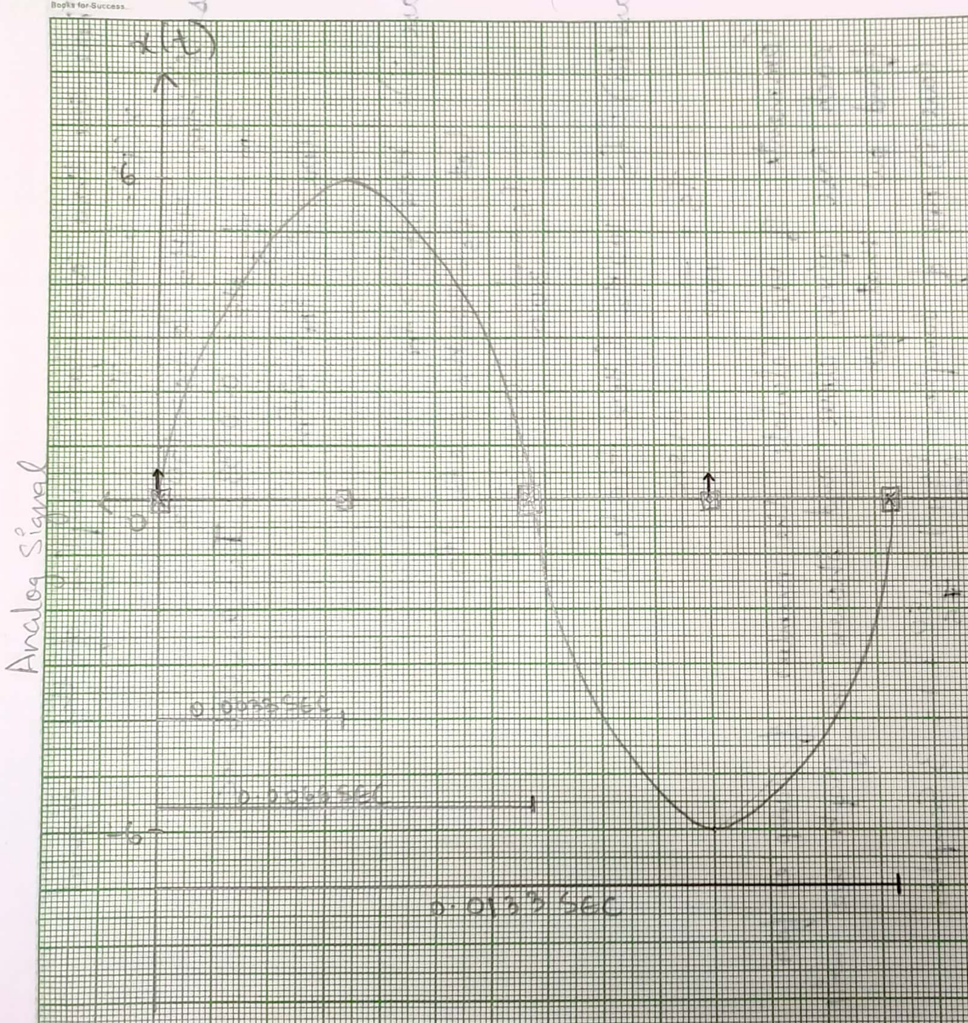

Scale:
On X-axis: 1cm = 0.001sec
On Y-axis: 1cm = 1 unit

$\boxtimes$ - Sample pts for $f_s = f_N = 150$ Hz

$\boxdot$ - Sample pts for $f_s > f_N$ i.e 300 Hz

$\uparrow$ - Sample pts for $f_s < f_N$ i.e 110 Hz

$x(t) = 6\sin(150\pi t)$

$f = \frac{150\pi}{2\pi} = 75\,Hz$ or $75\,\frac{cycles}{sec}$

$T = \frac{1}{75}$

There are three cases for Sampling of the Signal

$x(t) = 6 \sin 150\pi t$

Case (i): $f_m = 75 Hz$ & $f_s = 150 Hz$

$T_m = \frac{1}{75} Hz = 0.0133$; $T_s = 0.0066$ sec.

Here, $f_s = f_N = 2f_m$.

Case (ii): Here, $f_s > f_N$

Let, $f_s = 300 Hz$; $e f_s > f_n$

$\therefore T_s = \frac{1}{300} = 0.0033$ sec.

Case (iii): $f_s = 100 Hz$ (Here, $f_s < f_N$)

$\therefore T_s = \frac{1}{100} = 0.01$ sec

<u>Comments</u>: If we Calculate the number of samples for each case given above and shown in graph we will find out that for,

Case (i) No. of Samples $= \frac{f_s}{f_m} + 1 = \frac{150}{75} + 1 = 3$ Samples.

Case (ii) No. of Samples $= \frac{f_s}{f_m} + 1 = \frac{300}{75} + 1 = 5$ Samples.

Case (iii) No. of Samples $= \frac{f_s}{f_m} + 1 = \frac{100}{75} + 1 = \frac{4}{3} + 1 = 2.33$

i.e. 2 Samples.

As we can see that in the graph, if we take $f_s >> f_m$, then the number of Samples are more. Thus, the Reconstruction of Signal is better.

AIM: Perform a C/C++ program on Discrete Convolution of a 1-D DT rada signal and its delayed response. Also find its cross-relation. Comment on your results.

THEORY:

Cross-Correlation:

Consider 2 signals $x(n)$ & $y(n)$ each of finite energy. The cross-correlation of $x(n)$ & $y(n)$ is a sequence $r_{xy}(l)$, which is defined as,

$$r_{xy}(l) = \sum_{-\infty}^{\infty} x(n)\, y(n-l)$$

$$l = -2, -1, 0, 1, 2, \ldots$$

or equivalently.

$$r_{xy}(l) = \sum_{-\infty}^{\infty} x(n+l) \cdot y(n) \quad l = \ldots -2, -1, 0, 1, 2, \ldots$$

Applications:

* Pattern recognition.
* Signal detector.
* Weather forecasting.
* Security system designing.
* Water traffic monitoring.
* Measuring pulse broadening and distortion.
* Used in X-ray diffraction data analysis.

Conclusion: Thus we successfully implemented a C/C++ program convolution of 2 sequence & cross correlation.

AIM: Perform a C/C++ program on Discrete Auto Correlation of a 1-D DT signal and analyse its value at lag = 0. Write a note on its applications.

THEORY:

Convolution:

Given 2 finite length sequences, $x(n)$ and $h(n)$, their linear convolution is,

$$y(n) = x(n) * h(n)$$
$$= \sum_{K=-\infty}^{\infty} x(k)\, h(n-\infty)$$

Where the symbol [*] is used to denote convolution.

Correlation:

$$r = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2} \sqrt{\sum_i (y_i - \bar{y})^2}}$$

Convolution is the technique for calculating the response to the requested impulse signal. On the other hand, correlation is the measure of similarity between two input signals. Convolution is used in cascaded blocks, periodic signals etc. whereas correlation is used in SONAR, communication system etc.
Convolution cannot be solved by correlation but correlation can be solved with the help of convolution.
If the folding filter is symmetric then convolution and correlation achieve the same result.

Applications of convolution:

* Image processing.
* Synthesizing a New Customizable Pattern Using the Impulse Response of a System.
* Signal Filtering.
* Polynomial Multiplication
* Audio Processing.
* Artificial Intelligence
* Synthesized Seismographs
* Optics.
* Probability Theory.
* Computed Tomography.

CONCLUSION:

Thus, we performed a C/C++ program on discrete autocorrelation of an DT signal & analysed its value of log = 0, successfully.

AIM: Perform a C/C++ program on 1-D 4-pt. Discrete Fourier Transform using the formula and verify your results using twiddle factor and matrix method. Find its significance.

THEORY:

The DFT is one of the most powerful tools in digital signal processing which enables us to find the spectrum of a finite-duration signal. There are many circumstances in which we need to determine the frequency content of a time-domain signal as shown by the following equations:

$$X[k] = \sum_{n=0}^{N-1} x[n] e^{-j\frac{2\pi nk}{N}}$$

$$x[n] = \frac{1}{N} \sum_{n=0}^{N-1} X[k] e^{j\frac{2\pi nk}{N}}$$

These are mainly used for Spectral Analysis of Signals, Frequency Response of Systems, Convolution via the Frequency Domain.

CONCLUSION: Thus we successfully implemented a C/C++ program on 1-D 4-pt discrete fourier transform using the formula.

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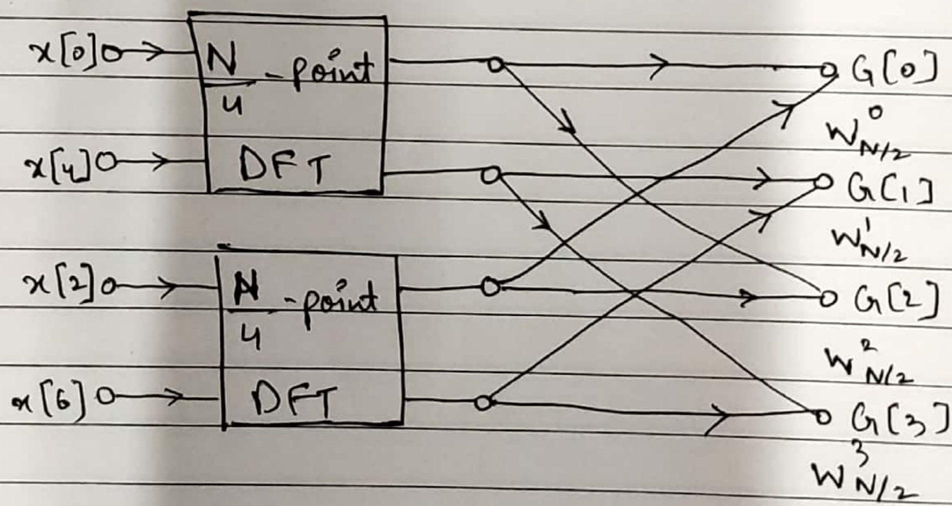
AIM: Perform a C/C++ program on 1-D 4pt fast fourier Transform of the above ~~sa~~ sequence and find the reduction in number of addition and multiplication.

THEORY:

FFT is faster than DFT and can be explained in the following way,

* Each DFT coefficient requires
  (i) N complex multiplications
  (ii) N-1 complex additions.
* All N DFT coefficients require.
  (i) N^2 complex multiplications.
  (ii) $N(N-1)$ complex additions.

Complexity in terms of real operations.
(i) $4N^2$ real multiplications.
(ii) $2N(N-1)$ real additions.



Applications:

* Analysis in Image Processing.
* Image Restoration.
* Signal and noise Estimation.
* Filters.
* Radar, Echo, Ultrasonics based applications.
* Data processing and analysis.

~~THEORY:~~

CONCLUSION: Thus we ~~&~~ implemented a C/C++ program on 1-D 4pt Fast fourier tranform Successfully.

Page No.			
Date			

AIM: To perform Contrast Stretching in MATLAB for a 2-D lower contrast image, find its equations and evaluate the same using and example.

THEORY:

Equations:

$$s = 0.5 \times r;$$

$$s = 2 * (r - 80) + 0.5 \times 80;$$

$$s = 0.5 \times (r - 140) + 0.5 \times 80 + 2 \times (140 - 80);$$

Contrast stretching is a point processing, zero memory operation for basic linear transformations of an image based on piece-wise image transformation operation.

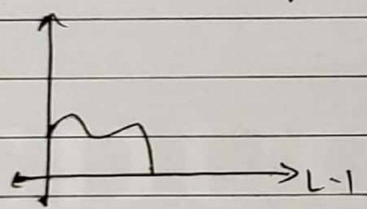
It is very useful for stretching the contrast of those images which does not utilize (0, L-1) possible intensity values in an image.

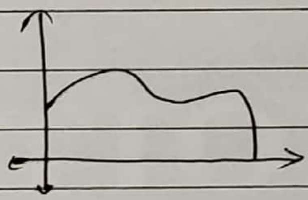
Difference between Contrast Stretching

Contrast is defined as difference between the highest and lowest pixel value in an image also known as a dinamic range within an image. Contrast Stretching stretches the contrast on an image in a minimum of three pieces i.e. { 0 - LT ~~UT-LT~~, LT - UT, UT - L-1. In these pieces slopes of the three ~~linear~~ input-output lines are guided by three slopes. which can be choses according

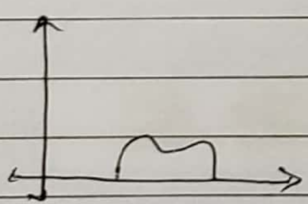
Teacher's Sign.: ______

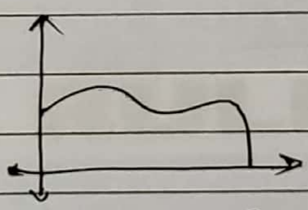
to the requirements of the problem statement.
Therefore contrast stretching does not perform a single transformation on a single image ~~B~~ rather does the same on three sections of the image.
Histogram processing on the other hand operates on the whole image and therefore keeping the variation of histogram curve constant it stretches the original histogram image so as to cover the complete dynamic range. The programmer has no choice for selecting any section of the image.
For example:





~~low contrast~~
dark image.



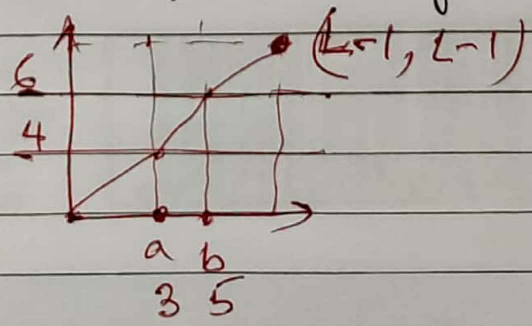


low-contrast.

Equalized image.

Q:

5	7	0
1	5	3
4	6	2



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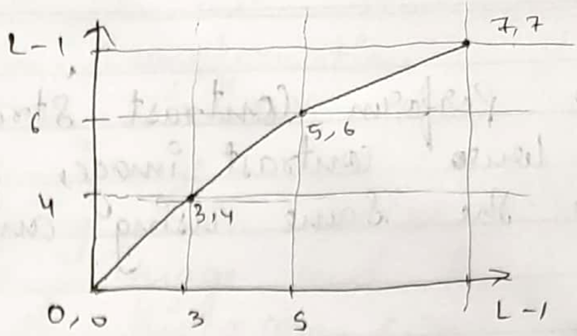
5	7	0
1	5	3
4	6	2



(A) $S = \frac{4}{3} r$ —— (1) $\quad 0 \leq r < 3$

(B) $S - 4 = \frac{6-4}{5-3} (r-3)$

$= 1 \times (r-3) + 4$ —— (2) $\quad 3 \leq r < 5$

(C) $y - y_1 = m_3 (x - x_1)$

$S - 6 = \frac{7-6}{7-5} (r-5)$

$S = 0.2 (r-5) + 6$ —— (3) $\quad 5 \leq r < 7$

I/P	O/P	rounding
0	0	0
1	1.3	1
2	2.6	3
3	4	4
4	5	5
5	6	6
6	6.2	6
7	6.4	6

6	7	0
1	6	4
5	6	3

AIM: Implementation of Image negative, Gray level slicing and thresholding of a 2-D grey level image using MATLAB and evaluate its significances.

THEORY:

[i] Image negative.

If $S(x,y)$ and $R(x,y)$ are output and input images respectively. then, ~~St~~

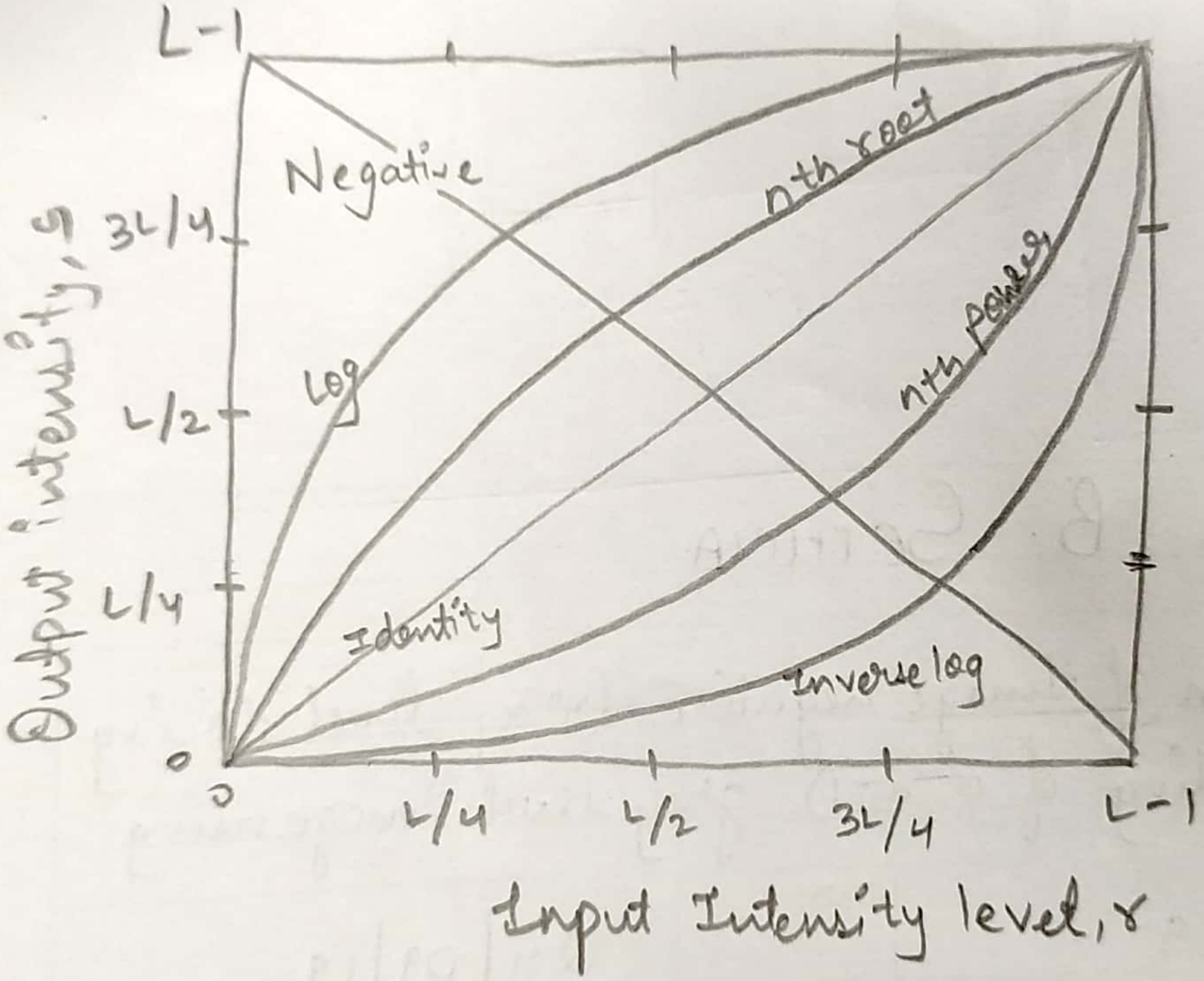
$$S(x,y) = L-1-(R(x,y))$$

For example, A 3-BPP image is as shown below,

$$\begin{bmatrix} 7 & 0 & 1 \\ 5 & 2 & 3 \\ 3 & 4 & 5 \end{bmatrix} \longrightarrow S = T(R) \longrightarrow \begin{bmatrix} 0 & 7 & 6 \\ 2 & 5 & 4 \\ 4 & 3 & 2 \end{bmatrix}$$

APPLICATIONS:

Reversing the intensity level of image produces the equivalent of a photographic negative therefore finds application in medical image processing.
It is also useful ~~f~~ to visualize stars during the day of a clear sky.



L-1
3L/4
L/2
L/4
0
Output intensity, s
Negative
nth root
Log
Identity
nth power
Inverse log
0
L/4
L/2
3L/4
L-1
Input Intensity level, r

[ii] Gray level Slicing :

For Gray level slicing without background,

$$S = L-1 \quad (\text{If } a \le s \le b) \quad a \text{ \& } b \text{ is threshold value.}$$
$$= 0 \quad \text{otherwise}$$

For Gray level slicing with background,

$$S = L-1 \quad (\text{If } a \le s \le b)$$
$$= R \quad \text{otherwise}$$

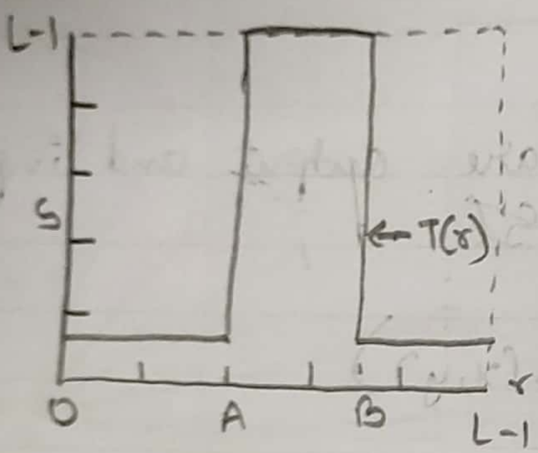
APPLICATIONS :

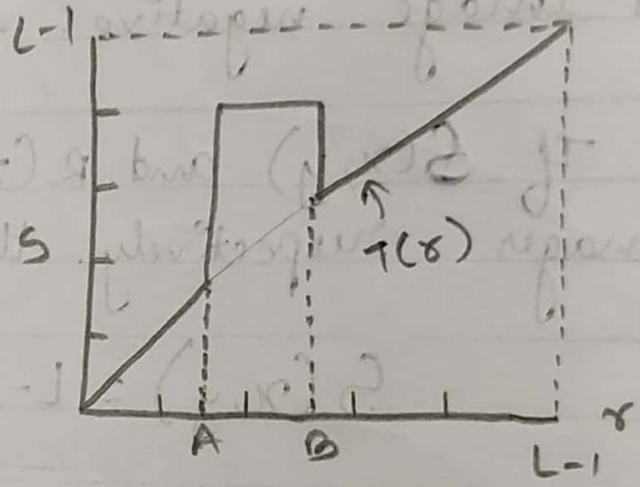
Intensity level slicing is useful when transformation require brightness or darkness to be changed in the desired range of intensities leaving all other intensities either 0 or intact. This type of enchancement produces a binary image and is useful for producing the shape of the flow of contrast medium i.e. select blockages within the arteray within medical image processing.

$a=3, b=5$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 7 \\ 7 & 7 & 0 \end{bmatrix} \qquad \begin{bmatrix} 7 & 0 & 1 \\ 5 & 2 & 7 \\ 7 & 7 & 5 \end{bmatrix}$$

Without background   With background.


L-1
S
T(r)
0
A
B
L-1
r


L-1
S
T(r)
A
B
L-1
r

[iii] Thresholding :

$$S = L-1 \quad (\text{If } S \leq a)$$
$$= 0 \quad (\text{Otherwise})$$

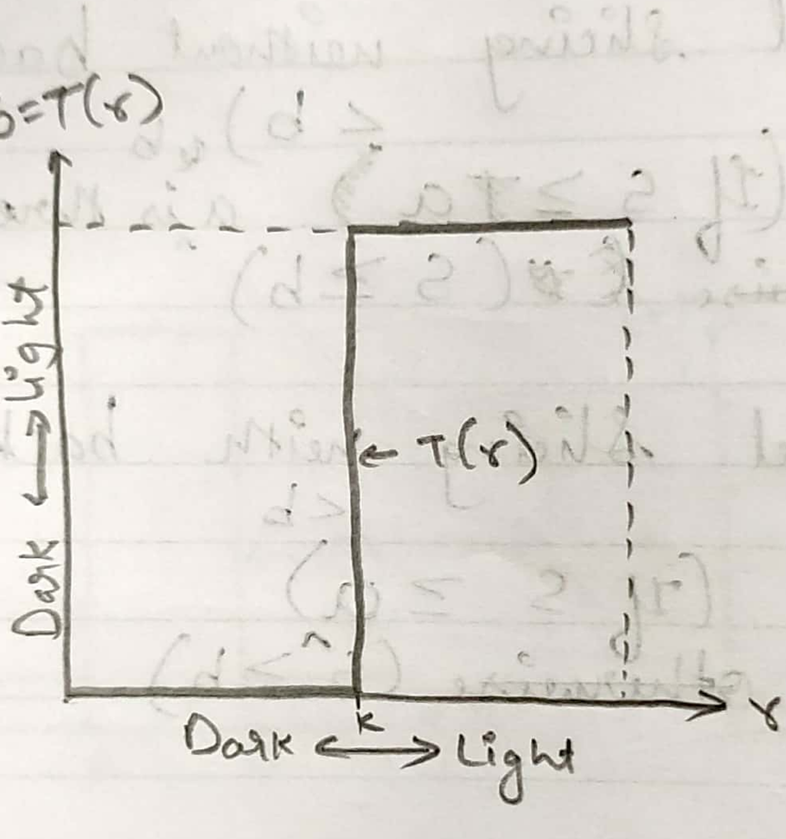
APPLICATIONS :

Thresholding is a most common preprocessing task in image processing and is usually used to convert Gray Scale image into a binary image and finds use in factories, defects in PCB manufacturing, etc.

~~CONCLUSION~~: Performing thresholding a=5.

$$\begin{bmatrix} 0 & 7 & 7 \\ 7 & 7 & 7 \\ 7 & 7 & 7 \end{bmatrix}$$

CONCLUSION: Hence, we have implemented image negative, Gray level slicing and thresholding of a 2-D gray level image.


S=T(r)
Dark ⟷ Light
← T(r)
k
r
Dark ⟷ Light

AIM: Implementation of Bit plane slicing for Steganography of a 2-D grey level image using MATLAB.

THEORY:

Pixels are digital numbers composed of bits for example the intensity of each pixel in a 256 level grey scale image is composed of 8-bits or 1-byte. Instead of highlighting intensity level images, we can highlight the contribution made to the total image appearance by specific bits. An 8-bit image is considered as been composed of eight 1-bit planes with plane 1 containing the lowest order bits and plane 8 containing highest order bits. The four higher order bit planes and specially the last two contain a significant amount of the visually significant data.

Decomposing an image into its bit planes is useful for analyzing the relative importance of each bit in the image - A process the aids in determining the number of bits used to quantize the image (i.e. Image Compression).
The reconstruction is done by multiplying the pixels of the n^{th} plane by the constant 2^{n-1}. Each plane used is multiplied by the

Image

7	0	1
5	2	3
3	4	5

$\Rightarrow$

111	000	001
101	010	011
011	100	101

Plane 3

1	0	0
1	0	0
0	1	1

MSB

Plane 2

1	0	0
0	1	1
1	0	0

Mid-plane

Plane 1

1	0	1
1	0	1
1	0	1

LSB

corresponding constants and all ~~placed~~ planes used are added to obtain g

using more planes in the reconstruction does not contribute significantly in the construction of image. therefore storing 4 highest order bit planes is enough to reconstruct original image in acceptable detail. therefor providing 50% less storage.

Bit plane slicing is also used in steganography copy writing where MSB plane of the secret data or copy right replaces the MSB plane of the original image.

For reconstructing 2^{nd} bit plane, the constant to be used is $2^{2-1} = 2$. Multiplying each pixel with 2.

CONCLUSION: Hence, we have implemented Bit plane slicing for steganography of a 2-D grey level image.

FOR EDUCATIONAL USE

AIM: Implementation of Histogram equalization of a 2-D grey level image using MATLAB & analyze the need of this process.

THEORY: Histogram equalization is used to enlight contrast. It is not necessary that contrast always increases in this. There may be SC where histogram equalization can be work that cases the contrast is decreased.

PMF: First we have to calculate the PMF probability mass function of all the p.l. the image.

CDF: Next step involves calculation of CDF distribution function.

Example: Given a histogram, what happen when we equate it twice.

grey level	0	1	2	3
pixels	70	20	7	3

Step 3: Perform Histogram Equalization.

Grey level	Pixels	PMF	CDF	(L-1)xCDF	Rounding off.
0	70	0.7	0.7	2.1	2
1	20	0.2	0.9	2.7	3
2	7	0.07	0.97	2.91	3
3	3	0.03	1	3	3
Total	100				

Step 3: Make new histogram 1 Table.

Old Grey level (r)	Old n_k	New Grey Level (r_k)	New n_k.
0	70	2	70
1	20		
2	7	3	30
3	3		

Intensity (r)	Pixels (n_k) no. of
0	0
1	0
2	70
3	30

Step 5: Again Perform Histogram Equalization on Histogram 1.

Grey level (r)	n_k	$PDF = \frac{nk}{n}$	CDF = ΣPDF	CDF x (L-1) CDF x 3	Rounding off (new grey level)
0	0	0	0	0	0
1	0	0	0	0	0
2	70	0.7	0.7	2.1	2
3	30	0.3	1	3	3
Total	100				

gray level (r)	Pixels (nk)
0	0
1	0
2	70
3	30

CONCLUSION: After plotting both the histograms, implemented successfully.

AIM: Implementation of Image Smoothing & Sharpening of a grey level image using MATLAB.

THEORY:

Smoothing an image: It is often used to reduce noise within an image or to produce a less pixelated image.

Image sharpening refers to any enhancement technique that highlights edges & fine details in an image.

Enhancement by Neighbourhood Processing, Spatial filtering.

It involves passing a weighted mask or kernel over the image & replacing the original image pixel value corresponding to the centre of kernel with sum of original pixel values in the region corresponding to the kernel multiplies by kernel weight.

Smoothing linear filters: Examples of linear filters are low pass averaging filter, weighted average filter & trimmed average filter.

Smoothing Non-linear filter: Non-linear filters are also called as ordered statistic filters.

Eg: median, max & min filter.

Sharpening first order derivative filters:
eg: are Robert, Prewitt, Sobel & Fri-chen filter.

Sharpening second order derivative filters.
eg: are palladian filter, high pass filter & high boost filter.

AIM: Implementation of Edge detection using Sobel & Prewitt masks of grey level Image using MATLAB.

THEORY: An edge in an image is a boundary or contour at which a significant change occurs in some physical aspect of an image & it typically occurs on the boundary between 2 different region in an image.

Edge detection is a technique for IP for finding the boundaries of objects within images. It works by detecting discontinuities in brightness.

The Prewitt operator is used in IP, particularly with edge detection algos. It is a discrete differentiation operator.
It provides us two masks one for detecting edges in horizontal direction & another for detecting edges in vertical direction.

Vertical direction

-1	0	1
-1	0	1
-1	0	1

Horizontal direction:

-1	-1	-1
0	0	0
1	1	1

Sobel operator:

The major difference is that in sobel operator the coefficients of masks are not fixed & they can be adjusted according to our requirement unless they do not violate the property of derivative masks.

Vertical mask:

-1	0	1
-2	0	2
-1	0	1

Horizontal mask:

-1	-2	-1
0	0	0
1	2	1