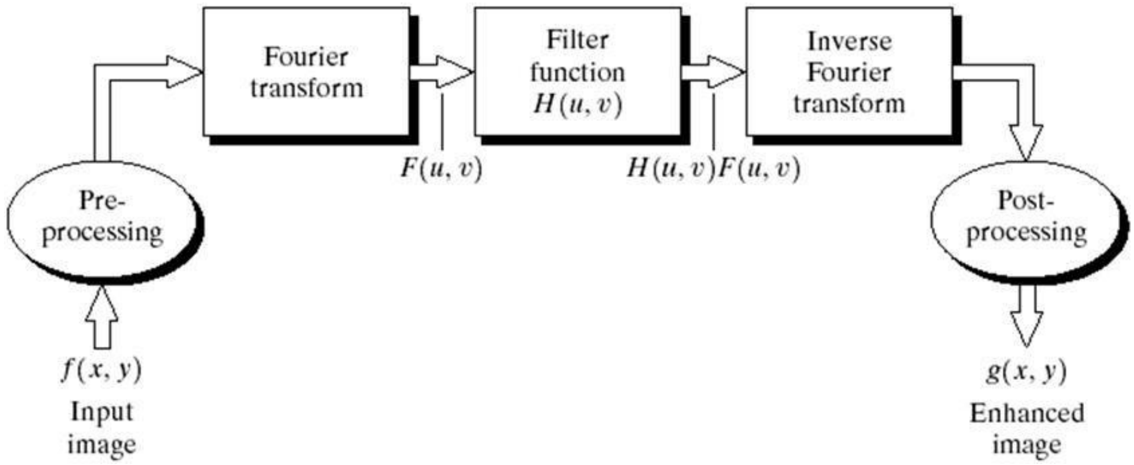
BASIC STEPS FOR FILTERING(IMAGE ENHANCEMENT) IN FREQUENCY DOMAIN.



1. Multiply the input image by $(-1)^{x+y}$ to center the transform, image dimensions M x N
2. Compute *F*(*u, v*) DFT of the given image ,DC at *M/*2, *N/*2.
3. Multiply *F(u, v*) by a filter function *H(u, v*) to get the FT of the output image,

$$G(u,v) = H(u,v)\,F(u,v)$$

Here each component of H is multiplied with both the real and imaginary parts of the corresponding component in F, such filters are called **zero-phase shift filters.** DC for *H(u, v*) at *M/*2, *N/*2.

4. Compute the inverse DFT of result in (c), so that the

$$\text{filtered image} = F^{-1}[G(u,v)]$$

5. Take real part of the result in (d)
6. The final enhanced image is obtained by Multiplying result in (e) by $(-1)^{x+y}$

HOMOMORPHIC FILTERING IN IMAGE ENHANCEMENT.

Definition: The filter which controls **both high frequency and low frequency** components are called Homomorphic filtering.

Homomorphic filtering is a generalized technique for signal and image processing, involving a nonlinear mapping to a different domain in which linear filter techniques are applied, followed by mapping back to the original domain.

Features & Application:

1. Homomorphic filter is used **for image enhancement**.
2. It simultaneously **normalizes the brightness** across an image and **increases contrast.**
3. It is also used to remove **multiplicative noise**.

Images normally consist of light reflected from objects. The basic nature of the image f(x,y) may be characterized by two components:

(1) The amount of source light incident on the scene being viewed, &

(2) The amount of light reflected by the objects in the scene.

These portions of light are called the ***illumination*** and ***reflectance*** components, and are denoted $i(x,y)$ and $r(x,y)$ respectively. The functions i and r combine multiplicatively to give the image function F:

$$f(x,y) = i(x,y)r(x,y),$$

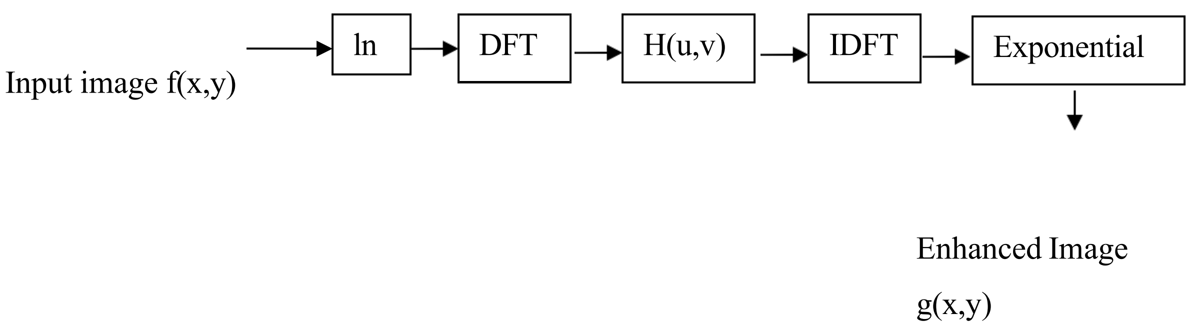
where $0 < i(x,y) < 1$-----indicates perfect black body -----indicates perfect absorption , and $0 < r(x,y) < 1$ -----indicates perfect white body ----indicates perfect reflection.

Since i and r combine multiplicatively, they can be added by taking log of the image intensity, so that they can be separated in the frequency domain.

Illumination variations can be thought as a multiplicative noise and can be reduced by filtering in the log domain.To make the illuminations of an image more even, the HF components are increased and the LF components are filtered, because the HF components are assumed to represent the reflectance in the scene whereas the LF components are assumed to represent the illumination in the scene.i.e., High pass filter is used to suppress LF's and amplify HF's in the log intensity domain.

illumination component tends to vary slowly across the image and the reflectance tends to vary rapidly. Therefore, by applying a frequency domain filter the intensity variation across the image can be reduced while highlighting detail. This approach is shown below.

BLOCK DIAGRAM:



Analysis:

WKT , $f(x,y) = i(x,y)r(x,y)$ --------------------(1)

Taking natural log on both sides of the above equation, we get,

$\ln[f(x,y)] = \ln[i(x,y)] + \ln[r(x,y)]$

Let $z = \ln[f(x,y)] = \ln[i(x,y)] + \ln[r(x,y)]$

Taking DFT on both sides of the above equation, we get,

$z(x,y) = \ln[f(x,y)] = \ln[i(x,y)] + \ln[r(x,y)]$

$DFT[z(x,y)] = DFT\{\ln[f(x,y)]\} = DFT\{\ln[i(x,y)] + \ln[r(x,y)]\}$

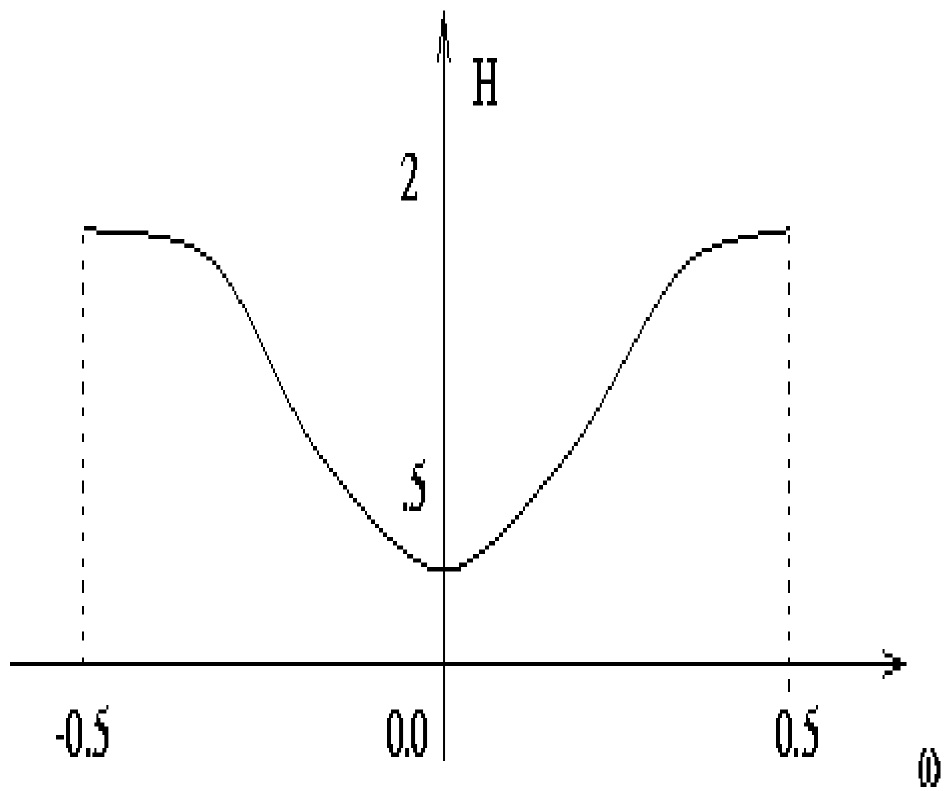
$= DFT\{\ln[i(x,y)]\} + DFT\{\ln[r(x,y)]\}$ ----- (2)

Since DFT[f(x,y)] = F(u,v), equation (2) becomes,

$Z(u,v) = F_i(u,v) + F_r(u,v)$ --(3)

The function *Z* represents the Fourier transform of the *sum* of two images: a low frequency illumination image and a high frequency reflectance image.

Figure : Transfer function for homomorphic filtering.



If we now apply a filter with a transfer function that suppresses low frequency components and enhances high frequency components, then we can suppress the illumination component and enhance the reflectance component.

Thus ,the Fourier transform of the output image is obtained by multiplying the DFT of the input image with the filter function H(u,v).

i.e., S(u,v) = H(u,v) Z(u,v) --(4)

where S(u,v) is the fourier transform of the output image.

Substitute equation (3) in (4), we get,

$S(u,v) = H(u,v) [F_i(u,v) + F_r(u,v)] = H(u,v) F_i(u,v) + H(u,v) F_r(u,v)$ --(5)

Applying IDFT to equation (6), we get,

$T^{-1}[S(u,v)] = T^{-1} [H(u,v) F_i(u,v) + H(u,v) F_r(u,v)]$

$= T^{-1}[H(u,v) F_i(u,v)] + T^{-1}[H(u,v) F_r(u,v)]$

- s(x,y) = i'(x,y) + r'(x,y) --(6)

The Enhanced image is obtained by taking exponential of the IDFT s(x,y),

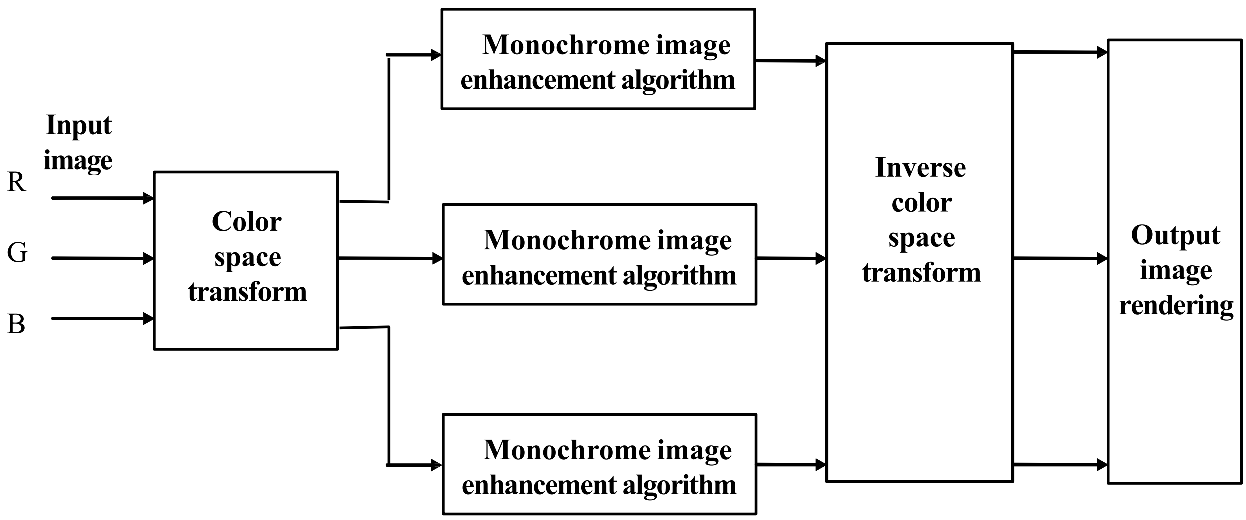
i.e., $g(x,y) = e^{s(x,y)} = e^{i'(x,y)} e^{r'(x,y)} = i_o(x,y) r_o(x,y)$

where, $i_o(x,y) = e^{i'(x,y)}$, $r_o(x,y) = e^{r'(x,y)}$ are the illumination and reflection components of the enhanced output image.

COLOR IMAGE ENHANCEMENT

Color image enhancement**:**

An image enhancement technique that consists of changing the colors of an image or assigning colors to various parts of an image.



1. Color code regions of an image based on frequency content
2. The Fourier transform of an image is modified independently by three filters to produce three images used as Fourier transform of the R, G, B components of a color image
3. Additional processing can be any image enhancement algorithm like histogram equalization
4. Take inverse color transformation to obtain R’,G’,B’ components