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Question 2 :-

g : gradient image ; h : convolution kernel ,
f : original image .

$$g(x) = (h * f)(x)$$

Taking Fourier Transform and using convolution thm, we get

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

$$\therefore \hat{F}(u) = \frac{G(u)}{H(u)}$$

Taking IFT we get

$$f(x,y) = F^{-1}(\hat{F}(u))$$

The fundamental difficulties he will face will be that as $h(x)$ is a convolution kernel for calculating gradient, $H(u)$ will be a high pass filter and so at low frequencies $H(u)$ will tend to 0. If $H(u)$ becomes 0, then this approach to extract low frequency components cannot be used. Images typically have ~~It~~ large magnitudes of these components

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Part 2] (2D)

Consider g_x : gradient of 2D image in x direction, g_y : gradient in y direction.

Take h_x : convolution kernel for x gradient

h_y : convolution kernel for y gradient

f : original 2-D image

Then,

$$g_x(x,y) = (h_x * f)(x,y)$$
$$g_y(x,y) = (h_y * f)(x,y)$$

Taking Fourier Transform of these equations and using convolution theorem we get -

$$G_x(u,v) = H_x(u,v)\,F(u,v)$$
$$G_y(u,v) = H_y(u,v)\,F(u,v)$$

Using the two equations we get

$$\hat{F}(u,v) = \frac{G_x(u,v)}{H_x(u,v)} \quad \ldots (1)$$

and also $$\hat{F}(u,v) = \frac{G_y(u,v)}{H_y(u,v)} \quad \ldots (2)$$

As h_x is the gradient kernel in x direction $H_x(u,v)$ will be a high pass filter in u ; so when u is small, $H_x(u,v)$ will tend to 0 and calculating $\hat{F}(u,v)$ using (1) would not be appropriate since the value will blow up.

Similarly for low values of v, $\hat{F}(u,v)$ calculated by (2) would be inappropriate.

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Consider different cases for values of (u,v) :-

so 1) for (low u, high v) we use eq (2) ;

2.) (high u, low v) we use eq(1)

3.) (high u, high v) can use both

The last case of both low u and low v will be problematic

Now given $\hat{F}(u,v)$ we can take the IFT of $\hat{F}(u,v)$ to get $f(x,y) = \mathcal{F}^{-1}(\hat{F}(u,v))$

This is problematic as images generally have large magnitudes of these components.