ASSIGNMENT 1

IMAGE PROCESSING

EE 610

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ABSTRACT—Digital image processing is a procedure of converting an image into its digital form and carry out information by performing some mathematical operations. Some of the important applications arelike medical images, computer vision, remote sensing and microscopic imaging and many more.The operations that have been used are mentioned here like blurring, negative of an image,spatial domain processing as well as frequency domain processing and so on. For better representation of all the operations and making it user friendly, GUI is developed, for the interface to be easily useable and manageable the information must be laid out in a consistent and systematic manner. GUI is very helpful as if the user is unable to understand the use and working ,then there is no importance of the software's functionality. A good user interface allows the user to carry out their intended purposes efficiently.We have built a GUI which includes many buttons and display image area. User can easily modify the image according to their need as the operation names have been clearly mentioned on the buttons.

Introduction

"Interest in image processing methods originates from two principal application areas: improvement of pictorial information for human interpretation and processing of image data for storage and transmission". Image processing in its general form pertains to the alteration and analysis of pictorial information. Image processing can be defined as the processing or altering an existing image in a desired manner.Image processing is any form of signal processing for which input is an image such as photograph or any video form.,the output of image processing may either of an image or a set of characterstic parameters or parameters related to an image.The objective of image processing is to visually enhance and statistically evaluate some aspects of an image not readily apparent from its original image. The objective is carried out through development and implementation of processing

1.BACKGROUND READ

1. *IMAGE ENHANCEMENT TECHNIQUES-*The main objective is to process an image so that the result is more suitable more than the original image.It improves the quality of an image.

   ➢ ***Spatial filtering***- Spatial refers to the taking average of the pixels composing in an image. It is the process of dividing an image into its constituent spatial frequencies and selectively altering some specific spatial frequencies to emphasize some image features.

   - *Blurring-* The simplest smoothing operation is blurring especially at the edges of the objects.The simplest low pass filter evaluates a particular input brightness pixel value and the pixel surrounding the input pixel and outputs the brightness value that is the mean of its convolution, also used for noise reduction.
   - *Sharpening-*It increases the contrast between bright and dark regions to

bring out the desired features.It also highlights fine details in an image.

- *Histogram equalization-*Histogram is the estimation of probability distribution of a particular type of data. An image histogram offers a graphical representation of the tonal distributions of the gray values in a digital image.Histogram equalisation is a technique for adjusting image intensities to enhance contrast.
- *Gamma correction-*It defines the relationship between the pixel value and luminance. It is a non linear adjustment to individual pixel values.
- *Negative image-*It is the total inversion of positive image(original image),in which light area appears dark and vice versa.
- *Edge detection-*Edge contains most of the shape information of an image.So by applying filters,detecting edges and enhancing the image that makes the image more clearer.
- *DFT-*DFT is used for analyzing discrete time finite duration signals in frequency domain. DFT is a sampled fourier transform so it not consists of all the frequencies but the samples are large enough to describe the full spatial range in an image.

3. APPROACH & DESIGN-

→ ***MATLAB***-It is an interactive system whose basic data element is an array that does not require dimensioning.It is a high performance for computing.

s is the output intensity level and r is the input intensity level.

★ ***Gamma correction-***

- Corrected value $(s) = cr^{\gamma}$
- c and γ are positive constants.,γ maps narrow range of dark input values into a wider range of input values.
- The output is proportional to the input raised to the gamma value.

★ ***Sharpening-***Image sharpening consists of adding to the original image that is proportional to the high pass filtered version of an original image.

- $S_{x,y}=r_{x,y}+cF(r_{x,y})$,
- $r_{x,y}$ is the original image at coordinate(x,y)
- F(.) is the high pass filter, c is the tuning parameter $c\geq0$, $S_{x,y}$ is the sharpened pixel at coordinate (x,y)
- Increasing c yields more sharpened image.
- The matrix is chosen such that the sum of all the coefficients is zero.

★ ***DFT-***

$$F(u,v)=\sum\sum f(x,y)\, e^{-j2\pi(ux/M+vy/N)},$$

$0\leq u\leq M-1,\ 0\leq v\leq N-1$

- F(U,V) is the 2d DFT image and f(x,y) is the original image.
- 2D DFT of f(x,y) can be obtained by computing the 1D DFT of each row of f(x,y) and then computing the 1D DFT of each column of the result (deal with one variable at a time).

★ ***Color to hsi-*** H is the H component of each RGB pixel.

- I is the intensity component and S is the saturation component.
- RGB values have been normalized to the range [0,1].
- Angle θ is measured with respect to red axis of HSI space.

$$I = (R + G + B)/3$$

$$H = \cos^{-1}\left(\frac{(R-G)+(R-B)}{2\sqrt{(R-G)^2+(R-B)(G-B)}}\right)$$

$$S = 1 - 3\ \min(R,\ G\ B)/I$$

★ ***Histogram equalization***

- Range of r [0, L-1], r=0 represents black and r=1 represents white.
- $s = T(r)$, transformation in input image.
- $ds/dr = dT(r)/dr$
- $p(s) = p(r)\ dr/ds$, p is the pdf function.
- $s = T(r) = L - 1 \int p(w)dw$

w is some dummy variable.

discrete form of the transformation -

- $s_k=T(r_k)=(L-1)\ \sum p_r(r_j)$

★ ***Negative of an image-***

- Intensity level of an image in the range [0,L-1]

$s = L - 1 - r$

- Reversing the intensity levels of an image produces the negative of an image.

★ ***Edge detection-***Edges are calculated by using the differences between corresponding pixel intensities of an image.

1. *Vertical edges-* It will detect the vertical edge due to zero column in the vertical direction of the matrix after convolving it with the image, detects vertical edge.

It works as first order derivative.

Calculates the difference of pixel intensities in a edge region.

As the center column is of zero so it does not include the original values of an image but rather it calculates the difference of right and left pixel values around that edge.

This increase the edge intensity and it become enhanced comparatively to the original image.

2.*Horizontal edge-*It will detect the horizontal edge as the zero column is in the horizontal direction.

Calculates difference among the pixel intensities of a particular edge.

As the center row of mask is consist of zeros so it does not include the original values of edge in the image but rather it calculate the difference of above and below pixel intensities of the particular edge.

★ ***Log transform-***This transformation maps a narrow range of low intensity values in the input to a wider range of output levels.

$s = c\ log(1 + r)$, c is some constant and r≥0

This transform compresses the dynamic range of images with large variations in pixel values.

★ ***Blurring-***

- Replace value of every pixel in an image by average of the intensity levels in the neighbourhood defined by the filter mask.

$R = 1/9\ \sum z_i$

- **1≤ i≤9,** m□n mask would have a normalizing constant equal to 1/mn.

- If all the coefficients are equal then it is called box filterI.

4.Testing-

1.The testing was done using RGB jpeg image, png image and grayscale image.

The test results agrees with the theory.

RGB jpeg image

2.This image resembles the V channel extracted from the rgb image by conversion from rgb2hsv.

3.*Gamma value=0.4*

As explained in theory, when gamma value is less than 1, image becomes brighter. Intensity levels are shifted towards higher intensity levels.

4.Gamma value=1.67

We observed while testing, that when gamma value is greater than 1, image becomes darker. Intensity levels are transformed into lower intensity levels.

5.We have tested the sharpening mask on the rgb image and we obtained this result, where the edges are detected, as high pass filtering is done.

6.Log transformed image with value of the constant multiplied greater than 1.

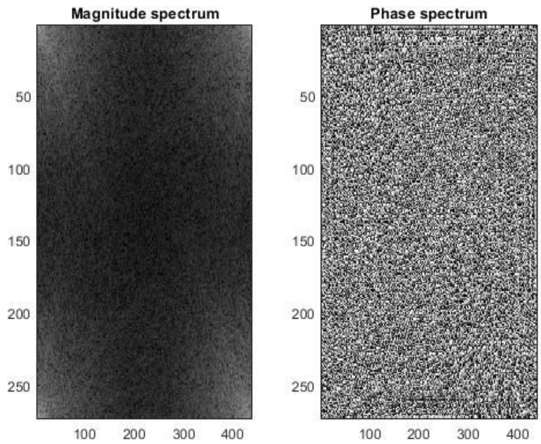
7. Log transformed with value of c less than 1

(c=0.1).

8.Blurred image using weighted averaged low pass filter mask. We observe that the original image has been blurred, smoothning in edges can be observed.

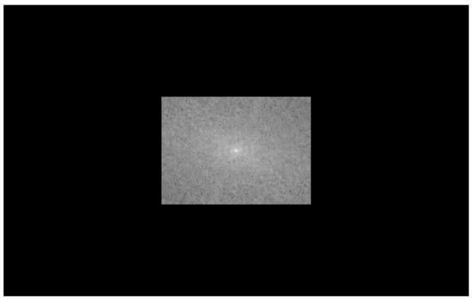
9.Image obtained after *histogram equilization*. The intensity values were concentrated in mid-range intensities, so after equilization the intensities were distributed over a wider ranger giving a better contrast image.

10.DFT performed on RGB image results in



above magnitude and phase plots.

11.This is the frequency domain mask used for filtering(or tranforming the image) in frequency domain. We can change the window size.



12.We have used prewitts operator to detect the horizontal edges in the images. Testing approves with the theory.

13. We observe that vertical edges have been detected in this image. Prewitts operator has been used.

14.As mentioned in theory of negative of image, comparing the rgb2hsv image and above image, we observe that the intensity levels have been reversed and hence we obtain negative of the image.

15. Grayscale image

This is the grayscale jpeg image selected for testing the gui on these images.

We get successful results for all the operations, except for the histogram equalization. As histogram code written solely works on the V 14.channel of image, some values become negative so code doesn't work for this.

16.Gamma value=0.1

17.gamma value=2

#Both the test result images of gamma correction agree with test results of rgb image.

18.Log transform constant multiplier = 2

19.Log transform constant multiplier = 0.2

The log transform results match with the theory.

20.LPF blurred image, smoothening effect can be seen.

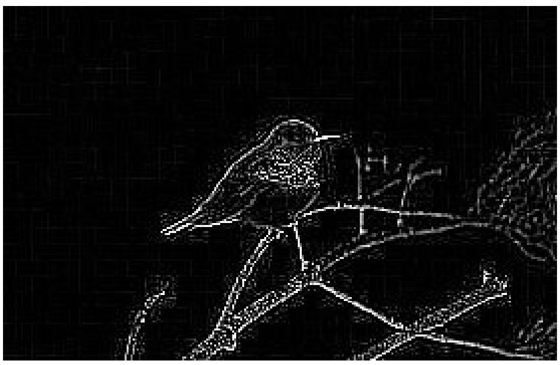
21.Gaussian filter has been used for blurring the image.

It can be observed that the gaussian filter gives better smoothening results than the lpf.

22..Horizontal edges can be seen in the image. The same prewitt's operator has been usd.

23.The intensity values are inverted and obtained the *negative of image.*

24.Sharpened image, using the same high pass filter kernel as in rgb. Both results are similar.



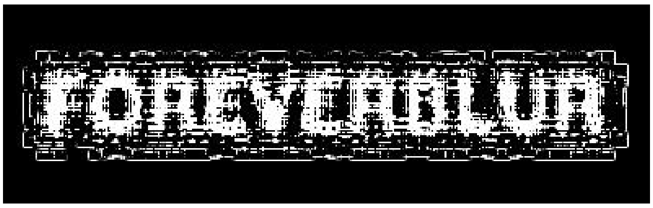
#CHALLENGES FACED

1.Learning about the GUI concept in matlab was challenging and time consuming, as it was the first time we built a gui,understanding how to use global variables(similar to C).

2.One of the main challenges faced were testing the sharpening of image. For approval that the obtained sharpened images are correct, we test the HPF kernnel on a already blurred image.

This is a blurred image.

We extracted the correct letters from the image using the HPF kernel as follows :



We can read the words written in image : foreverblur

Hence, the sharpening results are concluded to be correct.

3.Creating a function for 'Undo last change' was one of the problems we faced and overcame. Simple things seem more complicated. But the logic was just like using the global variable to call the same image on which modifications were done in the next function.

4.The frequency magnitude mask concept was bit time consuming to understand, but once understood was too trivial to implement.

CONCLUSION-A User friendly GUI is successfully completed,is consistent and comparatively easy to use and manage. All the operations were successfully running on the image and were responding with changes in images pertaining to changes in the variables.

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