Implementation of Different Image Enhancement Techniques

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Abstract- Image is a representation of the external form of a thing or a person, etc. One picture is worth more than ten thousand words. Image processing refers to processing a two dimensional image. Image processing takes the input image, process that image and gives the output image. Image Processing is the art and science of manipulating digital images. Image Enhancement is one of the techniques of the image processing. Image Enhancement is used for making the image more suitable for particular application.

Keyword- Image enhancement, Homogenity, Sobel, Canny, Median

I. INTRODUCTION

An image may be represented as a two-dimensional function, f(x, y), where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y and the amplitude values of f are all finite, discrete quantities, we call the image a digital image. [1] The aim of image enhancement is to improve the perception of information in images for human viewers, or to provide `better' input for other automated image processing techniques.

II. OBJECTIVE OF THE PAPER

The principal objective of image enhancement techniques is to process an image with a aim to make the image more better and suitable for specific application. The word specific is important, because techniques are mostly problem oriented. Thus, for example, a method that is useful for enhancing x-ray images may not be the best approach for enhancing pictures of Mars transmitted by a space probe. Digital images are often get worse by noises due to various sources of interference and other phenomena that may affect the quality of these images. There is a need to process these images to improve their quality to correct distortion introduced by sensor to reduce fluctuations caused by atmospheric turbulence to analyze the image to extract the information contained in various features in the image. With the help of advanced digital computers and various techniques the above mentioned problems are overcome.

III. LITERATURE SURVEY

The growing need for efficiently processing and analyzing the information contained in digital images is a continuous challenge in order to apply image enhancement [10]. Image enhancement is the task of applying certain alterations to an input image like as to obtain a more visually pleasing image [11]. The goal is to retrieve the important and useful information from the image. While imaging the information in the front scene is not only the source of information but some scenes on the dark side can also have the useful information [10]. Statistics are useful in characterizing image qualities such as brightness and contrast and can be used as the basic of digital image processing algorithms to visually improve the displayed image [10]. Image enhancement is mostly used as the pre-processing task. Which method or technique should apply to the image is depend on the original image and its condition. To enhance the image, it is necessary to select the appropriate technique. We have referred the book for digital image processing i.e. "DIGITAL IMAGE PROCESSING" written by Rafael C. Gonzales and Richard E. Woods. For the development of the system we have to take knowledge of what happens and how it happens when we apply effects on an image so we were going though the literature related to the image enhancement.

IV. IMPLEMENTATION AND RESULTS

4.1 Color Filters

4.1.1 Grayscale

To convert the color image into the grayscale image we have used the ITU-R recommendation BT.709 i.e. Gray = (Red * 0.2125 + Green * 0.7154 + Blue * 0.0721). Figure 1 shows the original image and the result image.
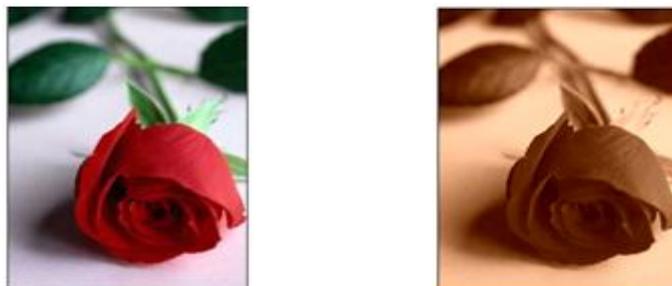

(a)   *(b)*

"Figure 1. (a) Original Image [9] (b) Result Image"

4.1.2 Sepia

To convert the image into sepia we have used the equation Sepia = (Red * 0.299 + Green * 0.587 + Blue * 0.114).

(a)   *(b)*

"Figure 2. (a) Original Image [9] (b) Result Image"

4.1.3 Invert

Invert is the process of inversing the image. To do so, the intensity value of the each pixel is subtracted from the maximum intensity value. The original image is a digital mammogram showing a small lesion. In spite of the fact that the visual content is the same in both images, it is easier to analyze the breast tissue in the negative image in this particular case.

(a)   *(b)*
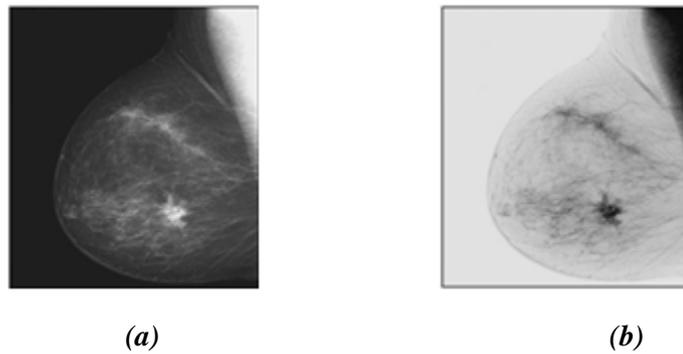
"Figure 3. (a) Original Image [1] (b) Result Image"

4.1.4 Rotate Channel

This filter rotates the channel of the image i.e. red is replaced with blue, blue is replaced with green and green is replaced with red. Figure 4 (b) the result of this filter for the original image shown in figure 4 (a).

(a)   *(b)*

"Figure 4. (a) Original Image [9] (b) Result Image"

4.2 HSL Filters

4.2.1 Brightness

Brightness and gamma correction is two different techniques. Increasing gamma is not the same as increasing brightness. Increasing Gamma can make an image look brighter, but in that it only increases brightness of the shadows and mid-tones in an image without affecting the highlights. Brightness on the other hand, simply brightens the entire image from the shadows to the highlights equally.

(a)   *(b)*

"Figure 5. (a) Original Image [1] (b) Result Image"

4.2.2 Contrast

Contrast is the separation between the darkest and brightest areas of the image. By increasing contrast you increase the separation between dark and bright, making shadows darker and highlights brighter. By decrease contrast you bring the shadows up and the highlights down to make them closer to one another. Figure 6 (a) shows the scanning electron microscope image of pollen, magnified approximately 700 times and figure 6 (b) shows the result after correcting the contrast.

(a)   *(b)*
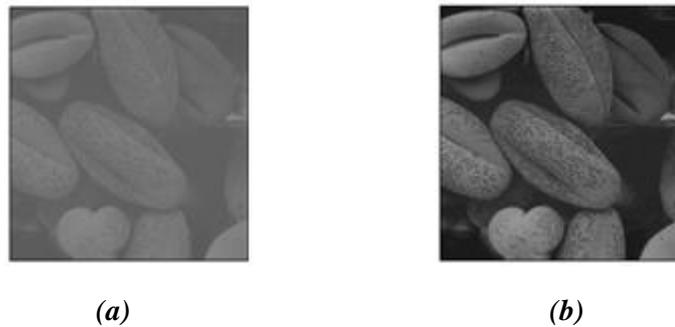
"Figure 6. (a) Original Image [1] (b) Result Image"

4.2.3 Saturation:

Saturation is the same as contrast, the only difference is we increase the separation between colors instead of increasing separation between shadows and highlight.

(a)   **(b)**   **(c)**
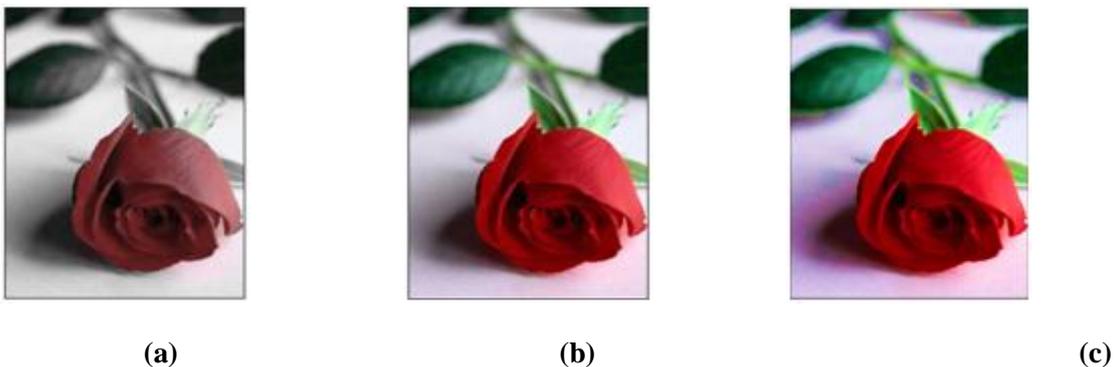
"Figure 7. (a) Less Saturated Image (b) Original Image [9] (c) More Saturated Image"

4.2.4 Hue Modifier

The filter operates in HSL color space and updates pixels' hue values setting it to the specified value but luminance and saturation are kept unchanged. The result of the filter looks like the image is observed through a glass of the given color.
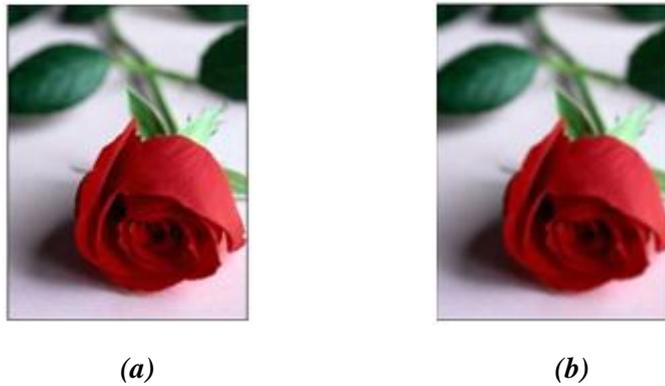

(a)   *(b)*

"Figure8. (a) Original Image [9] (b) Result Image"

4.3 Convolution & Correlation Filters
4.3.1 Mean

This filter works as a low pass one. This filter takes an average across its neighborhood and replaces the middle pixel value by the result of averaging.
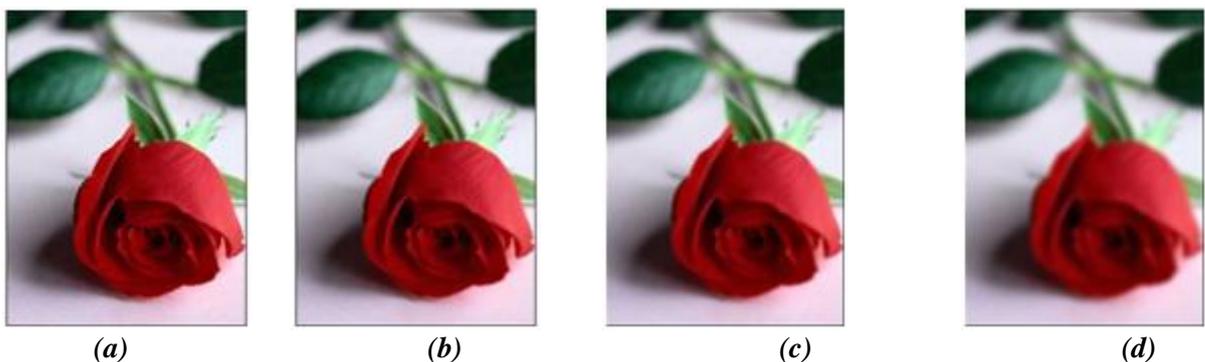

(a) *(b)*

"Figure 9. (a) Original Image [9] (b) Result Image"

4.3.2 Blur

Noise reduction can be accomplished by blurring. Blurring is used in preprocessing task, such as removal of small details from an image prior to object extraction, and bridging of small gaps in lines or curves. Figure shows the 3X3 smoothing filter.

1	2	1
2	4	2
1	2	1

(a) *(b)* *(c)* *(d)*

"Figure10. (a) Original image [9]. (b) Image after applying 3X3 filter. (c) Image after applying 5X5 filter. (d) Image after applying 9X9 filter"

4.3.3 Sharpen

The principle objective of the image sharpening is to highlight transitions in intensity. Application of sharpening ranges from electronic printing and medical imaging to industrial inspection and autonomous guidance in military systems [1].
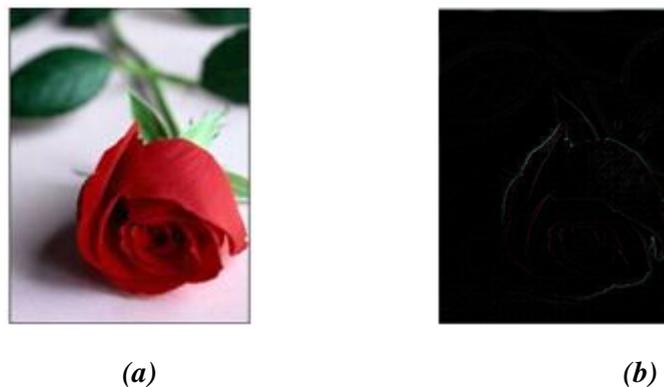

(a)   *(b)*

"Figure11. (a) Blurred image of the North Pole of the moon [1] (b) Sharpened image"

4.3.4 Edges

This is the convolution filter which uses the kernel to detect the edges of images. We have used the following kernel to detect edges:

0	-1	0
-1	4	-1
0	-1	0

(a)   *(b)*

"Figure 12. (a) Original Image [9] (b) Result Image"

4.4 Median Filter

In order to perform median filtering at a point in an image, we first sort the values of the pixel in the neighborhood, determine their median, and assign that value to the corresponding pixel in the filtered image. This filter is suited for the images which are affected by the salt-and-pepper noise.
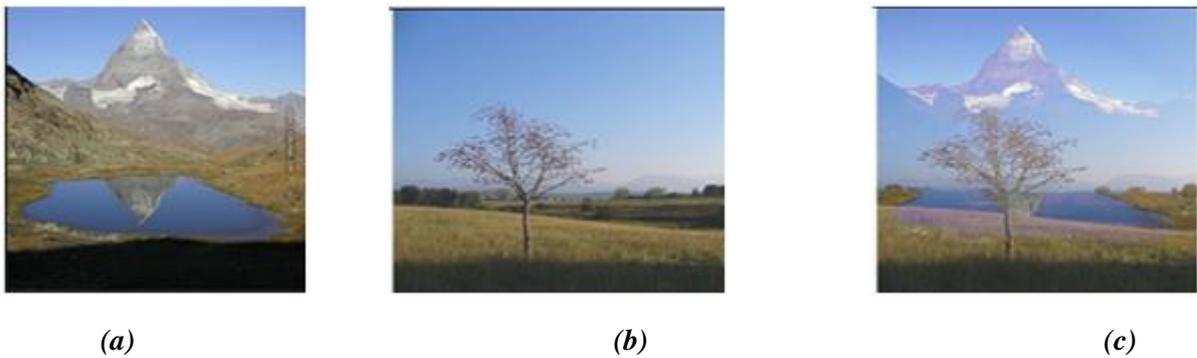
| (a) | (b) | (c) |

"Figure 13. (a) Original Image (b), (c) Result of median filter"

4.5 Two Source Filters

4.5.1 Merge

The merge filter takes two images, one source image and one overlay image. This filter produces the result by comparing the corresponding pixel values from two images and taking the maximum value for the result image.

| (a) | (b) | (c) |

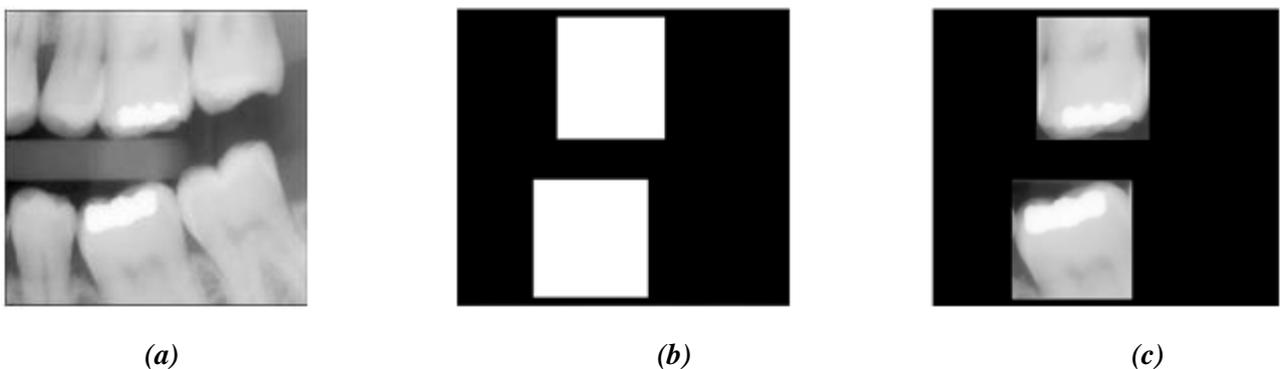*"Figure 14. (a) First Image (b) Second Image (c) Result Image"*
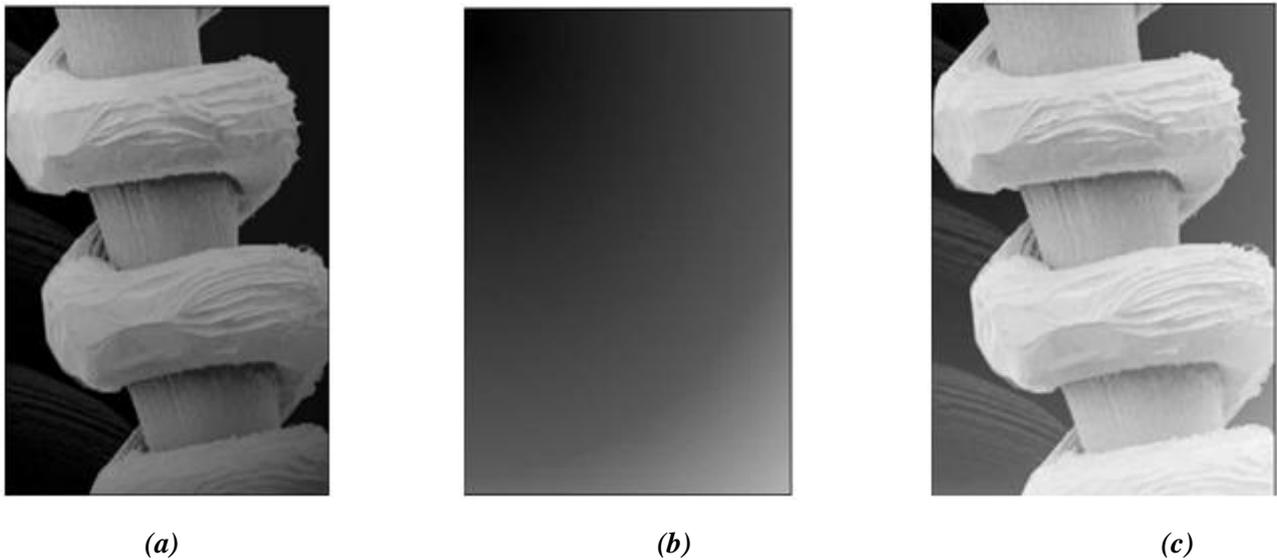
4.5.2 Intersect

The intersect filter takes two images, one source image and one overlay image. This filter produces the result by comparing the corresponding pixel values from two images and taking the minimum value for the result image.

| (a) | (b) | (c) |

"Figure 15. (a) Digital dental X-ray image [1] (b) ROI mask for isolating teeth with filling [1] (c) Intersection of (a) and (b)"
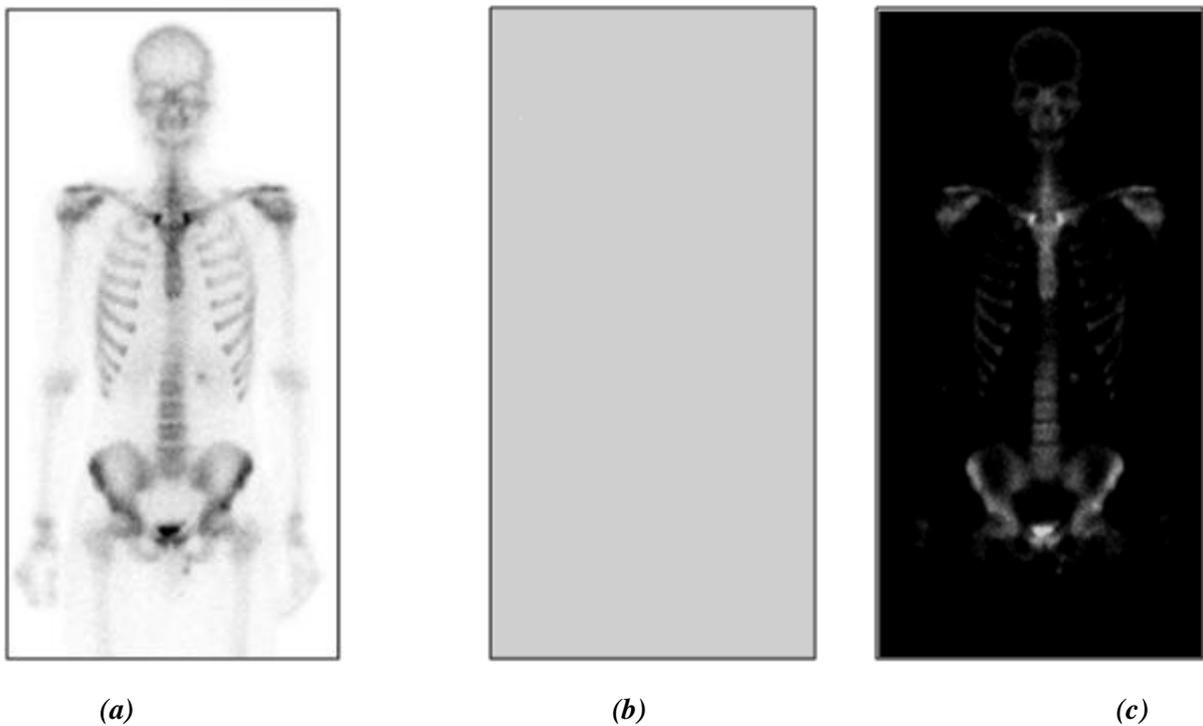
4.5.3 Add

The add filter takes two images, one source image and one overlay image. This filter produces the result by taking sum the corresponding pixel values. If the sum is greater than maximum value, 255 or 65535, then it is truncated to that maximum value. Figure 16 shows an example.

| (a) | (b) | (c) |

"Figure 16. (a) Shaded SEM image of a tungsten filament and support, magnified approximately 130 times [1] (b) The shading pattern [1] (c) Addition of (a) and (b)"

4.5.4 Subtract

The subtract filter takes two images, one source image and one overlay image. This filter produces the result by taking difference the corresponding pixel values. If the difference is less than minimum value, 0, then it is truncated to that minimum value. Figure 17 shows an example.

| (a) | (b) | (c) |

"Figure 17. (a) First Image [1] (b) Second Image (c) Result Image"

4.5.5 Difference

The difference filter takes two images, one source image and one overlay image. This filter produces the result by taking absolute difference the corresponding pixel values. Figure 18 shows an example.

(a)   *(b)*   *(c)*
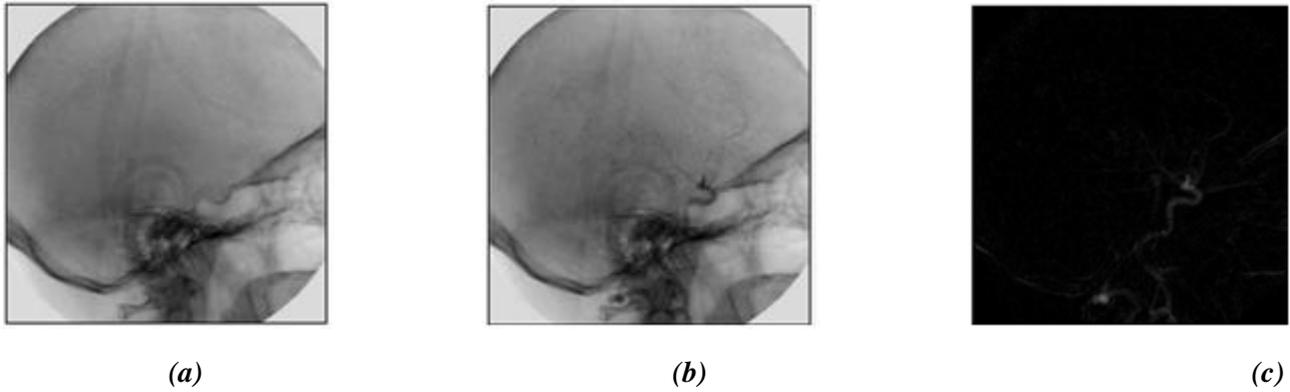
"Figure 18 (a) Mask image [1] (b) A live image [1] (c) Difference between (a) and (b)"

4.6 Edge Detection

Edge detection is the name for a set of mathematical methods which aim at identifying points in a digital image at which the image brightness changes sharply or, more formally, has discontinuities [2]. The points at which image brightness changes sharply are typically organized into a set of curved line segments termed edges [2].
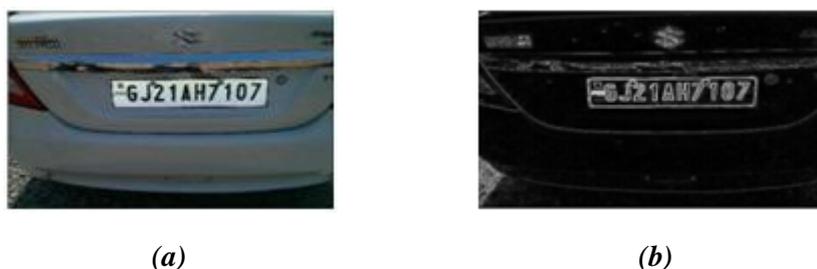
4.6.1 Homogenity

This filter finds edges for images by calculating maximum difference of processing pixel with neighboring pixels in 8 directions. Here x - is currently processed pixel and other is neighboring pixels:

p1	p2	p3
p8	x	p4
p7	p6	p5

The corresponding pixel of the result image equals to:

$$\max(|x-P1|, |x-P2|, |x-P3|, |x-P4|, |x-P5|, |x-P6|, |x-P7|, |x-P8|)$$

(a)   *(b)*

"Figure 19. (a) Original Image (b) Result Image"

4.6.2 Difference

This filter finds edges for image by calculating maximum difference between pixels in 4 directions around the processing pixel. Here x - is currently processed pixel and other is neighbouring pixels:

p1	p2	p3
p8	x	p4
p7	p6	p5

The corresponding pixel of the result image equals to:

$$max(|P1-P5|, |P2-P6|, |P3-P7|, |P4-P8|)$$

(a)	*(b)*

"Figure 20. (a) Original Image (b) Result Image"

4.6.3 Sobel

This filter finds edges for images by applying Sobel operator. Each pixel of the result image is calculated as approximated absolute gradient magnitude for corresponding pixel of the source image:

$|G| = |Gx| + |Gy]$,

where Gx and Gy are calculate utilizing Sobel convolution kernels:

Gx

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

Gy

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

Using the above kernel the approximated magnitude for pixel **x** is calculate using the next equation:

p1	p2	p3
p8	x	p4
p7	p6	p5

$$|G| = |P1 + 2P2 + P3 - P7 - 2P6 - P5| + |P3 + 2P4 + P5 - P1 - 2P8 - P7|$$

(a)   *(b)*

"Figure 21. (a) Original Image (b) Result Image"

4.6.4 Canny

Although the algorithm is more complex, the performance of the canny edge detector is superior in general to the other edge detectors. Canny's approach is based on three basic objectives [1]:

➢ Low error rate. All edges should be found, and there should be no spurious responses. That is, the edges detected must be as close as possible to the true edges.
➢ Edge points should be well localized. The edges located must be as close as possible to the true edges. That is, the distance between a point marked as an edge by the detector and the center of the true edge should be minimum.
➢ Single edge point response. The detector should return only one point for each true edge point. That is, the number of local maxima around the true edge should be minimum.

(a)   *(b)*
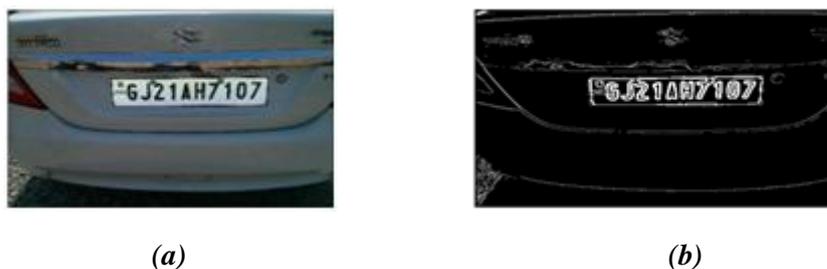
"Figure 22. (a) Original Image (b) Result Image"

4.7 Binarization

4.7.1 Threshold

The simplest binariazation method is the regular thresholding, which just takes the specified threshold and separates image's pixels into black and white pixels according to the specified threshold.

(a)   *(b)*
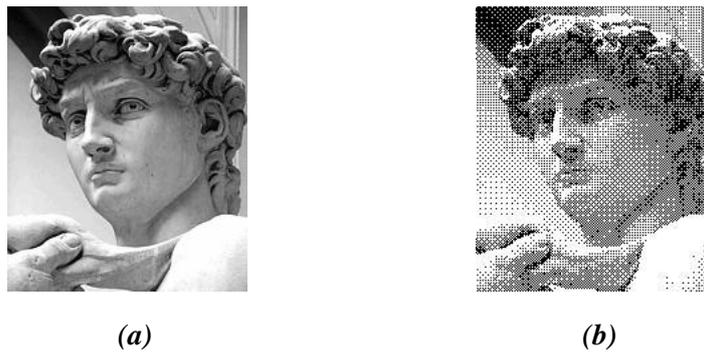
"Figure 23. (a) Original Image [1] (b) Result Image"

4.7.2 Dither

In a dithered image, colors that are not available in the palette are approximated by a diffusion of colored pixels from within the available palette. Ordered dithering is an image dithering algorithm. It is commonly used by programs that need to provide continuous image of higher colors on a display of less color depth. Ordered dithering dithers using a "dither matrix". For every pixel in the image the value of the pattern at the corresponding location is used as a threshold. Neighboring pixels do not affect each other, making this form of dithering suitable for use in animations [3].

(a)   *(b)*
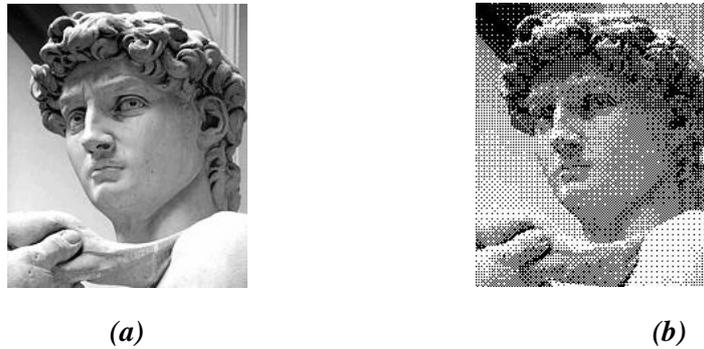
"Figure 24. (a) Original Image [3] (b) Result of ordered dither"

A Bayer matrix produces a very distinctive cross-hatch pattern [3].

(a)   *(b)*

"Figure 25. (a) Original Image [3] (b) Result of bayer ordered dither"

Floyd–Steinberg dithering only diffuses the error to neighbouring pixels. This results in very fine-grained dithering [3].

(a)   *(b)*

"Figure 26. (a) Original Image [3] (b) Result of Floyd-Steinberg dither"

Jarvis, Judice, and Ninke dithering diffuses the error also to pixels one step further away. The dithering is coarser, but has fewer visual artifacts. However, it is slower than Floyd–Steinberg dithering, because it distributes errors among 12 nearby pixels instead of 4 nearby pixels for Floyd–Steinberg [3].

(a)   *(b)*

"Figure 27. (a) Original Image [3] (b) Result of Jarvis, Judice, and Ninke dither"

Stucki dithering is based on the above, but is slightly faster. Its output tends to be clean and sharp [3].

(a)   *(b)*

"Figure 28. (a) Original Image [3] (b) Result of Stucki dither"

Burkes dithering is a simplified form of Stucki dithering that is faster, but is less clean than Stucki dithering [3].

(a)   *(b)*

"Figure 29. (a) Original Image [3] (b) Result of Burkes Dither"

Sierra dithering is based on Jarvis dithering, but it's faster while giving similar results [3].

(a) *(b)*

"Figure 30. (a) Original Image [3] (b) Result of Sierra dither"

V. CONCLUSION

We have implemented the enhancement techniques that are described in the above section. These techniques are used to enhance the image for better view and use. As enhancement is mostly used as the pre-processing task, we need to select the appropriate technique. We can also apply combination of techniques to enhance the image. Invert, grayscale, brightness correction, contrast correction etc. are the basic methods which we are using in day to day life. Application areas of image enhancement include medical imaging, industrial imaging, satellite imaging, law enforcement, agriculture etc.

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