**Title: Image enhancement techniques**

**Aim: Write C++ Program to read uncompressed TIFF Image to perform following functions (Menu Driven). Image Frame1 is used for displaying Original Image and Image Frame 2 is used for displaying the action performed.**

1. Sharpen the Image
2. Blur the Image
3. Programmable image Contrast and Brightness
4. Histogram.
5. Mean and Standard Deviation of image
6. Rotate image by programmable angle
7. PDF

**Objective:**

* To understand the image as a signal
* To understand image processing
* Able to use OOP technique

**Theory:**

**Image Definition:**

Image is a collection of pixels. An image is an array, or a matrix, of square pixels (Picture elements) arranged in columns and rows. These numbers determine the color of the pixel.

**Types of Images:**

* 1. Binary Image
  2. Grayscale image
  3. Colored image

Image has two attributes number of channels and depth.

Depth defines the maximum bit size of the number which is used to represent the pixel value stored in array.

**Raster formats:**

1. **JPEG/JFIF:**

JPEG (Joint Photographic Experts Group) is a lossy compression method; JPEG-compressed images are usually stored in the JFIF (JPEG File Interchange Format) file format. The JPEG/JFIF filename extension is JPG or JPEG. JPEG/JFIF format, which supports 8-bit grayscale images and 24-bit color images. JPEG applies lossy compression to images, which can result in a significant reduction of the file size.

1. **JPEG 2000:**

JPEG 2000 is a compression standard enabling both lossless and lossy storage. The compression methods used are different from the ones in standard JFIF/JPEG; they improve quality and compression ratios, but also require more computational power to process. JPEG 2000 also adds features that are missing in JPEG.

1. **TIFF:**

The TIFF (Tagged Image File Format) format is a flexible format that normally saves 8 bits or 16 bits per color for 24-bit and 48-bit totals, respectively. Images are stored using either the TIFF or TIF filename extension. TIFFs can be lossy and lossless; some offer relatively good lossless compression for bi-level (black & white) images. Some digital cameras can save images in TIFF format.

**BMP:**

The BMP file format (Windows bitmap) handles graphics files within the Microsoft Windows OS. Typically, BMP files are uncompressed, and therefore large and lossless; their advantage is their simple structure and wide acceptance in Windows programs.

1. **PNG:**

The PNG (Portable Network Graphics) file format was created as a free, open-source alternative to GIF. The PNG file format supports 8 bit palette images (with optional transparency for all palette colors) and 24 bit true color or 48 bit.

### Image Processing:

Image processing is a method to perform some operations on image, in order to get an enhanced image or to extract some useful information from it. Here input is image, like photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them.

**Different Operations on Images:**

1. **Sharpening Image:**

Sharpening of digital image files is one of the most important aspects of image quality. Sharpening brings out detail and gives an image presence. Sharpening is used to enhance line structures or other details in an image.

In image processing a kernel, convolution matrix or mask is a small matrix useful for blurring, sharpening etc.

-1 -1 -1

-1 8 -1

-1 -1 -1

Sharpen=

1. **Blurring:**

In blurring, we blur an image. In blurring, we reduce the edge content and make the transition from one color to the other very smooth. In blurring, the number of pixels of a normal image and a blurred image remains the same.The main objective of blurring is to reduce noise. Such noise reduction is a typical image pre-processing method which will improve the final result.

**Mean Filter:**

Mean filter is also known as Box filter and average filter. A mean filter has the following properties.

* It must be odd ordered
* The sum of all the elements should be 1
* All the elements should be same

If we follow this rule, then for a mask of 3x3. We get the following result.

|  |  |  |
| --- | --- | --- |
| **1 /9** | **1/9** | **1/9** |
| **1 /9** | **1 /9** | **1 /9** |
| **1 /9** | **1 /9** | **1 /9** |

The condition that all element sum should be equal to 1 can be achieved by dividing each value by 9. As 1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 + 1/9 = 9/9 = 1

When this kernel is applied, each pixel and its eight neighbors are multiplied by 1/9 and added together. The pixel in the middle is replaced by the sum. This is repeated for each pixel in the image. If results are not much clear, then we increase the blurring.The blurring can be increased by increasing the size of the mask. The more is the size of the mask, the more is the blurring. Because with greater mask, greater number of pixels are catered and one smooth transition is defined. It does smoothing by sliding a kernel (filter) across the image. Each pixel value will be calculated based on the value of the kernel and the overlapping pixel's value of the original image. Mathematically speaking, we do convolution operation on an image with a kernel. What kernel we're applying to an image makes difference to the result of the smoothing. What we do for this filter is assigning average values of a pixel's neighbors.We need to choose right size of the kernel. If it's too large, it may blur and remove small features of the image. But if it is too small, we may not be able to eliminate noises of the image.

Algorithm:

1. Read source image using imread().
2. Filter the image with different kernel sizes.
3. Display source image using imshow().
4. Display blurred image using imshow().
5. **Histogram:**

A histogram is a graph. Usually histograms have bars that represent frequency of occurring data in the whole data set. A Histogram has two axes the x axis and the y axis. The x axis contains event whose frequency you have to count. The y axis contains frequency.

Histogram of an image, like other histograms also shows frequency. But an image histogram shows frequency of pixels intensity values. In an image histogram, the x axis shows the gray level intensities and the y axis shows the frequency of these intensities.

Algorithm:

1. Take an input image.
2. Create 1D array for holding the pixel value.
3. Count the number of pixels for each pixel intensity value.
4. Create the canvas for drawing the histogram.
5. For plotting the histogram, draw lines on the canvas to represent the histogram value.
6. Display the histogram.
7. **Image Brightness and Contrast:**

## Brightness:

Brightness is a relative term. It depends on your visual perception. Since brightness is a relative term, so brightness can be defined as the amount of energy output by a source of light relative to the source we are comparing it to.

Changing brightness is a point operation on each pixel. If you want to increase the brightness, you have to add some constant value to each and every pixel.  
                         new\_img (i, j) = img(i, j) + c  
 If you want to decrease the brightness, you have to subtract some constant value from each and every pixel.  
                         new\_img (i, j) = img(i, j) - c

Algorithm:

1. Load image using imread().
2. Increase brightness by adding scalar to the original image

bright\_img= original\_img + scalar();

1. Show bright\_img using imshow().

## Contrast:

## Contrast can be simply explained as the difference between maximum and minimum pixel intensity in an image.Low contrast images occur due to poor or non uniform lighting conditions or due to nonlinearity or small dynamic range of the imaging sensor.Contrast Stretching is one of the piecewise linear function. Contrast Stretching increases the dynamic range of the grey level in the image being processed.

## <http://4.bp.blogspot.com/-uQChNO3u6oM/UOuNEc6LtoI/AAAAAAAAAfM/2MICTi5jN4U/s1600/contrastStretching.jpg>

## Points (r1, s1) and (r2, s2) control the shape of the transformation. The selection of control points depends upon the types of image and varies from one image to another image. If r1 = s1 and r2 = s2 then the transformation is linear and this doesn't affect the image.

## Algorithm:

## Load image using imread().

## Accept transformation coefficients r1,s1,r2,s2 from user.

## Calculate new pixel value as output using equations

## for 0 <= x <= r1   output = s1 / r1 \* x

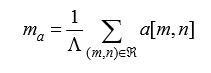
## for r1 < x <= r2   output = ((s2 - s1)/(r2 - r1))\*(x - r1) + s1

## for r2 < x <= L - 1   output = ((L-1 - s2)/(L-1 - r2))\*(x - r2) + s2

## Show output image using imshow().

1. **Mean And Standard Deviation:**

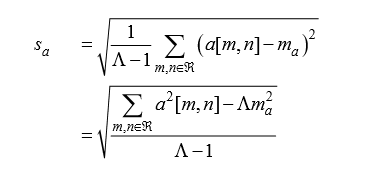
The average brightness of a region is defined as the sample mean of the pixel bright nesses within that region. The average, ma, of the bright nesses over the Λ pixels within a region (ℜ) is given by:

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The average brightness, ma, is an estimate of the mean brightness

**Standard Deviation:**

The unbiased estimate of the standard deviation, sa, of the bright nesses within a region (ℜ) with Λ pixels is called the sample standard deviation and is given by:



The standard deviation, sa, is an estimate of variance σa of the underlying brightness probability distribution.

**Algorithm:**1) Load the image and calculate its height and width

2) Calculate the mean of the image

3) Calculate standard deviation by the formula: std\_dev = sqrt of variance

Variance = (imagedata-mean) ^2/width\*height

4) Display all the values

1. **Image Rotation:**

The rotation operation performs a geometric transformation which maps the position (x1, y1) of a picture element in an input image onto a position (x2, y2) in an output image by rotating it through specified angle about the origin.

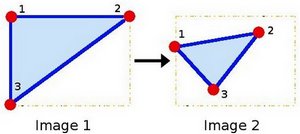
Rotation performs a transformation of the form:

x2 =cosθ x ( x1- x0 ) - sinθ x ( y1 - y0 ) + x0

y2 =sinθ x ( x1- x0 ) +cosθ x ( y1 - y0 ) +y0

Where ( x0,y0 ) are the coordinates of the centre of rotation.

θ is the angle of rotation, with clockwise rotation having positive angle



the points 1, 2 and 3 (forming a triangle in image 1) are mapped into image 2.

Algorithm:

1. Read image using imshow().
2. Rotate the image with user defined angle.
3. Show rotated image using imshow().

**Input:** Input image in TIFF file format.

**Output:** A transformed image based on option selected from menu in TIFF format.

**Conclusion:** Thus, we have successfully implemented blurring, sharpening, rotation, contrast stretching, convolution, histogram, mean and standard deviation operations on an image.

**Mathematical Model: Mathematical model is to be given by students**

**FAQs:**

Q. 1 Explain all the functions of Opencv used in the program with input it takes, output of the function and what operation it does?

Q.2 Give difference between color image and gray image.

Q.3 what is difference between PNG and TIFF image file formats?

Q.4 How to access pixel value in OpenCV?

Q.5 Distinguish between point operations and neighborhood operations.

Q.6 what do you mean by frequency in image.