IMAGE PROCESSING ASSIGNMENT-1

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ABSTRACT

I have developed tool to perform the basic intensity transformation on the Images. Images here can be grey scale or color but only images of the type png,jpeg,jpg,xmp are accepted as input. Intensity transforms that can be performed on this images using the tool are Histogram Equalization, Gamma transform, Log transform, Blurring Image, Sharpening Image and Edge detection using Sobel operators is added as the additional transform. All of these transforms are applied on some of the images and the results are shown in this report.

1. INTRODUCTION

Main idea behind this tool is to implement various transformation techniques on any of the image.Images can be of many types like color, grey scale etc. Different Images have different underlying data representations like color images can be represented with 3 arrays if the pixel intensities are represented in RGB format, Same image if represented in HSV format will have arrays corresponding to H,S,V respectively each array element will be the value of Hue,Saturation and Value. Similarly grey scale is one in which the value of each pixel represents intensity information. This tool will convert any image given to it into its HSV data and performs all the operations on the Intensity(V) array and then merge it with the original Hue(H) and Saturation(S) arrays to get back the original image.

2. BACKGROUND READ

This tool is implemented using Python. I have used PyQt4 binding for implementing GUI it runs on Windows, Linux, Mac OS X and various UNIX platforms. It does not support Android and iOS. To handle color and grey scale images opencv library is used. Any image uploaded will be considered as color image and its HSV arrays are extracted. To perform operations on the Intensity values numpy library is used

3. APPROACH

Apart from transformations there are some file handling and operation control features in this tool. Every operation is associated with a button or scroll bar(only for sharpening image). Each button in turn when clicked calls the corresponding method to perform the operation on the image. Before any change is made to the data it is stored in a global variable so that the Undo functionality can be implemented easily. Each of the transform that is implemented by this tool and approach followed to implement it is listed below

3.1. Histogram Equalization

Histogram equalization is implemented by taking the CDF of the pixel intensities, for each intensity level number of such pixels in the image are found and this result is stored in a variable(CDF) and it is updated for every intensity level by adding the previous value also the new intensity is calculated by dividing it with the size of the image and then multiplying it with maximum intensity i.e.,255.

3.2. Gamma transform

Each intensity value of the original image is normalized and raised to the power of $1/gamma$ given by the user this result is multiplied with a constant value to return the intensity range of the original image. In this tool constant for gamma transform is chosen to be 255.So if the user gives gamma to be less than 1 all the intensity values are reduced and the image appears darker. Similarly if gamma is greater than 1 image appears brighter.

3.3. Log transform

Each intensity value of the original image is multiplied by a constant and log of that value is taken as new intensity. In this tool constant for log transform is chosen to be 46 because the intensity range from images is from 0 to 255. log of these values would result in values from 0 to 5.54 to keep the range of intensities same constant is chosen to be 46.

3.4. Blurring Image

To blur an image blurring kernel is used. Gaussian kernel is used and the window size of the kernel is determined by the sigma(variance) value given by the user larger the sigma value more blurring happens and vice-verse. After sigma is taken from the user kernel of size $(2 * sigma, 2 * sigma)$ is formed

and the image is convolved with the filter(kernel) to get the blurred image.

3.5. Sharpening Image

To Sharpen an image kernel is used. Laplacian kernel is used and the window size of the kernel $(3, 3)$ is formed and the image is convolved with the image to get the sharpened image. Extent of sharpening is controlled with the scroll bar minimum value of the scroll bar is 1 and maximum is 10. If scroll bar is set to 1 the resultant image is the sum of original image and convolved image. Similarly if the scroll bar is set to 10 the resultant image is sum of the original image and 10 times the convolved image.

3.6. Sobel operators(Horizontal and vertical edge detection)

To detect edges kernel is used. Here Sobel kernel is used and the window size of the kernel $(3, 3)$ is formed and the image is convolved with the image to get the sharpened image. Two kernels are used to detect 2 edges (horizontal and vertical) and the result of both of them is added to display the horizontal and vertical edges.

4. SELECTION OF TEST IMAGES

Following are the images used for testing the various transformation techniques.

4.1. Histogram Equalization

Test image for Histogram equalization

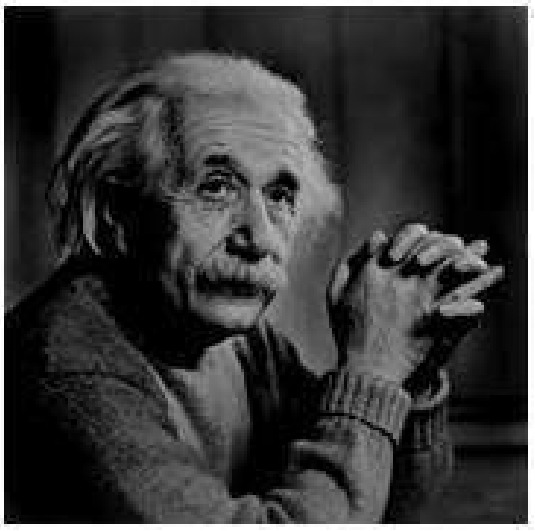
This is image is chosen for histogram equalization because its Histogram is more skewed towards low intensity levels. Results of histogram equalisation will be clearly visible with this image.

4.2. Gamma Correct

Test image for Gamma correction

This is image is chosen for Gamma correction because it is brighter image and the effect of gamma transform for different gamma values can be clearly observed.

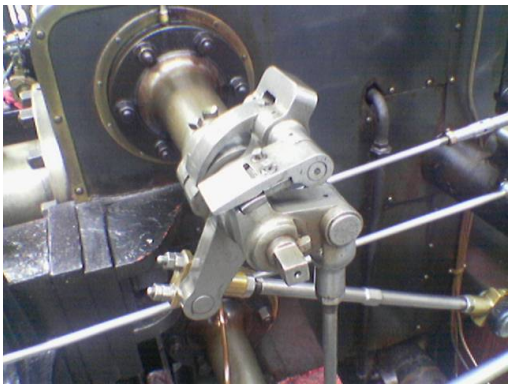
4.3. Log Transform



Test image for Log Transform

Effect of Log transformation is more clearly visible in Grey scale image, So grey scale image is chosen for testing Log transformation.

4.4. Blur Image



Test image for Blurring

Any image can chosen for blurring image but image which has more details in it will give the best output so this image is chosen.

4.5. Sharpen Image

Test image for Blurring

4.6. Sobel operation

Test image for Blurring

Image which has more horizontal and vertical edges will be required since Sobel operators for detecting horizontal and vertical edges is used as kernel

5. RESULTS ON TEST IMAGES

Following are the images after appying various transformation techniques.

5.1. Histogram Equalization

Test image after applying Histogram equalization

5.2. Gamma Correct

5.2.1. gamma = 0.1

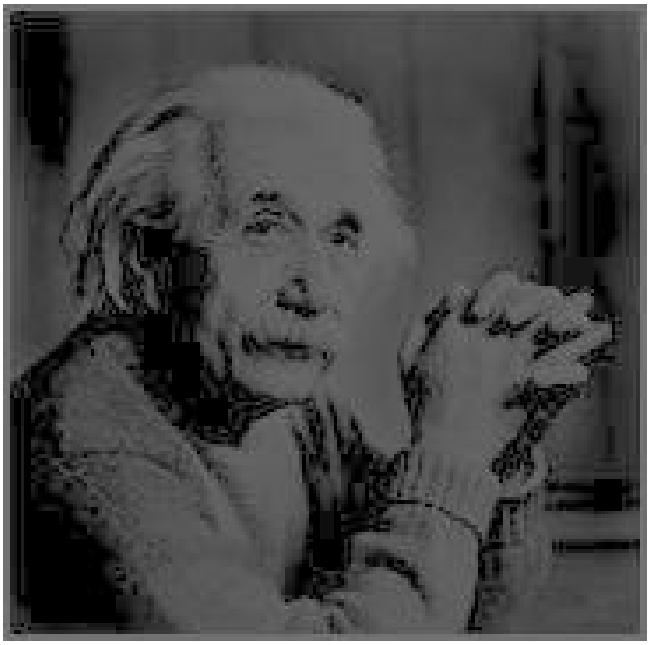
Test image after applying Gamma correction with gamma = 0.1

5.2.2. gamma = 2.2

Image after applying gamma transform

Test image after applying Gamma correction with gamma = 2.2

5.3. Log Transform

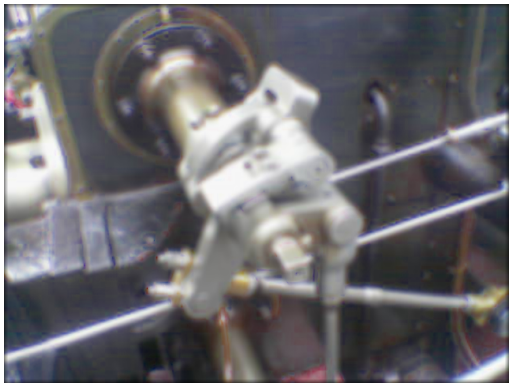


Test image after applying Log Transform

5.4. Blur Image

Results of blurring with different Gaussian kernels

5.4.1. Blur using Gaussian kernel with variance 5



Test image after Blurring with Gaussian kernel with variance 5

5.4.2. Blur using Gaussian kernel with variance 20

Test image after Blurring with Gaussian kernel with variance 20

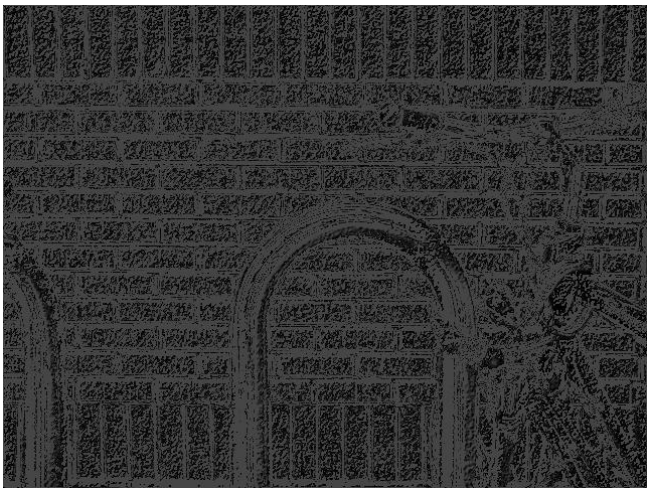
5.5. Sharpen Image

Result after applying Laplacian $(3, 3)$ kernel

Test image after applying sharpening filter

5.6. Sobel operation

Result of applying Sobel kernel to detect horizontal and vertical edges. Here the test image is convolved with the kernel to detect horizontal edges at the same time another kernel is applied to the test image to detect vertical edges to detect vertical edges. Result of the convolution of these is added to get the horizontal and vertical edges in image



Test image after applying Sobel operator

6. DISSCUSSION

Main problem faced during development is choice of language. I got to know that Matlab has a drag and drop type of making GUI, but it is licensed i wanted to work with open source. The choice I was left with was c++ and python. I was not well versed in both of them. Since python syntax is easy i chose python. Implementation of GUI created a lot of problems I did not know which python binding to use, after searching online and found that tkinter is the basic and primitive binding in python so i chose that and started working with it but after spending entire day on it nothing much was happening so i shifted to pyqt after finding a tutorial on pyqt and completed the GUI part using pyqt. For image operations Opencv and numpy libraries are used though it was not easy documentation is available online.

If more time was given i would have implemented convolution using vectors to reduce the computations and GUI also can improved by making the window responsive adding short cuts to all the operations etc.,

7. REFERENCES

8. APPENDIX

```
#!/usr/bin/python

import sys # import libraries needed
import PyQt4
import math
import numpy as np
import cv2 as cv
from PyQt4 import QtGui, QtCore
from PyQt4.QtGui import *
from PyQt4.QtCore import *
from PyQt4.QtCore import pyqtSlot,SIGNAL,SLOT

class Window(QtGui.QMainWindow): #create a class to display a window

    def __init__(self): #method to declare attributes of the class
        super(Window,self).__init__()
        self.setGeometry(50,50,1400,650)     # to set the size of the window to 1400*650
        self.setWindowTitle("Basic Image Editor") # give title to the window
        self.home() #method called home will have all the main features of the GUI
        self.__pixmap = None # create pixmap attribute to display image to GUI
        self.__mdfd_img_lstchg = None # to store the last the changed image data
        self.__mdfd_img = None # to store the current image data
        self.__img_h = None # empty attribute to store hue values of image
        self.__img_s = None # empty attribute to store saturation values of image
        self.__img_v = None # empty attribute to store intensity value of image
        self.__img_height = None # height of the Image
        self.__img_width = None # widht of the Image
        self.lbl = QtGui.QLabel(self)  # create a Qlabel object to display input image
        self.lbl1 = QtGui.QLabel(self) # create a Qlabel object to display title for input ima
        self.lbl2 = QtGui.QLabel(self) # create a Qlabel object to display title for output im
        self.lbl3 = QtGui.QLabel(self) # create a Qlabel object to displat output image
        self.lbl_s1 = QtGui.QLabel(self) # create a Qlabel object to display scroll title "Hig
        self.lbl_s2 = QtGui.QLabel(self) # create a Qlabel object to display scroll title "Low
        self.lbl_s3 = QtGui.QLabel(self) # create a Qlabel object to display text for text ed
        self.s2 = QtGui.QScrollBar(self) # create a QScrollBar object to display scrollbar
        self.e2 = QtGui.QLineEdit(self) # create a QLineEdit object to display scroll title

    def home(self): # home method of the QMainWindow
        btn = QtGui.QPushButton("Upload Image",self) # button for uploading image
        btn.clicked.connect(self.file_open) # go to file_open method when clicked on Upload Im
        btn.resize(200,40) # resize the button to the required size
        btn.move(500,50 ) # reposition the button at the required position
        btn1 = QtGui.QPushButton("Equalize histogram",self)
        btn1.clicked.connect(self.hist_equal) # go to hist_equal method when clicked on quali
        btn1.resize(200,40) # resize the button to the required size
        btn1.setSizePolicy(QtGui.QSizePolicy.Expanding, QtGui.QSizePolicy.Expanding)
        btn1.move(500,100 )
        btn2 = QtGui.QPushButton("Gamma correct",self)
        btn2.clicked.connect(self.gamma_correct_btn) # go to gamma_correct_btn method when cl
        btn2.resize(200,40) # resize the button to the required size
        btn2.move(500,150 ) # reposition the button at the required position
        btn3 = QtGui.QPushButton("Log transform",self)
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        btn3.clicked.connect(self.log_transform) # go to log_transform method when clicked on
        btn3.resize(200,40) # resize the button to the required size
        btn3.move(500,200 ) # reposition the button at the required position
        btn4 = QtGui.QPushButton("Blur Image",self)
        btn4.clicked.connect(self.blur_img_scr_bar) # go to blur_img_scr_bar method when click
        btn4.resize(200,40) # resize the button to the required size
        btn4.move(500,250 ) # reposition the button at the required position
        btn5 = QtGui.QPushButton("Sharpening",self)
        btn5.clicked.connect(self.sharpen_img_scr_bar) # go to sharpen_img_scr_bar method whe
        btn5.resize(200,40) # resize the button to the required size
        btn5.move(500,300 ) # reposition the button at the required position
        btn6 = QtGui.QPushButton("Sobel Operator",self)
        btn6.clicked.connect(self.edge_detect) # go to save_image method when clicked on Sobe
        btn6.resize(200,40) # resize the button to the required size
        btn6.move(500,350 ) # reposition the button at the required position
        btn7 = QtGui.QPushButton("Undo last Change",self)
        btn7.clicked.connect(self.undo) # go to undo method when clicked on Undo last Change
        btn7.resize(200,40) # resize the button to the required size
        btn7.move(500,400 ) # reposition the button at the required position
        btn8 = QtGui.QPushButton("Undo All Changes",self)
        btn8.clicked.connect(self.undoall) # go to undoall method when clicked on Undo All Ch
        btn8.resize(200,40) # resize the button to the required size
        btn8.move(500,450 ) # reposition the button at the required position
        btn9 = QtGui.QPushButton("Save Image",self)
        btn9.clicked.connect(self.save_image) # go to save_image method when clicked on Save
        btn9.resize(200,40) # resize the button to the required size
        btn9.move(500,500 ) # reposition the button at the required position
        btn10 = QtGui.QPushButton("Close Window",self)
        btn10.clicked.connect(self.win_close) # go to win_close method when clicked on Close
        btn10.resize(200,40) # resize the button to the required size
        btn10.move(500,550 ) # reposition the button at the required position
        self.show() #show the window

    def file_open(self): #method to open file
        name = QtGui.QFileDialog.getOpenFileName(self,'Open File','','Images (*.png *.xpm *.jp
        upld_img = QtGui.QImage() # create Qimage object to store the uploaded image data
        self.__ip_img =  cv.imread(str(name),cv.IMREAD_COLOR) # upload the image from the dia
        img_hsv = cv.cvtColor(self.__ip_img, cv.COLOR_BGR2HSV) #convert color image to HSV us
        # get image properties.
        self.__img_h,self.__img_s,self.__img_v = cv.split(img_hsv)
        self.__img_height,self.__img_width = self.__img_v.shape
        # print self.__img_v.shape
        self.__mdfd_img_lstchg = None
        self.__mdfd_img = None
        self.__mdfd_img_lstchg = self.__img_v # update the last changed value to uploaded ima
        self.__mdfd_img = self.__img_v # update the current changed image to uploaded image
        if upld_img.load(name): # if the image is uploaded properly then upld_img.load will b
            self.lbl1.clear() # clear the past content in label if any is present
            self.lbl1.setText("Orignal Image") # Set title for the input image to display
            self.lbl1.move(200,50) # position the title
            self.lbl1.show() # show the title
            pixmap = QtGui.QPixmap(upld_img) #convert the opencv image to pixmap to display i
            self.__pixmap = pixmap.scaled(400, 650, QtCore.Qt.KeepAspectRatio) # scale the pix
            self.lbl.clear() # clear the past content in label if any is present
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            self.lbl.resize(400,650) # set the size of the input pixmap to 400*650
            self.lbl.move(50,0) # position the input pixmap
            self.lbl.setSizePolicy(QtGui.QSizePolicy.Minimum, QtGui.QSizePolicy.Minimum)
            self.lbl.setScaledContents(False)
            self.lbl.setPixmap(self.__pixmap) # set the pixmap to the label
            self.lbl.show()# show the pixmap as image
            print("Selected Image uploaded") #print status to the terminal or IDE
            self.dialog = QProgressDialog('In progress please wait...','Cancel', 0, self.__img
            self.dialog.setWindowModality(Qt.WindowModal)
        else: #if the image is not uploaded then
            print("Could not upload Image") # print status to the terminal or IDE

    def hist_equal(self):# this method is for Histogram Equalization
        self.__mdfd_img_lstchg = self.__mdfd_img # store the last changed image data for undo
        sum = 0 # initialise sum variable to store the cdf
        hist_equal_img = self.__mdfd_img # assign the image data to temporary variable to do
        new_img=np.empty_like(hist_equal_img) # create a empty numpy array with the same size
        # print(np.max(hist_equal_img))
        for i in range (256): # for each intensity value
            idx = np.where(hist_equal_img == i) # get the indexes of the pixels with that ima
            i_intnsty_freq = len(idx[0]) # find the number of such pixels
            sum = sum +i_intnsty_freq # find the CDF
            new_intnsty = (float(sum)/hist_equal_img.size)*255.0 # calculate the new intensity
            # print new_intnsty
            new_img[idx] = new_intnsty # assign the new intensity to new array
        self.__mdfd_img = new_img # now move the data in temp variable to global variable
        self.disp("Histogram Equalization") # to display the changed image
        print("Histogram Equalized") # Print status to terminal or IDE

    def gamma_correct_btn(self): # method to ask for gamma value when gamma correct button is
        gamma,ok = QtGui.QInputDialog.getDouble(self,"Gamma value","enter a number") # get the
        if ok: # if the user inputs any value
            print 'Gamma value = '+str(gamma) # Print status to terminal or IDE
            self.gamma_correct(gamma) # call the gamma_correct method with the given gamma
        else: # if user does not give any value
            print("No input gamma value given") # Print status to terminal or IDE

    def gamma_correct(self,gamma): #method to do gamma correction
        self.__mdfd_img_lstchg = self.__mdfd_img # store the last changed image data for undo
        gamma_correct_img = self.__mdfd_img # store the image data to temporary array
        new_img_2=np.empty_like(gamma_correct_img) # create a temporary array to store calcul
        c = 255 # let c be 1
        for i in range (256): # for each intensity value
            idx = (gamma_correct_img == i) #get the indexes with the same intensity values
            new_intnsty = c*((float(i)/255.0)**(1/gamma)) # apply gamma transform on each int
            new_img_2[idx] = int(new_intnsty) # store the values in temporary array
        self.__mdfd_img = new_img_2 # save the gamma corrected image to global variable
        self.disp("Gamma transformation")# to display the changed image
        print("Gamma transformation Applied") # Print status to terminal or IDE

    def log_transform(self):
        self.__mdfd_img_lstchg = self.__mdfd_img # store the last changed image data for undo
        log_trnsfrm_img = self.__mdfd_img # temp array to do operations on
        new_img_3 = np.empty_like(log_trnsfrm_img) # empty array to assign new intensity valu
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    c = 47 # let c be 100
    for i in range (256): # for each instensity value of the image
        idx = (log_trnsfrm_img == i) # get the indexes with the same intensity levels
        new_intnsty = float(c*(math.log10(i+1))) # apply log transformation
        new_img_3[idx] = new_intnsty # assign the new intensity values to the temporary a
    self.__mdfd_img = new_img_3 # store the modified data to the global variable
    self.disp("Log transformation")# to display the changed image
    print("Log transformation Applied") # Print status to terminal or IDE

def blur_img_scr_bar(self):
    self.lbl_s3.resize(500,50)#label to display title for output image
    self.lbl_s3.setText("Please Enter an Integer value Sigma for Gaussian Blur")#title te
    self.lbl_s3.move(100,590) #positioning
    self.lbl_s3.show() #display title
    self.e2.setValidator(QIntValidator())#text box setting to allow only integer values
    self.e2.move(500,600) #positioning
    btn_blur_img = QPushButton('OK', self) #button to click ok to start operaion on the i
    btn_blur_img.resize(50,30) #resize the button
    btn_blur_img.move(610, 600) #positioning
    btn_blur_img.show() #display button
    self.e2.show() #display text box
    btn_blur_img.clicked.connect(lambda: self.blur_img(int(self.e2.text()))) #call blur_im

def blur_img(self,sigma):
    self.__mdfd_img_lstchg = self.__mdfd_img # store the last changed image data for undo
    x_count = -1#initialise
    y_count = -1#initialise
    filter = np.zeros((2*sigma+1,2*sigma+1), dtype=np.float) #empty filter kernel
    blur_img = self.__mdfd_img#take the data to temp array
    padd_blur_img = np.append(np.zeros((sigma,self.__img_width)), blur_img, axis=0)#padd
    padd_blur_img = np.append(padd_blur_img,np.zeros((sigma,self.__img_width)), axis=0)#pa
    padd_blur_img = np.append(np.zeros((self.__img_height+2*sigma,sigma)), padd_blur_img,
    padd_blur_img = np.append(padd_blur_img,np.zeros((self.__img_height+2*sigma,sigma)),a
    new_img_4 = np.empty_like(blur_img)#empty array for storing the output
    for x in range(-sigma,sigma+1):#for the rows of the filter
        x_count+=1
        y_count = -1
        for y in range(-sigma,sigma+1):#for the columns of the filter
            y_count+=1
            filter[x_count,y_count] = math.exp(-(x**2.0+y**2.0)/(2.0*sigma*sigma))#comput
    neighbourhood = np.zeros((2*sigma+1,2*sigma+1))#window
    progress = 0#to display progress in progres bar
    self.dialog.forceShow() # show the progress bar
    for j in range(sigma,self.__img_height+sigma):#for the rows of the image
        for k in range(sigma,self.__img_width+sigma): #for the columns of the images
            neighbourhood = padd_blur_img[j-sigma:j+sigma+1,k-sigma:k+sigma+1]#take the p
            new_img_4[j-sigma,k-sigma] = np.sum(neighbourhood*filter,dtype=np.float)/np.su
            progress = progress + 1#increment the status
            if(progress%3000==0):#display progress every 3000 loops
                self.dialog.setValue(progress)#to display progress
            if(self.dialog.wasCanceled()):#if the cancel button is pressed
                break # stop the loog
    self.dialog.setValue(progress) # set the progress
    self.__mdfd_img = new_img_4 #store the computed values in global variable
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```
        self.disp("Blurred Image",1)# to display the changed image
        print("Image Blurred") # Print status to terminal or IDE

    def sharpen_img_scr_bar(self):
        self.s2.resize(20,400) #scrollbar
        self.s2.move(1330,100) #positioning
        self.s2.setMaximum(10) #set maximum scroll value to 10
        self.s2.setMinimum(1) #set minimum scroll value to 1
        self.s2.show() #display scroll bar
        self.lbl_s1.resize(30,50)#resize the label
        self.lbl_s1.setText("High") # set the display text
        self.lbl_s1.move(1330,500) #positioning
        self.lbl_s1.show() #display the label
        self.lbl_s2.resize(30,50)#resize the label
        self.lbl_s2.setText("Low") # set the display text
        self.lbl_s2.move(1330,50) #positioning
        self.lbl_s2.show() #display the label
        self.__mdfd_img_lstchg = self.__mdfd_img # store the last changed image data for undo
        filter = np.zeros((3,3), dtype=np.float) #initialise filter with zeros
        sharp_img = self.__mdfd_img #take image data to a temp variable
        padd_sharp_img = np.insert(sharp_img,[0],0,axis = 0)  #padd zeros to the image
        padd_sharp_img = np.insert(padd_sharp_img,[self.__img_height+1],0,axis = 0) #padd zero
        padd_sharp_img = np.insert(padd_sharp_img,[0],0,axis = 1) #padd zeros to the image
        padd_sharp_img = np.insert(padd_sharp_img,[self.__img_width+1],0,axis = 1) #padd zeros
        new_img_5 = np.empty_like(sharp_img) #temp array to store new values
        # print(padd_blur_img[:,0],padd_blur_img[0,:],padd_blur_img[self.__img_height+1,:],pa
        # filter = np.array([[-1.0,-1.0,-1.0],[-1.0,9.0,-1.0],[-1.0,-1.0,-1.0]])
        # filter = np.array([[-1.0,-1.0,-1.0],[-1.0,8.0,-1.0],[-1.0,-1.0,-1.0]])
        filter = np.array([[0.0,1.0,0.0],[1.0,-4.0,1.0],[0.0,1.0,0.0]])
        # print(len(filter),len(filter[0]))
        neighbourhood = np.zeros((3,3)) # initialise window
        # new_img_5 = cv.filter2D(sharp_img,-1,filter)
        progress = 0 #initialise progress variable
        self.dialog.forceShow() #show the progress bar
        # print(padd_sharp_img[padd_sharp_img==np.max(padd_sharp_img)])
        # print(np.max(padd_sharp_img),np.max(self.__mdfd_img),np.max(self.__img_v))
        for j in range(1,self.__img_height+1): #for row in image
            for k in range(1,self.__img_width+1): #for columns in image
                progress = progress+1 # invrement progress value
                neighbourhood = padd_sharp_img[j-1:j+2,k-1:k+2] #neighbourhood of the pixel
                new_img_5[j-1,k-1] = np.sum(neighbourhood*filter,dtype=np.float)
                # print(neighbourhood*filter,np.sum(neighbourhood*filter),new_img_5[j-1,k-1],
                if(progress%3000==0): #display progress for every 3000 loops
                    self.dialog.setValue(progress) # display the progress
                if(self.dialog.wasCanceled()): # cancel button is pressed
                    break # stop execution and return to the main window
        self.dialog.setValue(progress) #display the progress using progress bar
        self.__mdfd_img = self.__img_v+new_img_5 # store the computed array values in global
        self.disp("Scroll to display sharpened image",1)# to display the changed image
        # print( np.where(new_img_5==np.max(new_img_5)))
        np.clip(new_img_5, 0,255, out=new_img_5) #clip the values to make them lie in (0,255)
        self.s2.valueChanged.connect(lambda: self.sharpen_img(new_img_5)) # call the sharpen_i

    def sharpen_img(self,new_img_5): # to sharpen the image
```

```
        self.__mdfd_img_lstchg = self.__mdfd_img #keep the data of last changed image for undo
        sigma = self.s2.value() # get the constant to multiply with the image
        # sigma = 1
        new_img = np.empty_like(new_img_5) # create an temp array to store the image
        np.clip(sigma/10*new_img_5,0,255,out=new_img) #clip the values to make them lie in (0
        self.__mdfd_img +=  new_img  # save the final sharpened image
        self.disp("Sharpened Image",1,1)# to display the changed image
        print("Image Sharpened") # Print status to terminal or IDE

    def edge_detect(self):
        self.__mdfd_img_lstchg = self.__mdfd_img # store the last changed image data for undo
        filter_6 = np.zeros((3,3), dtype=np.float) #filter for edge detection
        filter_7 = np.zeros((3,3), dtype=np.float) #filter for edge detection
        blur_img = self.__mdfd_img #take the image data to a empty array
        padd_blur_img = np.append(np.zeros((1,self.__img_width)), blur_img, axis=0) #padd zero
        padd_blur_img = np.append(padd_blur_img,np.zeros((1,self.__img_width)), axis=0) #padd
        padd_blur_img = np.append(np.zeros((self.__img_height+2,1)), padd_blur_img,axis=1) #pa
        padd_blur_img = np.append(padd_blur_img,np.zeros((self.__img_height+2,1)),axis=1) #pad
        new_img_7 = np.empty_like(blur_img)  # empty array to store the computed data
        new_img_6 = np.empty_like(blur_img) # empty array to store the computed data
        new_img_final = np.empty_like(blur_img) # store final image data
        filter_x = np.array([[1.0,0.0,-1.0],[2.0,0.0,-2.0],[1.0,-0.0,-1.0]]) #filter to detec
        filter_y = np.array([[1.0,2.0,1.0],[0.0,0.0,0.0],[-1.0,-2.0,-1.0]]) #filter to detect
        # print(padd_blur_img[:,0],padd_blur_img[0,:],padd_blur_img[self.__img_height+1,:],pa
        neighbourhood = np.zeros((3,3)) #window of size 3*3
        progress = 0 #variable to display progress
        self.dialog.forceShow() # show the progress dialog box
        for j in range(1,self.__img_height+1): #for rows in image
            for k in range(1,self.__img_width+1): #for columns in image
                neighbourhood = padd_blur_img[j-1:j+2,k-1:k+2] # get pixels intensites of the
                new_img_7[j-1,k-1] = np.sum(neighbourhood*filter_x,dtype=np.float) #convolve
                new_img_6[j-1,k-1] = np.sum(neighbourhood*filter_y,dtype=np.float) #convolve
                progress = progress + 1 #increment the progress value
                new_img_final[j-1,k-1] = new_img_7[j-1,k-1]+new_img_6[j-1,k-1] #add the horiz
                if(progress%3000==0): # display the status every 3000 loops
                    self.dialog.setValue(progress) #set the progress value
                if(self.dialog.wasCanceled()): #if the cancel button is pressed
                    break # stop the operation
        self.dialog.setValue(progress)
        np.clip(new_img_final,0,70 , out = new_img_final) #keep the intensites in the range(0
        self.__mdfd_img = new_img_final #store the transformed data in the global variable
        self.disp("Image edges")# to display the changed image
        print("Image Edges Detected") # Print status to terminal or IDE

    def undoall(self): # to undo all changes done on the image
        self.__mdfd_img = self.__img_v # change the data in the current changed data to origi
        # self.__mdfd_img_lstchg = self.__img_v
        self.disp("All changes undone") # To Display title
        print("All changes UNDONE ") # Print status to terminal or IDE

    def undo(self): #to undo the last change done on the image
        self.__mdfd_img = self.__mdfd_img_lstchg #update the current changed image as last ch
        self.disp("Last change undone") # To Display title
        print("Last change UNDONE ")# Print status to terminal or IDE
```

```
    def save_image(self): # this method is used for saving the image to the file
        name = QtGui.QFileDialog.getSaveFileName(self, 'Save File','','Images (*.png *.xpm *.
        itos = cv.merge([self.__img_h,self.__img_s, self.__mdfd_img])#merge intensity with the
        itos = cv.cvtColor(itos, cv.COLOR_HSV2RGB)#convert hsv to rgb image
        img_to_save = QtGui.QPixmap(QtGui.QImage(itos,self.__img_width, self.__img_height,3*s
        if img_to_save.save(name):#if the image is saved
            print("Image Saved To file") # Print status to terminal or IDE
        else:#if the could not be saved
            print("Could not save the Image to folder") # Print status to terminal or IDE

    def win_close(self): # this method is used for closing the window
        print("Window closed") # Print status to terminal or IDE
        sys.exit() #exit the application

    def disp(self,txt,flag = 0,scroll = 0): # this method is used to display the transformed
        if (flag == 0): #whether to clear some labels or not is decided by this flag variable
            self.s2.hide() #to hide the scroll bar
            self.lbl_s3.clear() #to clear the label to show new objects
            self.e2.clear() #to clear the label to show new objects
            self.e2.hide() #to hide the text box
            self.lbl_s1.clear() #to clear the label to show new objects
            self.lbl_s2.clear() #to clear the label to show new objects
        if (scroll == 0):#if the button other than sharpen is pressed
            self.s2.setValue(1) #reset the value every time
        img_pix1 = cv.merge([self.__img_h,self.__img_s, self.__mdfd_img]) #merge the v with h
        img_color = cv.cvtColor(img_pix1, cv.COLOR_HSV2RGB) #convert the image to color image
        pix_img = QtGui.QPixmap(QtGui.QImage(img_color,self.__img_width, self.__img_height,3*
        self.lbl2.clear() #to clear the label to show new objects
        self.lbl2.setText(txt) #set the text to display
        self.lbl2.resize(300,50) #resize the label to required size
        self.lbl2.move(950,0) #positioning the label
        self.lbl2.show() #show the label
        pix_img= pix_img.scaled(600,600, QtCore.Qt.KeepAspectRatio)
        self.lbl3.clear() #to clear the label to show new objects
        self.lbl3.resize(600,600) #resize the label to required size
        self.lbl3.move(720,40) #positioning the label
        self.lbl3.setSizePolicy(QtGui.QSizePolicy.Minimum, QtGui.QSizePolicy.Minimum)
        self.lbl3.setScaledContents(False) #keep the image as it is while scaling
        self.lbl3.setPixmap(pix_img) #shoe the image
        self.lbl3.show() #show the label

def main(): # define  a main class to call window created
    app = QtGui.QApplication(sys.argv) # start a qtgui application
    GUI = Window() #create an object of the window
    # GUI.disp() # display it
    sys.exit(app.exec_()) #close the window
main()
```