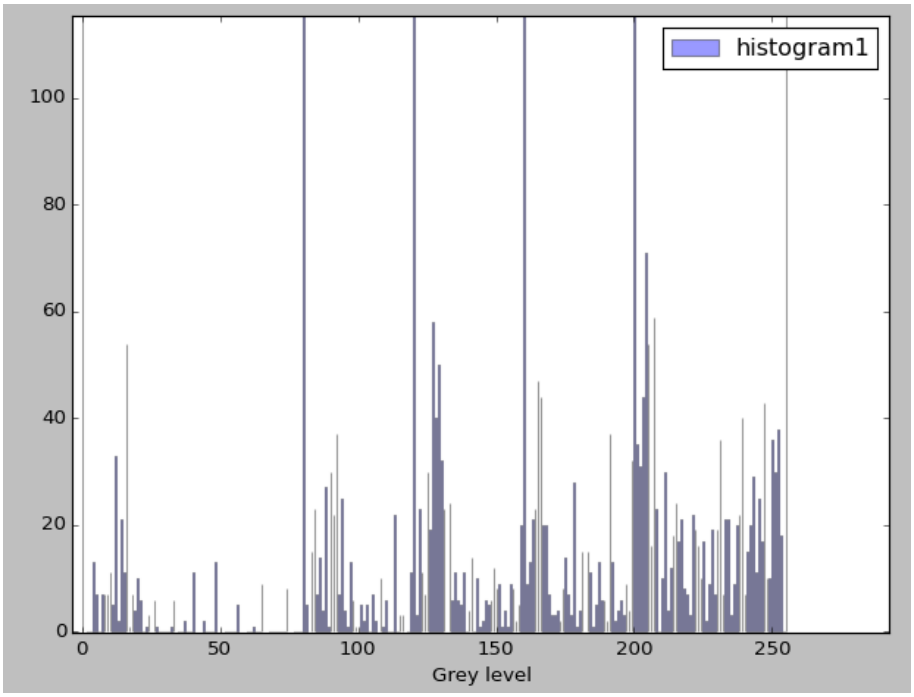
Homework Report

Digital Image Processing: Computer Assignment 1

1. Histogram and Object Moment

1.1)



รูปที่ 1.1 Histogram

Example code from my library

```
myLib = ImageLib()
pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg = myLib.readPGMImage('scaled_shapes.pgm')
# pgmData is array that contain grey scale data of each pixel in picture
# htg is array that contain histogram data of each grey level
print "object : "+ str(myLib.countingObject(htg,1000))
# return object counting array. Second parameter is threshold value.
myLib.plotHistogramFromArray(htg) # call plot histogram function
```

รูปที่ 1.1 คือ histogram ได้จากรูป scaled_shapes.pgm ซึ่งถ้าเรากำหนด Threshold ให้ว่าถ้าจำนวน histogram ของ Grey level ที่มีขนาดมากกว่า 1000 pixel เราจะพบว่า มีกราฟแท่งที่สูงกว่า Grey Level อื่นอยู่ 6 แท่ง นั้นเราสามารถสรุปได้ว่า Grey level ที่สูงกว่าแท่งอื่นแบบกระโดดมานั้นประกอบด้วย Object อยู่ 5 แท่งที่มี Grey level ดังนี้ [0, 80, 120, 160, 200] และเป็น Background อยู่ 1 แท่งและมี Grey level คือ [255]

1.2)

Example code from my library

```
myLib = ImageLib()

pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg =
myLib.readPGMImage('scaled_shapes.pgm')

print myLib.pqMoment(0,2,pgmData,pgmSize,pgmGreyscale,0) # return pq-moment

print myLib.centralMoment(2,0,pgmData,pgmSize,pgmGreyscale,0) # return central moment

print
myLib.scaleInvariantMoment(2,0,pgmData,pgmSize,pgmGreyscale,0)+myLib.scaleInvariantMoment(0,2,
pgmData,pgmSize,pgmGreyscale,0),80) # return quantity
```

Object 1 Grey Level: 0

Result

- Center of mass : 116.130408533 , 85.512980479
- Central moment : (2,0) 1100035.49527 , (0,2) 6345057.41276
- Quantity : 0.301531111245

Object 2 Grey Level: 80

Result

- Center of mass : 189.080306699 , 215.044995964
- Central moment : (2,0) 2456890.03793 , (0,2) 4941000.9659
- Quantity : 0.301193318142

Object 3 Grey Level: 120

Result

- Center of mass : 280.547748705 , 95.1498206933
- Central moment : (2,0) 8460663.08434 , (0,2) 7875173.00226
- Quantity : 0.288181948056

Object 4 Grey Level: 160

Result

- Center of mass : 428.010404624 , 100.979768786
- Central moment : (2,0) 975991.625434 , (0,2) 2194070.58382
- Quantity : 0.26479854065

Object 5 Grey Level: 200

Result

- Center of mass : 391.438748739 , 227.531382442
- Central moment : (2,0) 4792344.16024 , (0,2) 3007131.87003
- Quantity : 0.317671394937

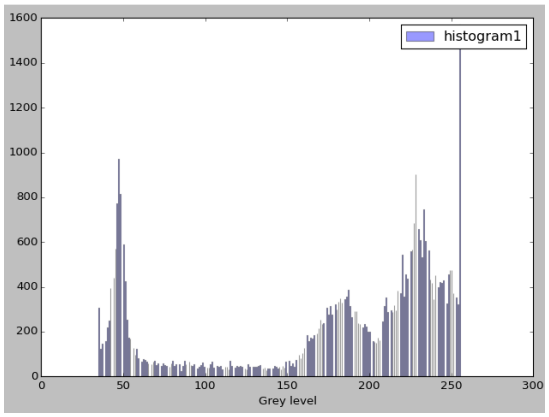
2. Point Operations

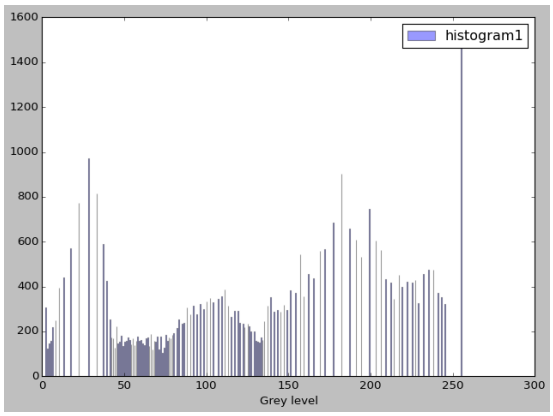
Example code from my library

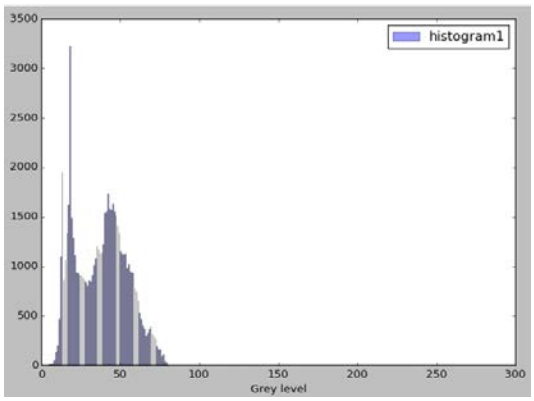
```
myLib = ImageLib()
myLib.histogramEqualization("EqualCameraman","Cameraman")
myLib.histogramEqualization("EqualSEM256_256","SEM256_256")
```

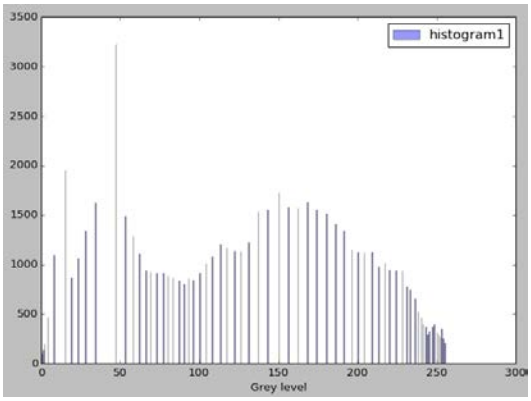
Before

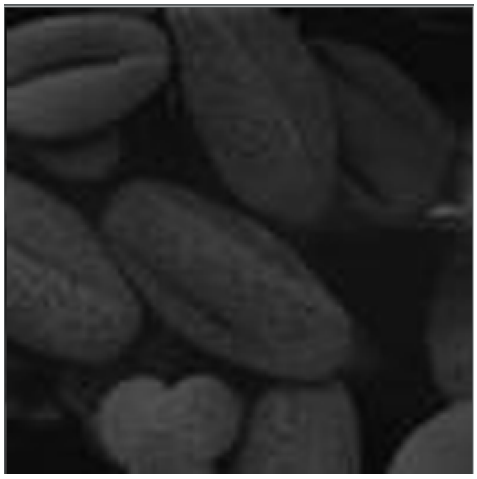
After











ผมเลือก Histogram Equalization ซึ่งเป็นหนึ่งใน Point Operation วิธีการนี้จะเกลี่ยค่า Histogram ให้เท่าๆกัน ทุก grey scale โดยใช้หลักการของ CDF มาช่วยในการหาความหนาแน่นของความน่าจะเป็นที่จะเกิดขึ้น หลังจากได้ค่า Histogram ใหม่มาแล้วก็ใช้วิธีปัดเศษ เพื่อให้ค่า pixel เก่าถูกปัดเข้า Grey level ใหม่ที่ได้มา

ดังนั้นจะสังเกตได้ว่าภาพ Cameraman.pgm นั้นมีความสว่างมากเกินไป หลังจากนำไปผ่าน Histogram Equalization ผลที่ได้จากการทำ จะทำให้ภาพมืดลง และเห็นลายละเอียดของภาพมากขึ้น

ส่วนภาพ SEM256_256.pgm นั้นมืดมากจนไม่เห็นลายละเอียดชัดเจนว่าเป็นรูปอะไร หลังจากนำไปผ่าน Histogram Equalization ผลที่ได้จากการทำ จะทำให้ภาพสว่างขึ้น และเห็นลายละเอียดของวัตถุมากขึ้น

3. Algebraic Operations

เป็นการดำเนินการคณิตศาสตร์กับ Pixel ของแต่ละสีโดยตรง

Example code from my library

```
myLib = ImageLib()
myLib.geometricOperationsImage("SanFranPeak_red","SanFranPeak_green","SanFranPeak_blue")
```

2g-r-b (excess green)

red-blue difference

gray-level (intensity)

(((r+g)/2) + (2*b))/3 เพิ่มโทนสีฟ้า

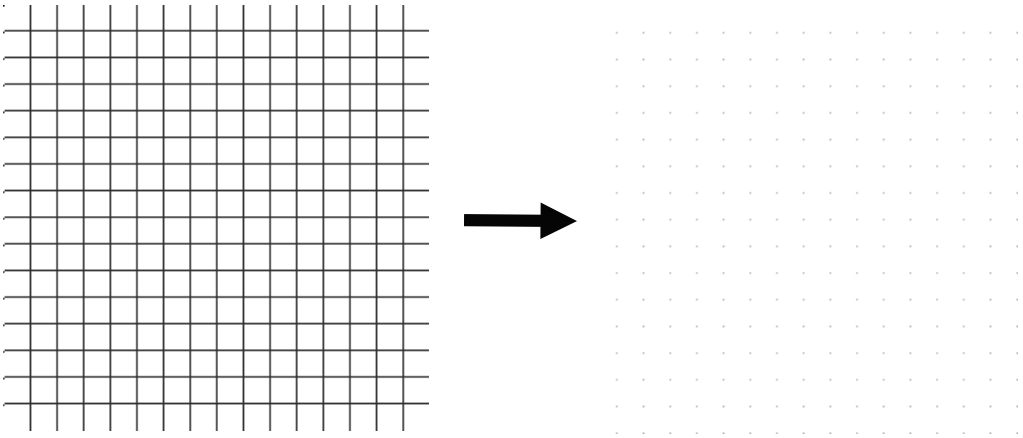
4. Geometric Operations

โจทย์กำหนดให้แปลงรูปเบี้ยวให้กลับมาเป็นรูปปกติ โดยเลือกใช้วิธี Control Grid Interpolation โดยผมมีขั้นตอนดำเนินการดังนี้

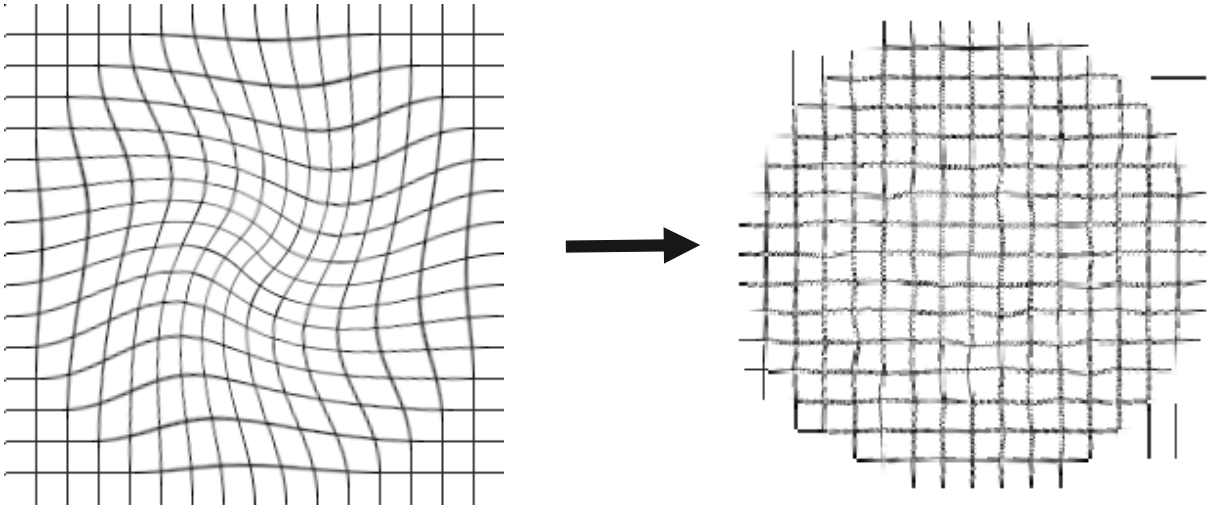
1) เนื่องจากเรามี File ที่มี ภาพ Grid ก่อนที่จะเบี้ยว ดังนั้นเราต้องหาตำแหน่งของแต่ละจุดนั้นคือ x1,y1,x2,y2,x3,y3,x4,y4 ของแต่ละ Grid ย่อย ผมเลือกใช้ Convolution กับ Kernel

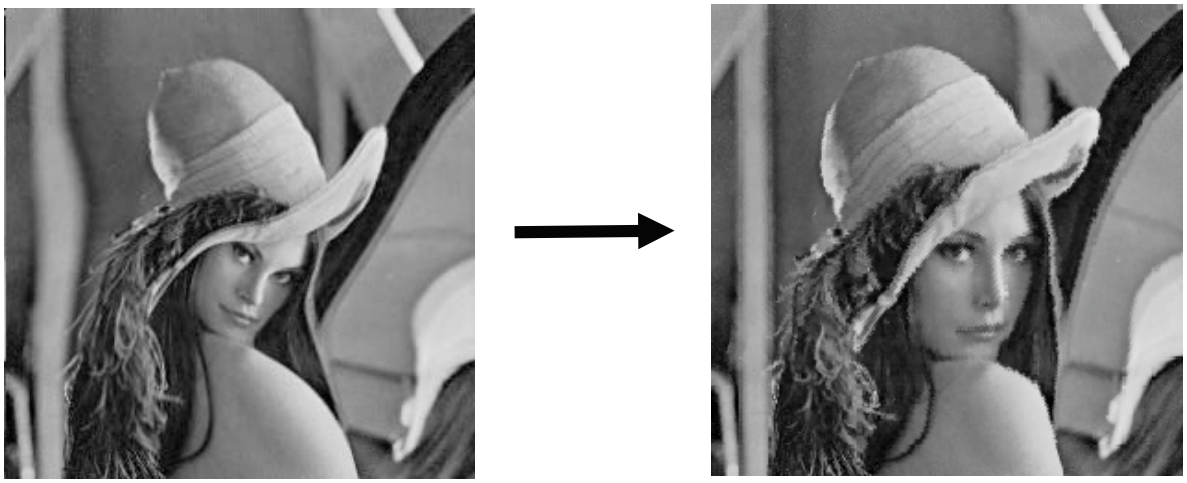
$$\begin{matrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{matrix}$$

เราจะได้จุดพิกัดที่ตัดกันมีค่า Grey Level น้อยสุด จึงทำให้เราเห็นจุดสีเทาๆ และจุดที่ไม่ใช้จุดตัดจะมีค่า Grey Level สูงทำให้เราเห็นเป็นสีขาว หลังจากนั้นนำมาเติมจุดทางขวาและด้านล่างสุดให้ครบจำนวน Grid



2) หลังจากนั้นก็นำค่าแต่ละตำแหน่งของแต่ล่ะ Grid ไปหาค่า w1,w2,w3,w4 เพื่อนำไปแทนสมการ
3) หลังจากนั้นก็สร้าง Array ชุดใหม่ขึ้นมาจำลองว่าเป็นรูปดี นำตำแหน่งในรูปดีที่เราต้องการไปแทนสมการเราจะได้ตำแหน่ง Grey Level ของรูปเสียเพื่อนำไปแทนในรูปดี





Example code from my library

```
myLib = ImageLib()

kernel = np.array([[0,1,0],[1,1,1],[0,1,0]])

pgmDataCon,pgmCon = myLib.convolutionWithKernel("grid",kernel)

normalGridPosition = myLib.findPixelPosition(pgmDataCon,256,256)

unNormalGridPosition = myLib.readJsonPixelPosition("disgrid.json")

xWeight,yWeight =  myLib.findWeight(normalGridPosition,unNormalGridPosition)

myLib.fixBadPicture(xWeight,yWeight,"distgrid",normalGridPosition)
```

โค้ดทั้งหมดของผมครับอยู่ที่ File : img_main.py

Link บน Github ครับ → https://github.com/SupakornYu/ImageProcessingHW1.git

```
import numpy as np
import matplotlib.pyplot as plt
import math
import json
class ImageLib:
    def readPGMImage(self,path): #Use for PGM File reading
        file = open(path, "rb")
        pgmVer = file.readline().split()
        pgmComment = []
        while True:
            pgmComment_eachline = file.readline()
            if(pgmComment_eachline[0]=="#"):
                pgmComment.append(pgmComment_eachline)
            else:
                break
        pgmSize = pgmComment_eachline.split()
        pgmGreyscale = file.readline().split()
        pgmDataList = []
        htg = np.zeros((256),dtype=np.int32)
        np.set_printoptions(suppress=True)
        for j in range(int(pgmSize[1])):
            pgmDataX = []
            for i in range(int(pgmSize[0])):
                byte = file.read(1)
                chrToInt = ord(byte)
                pgmDataX.append(chrToInt)
```

```
            htg[chrToInt] = htg[chrToInt]+1
        pgmDataList.append(pgmDataX)
    file.close()
    pgmData = np.asarray(pgmDataList,dtype=np.int32)
    return pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg
    #pgmData is data pixel that i get from pgm file under grey level value(numpy array).
    #pgmSize contain width and height of pixel(list).
    #htg is a histogram of image (numpy array).

def plotHistogramFromArray(self,histogram_arr): #Use for histogram ploting
    index = np.arange(256)
    bar_width = 0.35
    opacity = 0.4
    rects1 = plt.bar(index, histogram_arr, bar_width,
                     alpha=opacity,
                     color='b',
                     label='histogram1')
    plt.xlabel('Grey level')
    plt.legend()
    plt.tight_layout()
    plt.show()

def countingObject(self,histogram,threshold_object): #Use for counting object
    countObject = 0
    countObjectGreyLevel = []
    for i in range(histogram.size):
        if histogram[i] >= threshold_object:
            countObject += 1
            countObjectGreyLevel.append(i)
    countObjectGreyLevel.remove(max(countObjectGreyLevel))
    return countObject-1,countObjectGreyLevel # minus 1 for backgroud
```

```
    #def buildPGMInterestObject(self,inputFileName):



    def pqMoment(self,p,q,pgmData,pgmSize,greyLevel,greyLevelSelected):
            # Use for pq moment finding
        moment = 0
        pgmDataMoment = np.zeros((int(pgmSize[1]),int(pgmSize[0])), dtype=np.int32)
        for i in range(int(pgmSize[1])):
            for j in range(int(pgmSize[0])):
                if pgmData[i][j] == greyLevelSelected:
                    pgmDataMoment[i][j] = 1
                else:
                    pgmDataMoment[i][j] = 0
                moment += ((math.pow(j,p))*((math.pow(i,q))*pgmDataMoment[i][j]))
        #ImageLib.buildPGMFile(self,"testmoment",pgmSize[0],pgmSize[1],greyLevel,pgmDataMoment)
        return moment,pgmDataMoment


    def centralMoment(self,p,q,pgmData,pgmSize,greyLevel,greyLevelSelected):
        centralMoment = 0
        moment1,pgmDataMoment =
ImageLib.pqMoment(self,1,0,pgmData,pgmSize,greyLevel,greyLevelSelected)
        moment2,pgmDataMoment =
ImageLib.pqMoment(self,0,1,pgmData,pgmSize,greyLevel,greyLevelSelected)
        moment3,pgmDataMoment =
ImageLib.pqMoment(self,0,0,pgmData,pgmSize,greyLevel,greyLevelSelected)
        xCoor = moment1/moment3
        yCoor = moment2/moment3
        print "Central of Mass x : " + str(xCoor)
        print "Central of Mass y : " + str(yCoor)
        for i in range(int(pgmSize[1])):
            for j in range(int(pgmSize[0])):
```

```
            centralMoment += ((math.pow((j-xCoor),p))*((math.pow(i-
yCoor,q))*pgmDataMoment[i][j]))
        return centralMoment


    def scaleInvariantMoment(self,p,q,pgmData,pgmSize,greyLevel,greyLevelSelected):
        scaleInvariantMoment = 0
        centralMomentPQ =
ImageLib.centralMoment(self,p,q,pgmData,pgmSize,greyLevel,greyLevelSelected)
        centralMoment00 =
ImageLib.centralMoment(self,0,0,pgmData,pgmSize,greyLevel,greyLevelSelected)
        scaleInvariantMoment = centralMomentPQ/(math.pow(centralMoment00,(1+((p+q)/2))))
        return scaleInvariantMoment


    def buildPGMFile(self,fileName,width,height,greyLevel,pgmData): #Write PGM File
        f = open(str(fileName)+".pgm","wb")
        f.write("P5\n");
        f.write("# "+str(fileName)+"\n");
        f.write(str(width)+" "+str(height)+"\n"+str(greyLevel[0])+"\n");
        for i in range(int(height)):
            for j in range(int(width)):
                if pgmData[i][j]<0:
                    pgmData[i][j] = 0
                elif pgmData[i][j]>int(greyLevel[0]):
                    pgmData[i][j] = int(greyLevel[0])
                f.write(chr(pgmData[i][j]));
        f.close()


    def histogramEqualization(self,outputFileName,inputFileName):
        pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg =
ImageLib.readPGMImage(self,str(inputFileName)+".pgm")
        ImageLib.plotHistogramFromArray(self,htg)
        imgArea = int(pgmSize[0])*int(pgmSize[1])
```

```
        htgScaleAfter = np.zeros(int(pgmGreyscale[0])+1,dtype=np.int32)
        propOfA = 0.0
        for i in range(htg.size):
            propOfA += float(htg[i])/float(imgArea)
            #print "propA" + str(propOfA)
            fDa = propOfA * float(pgmGreyscale[0])
            htgScaleAfter[i] = round(fDa)
        pgmDataAfter = np.zeros((int(pgmSize[1]),int(pgmSize[0])),dtype=np.int32)
        for i in range(int(pgmSize[1])):
            for j in range(int(pgmSize[0])):
                pgmDataAfter[i][j] = htgScaleAfter[pgmData[i][j]]

ImageLib.buildPGMFile(self,outputFileName,pgmSize[0],pgmSize[1],pgmGreyscale,pgmDataAfter)
        pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg =
ImageLib.readPGMImage(self,str(outputFileName)+".pgm")
        ImageLib.plotHistogramFromArray(self,htg)


    def geometricOperationsImage(self,redPgmFileName,greenPgmFileName,bluePgmFileName):
        redpgmVer,redpgmComment,redpgmSize,redpgmGreyscale,redpgmData,redhtg =
ImageLib.readPGMImage(self,str(redPgmFileName)+".pgm")
        greenpgmVer,greenpgmComment,greenpgmSize,greenpgmGreyscale,greenpgmData,greenhtg =
ImageLib.readPGMImage(self,str(greenPgmFileName)+".pgm")
        bluepgmVer,bluepgmComment,bluepgmSize,bluepgmGreyscale,bluepgmData,bluehtg =
ImageLib.readPGMImage(self,str(bluePgmFileName)+".pgm")


        print redpgmData
        print greenpgmData
        print bluepgmData


        geo1 = ((2*redpgmData)-greenpgmData)-bluepgmData
        ImageLib.buildPGMFile(self,"geo1",redpgmSize[0],redpgmSize[1],redpgmGreyscale,geo1)


        geo2 = (redpgmData-bluepgmData)
```

```
        ImageLib.buildPGMFile(self,"geo2",redpgmSize[0],redpgmSize[1],redpgmGreyscale,geo2)

        geo3 = (redpgmData+greenpgmData+bluepgmData)/3
        ImageLib.buildPGMFile(self,"geo3",redpgmSize[0],redpgmSize[1],redpgmGreyscale,geo3)

        geo4 = (((redpgmData+greenpgmData)/2)+2*bluepgmData)/3 #my own option
        ImageLib.buildPGMFile(self,"geo4",redpgmSize[0],redpgmSize[1],redpgmGreyscale,geo4)



    def convolutionWithKernel(self,inputFileName,kernel):
        pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg =
ImageLib.readPGMImage(self,str(inputFileName)+".pgm")
        pgmDataCon = np.zeros((int(pgmSize[1]),int(pgmSize[0])),dtype=np.int32)
        pgmDataCon.fill(255)
        #print pgmData
        for i in range(1,int(pgmSize[1])-1):
            for j in range(1,int(pgmSize[0])-1):
                temp = 0
                #XYY
                #YYY
                #YYY
                temp += pgmData[i][j]*kernel[1][1]
                temp += pgmData[i-1][j-1]*kernel[0][0]
                temp += pgmData[i-1][j]*kernel[0][1]
                temp += pgmData[i+1][j+1]*kernel[2][2]
                temp += pgmData[i][j-1]*kernel[1][0]
                temp += pgmData[i][j+1]*kernel[1][2]
                temp += pgmData[i+1][j-1]*kernel[2][0]
                temp += pgmData[i+1][j]*kernel[2][1]
                temp += pgmData[i+1][j+1]*kernel[2][2]
```

```
            pgmDataCon[i][j] = temp
        pgmCon = np.array(pgmDataCon)

        #extend grid
        for i in range(15,int(pgmSize[1]),16):
            pgmDataCon[255][i] = 160
            pgmDataCon[i][255] = 160



ImageLib.buildPGMFile(self,str(inputFileName)+"Con",pgmSize[0],pgmSize[1],pgmGreyscale,pgmDataCon)
        return pgmDataCon,pgmCon


    def readJsonPixelPosition(self,fileName):
        json_data=open(fileName)
        data = json.load(json_data)
        json_data.close()
        #print data[0]["y"+str(4)]
        return data

    def findPixelPosition(self,convoluteArr,width,height):
        normalGridPosition = []
        count = 0
        for i in range(height):
            for j in range(width):
                if(convoluteArr[i][j]==160):
                    dict = {'u': count,'x1': j-15,'y1': i-15,'x2':j,'y2': i-15,'x3': j-15,'y3': i,'x4': j,'y4': i}
                    normalGridPosition.append(dict)
                    count +=1
        return normalGridPosition
```

```
    def findWeight(self,goodGrid,badGrid):
        xWeight = []
        yWeight = []
        for i in range(256):
            a = np.array([[ goodGrid[i]['x1'],goodGrid[i]['y1'],goodGrid[i]['x1']*goodGrid[i]['y1'],1 ],[
goodGrid[i]['x2'],goodGrid[i]['y2'],goodGrid[i]['x2']*goodGrid[i]['y2'],1 ],[
goodGrid[i]['x3'],goodGrid[i]['y3'],goodGrid[i]['x3']*goodGrid[i]['y3'],1 ],[
goodGrid[i]['x4'],goodGrid[i]['y4'],goodGrid[i]['x4']*goodGrid[i]['y4'],1 ]])
            b = np.array([badGrid[i]['x1'],badGrid[i]['x2'],badGrid[i]['x3'],badGrid[i]['x4']])
            x = np.linalg.solve(a, b)
            xWeight.append(x)
            a = np.array([[ goodGrid[i]['x1'],goodGrid[i]['y1'],goodGrid[i]['x1']*goodGrid[i]['y1'],1 ],[
goodGrid[i]['x2'],goodGrid[i]['y2'],goodGrid[i]['x2']*goodGrid[i]['y2'],1 ],[
goodGrid[i]['x3'],goodGrid[i]['y3'],goodGrid[i]['x3']*goodGrid[i]['y3'],1 ],[
goodGrid[i]['x4'],goodGrid[i]['y4'],goodGrid[i]['x4']*goodGrid[i]['y4'],1 ]])
            b = np.array([badGrid[i]['y1'],badGrid[i]['y2'],badGrid[i]['y3'],badGrid[i]['y4']])
            y = np.linalg.solve(a, b)
            yWeight.append(y)
        return xWeight,yWeight


    def fixBadPicture(self,xWeight,yWeight,badPictureFileName,goodGrid):
        pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg =
ImageLib.readPGMImage(self,str(badPictureFileName)+".pgm")
        pgmFixedPicture = np.zeros((int(pgmSize[1]),int(pgmSize[0])), dtype=np.int32)
        for k in goodGrid:
            #print k
            for i in range(k['y1'],k['y4']+1):
                for j in range(k['x1'],k['x4']+1):
                    xAxis = round((xWeight[k['u']][0]*j) + (xWeight[k['u']][1]*i) + (xWeight[k['u']][2]*i*j) +
(xWeight[k['u']][3]),1)
                    yAxis = round((yWeight[k['u']][0]*j) + (yWeight[k['u']][1]*i) + (yWeight[k['u']][2]*i*j) +
(yWeight[k['u']][3]),1)
```

```
            """
            if xAxis >=255 or yAxis >=255:
               xAxis = 255
               yAxis = 255
               print "over"
            elif xAxis <=0 or yAxis <=0:
               xAxis = 0
               yAxis = 0
               print "less"
            """
            pgmFixedPicture[i][j] = pgmData[yAxis][xAxis]


            """
            print "i " + str(i)
            print "j " + str(j)
            print "x " + str(xAxis)
            print "y " + str(yAxis)
            print "xW " + str(xWeight[k['u']])
            print "yW " + str(yWeight[k['u']])
            print "u " + str(k['u'])
            """

ImageLib.buildPGMFile(self,str(badPictureFileName)+"fix",pgmSize[0],pgmSize[1],pgmGreyscale,pgmFixedPicture)



# under this line is for solving each problem
"""
#4
myLib = ImageLib()
#myLib.readJsonPixelPosition("disgrid.json")
kernel = np.array([[0,1,0],[1,1,1],[0,1,0]])
```

```
print kernel
#np.set_printoptions(threshold=np.nan)
pgmDataCon,pgmCon = myLib.convolutionWithKernel("grid",kernel)

#print np.amax(pgmCon) #find max value
#print np.unique(pgmDataCon) #find number
#np.set_printoptions(threshold=np.nan)
#print pgmDataCon
#print pgmCon

normalGridPosition = myLib.findPixelPosition(pgmDataCon,256,256)
unNormalGridPosition = myLib.readJsonPixelPosition("disgrid.json")

#print normalGridPosition
#print unNormalGridPosition[255]['x2']
#print normalGridPosition[255]['x2']

xWeight,yWeight =  myLib.findWeight(normalGridPosition,unNormalGridPosition)
#print xWeight
#print yWeight
myLib.fixBadPicture(xWeight,yWeight,"distgrid",normalGridPosition)

"""

"""
#3
myLib = ImageLib()
myLib.geometricOperationsImage("SanFranPeak_red","SanFranPeak_green","SanFranPeak_blue")
"""

"""
```

```
#2
myLib = ImageLib()
myLib.histogramEqualization("EqualCameraman","Cameraman")
myLib.histogramEqualization("EqualSEM256_256","SEM256_256")
"""



"""
#1.1
myLib = ImageLib()
pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg =
myLib.readPGMImage('scaled_shapes.pgm')
#myLib.buildPGMFile("test",pgmSize[0],pgmSize[1],pgmGreyscale,pgmData)
print htg
#monent,pgmDataMoment =  myLib.pqMoment(1,1,pgmData,pgmSize,pgmGreyscale,255)
print "object : "+ str(myLib.countingObject(htg,1000))
myLib.plotHistogramFromArray(htg)
"""


"""
#1.2
myLib = ImageLib()
pgmVer,pgmComment,pgmSize,pgmGreyscale,pgmData,htg =
myLib.readPGMImage('scaled_shapes.pgm')
print myLib.pqMoment(0,2,pgmData,pgmSize,pgmGreyscale,200) #return pq-moment
print myLib.centralMoment(0,2,pgmData,pgmSize,pgmGreyscale,200) #return central moment
print
myLib.scaleInvariantMoment(2,0,pgmData,pgmSize,pgmGreyscale,200)+myLib.scaleInvariantMome
nt(0,2,pgmData,pgmSize,pgmGreyscale,200)
"""
```