CSE 365

Project

Computer vision in real life

Name: Abdelrahman Mahmoud Fangary

ID: 17P6006

The PDF contains Project description, steps done, samples, the project implementation in python, and instruction manual.

Project Description

The idea of the project to make an OCR application that converts an image into text using OpenCV methods and pytesseract library.

The OCR engine does not produce accurate result when the image contains noise, or when the image is distorted or if the image is bad in terms of quality and resolution. The accuracy of OCR depends on how well the image is preprocessed and segmented.

So, it was required to make document-scanning as a preprocessing to enhance the image in terms of noise, perspective.

After scanning, the scanned image is passed to an OCR engine to be converted into text.

Project Samples and images used

Image 1

I Took this image using my phone camera. Which is a difficult case to process since the image perspective is not straight and difficult for OCR engine.

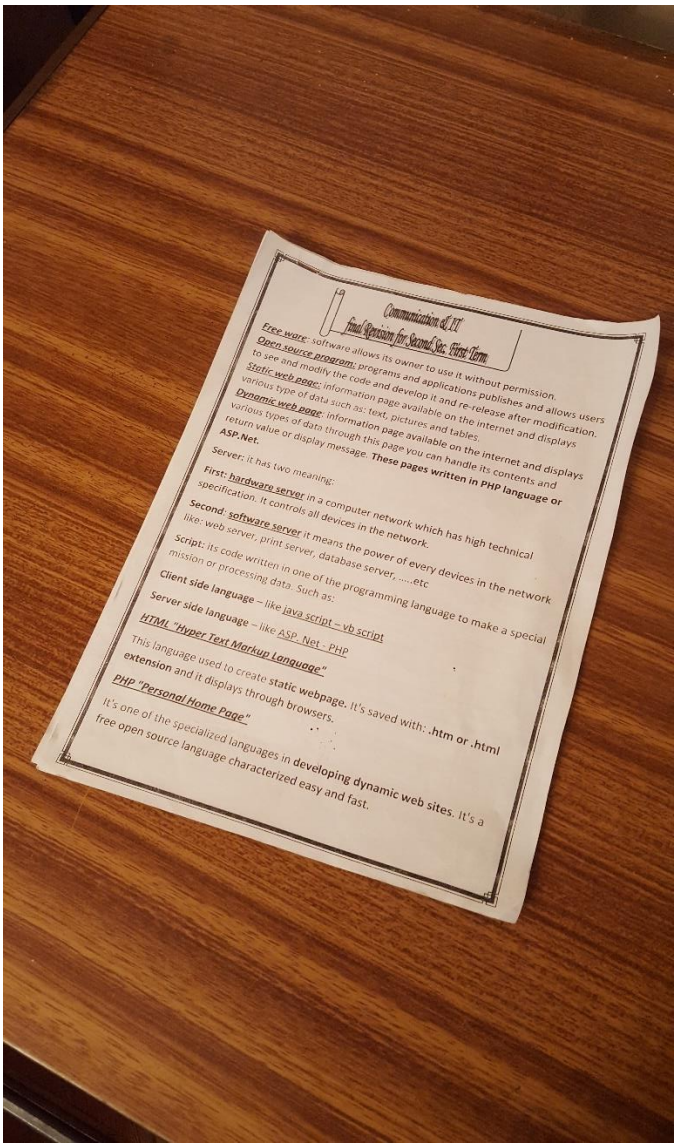
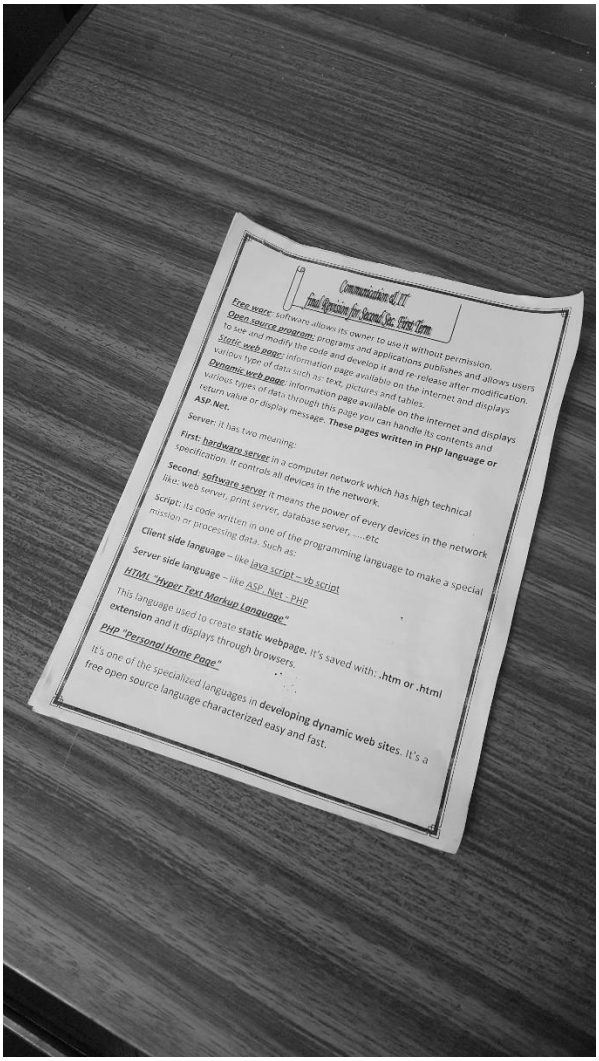
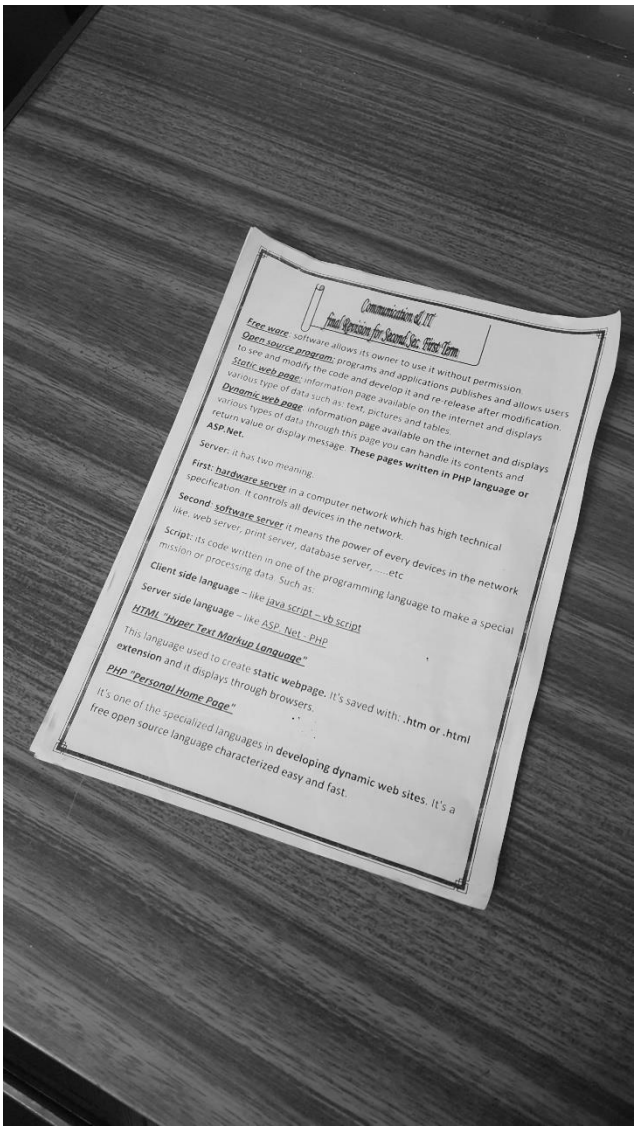


Image 1 Steps

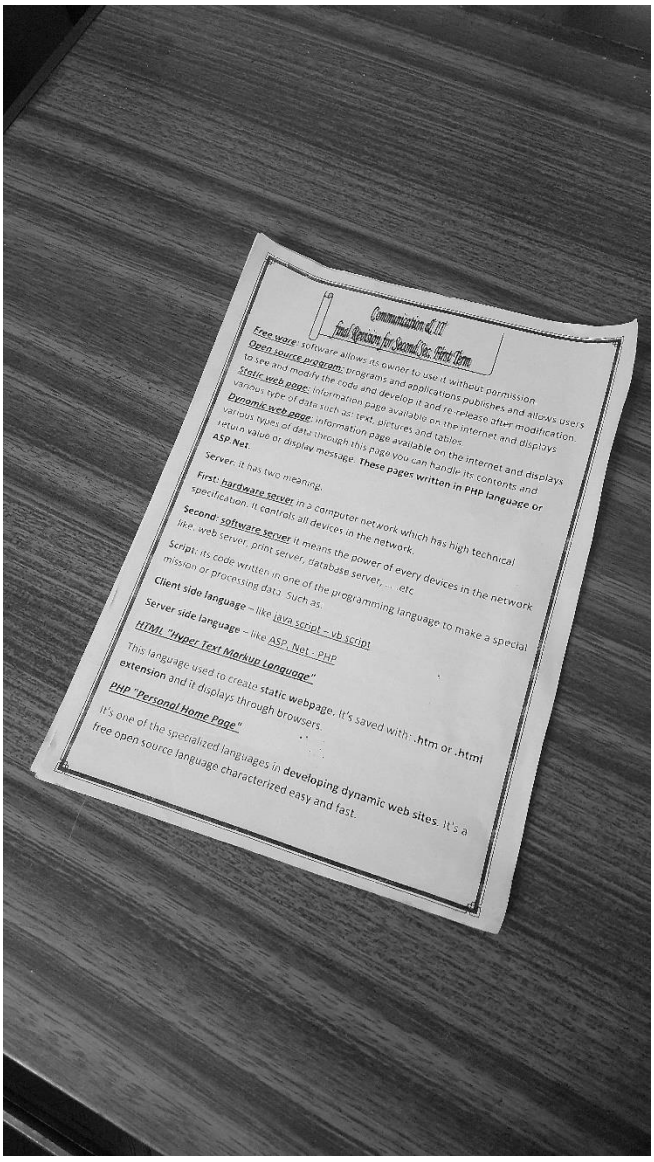
1. Gray scale



2. Median Blurring



3. Sharpening



Communication of IT

Final Revision for Second Voc. First Term

Free ware: software allows its owner to use it without permission

Open source program: programs and applications publishes and allows users to see and modify the code and develop it and re-release after modification

Static web page: information page available on the internet and displays various type of data such as: text, pictures and tables

Dynamic web page: information page available on the internet and displays various types of data through this page you can handle its contents and return value or display message. **These pages written in PHP language or ASP.Net**.

Server: it has two meaning.

First: hardware server in a computer network which has high technical specification. It controls all devices in the network.

Second: software server it means the power of every devices in the network like: web server, print server, database server, ...etc

Script: its code written in one of the programming language to make a special mission or processing data. Such as.

Client side language – like java script – vb script

Server side language – like ASP. Net - PHP

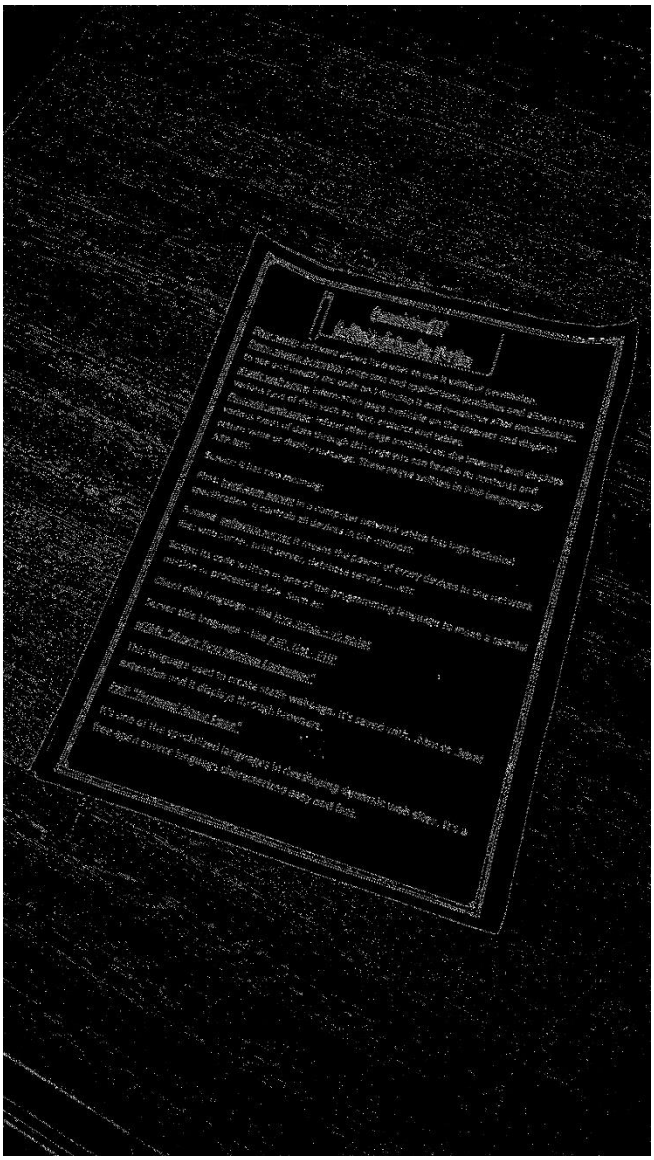
HTML "Hyper Text Markup Language"

This language used to create **static webpage**. It's saved with: **.htm or .html extension** and it displays through browsers.

PHP "Personal Home Page"

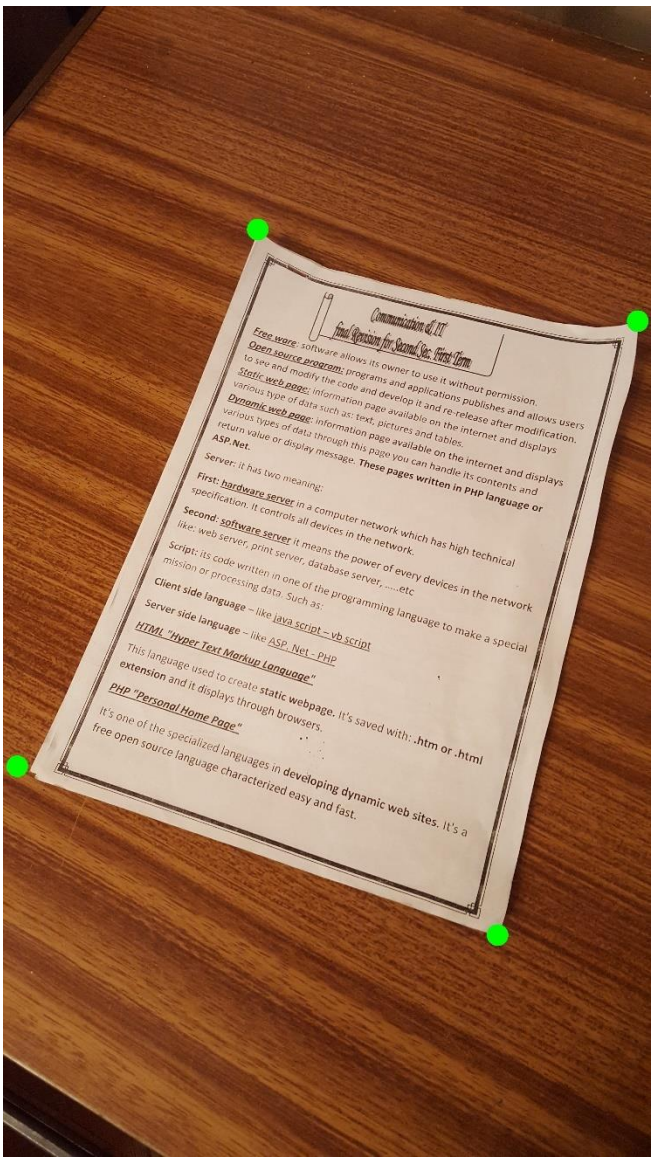
It's one of the specialized languages in **developing dynamic web sites**. It's a free open source language characterized easy and fast.

4. Canny

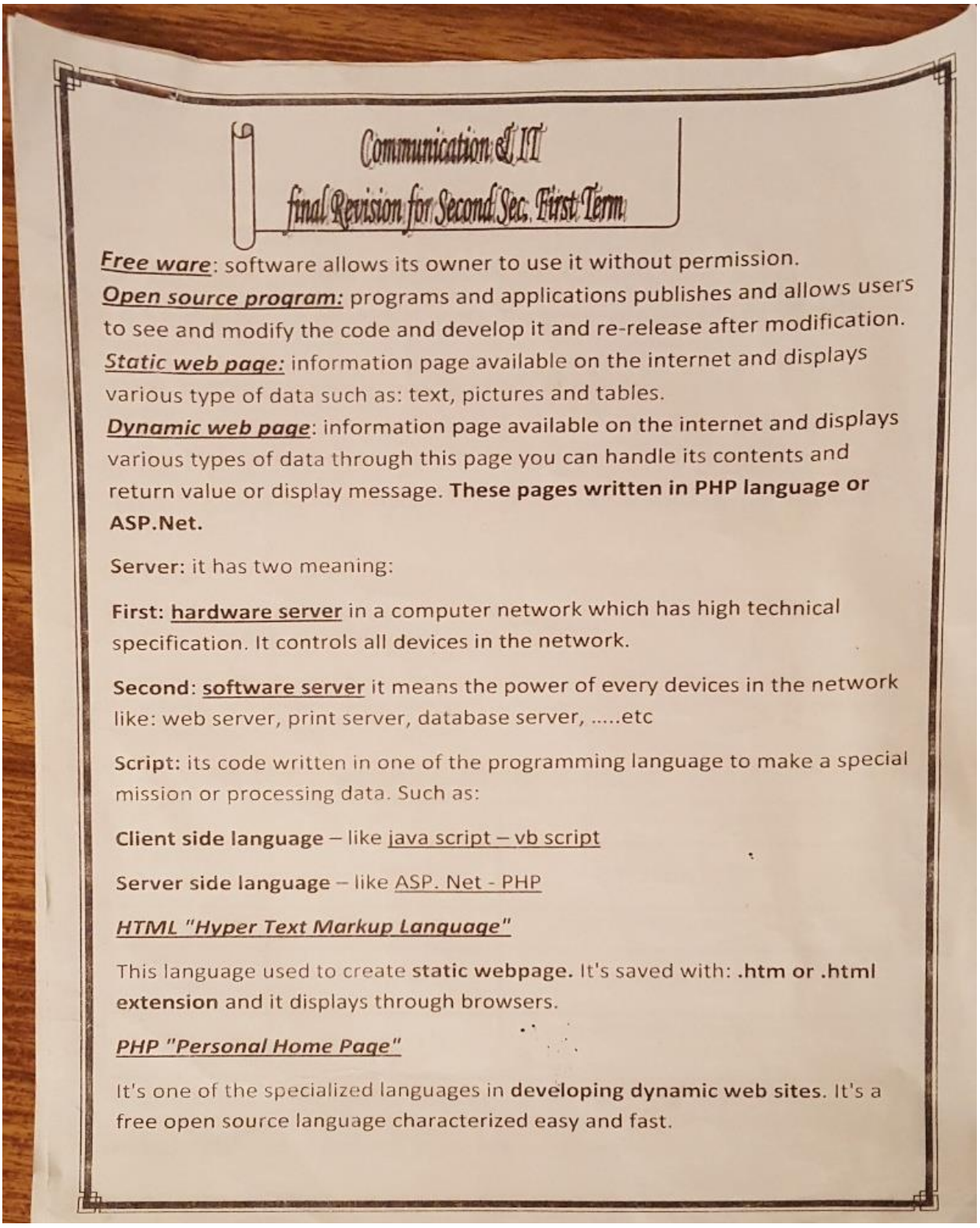


5. Closing morphology

6. Find largest contour



7. Transforming image into bird view perspective



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8. Final step, giving the previous photo to pytesseract OCR and saving text into .txt file.

text2.txt

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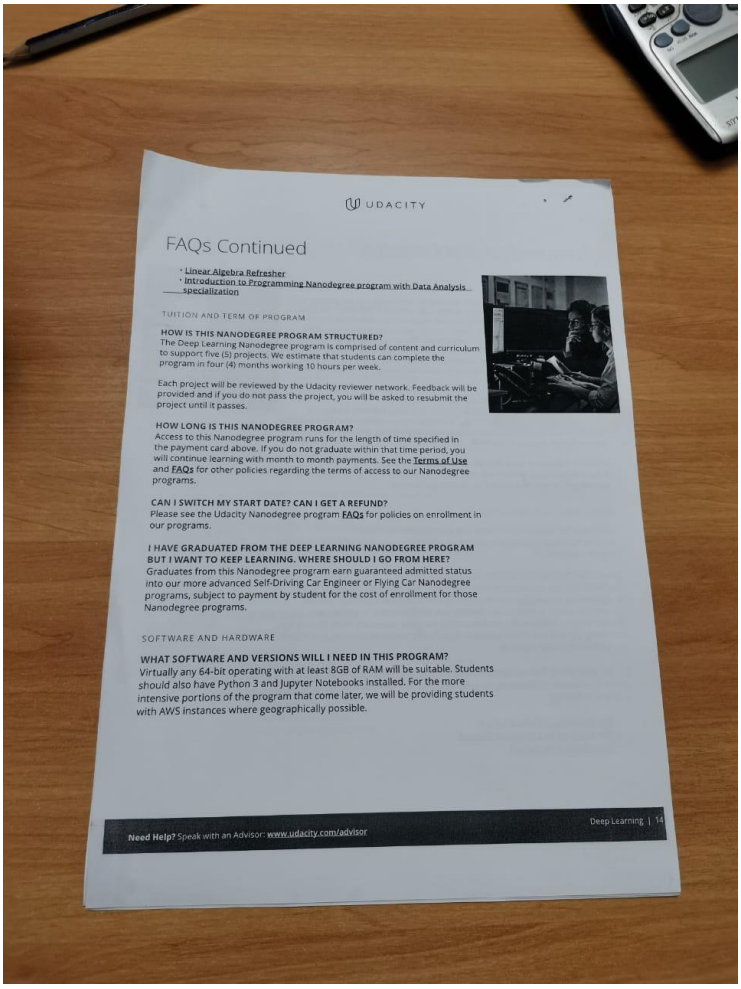
Image 2

I Took this image using my phone camera. Which was very different due to quality and light different light illumination on the paper.



UDACITY

FAQs Continued

- Linear Algebra Refresher
- Introduction to Programming Nanodegree program with Data Analysis specialization

TUITION AND TERM OF PROGRAM

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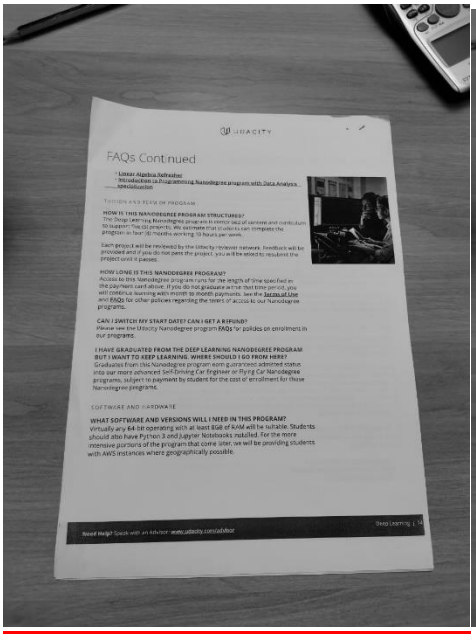
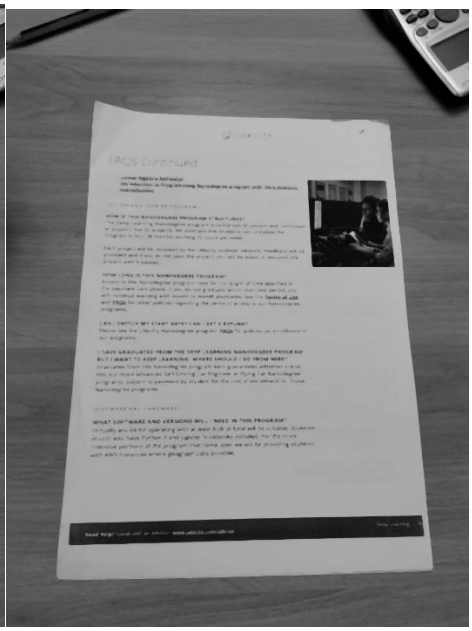
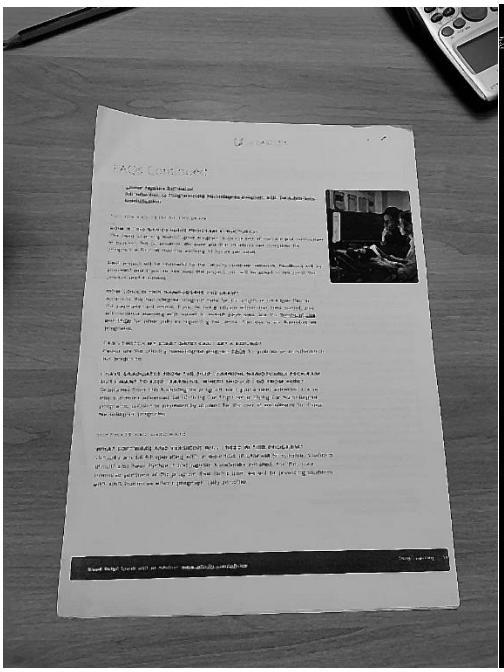
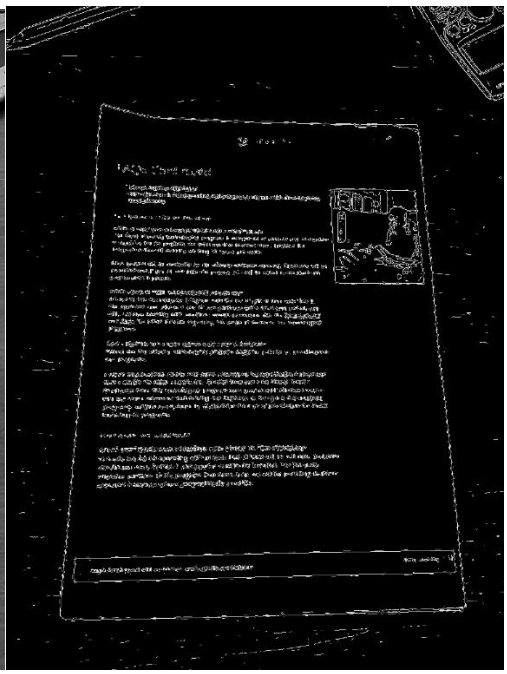
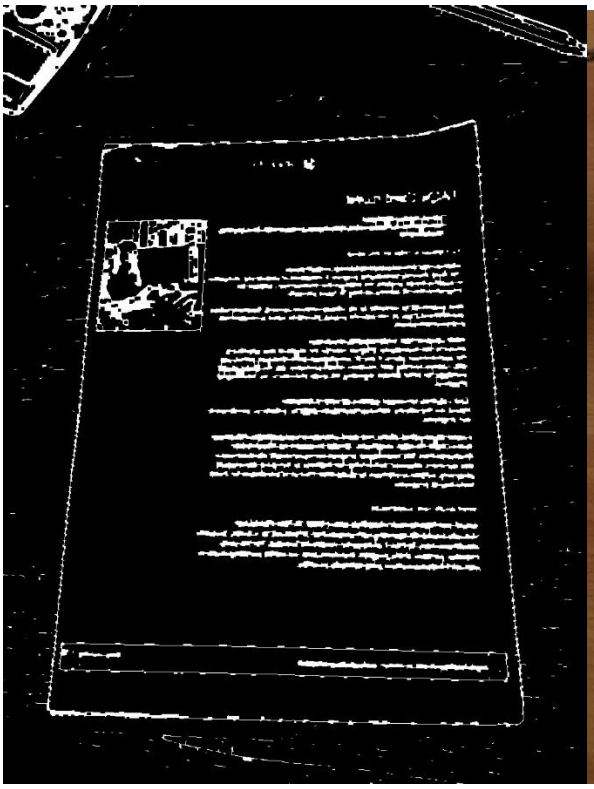
Image 2 Steps

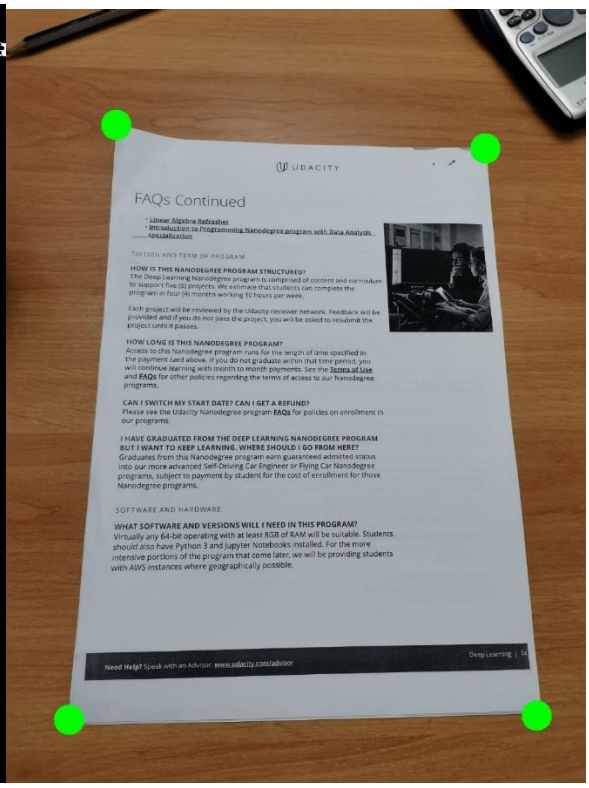












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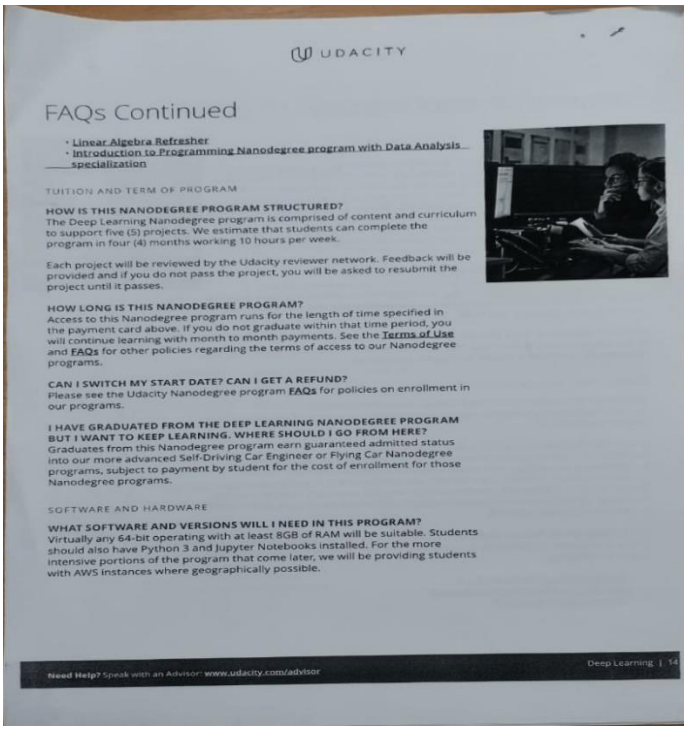

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Need Help? Speak with an Advisor: www.udacity.com/advisor Deep Learning | 14

text2.txt

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udacity

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The number of characters detected without spaces are = 1462
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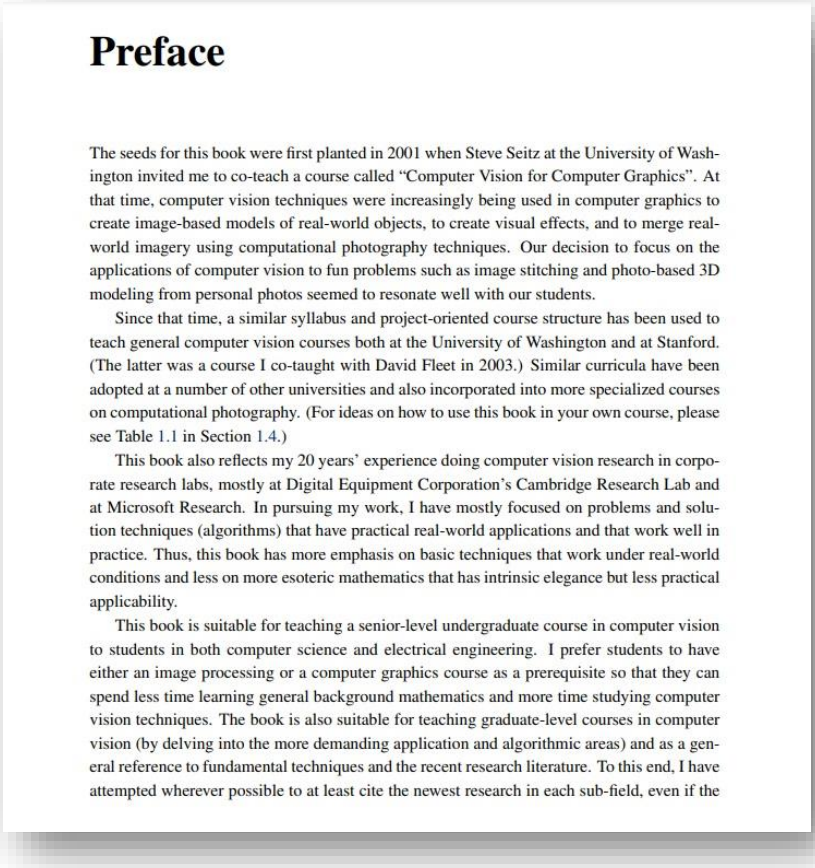
Image 3

I screenshotted this image from reference " Computer Vision: Algorithms and Applications". It didn't require any change in perspective. Slightly-post processing were done but it wasn't required since the image was good and had no noise.



Preface

The seeds for this book were first planted in 2001 when Steve Seitz at the University of Washington invited me to co-teach a course called "Computer Vision for Computer Graphics". At that time, computer vision techniques were increasingly being used in computer graphics to create image-based models of real-world objects, to create visual effects, and to merge real-world imagery using computational photography techniques. Our decision to focus on the applications of computer vision to fun problems such as image stitching and photo-based 3D modeling from personal photos seemed to resonate well with our students.

Since that time, a similar syllabus and project-oriented course structure has been used to teach general computer vision courses both at the University of Washington and at Stanford. (The latter was a course I co-taught with David Fleet in 2003.) Similar curricula have been adopted at a number of other universities and also incorporated into more specialized courses on computational photography. (For ideas on how to use this book in your own course, please see Table 1.1 in Section 1.4.)

This book also reflects my 20 years' experience doing computer vision research in corporate research labs, mostly at Digital Equipment Corporation's Cambridge Research Lab and at Microsoft Research. In pursuing my work, I have mostly focused on problems and solution techniques (algorithms) that have practical real-world applications and that work well in practice. Thus, this book has more emphasis on basic techniques that work under real-world conditions and less on more esoteric mathematics that has intrinsic elegance but less practical applicability.

This book is suitable for teaching a senior-level undergraduate course in computer vision to students in both computer science and electrical engineering. I prefer students to have either an image processing or a computer graphics course as a prerequisite so that they can spend less time learning general background mathematics and more time studying computer vision techniques. The book is also suitable for teaching graduate-level courses in computer vision (by delving into the more demanding application and algorithmic areas) and as a general reference to fundamental techniques and the recent research literature. To this end, I have attempted wherever possible to at least cite the newest research in each sub-field, even if the

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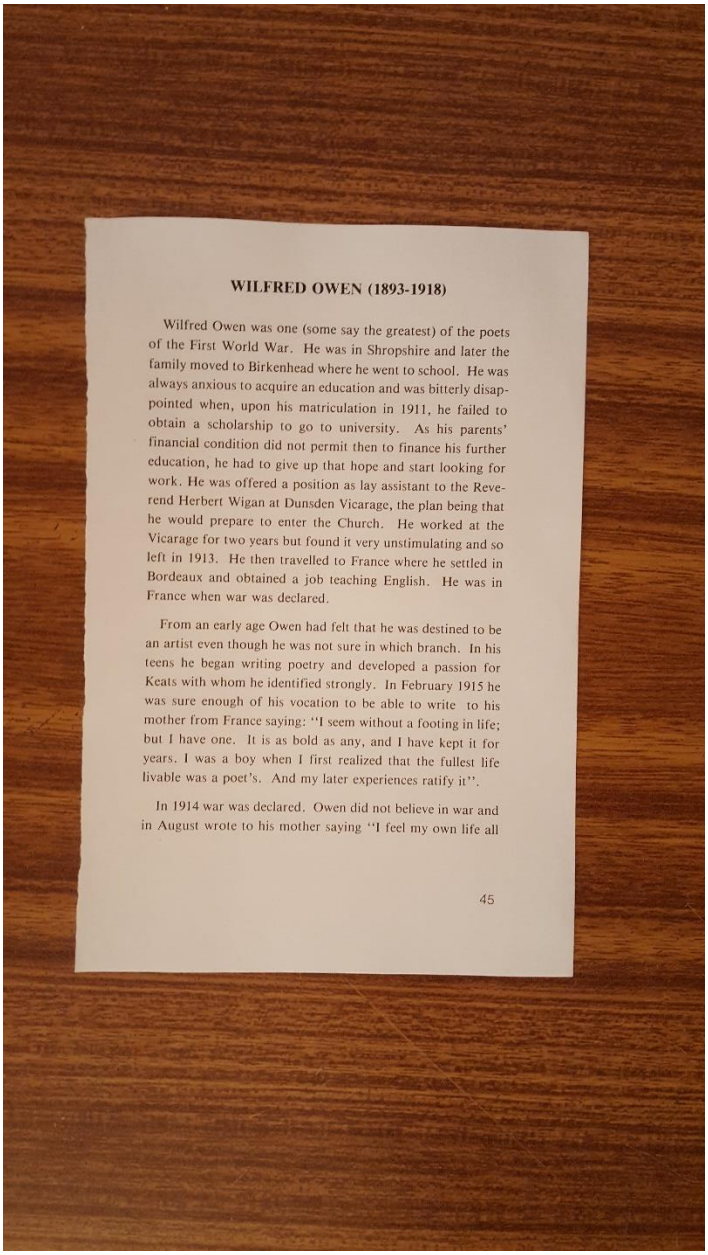
The number of characters detected without spaces are = 1996

Image 4

I took this image using my mobile camera. The image is a little far from the camera, so some enhancement was required to adjust its perspective.



WILFRED OWEN (1893-1918)

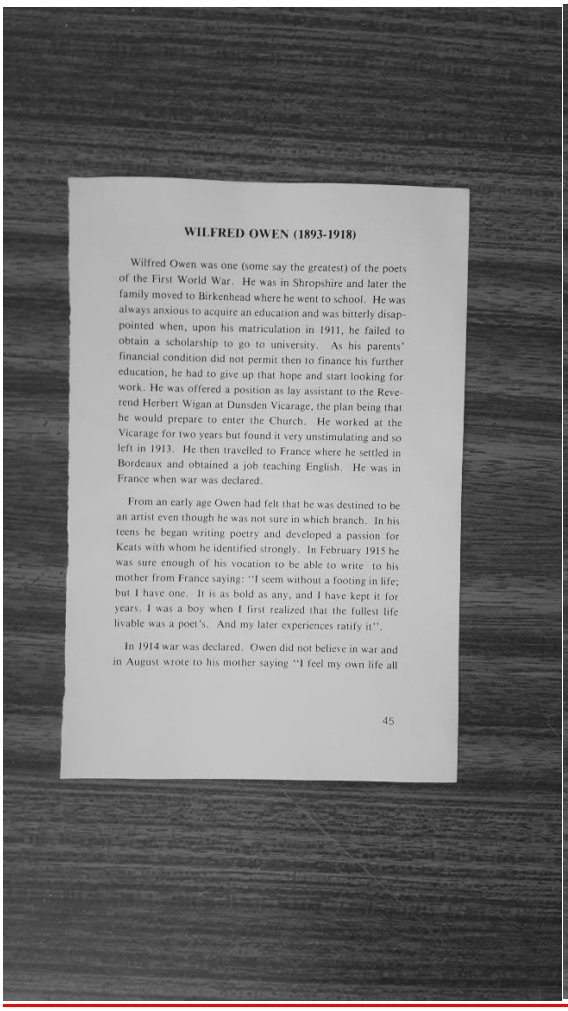
Wilfred Owen was one (some say the greatest) of the poets of the First World War. He was in Shropshire and later the family moved to Birkenhead where he went to school. He was always anxious to acquire an education and was bitterly disappointed when, upon his matriculation in 1911, he failed to obtain a scholarship to go to university. As his parents' financial condition did not permit then to finance his further education, he had to give up that hope and start looking for work. He was offered a position as lay assistant to the Reverend Herbert Wigan at Dunsden Vicarage, the plan being that he would prepare to enter the Church. He worked at the Vicarage for two years but found it very unstimulating and so left in 1913. He then travelled to France where he settled in Bordeaux and obtained a job teaching English. He was in France when war was declared.

From an early age Owen had felt that he was destined to be an artist even though he was not sure in which branch. In his teens he began writing poetry and developed a passion for Keats with whom he identified strongly. In February 1915 he was sure enough of his vocation to be able to write to his mother from France saying: "I seem without a footing in life; but I have one. It is as bold as any, and I have kept it for years. I was a boy when I first realized that the fullest life livable was a poet's. And my later experiences ratify it".

In 1914 war was declared. Owen did not believe in war and in August wrote to his mother saying "I feel my own life all

45

Image 4 Steps



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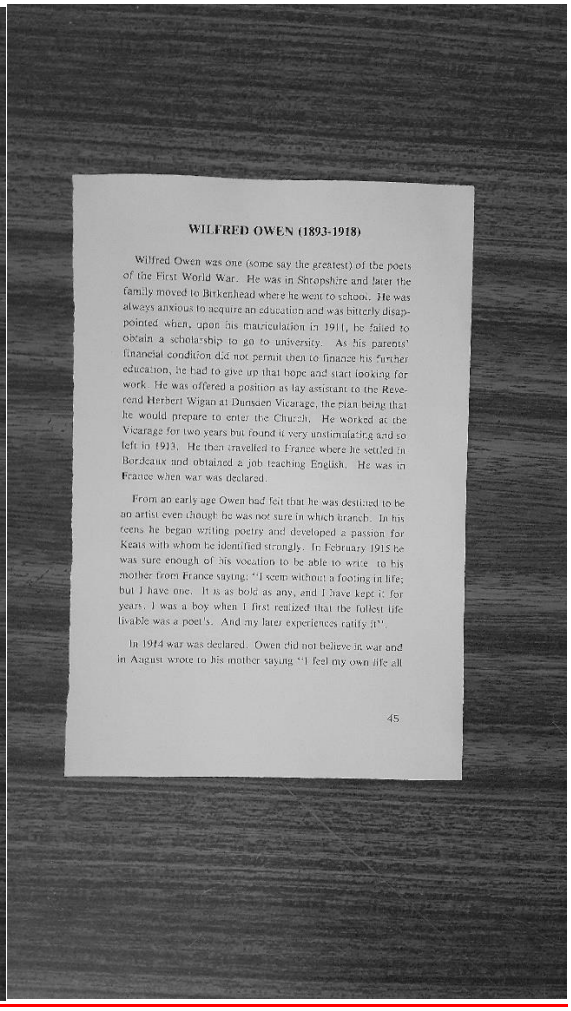

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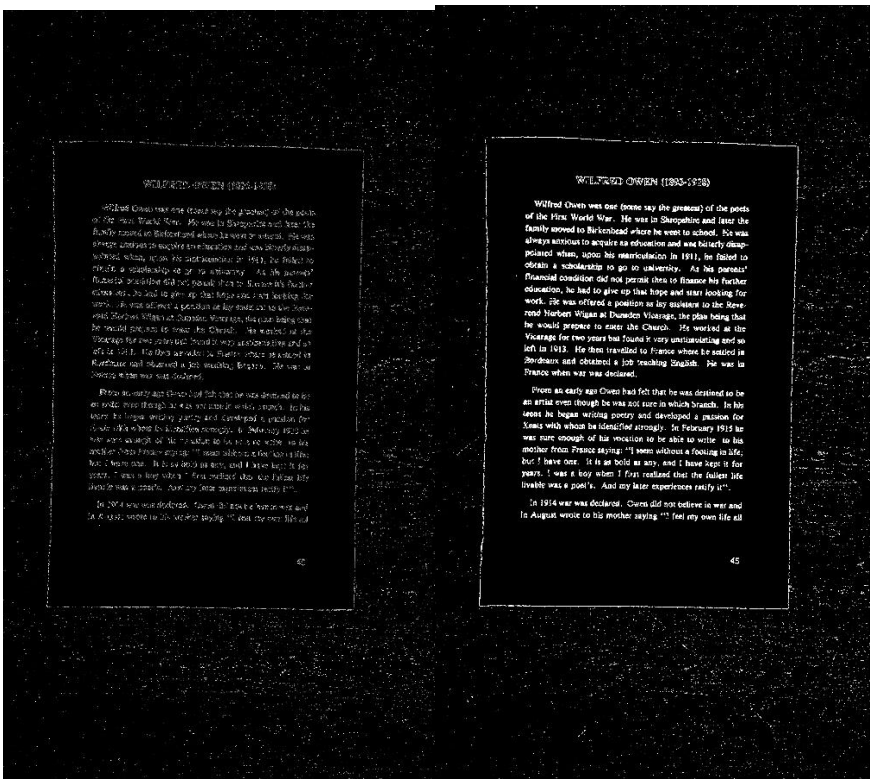
Wilfred Owen was one (some say the greatest) of the poets of the First World War. He was in Shropshire and later the family moved to Birkenhead where he went to school. He was always anxious to acquire an education and was bitterly disappointed when, upon his matriculation in 1911, he failed to obtain a scholarship to go to university. As his parents' financial condition did not permit then to finance his further education, he had to give up that hope and start looking for work. He was offered a position as lay assistant to the Reverend Herbert Wigan at Dunsden Vicarage, the plan being that he would prepare to enter the Church. He worked at the Vicarage for two years but found it very unstimulating and so left in 1913. He then travelled to France where he settled in Bordeaux and obtained a job teaching English. He was in France when war was declared.

From an early age Owen had felt that he was destined to be an artist even though he was not sure in which branch. In his teens he began writing poetry and developed a passion for Keats with whom he identified strongly. In February 1915 he was sure enough of his vocation to be able to write to his mother from France saying: "I seem without a footing in life; but I have one. It is as bold as any, and I have kept it for years. I was a boy when I first realized that the fullest life livable was a poet's. And my later experiences ratify it".

In 1914 war was declared. Owen did not believe in war and in August wrote to his mother saying "I feel my own life all

45



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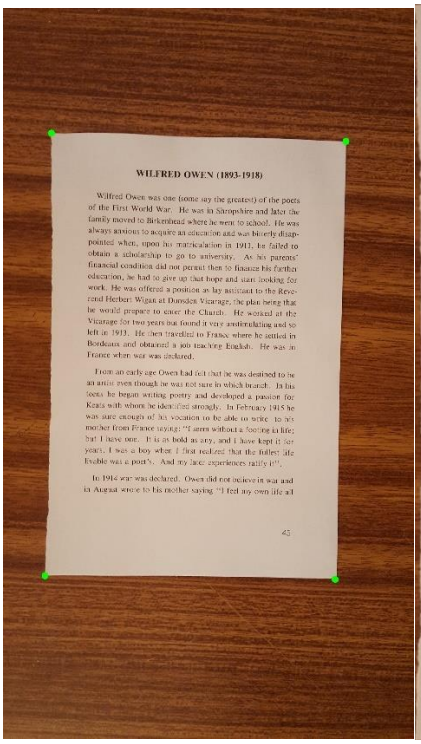

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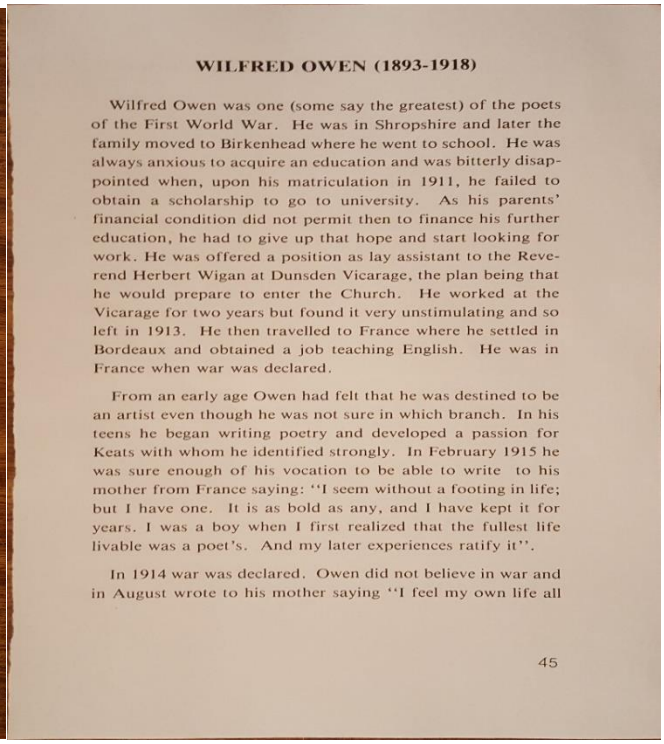

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In 1914 war was declared. Owen did not believe in war and in August wrote to his mother saying ''I feel my own life all

45

text2.txt

```
1
2
3   WILFRED OWEN (1893-1918)
4
5   Wilfred Owen was one (some say the greatest) of the poets
6   of the First World War. He was in Shropshire and later the
7   family moved to Birkenhead where he went to school. He was
8   always anxious to acquire an education and was bitterly disap-
9   pointed when, upon his matriculation in 1911, he failed to
10  obtain a scholarship to go to university. As his parents
11  financial condition did not permit then to finance his further
12  education, he had to give up that hope and start looking for
13  work. He was offered a position as lay assistant to the Reve-
14  rend Herbert Wigan at Dunsden Vicarage, the plan being that
15  he would prepare to enter the Church. He worked at the
16  Vicarage for two years but found it very unstimulating and so
17  left in 1913. He then travelled to France where he settled in
18  Bordeaux and obtained a job teaching English. He was in
19  France when war was declared.
20
21  From an early age Owen had felt that he was destined to be
22  an artist even though he was not sure in which branch. In his
23  teens he began writing poetry and developed a passion for
24  Keats with whom he identified strongly. In February 1915 he
25  was sure enough of his vocation to be able to write to his
26  mother from France saying:I seem without a footing in li
27  but I have one. It is as bold as any, and I have kept it for
28  years. I was a boy when I first realized that the fullest life
29  livable was a poets. And my later experiences ratify it.
30
31
32  In 1914 war was declared. Owen did not believe in war and
33
34  in August wrote to his mother saying I feel my own life all
35
36  45
37  The number of characters detected without spaces are = 1226
38
```

Image 5

I took this image using my mobile camera. This image seems to be deviated and needs to be adjusted into a good perspective.

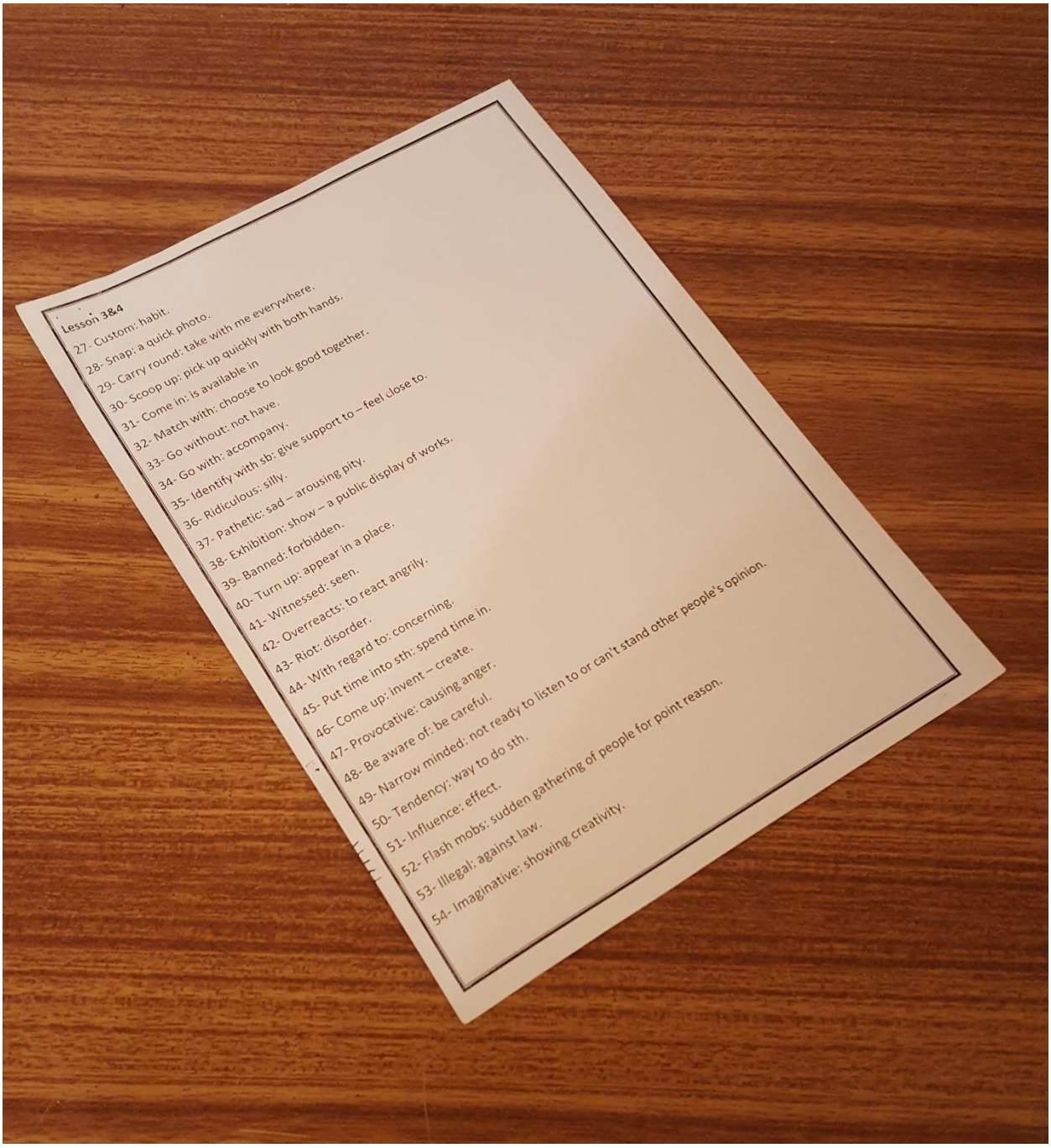
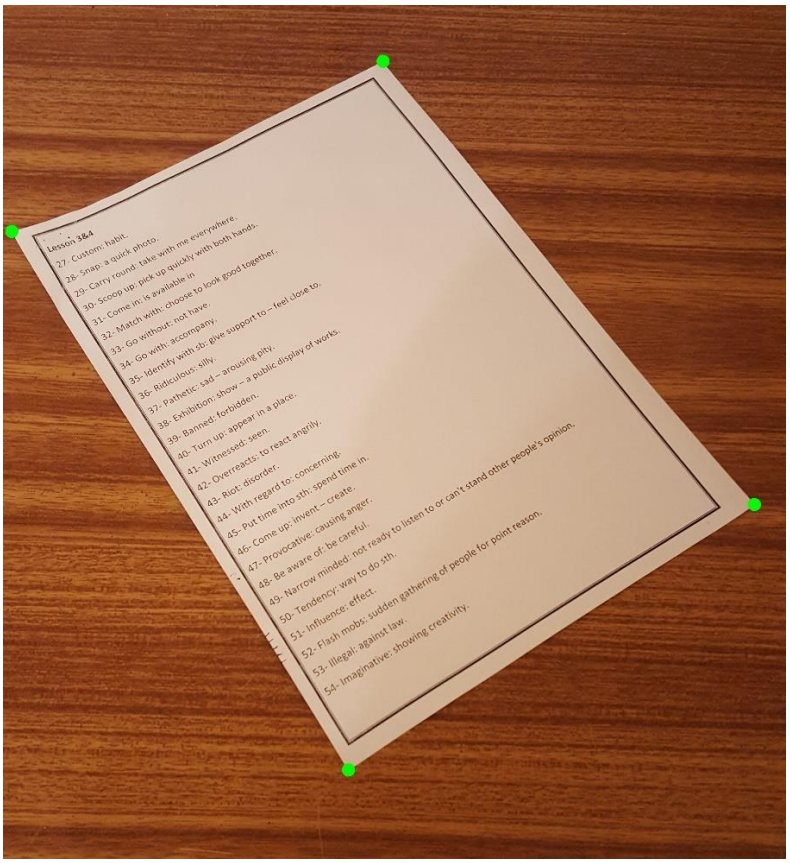


Image 5 Steps



Lesson 3&4

27- Custom: habit.
28- Snap: a quick photo.
29- Carry round: take with me everywhere.
30- Scoop up: pick up quickly with both hands.
31- Come in: is available in
32- Match with: choose to look good together.
33- Go without: not have.
34- Go with: accompany.
35- Identify with sb: give support to – feel close to.
36- Ridiculous: silly.
37- Pathetic: sad – arousing pity.
38- Exhibition: show – a public display of works.
39- Banned: forbidden.
40- Turn up: appear in a place.
41- Witnessed: seen.
42- Overreacts: to react angrily.
43- Riot: disorder.
44- With regard to: concerning.
45- Put time into sth: spend time in.
46- Come up: invent – create.
47- Provocative: causing anger.
48- Be aware of: be careful.
49- Narrow minded: not ready to listen to or can't stand other people's opinion.
50- Tendency: way to do sth.
51- Influence: effect.
52- Flash mobs: sudden gathering of people for point reason.
53- Illegal: against law.
54- Imaginative: showing creativity.

text2.txt

```
Lesson 384

27- Custom: habit.
28- Snap: a quick photo.
29- Carry round: take with me everywhere.
30- Scoop up: pick up quickly with both hands.
31- Come in: is available in
32- Match with: choose to look good together.
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48- Be aware of: be careful
43- Narrow minded: not ready to listen to or can't stand other people's opi
50- Tendency: way to do sth.
51- Influence: effect.
52- Flash mobs: sudden gathering of people for point reason.
53- Illegal: against law.
54- Imaginative: showing creativity.

The number of characters detected without spaces are = 718

```
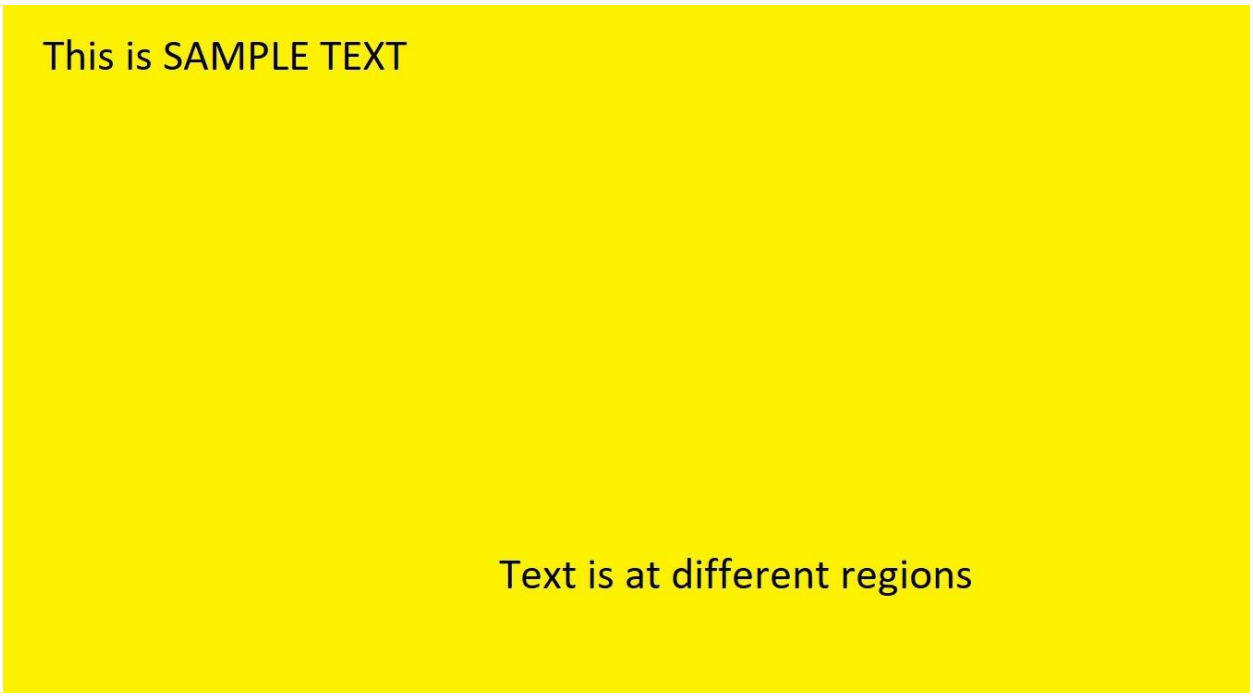

Image 6

This is the sample input that was given in the project description. The image is good in terms of perspective. A slight pre-processing was done however the image did not require that since it was good in terms of quality and had no noise.



text2.txt

```
1  This is SAMPLE TEXT
2
3  Text is at different regions
4
5  The number of characters detected without spaces are = 40
6
```

Finally, The Code.

```
#Importing necessary libraries
from cv2 import cv2
import re
import pytesseract
import numpy as np
width = 800
height = 800
```

```
def convert_to_grayscale(img):
    return cv2.cvtColor(img,cv2.COLOR_BGR2GRAY)

def apply_canny(img,low_thres,high_thres):
    """
    Canny steps:
    1.Apply gaussian blur
    2.image gradient
    3.non-maximum supression
    4.Hysteresis Thresholding
    """
    blur = cv2.GaussianBlur(img,(5,5),0)
    edges = cv2.Canny(blur,low_thres,high_thres)
    return edges
    # to do make canny more adaptive.


#Due to thinning-- closing is used for cutout pixels
def apply_closingMorphlogy(img,SE):
    kernel = np.ones((SE,SE),np.uint8)
    return cv2.morphologyEx(img, cv2.MORPH_CLOSE, kernel,iterations=1)
```

```
def find_largest_contours(img,imagecopy):
    """
    Steps of this function:
    1. find all contours from the edged image
    2. sort contours on area descendingly
    3. get the first 5 maximum contours
    4. for each contour, approxiamate egde points to only four points to targer square contou
r
    """
    cimg = img.copy()
    contours,hierarchy = cv2.findContours(cimg,cv2.RETR_EXTERNAL,cv2.CHAIN_APPROX_SIMPLE)
    cnts = sorted(contours, key=cv2.contourArea, reverse=True)[:5]
    #draw_contours(imagecopy,cnts)
    #showImage(imagecopy)


    for c in cnts:
        perimeter = cv2.arcLength(c,True)
        # only targeting squares or rectanges
        approximation = cv2.approxPolyDP(c,0.02*perimeter,True)
        if  len(approximation)==4:
            target = approximation
            break
        else:
            return cimg
    return target
```

```
def draw_contours(img,contours):
    cv2.drawContours(img, contours, -1, (0,255,0), 50)


def showImage(img):
    cv2.imshow('Output Image',img)
    cv2.waitKey(0)



def resize_image(img):
    resize = cv2.resize(img, (width, height))
    return resize
```

```
def transform(points_contour,img):

    if points_contour.size != 0  and points_contour.size ==8:
        ordered_points = order(points_contour)
        list_pts1 = np.float32(ordered_points)

        """
        # an attempt to improve the algorithm by computing euclidean distance for generic cod
e
        (tl, tr, br, bl) = list_pts1
        widthA = np.sqrt(((br[0] - bl[0]) ** 2) + ((br[1] - bl[1]) ** 2))
        widthB = np.sqrt(((tr[0] - tl[0]) ** 2) + ((tr[1] - tl[1]) ** 2))


        heightA = np.sqrt(((tr[0] - br[0]) ** 2) + ((tr[1] - br[1]) ** 2))
        heightB = np.sqrt(((tl[0] - bl[0]) ** 2) + ((tl[1] - bl[1]) ** 2))

        maxWidth = max(int(widthA), int(widthB))
        maxHeight = max(int(heightA), int(heightB))

        """

        list_pts2 = np.float32([[0, 0],[width, 0], [0, height],[width, height]])
        M = cv2.getPerspectiveTransform(list_pts1, list_pts2)
        warp = cv2.warpPerspective(img, M, (width,height))
        return warp
    else:
        return img
```

```
def order(contour_points):
    """
    Steps for this fucntion:
    1. parameter given is four points of the largest  contour
    2.  inialize a list of four points --> ordered_contour_points
    3. this list will have top left, top right, bottom right, bottom left
    4. list[0] will have the point of minmum sum, list list[3] maximum sum.. etc
    """

    contour_points = contour_points.reshape((4, 2))
    ordered_contour_points = np.zeros((4, 1, 2), dtype=np.int32)
    add = contour_points.sum(1)

    ordered_contour_points[0] = contour_points[np.argmin(add)]
    ordered_contour_points[3] =contour_points[np.argmax(add)]
    diff = np.diff(contour_points, axis=1)
    ordered_contour_points[1] =contour_points[np.argmin(diff)]
    ordered_contour_points[2] = contour_points[np.argmax(diff)]
    return ordered_contour_points
```

```
def post_process(transformed_image):
    """
    Post processing if required. in most casses, it's not required.
    gray = cv2.cvtColor(transformed_image,cv2.COLOR_BGR2GRAY)


    #blur=cv2.medianBlur(gray,5)
    #thres0= cv2.adaptiveThreshold(blur, 255, 1, 1, 7, 1)
    #rat,thres=cv2.threshold(blur, 0, 100, cv2.THRESH_BINARY + cv2.THRESH_OTSU)
    #showImage(thres)
    #thres=cv2.erode(thres,np.ones((3, 3), np.uint8))
    #howImage(thres)
    #thres=cv2.dilate(thres,np.ones((1, 1), np.uint8))
    #showImage(thres)


    imgAdaptiveThre = cv2.adaptiveThreshold(gray,255,cv2.ADAPTIVE_THRESH_GAUSSIAN_C,\
            cv2.THRESH_BINARY,51,2)

    imgAdaptiveThre = cv2.bitwise_not(imgAdaptiveThre)
    imgAdaptiveThre=cv2.medianBlur(imgAdaptiveThre,5)
    #showImage(imgAdaptiveThre)

    """
    return transformed_image
```

```python
def count_characters(text):
    return (len(re.sub(r"\W", "", text)))



def Preprocessing_hard_casses(img):
    gray = convert_to_grayscale(img)
    blur = cv2.medianBlur(gray, 5)
    sharpen_kernel = np.array([[-1,-1,-1], [-1,9,-1], [-1,-1,-1]])
    sharpen = cv2.filter2D(blur, -1, sharpen_kernel)
    thresh = cv2.Canny(sharpen,160,200)
    kernel = cv2.getStructuringElement(cv2.MORPH_RECT, (3,3))
    close = cv2.morphologyEx(thresh, cv2.MORPH_CLOSE, kernel, iterations=2)

    cv2.imwrite('D:\Courses\Computer Vision\Project\TempFolder\gray.jpg',gray)
    cv2.imwrite('D:\Courses\Computer Vision\Project\TempFolder\ blur.jpg',blur)
    cv2.imwrite('D:\Courses\Computer Vision\Project\TempFolder\sharpen.jpg',sharpen)
    cv2.imwrite('D:\Courses\Computer Vision\Project\TempFolder\canny.jpg',thresh)
    cv2.imwrite('D:\Courses\Computer Vision\Project\TempFolder\close.jpg',close)



    return close
```

```
#---------------------------------
# Steps
#---------------------------------

#-------------------------------
# Main program
#-------------------------------
```

```
#reading image
image = cv2.imread("img3.jpg")
imagecopy=image.copy()
"""
#Old Preprocessing.
#converting to grayscale
#gray = convert_to_grayscale(image)
#apply canny to detect edges
#canny = apply_canny(gray,75,200)
#apply dilating then eroson to connect cutoff pixels
#canny_Morph=apply_closingMorphlogy(canny,1)

"""
```

```
# new Preprocessing for hard casses images
canny_Morph= Preprocessing_hard_casses(image)


#detect contours in the image resulted from canny
contour_points = find_largest_contours(canny_Morph,imagecopy)
#draw_contours(imagecopy,contour_points)
#cv2.imwrite('D:\Courses\Computer Vision\Project\TempFolder\contour_detected.jpg',imagecopy)




#Prespective allignment and transformation
transformed_image = transform(contour_points,image)
#showImage(transformed_image)
cv2.imwrite('D:\Courses\Computer Vision\Project\TempFolder\ transformed.jpg',transformed_imag
e)

#post-prcessing
final_image = post_process(transformed_image)
```

```
#OCR
text = pytesseract.image_to_string(final_image)
print(text)
file = open("text2.txt", "a")
file.write(text)
file.write("\n")
file.write("The number of characters detected without spaces are = ")
file.write(str(count_characters(text)))
file.close
```

Instruction manual

What you need to do:

- Replace img1.jpg below with the image that you want and put the image in the project directory.
  ```
  image = cv2.imread("img1.jpg")
  ```
- Put an empty.txt file named text2.txt in the project directory.
- Make sure the text file is empty before every run of the program.
- Comment `cv2.imwrite(“ ”)` or save it in any preferred locations.
- Install tesseract-OCR engine and add it into environment variables.
- Python packages needed: opencv, numpy, pytesseract, regex.

Package Installation in windows

- `pip install opencv-python`
- `pip install numpy`
- `pip install regex`
- pip install pytesseract

Instruction manual cont.

Code steps:

Note: each step is input to the step following it.

1. Preprocessing for the input image to enhance it for the next step of finding contours, using `Preprocessing_hard_casses(img)` function. Steps of the function:
    - Reading image
    - Converting to gray scale
    - Image sharpening (was required for difficult cases)
    - Apply canny (blur, gradient, nonmax-supress, hysteresis)
    - Apply closing morphology operation

---

2. Find largest contour using `find_largest_contours(img,imagecopy)` function.

---

3. Transform the image into bird-eye perspective to ensure that the image is good in terms of perspective using `transform(points_contour,img)` Function, of width and height equal to 800 in most cases.

---

4. Some post processing were done to give, the output image from step one, the feel of a scanned image and to provide a more enhanced image for step 3 using `post_process(transformed_image)` function, but the post-processing wasn't required in most cases. Steps of the function:
    - Blurring image
    - Thresholding image using adaptive or binary + otsu if required.
    - dilation then erosion if required

---

5. Passing the image from the previous steps to OCR engine using pytesseract library using `pytesseract.image_to_string(final_image)` .

---

6. Count the number of characters using `count_characters(text)` function.
7. Save the text and counted number into text file .

Parameters and tuning:

these parameters were used in most cases.

- Canny: 160 low, and 200 high threshold.
- Median blur 5x5
- Sharpening kernel: [[-1,-1,-1], [-1,9,-1], [-1,-1,-1]]
- Closing morphology : 3x3, 2 iterations
- Image transformation width and height: 800, in most cases.
- for best results, make height and width values between 800-950.