Homework 2

Basic Info

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Course Name: Computer Vision

Homework Name: **Fit Ellipses on an Image**

Homework Purposes and Requirements

Call *OpenCV*'s CvBox2D and cvFitEllipse2(const CvArr* points) to fit ellipses on an image.

Actually, the interfaces provided here are already deprecated.

In *OpenCV*'s C++ API, the fitting function is changed to cv::fitEllipse

In Python API, the fitting function is cv2.fitEllipse

Homework Principles

We use Python to implement this homework.

In this project, we used these packages

```python
#!python
import matplotlib.pyplot as plt
import matplotlib as mpl
import os
import sys  # for commandline arguments
import cv2
import random
import logging
import coloredlogs
import numpy as np
```

Some of them are free since they come with a clean python installation

But numpy, matplotlib, opencv-python, coloredlogs should be installed using either pip or conda manually.

Note that you don't have to explicitly install them all since there're dependency in between. For example, when matplotlib is installed before numpy, the latter will be automatically installed by pip or conda.

These're the core functionalities we used from OpenCV for this homework:

```python
cv2.Canny(gray, 100, 200)  # using Canny to get edge
cv2.findContours(edge, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
cv2.minAreaRect(contour)
cv2.fitEllipse(contour)
```

The functionality for them are quite self explanatory.

And they're listed here in the sequence in which they will be called by our homework project.

Homework Procedure

In this homework, we do:

1. Read the image specified by the first user defined parameter

```python
def main():
    if len(sys.argv) > 1:
        imgName = sys.argv[1]
    else:
        imgName = "camaro.jpg"

    if not os.path.exists(imgName):
        log.error(f"Cannot find the file specified: {imgName}")
        log.info(f"This program fits ellipses to an image, usage:\npython hw2.py <image name>")
        return 1
    ...
    ...
    ...
```

2. Convert the image to rgb 3 channel image, grayscale image and detect edge using Canny operator

```python
def getImg(imgName):
    img = cv2.imread(imgName)
    rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
    gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    # img = cv2.imread(imgName, cv2.IMREAD_GRAYSCALE) # assuming the first user defined arg as img name
    edge = cv2.Canny(gray, 100, 200)  # using Canny to get edge
    return img, rgb, gray, edge
```

3. Find contours on the detected edge map and fit the contours with rectangles and ellipses using *OpenCV*

```python
def getFeatures(edge):
    contours, _ = cv2.findContours(edge, cv2.RETR_TREE, cv2.CHAIN_APPROX_SIMPLE)
    rects = [None]*len(contours)
    ellipses = [None]*len(contours)
    for index, contour in enumerate(contours):
        rects[index] = cv2.minAreaRect(contour)
        if contour.shape[0] > 5:
            ellipses[index] = cv2.fitEllipse(contour)
    return contours, rects, ellipses
```

4. Render the contours, rectangles, and ellipses using *OpenCV*

```python
def render(shape, contours, rects, ellipses):
    # plt.figure()
    drawing = np.zeros(shape, dtype='uint8')
    log.info(f"Drawing on shape: {shape}")
    for index, contour in enumerate(contours):
        color = randcolor()
        log.debug(f"Getting random color: {color}")
        cv2.drawContours(drawing, contours, index, color, 1, cv2.LINE_AA)
        if contour.shape[0] > 5:
            cv2.ellipse(drawing, ellipses[index], color, 3, cv2.LINE_AA)

        box = cv2.boxPoints(rects[index])
        box = box.astype(int)
        if box.shape[0] > 0:
```

```
            cv2.drawContours(drawing, [box], 0, color, 2, cv2.LINE_AA)

        # plt.imshow(drawing)
        # plt.show()

    return drawing
```

5. Display the rgb, grayscale, edge map and render result using matplotlib

```python
def main():
    ...
    ...
    ...

    # plt.figure(figsize=(16, 9))
    plt.figure("Fitting")
    plt.suptitle("Fitting ellipses and finding min-area rectangles", fontweight="bold")
    plt.subplot(221)
    plt.title("Original", fontweight="bold")
    plt.imshow(rgb)
    plt.subplot(222)
    plt.title("Grayscale", fontweight="bold")
    plt.imshow(gray, cmap="gray")
    plt.subplot(223)
    plt.title("Canny Edge", fontweight="bold")
    plt.imshow(edge, cmap="gray")
    plt.subplot(224)
    plt.title("Contour & Ellipses & Rects", fontweight="bold")
    plt.imshow(drawing)
    plt.show()

```

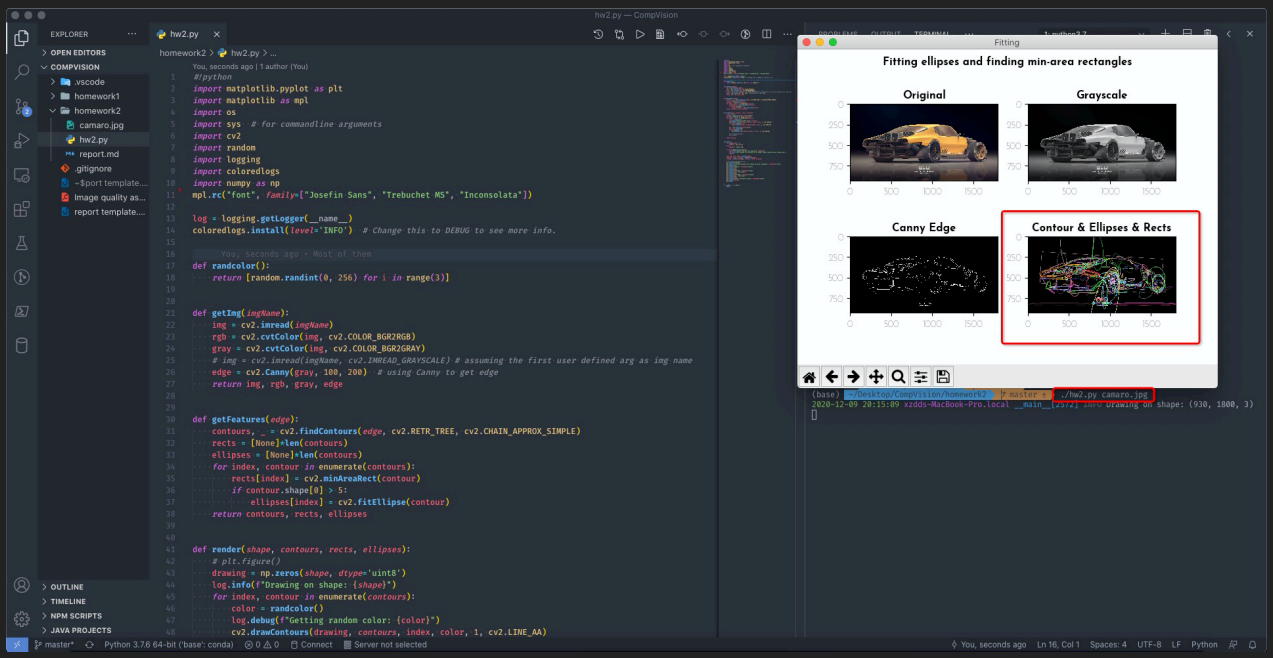
6. Utilities

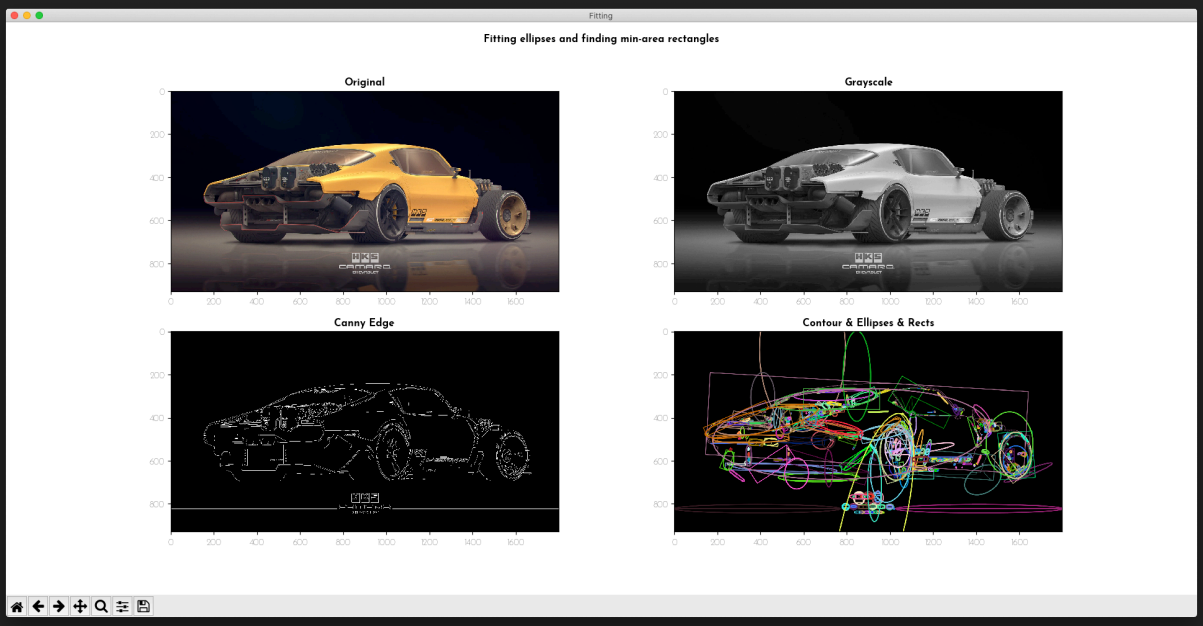
```python
mpl.rc("font", family=["Josefin Sans", "Trebuchet MS", "Inconsolata"])

log = logging.getLogger(__name__)
coloredlogs.install(level='INFO')  # Change this to DEBUG to see more info.


def randcolor():
    return [random.randint(0, 256) for i in range(3)]
```

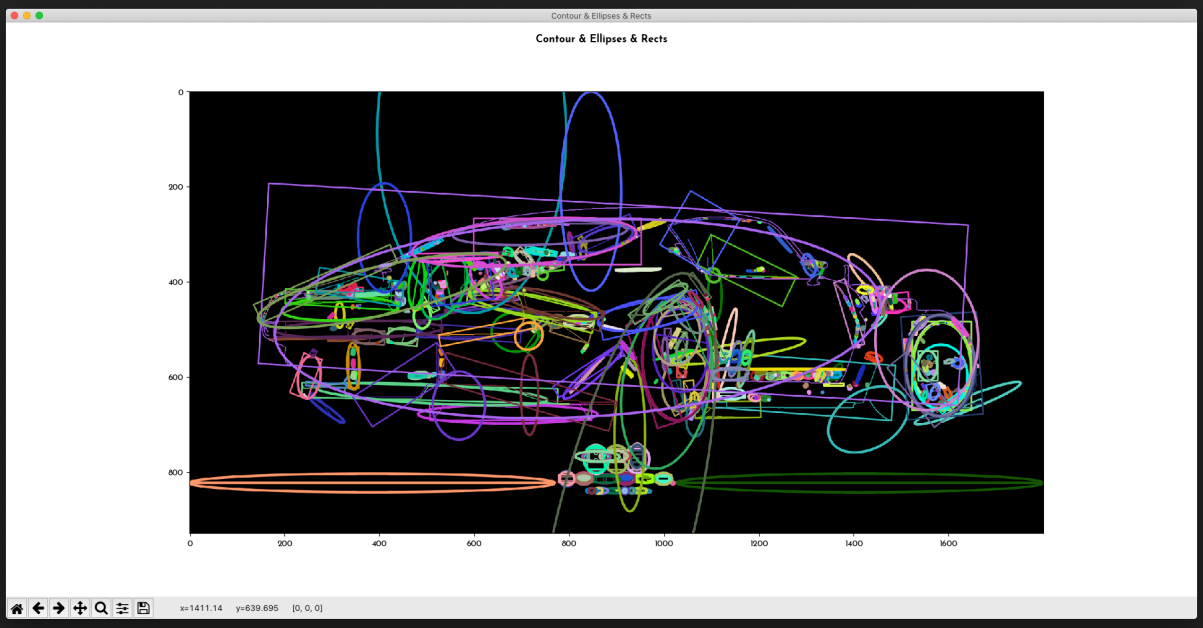
7. Main function

```python
def main():
    if len(sys.argv) > 1:
        imgName = sys.argv[1]
    else:
        imgName = "camaro.jpg"

    if not os.path.exists(imgName):
        log.error(f"Cannot find the file specified: {imgName}")
        log.info(f"This program fits ellipses to an image, usage:\npython hw2.py <image name>")
        return 1

    img, rgb, gray, edge = getImg(imgName)
    contours, rects, ellipses = getFeatures(edge)
    drawing = render(img.shape, contours, rects, ellipses)

    # plt.figure(figsize=(16, 9))
    plt.figure("Fitting")
    plt.suptitle("Fitting ellipses and finding min-area rectangles", fontweight="bold")
    plt.subplot(221)
    plt.title("Original", fontweight="bold")
    plt.imshow(rgb)
    plt.subplot(222)
    plt.title("Grayscale", fontweight="bold")
    plt.imshow(gray, cmap="gray")
    plt.subplot(223)
    plt.title("Canny Edge", fontweight="bold")
    plt.imshow(edge, cmap="gray")
    plt.subplot(224)
    plt.title("Contour & Ellipses & Rects", fontweight="bold")
    plt.imshow(drawing)
    plt.show()
```

Homework Results







Thoughts

Python forever...

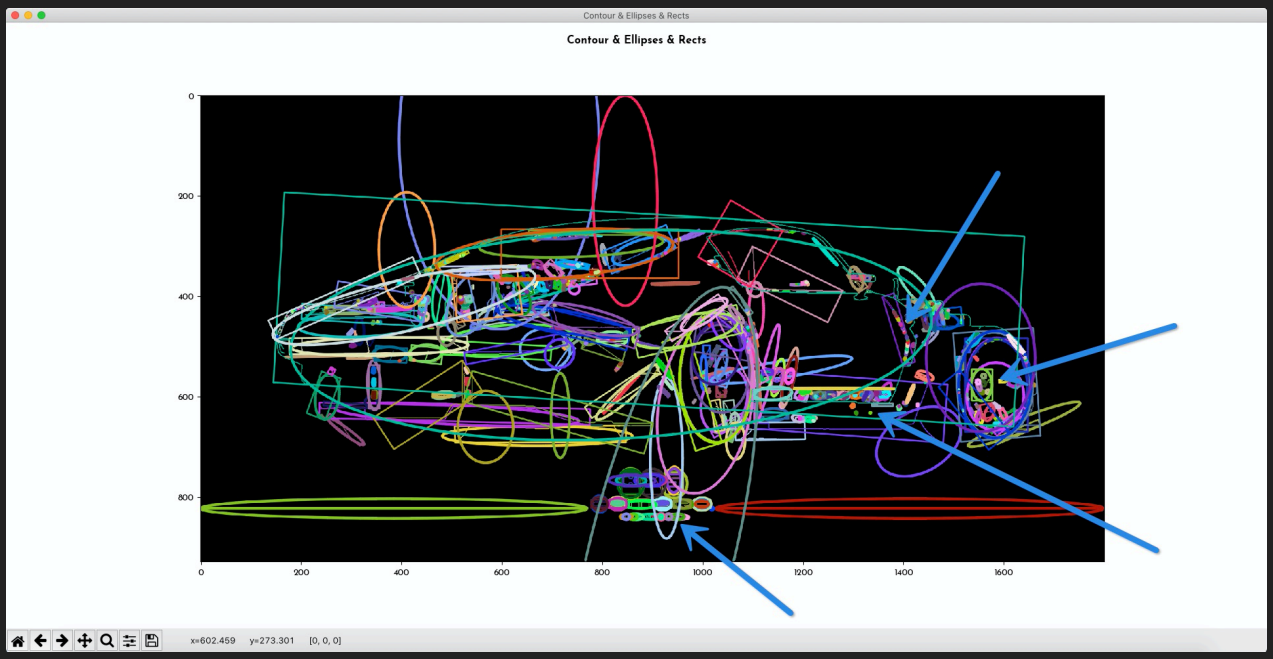
It's just muuuuch easier to implement things and see how they work out, especially with the recent development of `cv2` API.

With `cv2` we get rid of `CvArr` or `CvMat`, and we embrace `numpy.ndarray`, which is intuitive and easy to work on.

And it's much easier to *borrow* other packages' functionalities too. For example, it's not gonna be as easy to plot figures and stuff using C++, where `matplotlib` doesn't exist.

Although it's a fact that C++ is much faster. But we're not developing a full fledge application here. We're only defining some execution logic to make a toy example to experiment on things and explore around, which will NOT bring too much performance impact because *OpenCV* is doing the heavy lifting with C++ implementation in the background for us to enjoy.

The results look okay, but for a well detailed image, a lot of ellipses will pop up. So a possible improvements among this is try to set a lower bound for the radius in the ellipses (like in hough transform)



But I personally assume this is mainly a result of a too detailed image.

Appendix

Full source code:

```python
#!python
import matplotlib.pyplot as plt
import matplotlib as mpl
import os
import sys  # for commandline arguments
import cv2
import random  # random color generator
import logging
import coloredlogs
import numpy as np

```

```
12  # Setting up font for matplotlib
13  mpl.rc("font", family=["Josefin Sans", "Trebuchet MS", "Inconsolata"],
    weight="medium")
14
15  # Setting up logger for the project
16  log = logging.getLogger(__name__)
17  coloredlogs.install(level='INFO')  # Change this to DEBUG to see more
    info.
18
19
20  def randcolor():
21      '''
22      Generate a random color, as list
23      '''
24      return [random.randint(0, 256) for i in range(3)]
25
26
27  def getImg(imgName):
28      '''
29      Load image by name (relative or absolute path)
30      Convert BGR to RGB/Grayscale
31      Get edge using Canny
32      '''
33      img = cv2.imread(imgName)
34      rgb = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
35      gray = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
36      edge = cv2.Canny(gray, 100, 200)  # using Canny to get edge
37      return img, rgb, gray, edge
38
39
40  def getFeatures(edge):
41      '''
42      Detect contours in an image
43      Get minimum area box / best fit ellilpse of contours
44      '''
45      contours, _ = cv2.findContours(edge, cv2.RETR_TREE,
    cv2.CHAIN_APPROX_SIMPLE)
46      rects = [None]*len(contours)  # [None, None, None, ...]
47      ellipses = [None]*len(contours)  # [None, None, None, ...]
48
49      # All detected contour will have a min area box
50      # But only those with more than 5 points will have a ellipse
51      for index, contour in enumerate(contours):
52          rects[index] = cv2.minAreaRect(contour)
53          if contour.shape[0] > 5:
54              ellipses[index] = cv2.fitEllipse(contour)
55      return contours, rects, ellipses
56
57
58  def render(shape, contours, rects, ellipses):
59      '''
60      Render the contours, rectangles and ellipses to an image
61      for later display
62      '''
```

```
    # Specifying the data type so that matplotlib won't treat this as a floating point image
    # which will be truncated to [0, 1] (we're uint8 in [0, 255])
    drawing = np.zeros(shape, dtype='uint8')
    log.info(f"Drawing on shape: {shape} with type {drawing.dtype}")
    for index, contour in enumerate(contours):
        color = randcolor()
        log.debug(f"Getting random color: {color}")
        cv2.drawContours(drawing, contours, index, color, 1, cv2.LINE_AA)

        # All detected contour will have a min area box
        # But only those with more than 5 points will have a ellipse
        if contour.shape[0] > 5:
            cv2.ellipse(drawing, ellipses[index], color, 3, cv2.LINE_AA)

        box = cv2.boxPoints(rects[index])
        box = box.astype(int)
        cv2.drawContours(drawing, [box], 0, color, 2, cv2.LINE_AA)

    return drawing


def main():
    '''
    The main logic for this homework
    '''
    # help message
    log.info(f"This program fits ellipses to an image, usage:\npython hw2.py <image name>")
    # User might forget to give any commandline argument
    if len(sys.argv) > 1:
        imgName = sys.argv[1]
    else:
        imgName = "camaro.jpg"
    # Or he/she might mistype the file name
    if not os.path.exists(imgName):
        log.error(f"Cannot find the file specified: {imgName}")
        return 1

    img, rgb, gray, edge = getImg(imgName)
    contours, rects, ellipses = getFeatures(edge)
    drawing = render(img.shape, contours, rects, ellipses)

    # Display all four images in the same figure window
    plt.figure("Fitting")
    plt.suptitle("Fitting ellipses and finding min-area rectangles", fontweight="bold")
    plt.subplot(221)
    plt.title("Original", fontweight="bold")
    plt.imshow(rgb)
    plt.subplot(222)
    plt.title("Grayscale", fontweight="bold")
    plt.imshow(gray, cmap="gray")
```

```
    plt.subplot(223)
    plt.title("Canny Edge", fontweight="bold")
    plt.imshow(edge, cmap="gray")
    plt.subplot(224)
    plt.title("Contour & Ellipses & Rects", fontweight="bold")
    plt.imshow(drawing)
    plt.show()

    # Display the detected contours rectangles and ellipses separatedly for examination
    plt.figure("Contour & Ellipses & Rects")
    plt.suptitle("Contour & Ellipses & Rects", fontweight="bold")
    plt.imshow(drawing)
    plt.show()


# with the #!python at the beginning of this file
# you can ommit the python when executing this program
if __name__ == "__main__":
    main()

```