README.md

INF250: Mandatory Exercise 2

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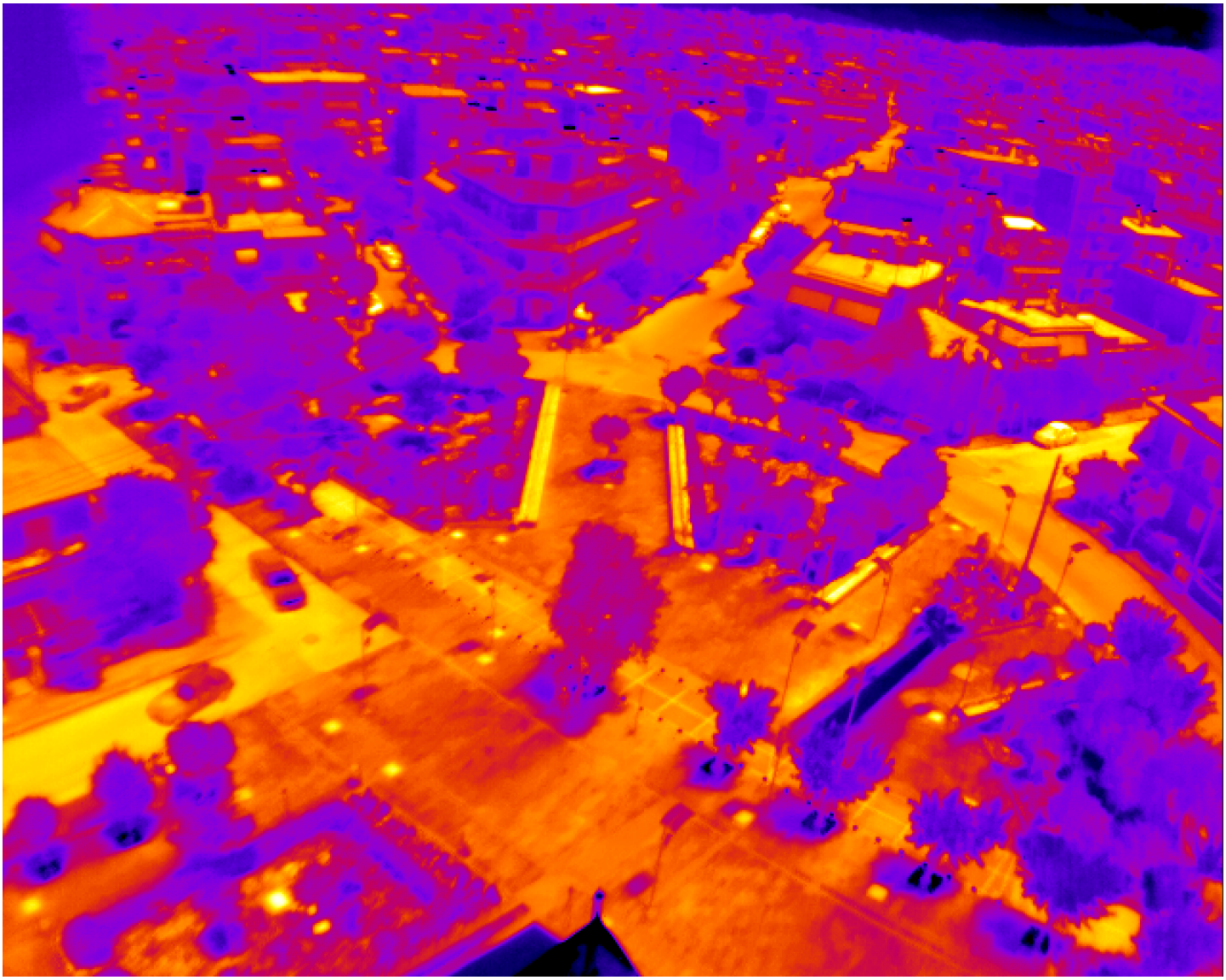
GitHub Repository

We'll sharpen and edge detect this image:



☑ TODO

The following is my interpretation of the exercise:

- [x] Write edge detection function
  - [x] Input
    - [x] Image (np.ndarray)
    - [x] Edge operator (string, `prewitt`, `sobel` or `canny`)
  - [x] Logic
    - [x] Apply ONE edge operator

        - [x] Prewitt
        - [x] Sobel
        - [x] Canny
    - [x] Output
        - [x] Image (with edge detection)
- [x] Write image sharpening function
    - [x] Input
        - [x] Image (np.ndarray)
        - [x] Method (string, `la_place` or `usm`)
    - [x] Logic
        - [x] Sharpen image
            - [x] La Place filter
            - [x] Unsharpening mask (USM)
    - [x] Output
        - [x] Image (with edge detection)
- [x] Make function to export PNG-images of all functions with all parameters
- [x] Write report in Word or Latex (as this seems arbitrary, I'll assume it's okay to use plain Markdown)
    - [x] Attach images
    - [x] Describe images and rate ~~sharpening~~ edge detection
        - [x] Edge detection algorithms
        - [x] Sharpening algorithms
    - [x] Include python program
- [x] Convert MD to PDF (for submission)

Code

Setup

Use a virtual environment if you like to follow best practices. I won't.

```
pip install -r requirements.txt
```

Python program

```
# -*- coding: utf-8 -*-

"""
INF250 Mandatory assignment 2

Sharpening and edge detection

See: https://github.com/VidunderGunder/inf250-mandatory-assignment-2
"""

__author__ = "Kristian Gunder Kramås"
__email__ = "kristiankramas@outlook.com"

from cv2 import cv2
import numpy as np
import os


def detect_edges(img, edge_operator="prewitt"):
    """
    Returns the result from one of the edge operators,
    prewitt, sobel or canny

    Based on:
        https://gist.github.com/rahit/c078cabc0a48f2570028bff397a9e154
        https://docs.opencv.org/master/da/d22/tutorial_py_canny.html

    Parameters:
```

```
    -----------
    img : np.ndarray
        Image to detect blobs in
    operator : string
        "prewitt", "canny" or "laplace"
        Defaults to "prewitt"

    Returns:
    --------
    output : np.ndarray(np.uint)
        Resulting image from the edge operator
        or given image if invalid edge operator
    """

    # Blurred version of the image, to reduce noise and facilitate
    # spotting actual edges as generally recommended by OpenCV, e.g.:
    # https://opencv-python-tutroals.readthedocs.io/en/latest/py_tutorials/py_imgproc/py_canny/py_canny.html
    img_gaussian = cv2.GaussianBlur(img, (3, 3), 0)

    # Functions to use in switch
    def prewitt():
        kernelx = np.array([[1, 1, 1], [0, 0, 0], [-1, -1, -1]])
        kernely = np.array([[-1, 0, 1], [-1, 0, 1], [-1, 0, 1]])
        return cv2.filter2D(img_gaussian, -1, kernelx) + cv2.filter2D(
            img_gaussian, -1, kernely
        )

    def sobel():
        img_sobelx = cv2.Sobel(img_gaussian, cv2.CV_8U, 1, 0, ksize=3)
        img_sobely = cv2.Sobel(img_gaussian, cv2.CV_8U, 0, 1, ksize=3)
        return img_sobelx + img_sobely

    def canny():
        return cv2.Canny(img, threshold1=50, threshold2=90)

    # Switch
    # Returns original image if no valid edge operator
    return {
        "prewitt": prewitt(),
        "sobel": sobel(),
        "canny": canny(),
    }.get(edge_operator.lower(), img)


def sharpen(img, method="la_place"):
    """
    Performs an image sharpening using laplace filter or unsharpen mask (USM)

    Based on:
        https://docs.opencv.org/3.4/d5/db5/tutorial_laplace_operator.html
        https://stackoverflow.com/questions/4993082/how-can-i-sharpen-an-image-in-opencv (top answer as of 10.11.2020)

    Parameters:
    -----------
    img : np.ndarray
        Image to sharpen.
    operator : string
        "la_place" or "usm"
        Defaults to "la_place"

    Returns:
    --------
    output : np.ndarray(np.uint)
        Resulting image from the given method
        or given image if invalid method
    """

    # Functions to use in switch
    def la_place():
        dst = cv2.Laplacian(img, cv2.CV_16S, ksize=3)
        return cv2.convertScaleAbs(dst)

    def usm():
        img2 = cv2.GaussianBlur(img, (0, 0), 2.0)
        return cv2.addWeighted(img, 1, img2, -0.5, 0, img)
```

```
    # Switch
    # Returns original image if no valid edge operator
    return {
        "la_place": la_place(),
        "usm": usm(),
    }.get(method.lower(), img)


def export(img, name):
    """
    Exports image to output directory

    Parameters:
    -----------
    img : np.ndarray
        Image to export
    name : string
        Filename
    """
    output_dir = "./output"

    if not os.path.exists(output_dir):
        os.makedirs(output_dir)

    cv2.imwrite(f"{output_dir}/{name}.png", img)


def show(img, name):
    """
    Shows image

    Parameters:
    -----------
    img : np.ndarray
        Image to show
    name : string
        Header
    """
    cv2.imshow(name, img)
    input("Press enter to continue")


if __name__ == "__main__":
    img_path = "./AthenIR.png"
    img = cv2.imread(img_path, cv2.IMREAD_GRAYSCALE)

    edge_operators = [
        "prewitt",
        "sobel",
        "canny",
    ]

    methods = [
        "la_place",
        "usm",
    ]

    for operator in edge_operators:
        result = detect_edges(img, operator)
        export(result, operator)

    for method in methods:
        result = sharpen(img, method)
        export(result, method)
```

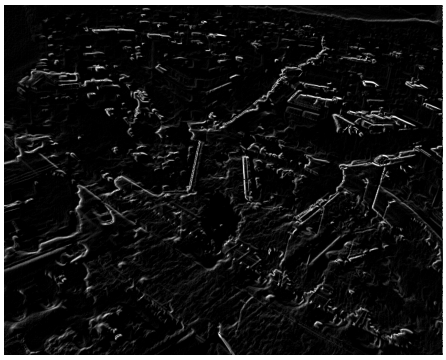
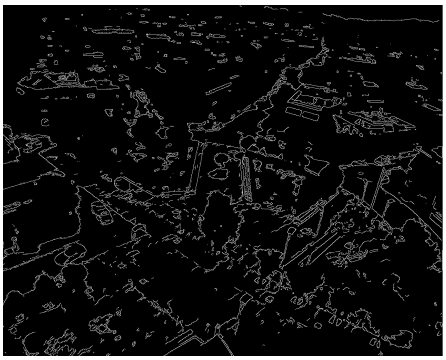
Parameter tuning was done manually within the functions, with images open (updated between changes).

Results

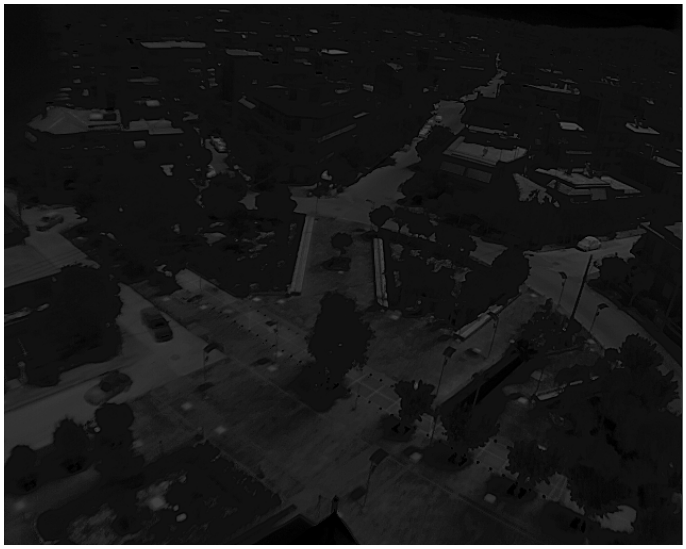
Images

I spent *some* time tuning the parameters to get the best result for each operator/method, but this could obviously be done more thoroughly.

Edge detection

prewitt	sobel	canny
		

Sharpening

la_place	usm
	

Discussion

Note: I assume the assignment wants us to discuss edge detection, as discussing sharpness seems a bit out of place when looking at the resulting images from all methods/operators (both functions), except USM.

Also, it is not clear for what purpose the sharpening will be used (aesthetics, image analysis, clarity for inspection by humans etc.), so it is hard to know what could be considered "best".

I will discuss the performance of edge detection for use in image analysis where object detection is the goal below:

- There was not a huge difference between results using a small amount of gaussian blur or not in my testing, but it did filter out some irrelevant details that is not considered the edge of an object.
- Canny gives us a binary result of wether something is a edge or not. It can be used as for crude edge detection, but a lot of detail and information is lost, and it is hard to process further
- Prewitt, Sobel and Laplace (with the current config) gives us more of a probability of something being an edge and will need further processing if we need a binary result. This approach retains much information, and the resulting image is comprehensible for humans.
- USM with the current config is basically useless for edge detection. As OpenCV recommends blurring images for edge detection, I don't see how it could be used in conjunction with the other algorithms to perform better edge detection either.

Best performer

To my eyes and with my parameter tweaking, Laplace seems the most suited for edge detection.

Miscellaneous

- Python script is auto-formatted by black with a custom line length of 79

  To enable in VSCode, install black

  ```
  pip install black
  ```

  Add this to your `settings.json`

  ```
  "editor.formatOnSave": true,
  "python.formatting.provider": "black",
  "python.formatting.blackArgs": ["-l", "79"],
  ```

  Say yes to any prompts the next time you save a Python file

- Exported using `grip`:

  ```
  pip install grip
  grip './README.md'
  ```

  Save as PDF using browser print.