EKSAMENSOPPGAVE

Fakultet: **REALTEK**

Eksamen i: **INF250** *emnekode* **Digital image analysis** *emnenavn*

Tid: 5 December 2022 at 9:00– 11 December 2022 at 23:00 *ukedag og dato* *kl. fra – til og antall timer*

Faglærer: Ingunn Burud mob. 40219286 *Navn, tlf*

Tillatte hjelpemidler:

Alle

Oppgaveteksten er på: 7 pages + image files *antall sider inkl. vedlegg*

Består eksamensoppgaven av deloppgaver, skal det opplyses om hvor mye hver av disse teller.

Emneansvarlig: Ingunn Burud

Sensor: Ingrid Måge

Dear students in INF250.
The exam consists of 3 exercises where you will carry out some image processing and analysis of different images. The images can be downloaded from **Canvas in the directory Exam2022**. Write a **report in pdf** including a description of your techniques and results for each exercise. A script or a pseudo code should also be included in the pdf. You can generate the report with Latex, Word, Jupyter notebook or something else. It can be in English or Norwegian.
Remember that you have access to example scripts from the lectures that will help you in all these tasks. Remember also that there is not always just one solution to the tasks. Try to be creative and use the techniques you have learned.

The grading of the exam will be from A to F. You will get points for each question, a total of 100 points.

Good luck! ☺

Exercise 1 (25p)

You will work on the image **soccerteam.jpeg** shown in Figure 1.
The photographer was very excited to capture an historical event and unfortunately the image turned out a bit blurry.

a) Try to sharpen the image to make it more presentable. Your rapport must include:
   - Description of the technique(s) you use (4p)
   - Demonstration of the result (5p)
   - Python script or pseudocode for ImageJ (4p)

Figure 1. soccerteam.jpeg

b) In Figure2 there are two images resulting from applying a Canny filter. One is applied on the original image and one on the sharpened image.
   - What is a Canny filter? Describe with a few lines. (3p)
   - Which of the images shows Canny applied on the sharpened image and which is on the original image? (2p)
   - Run the Canny filter on your original image and on your sharpened image from Exercise 1a) with 3 different values of sigma. What do you observe? (4p)
   - Include the images you make and your script/pseudocode. (3p)

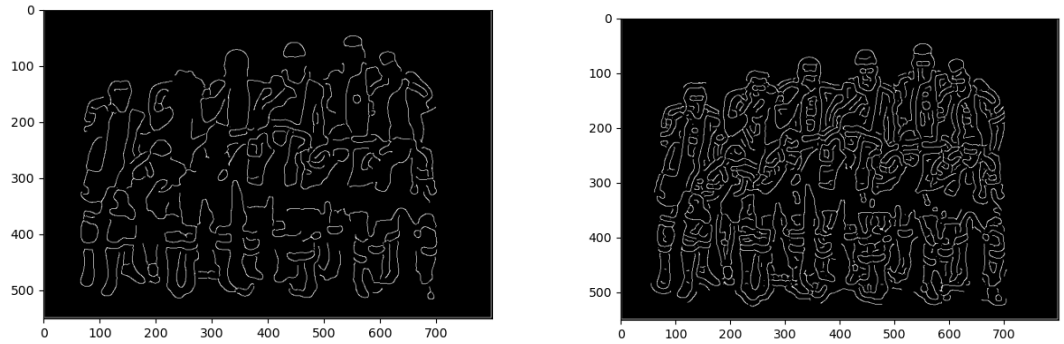

Figure 2: Canny filter applied on the sharpened and original image.

Exercise 2. (25p)

In this exercise you will work on the image **coffeebeans.jpeg** as showed in Figure 3.

Figure 3: Plate with coffee beans and cloves

There are shadows around each coffee bean and clove. Experiment with some techniques you have learned in the course and try to eliminate the shadows as much as you can.

a) Describe the techniques you use and explain how they work. Show images with results and intermediate results. (5p)
b) Create a mask of the beans and cloves and compute images of the beans and the cloves like showed in Figure 4. One with shadows included and one without. (5p)

Figure 4: Masked out background including beans and cloves with and without shadows.

c) We want to count only the coffee beans. Try to make a selection so that you only count the coffee beans and not the cloves. (5p)
d) Create a list with the center x,y positions of all the coffee beans in the image. (5p)
e) Can you compute the size of the coffee beans? Explain how and/or why it is challenging. (5p)

Exercise 3

The file **nmbu.py** is a hyperspectral airborne image of the TF-buildings and Aud Max. An RGB representation is shown in Fig.5.

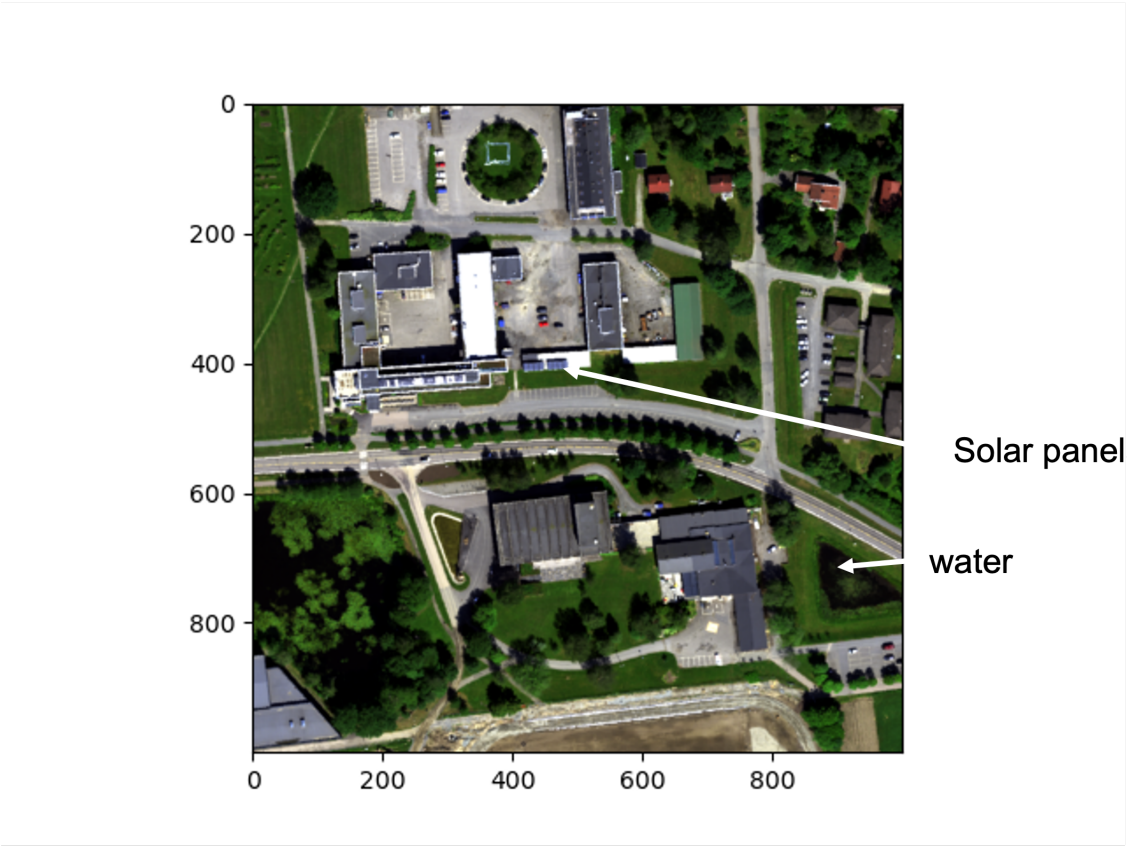

Figure 5: An RGB representation of the hyperspectral image nmbu.npy

a) Load the image **nmbu.npy** and the header file **nmbu.hdr** into Python and display the image by selecting three wavebands. Write which wavebands you display and which wavelength they correspond to. (5p)

b) Make a plot with the spectrum as a function of wavelength, from the following materials: (5p)
   - Grass
   - Asphalt
   - Black roof
   - Red roof
   - Solar panels (see where I have marked them on the image)
   - Water (see where I have marked them on the image)

c) Compute an NDVI (Normalized Difference Vegetation Index) image from the dataset and display it. (5p)

d) Compute a Principal Component Analysis of the data. (15p)

- Display the 5 first score images with the corresponding loadings. What do you observe? What can you tell from these figures about the data?
- Display the plot of the Eigenvalues. Why do you think there is such a break in the curve at component no 2?
- How much explained variance is included in the two first components?
- How many components do you need to cover 99.9% of the explained variance?

e) Compute a Gaussian Maximum Likelihood Classification to classify 4-6 classes. Run the classification on the complete hyperspectral image and on the stack of the 8 first principal component score images. (10p)
   - Show the ground truth image with your classes.
   - Show the results on both the full hyperspectral image and on the stack om 8 score images.
   - Comment on your results.

f) Apply an edge detecting filter on the class of vegetation and overlay the ndvi-image you computed earlier. This will outline the vegetation areas in the image as shown in Fig. 6. (10p)

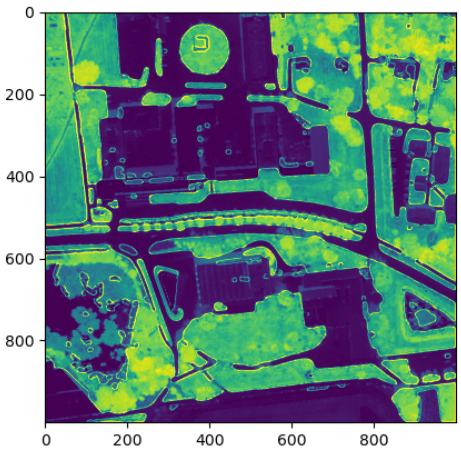

Figure 6. NDVI image with outlines of vegetation area.