Image Analysis
Exercise 02 - Cameras

2019

Introduction

The purpose of this exercise is to use Matlab to calculate camera and scene specific values. There are also two exercises from a previous exam that can be solved using pen and paper.

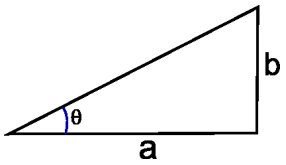
Matlab camera programs

From now on you are encouraged to create an .m file for each exercise. To create an empty M-file write:

```
edit cameraExercise.m
```

Hint: You can run a part of an M-file by hitting `F9` after selecting the part you want to run. Pressing `F5` will run the entire M-file.

Exercise 1 *Explain how to calculate the angle θ when a and b is given in Figure 1. Calculate θ (in degrees) when $a = 10$ and $b = 3$. Matlab has a specialized function for computing this angle. Try to find out what it is.*



Figur 1: Angle in a triangle

Exercise 2 *Create a new Matlab function called* `CameraBDistance.m`*:*

```
edit CameraBDistance.m
```

The function should accept two arguments, a focal length f and an object distance g. It should return the distance from the lens to where the rays are focused (b) (where the CCD should be placed)

The function should start like this:

```
function b = CameraBDistance(f,g)
% CameraBDistance returns the distance (b) where the CCD should be placed
% when the object distance (g) and the focal length (f) are given
```

It should be based on Gauss' lens equation:

$$\frac{1}{g} + \frac{1}{b} = \frac{1}{f} \tag{1}$$

If you cannot remember how to write a function, you can have a look at one of Matlabs function using:

```
type mean
```

You should decide if your function should calculate distances in mm or in meters, but remember to be consistent!

Use your function to find out where the CCD should be placed when the focal length is 15 mm and the object distance is 0.1, 1, 5, and 15 meters.

What happens to the place of the CCD when the object distance is increased?

Your own images

It is normally possible to extract information about the parameters used when an image is taken from the image file. However, the parameters are different from camera to camera.

Exercise 3 *Take 4-5 images with your camera of the same motive. Keep the camera steady and play around with zoom (and if you can also exposure time. This is not always possible on mobile phone cameras). Copy them to your Matlab folder. Use the Matlab command* `imfinfo` *to find about the focal length, exposure time and aperture values.* `imfinfo` *often returns a struct called DigitalCamera that will contain most of the information. Display it this way:*

```
info = imfinfo('FilePath/FileName')
info.DigitalCamera
```

From mobilephone cameras you can often get information about GPS coordinates and other types of meta-data. Try to see how much information is actually stored in the image file.

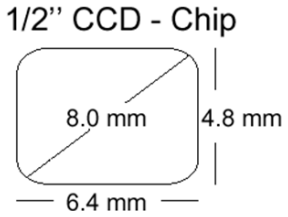
```
doc imfinfo
```

Camera exercise

In the following exercise, you should remember to explain when something is in mm and when it is in meters. To convert between radians and degrees you can use:

```
angleDegrees = 180 / pi * angleRadian
```

Exercise 4 *Thomas is 1.8 meters tall and standing 5 meters from a camera. The cameras focal length is 5 mm. The CCD in the camera can be seen in Figure 2. It is a 1/2"(inches) CCD chip and the image formed by the CCD is 640x480 pixels in a (x,y) coordinate system.*



Figur 2: The dimensions of a 1/2"CCD chip. The chip has 640x480 pixels.

It is easiest to start by drawing the scene. The scene should contain the optical axis, the optical center, the lens, the focal point, the CCD chip, and Thomas. Do it on paper or even better in a drawing program.

1. *A focused image of Thomas is formed inside the camera. At which distance from the lens?*
2. *How tall (in mm) will Thomas be on the CCD-chip? Create a Matlab function called* `RealSizeOnCCD.m` *that computes the answer and takes as input the object height and relevant distances.*
3. *What is the size of a single pixel on the CCD chip? (in mm)?*
4. *How tall (in pixels) will Thomas be on the CCD-chip? Create a Matlab function called* `PixelSizeOnCCD.m` *that computes the answer and takes as input the object height and distance.*
5. *What is the horizontal field-of-view (in degrees)?.*
6. *What is the vertical field-of-view (in degrees)?. Create a Matlab function called* `CameraFOV.m` *that computes the field of view (horizontal and vertical) of a camera.*

Exam question on camera geometry

Your camera has a focal length of 65 mm and a CCD chip of 10 x 8 mm. The image dimensions are 5120 x 4096 pixel. It can be assumed that $b = f$. You have taken a sharp photo of a completely circular melanoma from a distance of 120 cm. On the image the radius of the melanoma is 400 pixels. What is the physical area of the melanoma?

1. 654 mm^2
2. 356 mm^2
3. 732 mm^2
4. 450 mm^2
5. 620 mm^2

Exam question of field-of-view

You camera has a field-of-view of 15°. You have taken a photo of a finger, that exactly fits the image, when the camera is in a distance of 31.5 cm. How long is the finger?

1. 8.2 cm
2. 8.3 cm
3. 8.4 cm
4. 8.5 cm
5. 8.6 cm