Lab 3 – Kalman Filter

Goal: to provide an introduction to Kalman filtering algorithm implemented in Computer Vision System Toolbox. In this lab we'll learn to track moving object in video.

1. Kalman Filter

Use the command **doc** in Matlab command window. Then select:

Computer Vision System Toolbox→Examples.

Then find the section **Tracking** and choose **Using Kalman Filter for Object Tracking**.

Then press the button **Open this Example** (in the top-right corner). Then copy the contents of the file **kalmanFilterForTracking.m** to the file in your local directory. In order to simplify a task a bit, let's separate different sub-tasks by the command **pause;**. Add the command **pause;** in the lines 31, 43, 150, 179, 201 and 222.

General questions

1. Describe the Kalman filtering algorithm.
2. What is the *nested function*?
3. Describe the sharing of variables between parent function and nested functions.
4. Explain how the ball in the video is rolling through the box.

The Program - Part 1 (lines 1-31)

1. What is the reason of using of **repmat** in line 309?
2. In line 327 the *first* detected object is used. Suggest a simple criterion for smart selection of object (instead of selection of the first object).
3. What is the meaning of the argument **5** in line 343?

The Program - Part 2 (lines 32-43)

1. What is the reason of using of **max** in line 373?
2. What is the type of the variable **utilities.accumulatedImage** (line 373)?
3. What is the maximum of the variable **utilities.accumulatedImage** (line 373)? (**Hint**: use the answer to the previous question.)
4. What is the purpose of division by 2 and addition of 0.5 in the command **imshow(utilities.accumulatedImage/2+0.5);** (line 358)? (**Hint**: use the answer to the previous question.)

The Program - Part 3 (lines 44-150)

1. What states of the system are checked in the function **trackSingleObject** (that starts at line 84)? Draw a simple transition diagram (write names of states and draw connecting arrows).

2. What parameter from the function **trackSingleObject** corresponds to the _Process Noise_ that was studied in the lecture?

3. What parameter from the function **trackSingleObject** corresponds to the _Measurement Noise_ that was studied in the lecture?

The Program - Part 4 (lines 151-179)

1. Give examples "from life" about objects that move with
   A. constant velocity,
   B. constant acceleration.

2. Explain the use of arguments **(1:2)** in lines 175,176.

The Program - Part 5 (lines 180-201)

1. Carry out the experiment in this Part twice, changing the parameter
   param.initialEstimateError (line 198):
   A. to the value **100*ones(1,3);** (this value is used in this Part),
   B. to the value **1E5 * ones(1, 3);** (this is the default value).
   What value of **param.initialEstimateError** (from the two above) gives better result? Explain your answer.

The Program - Part 6 (lines 202-222)

1. Why the parameter **param.measurementNoise** (line 218) was increased from the default value 25 to the value 12500?