**Laboratory exam - Image Processing - subject C**

**Problem 1**

Implement the following drawing functions for color images. Use a black background. You are not allowed to call drawing functions from OpenCV. Each function should paint on a single given image channel (R, G or B) and using a given color value (e.g. red = 140). Drawing should be possible even if the shape is partially outside the image, but it should stop at image boundaries.

a. Draw and fill a rectangle which has its sides parallel to the coordinate axes. The rectangle is specified by its upper left corner, height and width.
b. * Draw a line segment defined by its starting and end point.
c. Draw and fill a rectangle in general orientation defined by its 4 corner points.
d. Estimate the area of the intersection (in pixels) between two general rectangles.

**Problem 2**

a. Construct the following 3 by 5 matrix *K*, based on the input parameter *0<n<10*:

| | | | | |
|---|---|---|---|---|
| -n/2 | -n | 0 | n | n/2 |
| $-n^2/2$ | $-n^2$ | 0 | $n^2$ | $n^2/2$ |
| -n/2 | -n | 0 | n | n/2 |

b. Implement a function which filters an image using *K* as the filter kernel and its transposed version (two separate outputs). Apply the correct normalization operation and visualize the results.
c. Decompose the filter kernel into two vectors such that *u* x *v* = *K* (normal matrix multiplication, *u* is *3x1*, *v* is *1x5*). Filter the image by first applying *u* and then *v* on the result. Perform a test to check if the results are identical with those from point *b* and compare the execution times.

Grading:
1p Granted;
1p Compilation, run-time errors/exceptions, code arrangement and organization;
1p Correct types for images, variables, input/output;
1p Each subproblem.