Introduction to Robotics

Assignment #5

Due: 24.06.2015, 13.00

Preferred tools/languages for programming, plotting and solving are

`python`, `matlab` or `gnuplot`.

Always provide source code as well as all intermediate steps. Make sure to annotate your code in detail in order to provide readability and fast understanding. *"Here, some magic happens"* will cost you points.

Task 5.1 (5 points) Basis-Splines - Programming Task: Draw the basis splines of the order 1 to 4 within the intervals $[t_i, t_{i+1}], i = 0, 1, 2, 3, 4$. Provide functions and plot within your solution as well as the attached source code.

Task 5.2 (4 points) Basis-Splines - Direct Computing: In the lecture the recursive calculation of the basis splines has been introduced. With regard to real-time time critical applications, direct computation for a given order has advantages. Deduce the explicit formula for the basis splines with the order 1 to 3.

Task 5.3 (5 points) Lagrange polynomial: Given a set of data points $(0, 1), (1, 3), (3, -2), (5, 4)$. Calculate the Lagrange polynomial $p_3(x)$ through the data points.

Simplify the equation as much as possible. Use a tool of your choice (`gnuplot` is preferred) to visualize the four Lagrange basis polynomials and the polynomial $p_3(x)$.

Task 5.4 (6 points) PID-controller: Calculate the response of a PID-controller with the factors k_p, k_d and k_i.

5.4.1 (3 points): to the heavy-side function:

$$y(t) = \begin{cases} 0 & t < 0 \\ 1 & t \geq 0 \end{cases}$$

5.4.2 (3 points): a ramp function

$$y(t) = \begin{cases} 0 & t < 0 \\ t/t_0 & t \geq 0 \end{cases}$$

Plot the function for $k_p = 1, k_v = 1, k_i = 1$, using a tool of your choice (`gnuplot` is preferred).