Exercise on 23.01.2019

Task 1 (4 points)

On ILIAS you will find a time series $\Delta v^p(t)$ for $t = t_1, t_2, t_3 \dots t_N \quad N = 1000$ which contains the change of velocities in a (fictive) 1D accelerometer which were recorded with a data rate of 100 Hz. Compute the acceleration over time as it was shown in the lecutures (see Eqn. (9.10)), by using either $a^p(t_{k-2})$, $a^p(t_{k-1})$ or $a^p(t_k)$. Plot your results as function of t and describe the differences between them.

Task 2 (6 points)

In the lecture we implemented $\boldsymbol{a}^p(t)$ by a first order Taylor expansion evaluated at t_{k-2} (Eqn. (9.5)) and expressed these values by using the measurements of change in velocity $\boldsymbol{\Delta v}^p(t_{k-1})$ and $\boldsymbol{\Delta v}^p(t_k)$.

Now, use a quadratic approximation of $\boldsymbol{a}^p(t)$ evaluated at point t_{k-3}, meaning

$$\boldsymbol{a}(t) = \boldsymbol{a}^p(t_{k-3}) + \dot{\boldsymbol{a}}^p(t_{k-3})(t - t_{k-3}) + \frac{1}{2}\ddot{\boldsymbol{a}}^p(t_{k-3})(t - t_{k-3})^2$$

and determine analytically the required values of $\boldsymbol{a}^p(t_{k-3})$, $\dot{\boldsymbol{a}}^p(t_{k-3})$ and $\ddot{\boldsymbol{a}}^p(t_{k-3})$ as a function of three sequential measurements $\boldsymbol{\Delta v}^p(t_{k-2})$,$\boldsymbol{\Delta v}^p(t_{k-1})$ and $\boldsymbol{\Delta v}^p(t_k)$ of your accelerometer as well as their time difference $\Delta t = t_i - t_{i-1}$.