Lab Exercise 1: Nonlinear Adaptive Pulse Coded Modulation-Based Compression (NADPCMC)

In this exercise, you will implement transmission and reception sides of Nonlinear Adaptive Pulse Coded Modulation-Based Compression (NADPCMC) and evaluate it with different source signals.

1) Implement NADPCMC scheme (Python is suggested). Parametrize the initialization vector size and number of bits used for encoding. Show result in terms of error in reproduction of the data at the received AND the amount of data needed to transmit.

2) Prepare a set of tests to verify functionality of at least some NADPCMC steps (e.g. predictor init and predictor output)

    a. Strongly suggested to use GIT/Gitlab to manage/document progress of the work (e.g. use commits after each development cycle phase: test creation, test passing, refactoring)

3) Create a slowly varying sensor data (e.g. slow sinusoid). Evaluate the NADPCMC performance (reconstruction error) with different values for length of initialization vector and size of error value transmitted (number of bits).

4) Create increasingly faster-changing sensor data, until the error of the sensor data reproduction becomes larger then 20%.

5) Prepare <u>short presentation</u> with your results. Present it to the class (about 5-10min).

6) Prepare <u>summary report</u> of the work with **conclusions** and **lessons learned** sections. Length of about 3-4 pages with selected, comparative results tables/plots.

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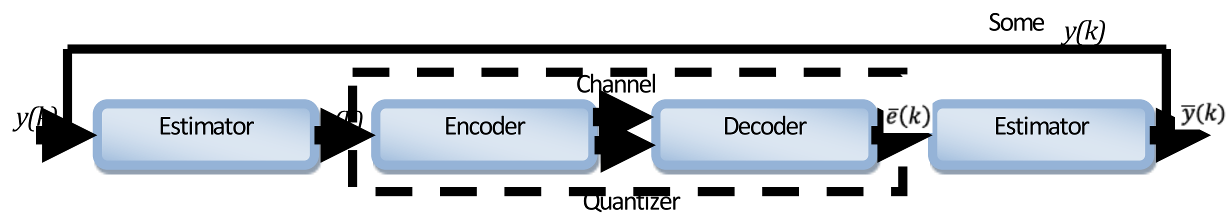

$$\hat{y}_T(k+1) = \hat{\theta}_T(k)\emptyset_T(k) - k_v e(k)$$

$$e(k+1) = y(k+1) - \hat{y}_T(k+1)$$

$$\hat{\theta}_T(k+1) = \hat{\theta}_T(k) + \alpha\emptyset_T(k)e^T(k+1)$$

$$\bar{e}(k) = Q(e(k)) = e(k) + \varepsilon_Q$$

$$\hat{y}_R(k+1) = \hat{\theta}_R(k)\emptyset_R(k) - k_v e_R(k)$$

$$e_R(k+1) = \bar{y}(k+1) - \hat{y}_R(k+1) = \bar{e}(k+1)$$

$$\hat{\theta}_R(k+1) = \hat{\theta}_R(k) + \alpha\emptyset_R(k)e_R{}^T(k+1)$$

$$\bar{y}(k+1) = \hat{y}_R(k+1) + \bar{e}(k+1)$$

$$Distortion = \left|\frac{y(k) - \bar{y}(k)}{y(k)}\right| * 100\%$$

$$Compression\ ratio = \frac{total\ bits\ in\ y(k)}{total\ bits\ in\ e(k) and\ some\ y(k)}$$

$$\boxed{\eta = \frac{1}{1-\alpha\|\emptyset(k)\|^2} \text{ and } k_v < \frac{1}{\sqrt{\eta}}}$$

$$\boxed{\alpha < \frac{1}{\|\emptyset(k)\|^2}}$$