IIR filter design with Prony method

Lab 3, SDP

Objective

Using the Prony method for designing IIR filters of various types

Theoretical notions

Exercises

1. Design with the Prony method an IIR filter of order 2 which approximates the following desired impulse response:

   $$h_d[n] = \{...0, \underset{\uparrow}{1}, 2, 3, 2, 1, 2, 3\}$$

   (the origin of time $n = 0$ is at the first value of 1 in the sequence).

2. Implement in Matlab a function for creating and then solving the equation system resulting from the **Prony method**:

   `[b,a] = pronymet(order, hd)`

   The function shall have the following arguments:

   - `order`: the order of the designed filter
   - `hd`: a vector holding the first samples of the desired impulse response

   The function shall return the coefficients of the system function for the resulting filter:

   - `b`: the numerator coefficients
   - `a`: the denominator coefficients

3. Use the function above to design a second order filter with the Pade method, for approximating the desired impulse response given below:

$$h_d[n] = \left(\frac{1}{3}\right)^n \cdot \cos(\frac{\pi}{4}n) \cdot u[n]$$

4. Use the function above to design with the Prony method a filter of order 2 which approximates the following higher-order filter (3):

$$H(z) = \frac{0.0736 + 0.0762z^{-1} + 0.0762z^{-1} + 0.0736z^{-3}}{1 - 1.3969z^{-1} + 0.8778z^{-1} - 0.1812z^{-3}}$$

   a. Use the function `impz()` to generate a sufficiently long impulse response of the given filter;
   b. Use your function `pronymet()` to actually design the filter;
   c. Plot on the same figure the impulse response of the given filter and the impulse response of the designed filter, for the first 50 samples.

5. Load a sample audio file in Matlab and filter it with the filter found above. Play the filtered signal. How does it sound like? Compare it with the original signal.

Final questions

1. TBD