Implementing digital FIR filters in the lattice form

Lab 5, SDP

Objective

The students should become familiar with *lattice*-type realization structure used for implementing FIR filters.

Theoretical notions

Exercises

1. Find the FIR filter coefficients in direct form, if the reflection coefficients of the lattice FIR structure are: $K_1 = \frac{1}{2}$, $K_2 = 0.6$, $K_3 = -0,7$, $K_4 = \frac{1}{3}$.
2. Find the reflection coefficients of the lattice structure for a FIR filter with system function:
$$H(z) = 1 + \frac{2}{5}z^{-1} + \frac{7}{20}z^{-2} + \frac{1}{2}z^{-3}$$
3. Using the Octave software, use the `fir1()` function to design one of the following elliptic FIR filters:
    a. A low-pass FIR filter of order 4, with cutoff frequency of 5kHz at a sampling frequency of 44.1kHz;
    b. A high-pass FIR filter of order 4, with cutoff frequency of 2kHz at a sampling frequency of 44.1kHz;
    c. A band-pass FIR filter of order 4, with passband between 1kHz and 3kHz at a sampling frequency of 44.1kHz.

    Read the documentation of the `fir1()` function to find out how to use it.

4. Create an Octave function to `tf2latc()` to compute the coefficients of the lattice form of a FIR filter, starting from the coefficients of the Transfer Function. Call it like this: `K = tf2lact(coef)`

5. Create an Octave script to filter an input signal `x` with a FIR filter in lattice form, for which the reflection coefficients `K` are known:

   ```
   y = filter_latc(x, K)
   ```

6. Use the function above to load and low-pass the audio signal `Kalimba.mp3`.

   a) Load the file using `audioread()`
   b) Use `tf2latc()` to convert the filter to lattice form
   c) Filter the signal with `filter_latc()`

Final questions

1. TBD