

Exercise No 7A
MODELING OF ADAPTIVE SYSTEMS USING LMS
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1. The aim of experiments

Learning the adaptive processes using LMS algorithm in identification, prediction and noise elimination tasks.

2. Dynamic models of adaptive processes

2.1 Identification of dynamic plant

The identification will be done using the linear model of the SOI structure and LMS algorithm. The plant under identification is of the SOI and NOI type. Fig. 1 presents the Simulink model of the adaptive identification (file `ad_ident53.mdl`). As the excitation we use the white noise generator.

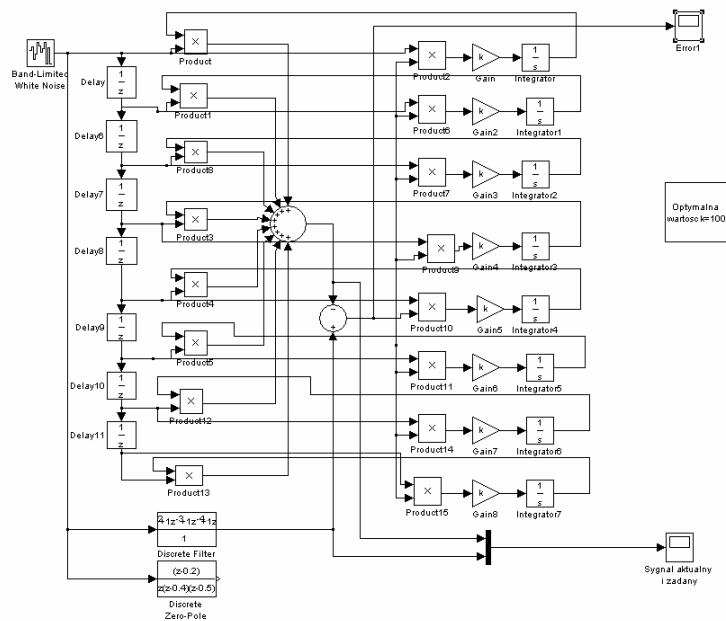


Fig. 1 Simulink model of the dynamic block adaptive identification

2.2 Elimination of the interference noise

The white noise has been chosen as the interference signal under elimination. The useful signal distorted by this noise is taken as one the signals (the sinusoidal, sawtooth and square wave) accessible from the block *signal generator*. Fig. 2 presents the Simulink model of the adaptive system for the interference noise elimination (file `ad_el_szum.mdl`).

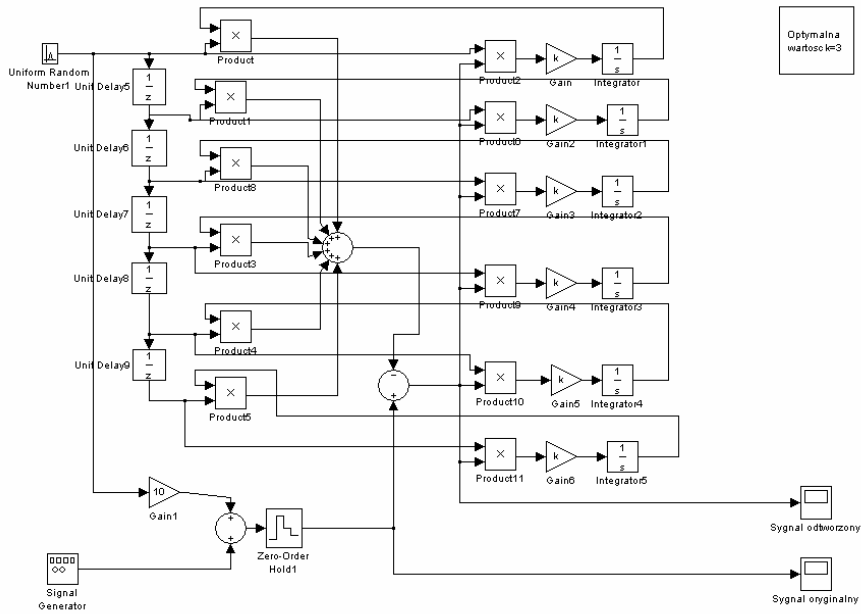


Fig. 2 Simulink model of the adaptive system for interference elimination

2.3. The adaptive system as the predictor

The adaptive system task is to predict the next sample of the time series on the basis of the previous (historical) data samples.

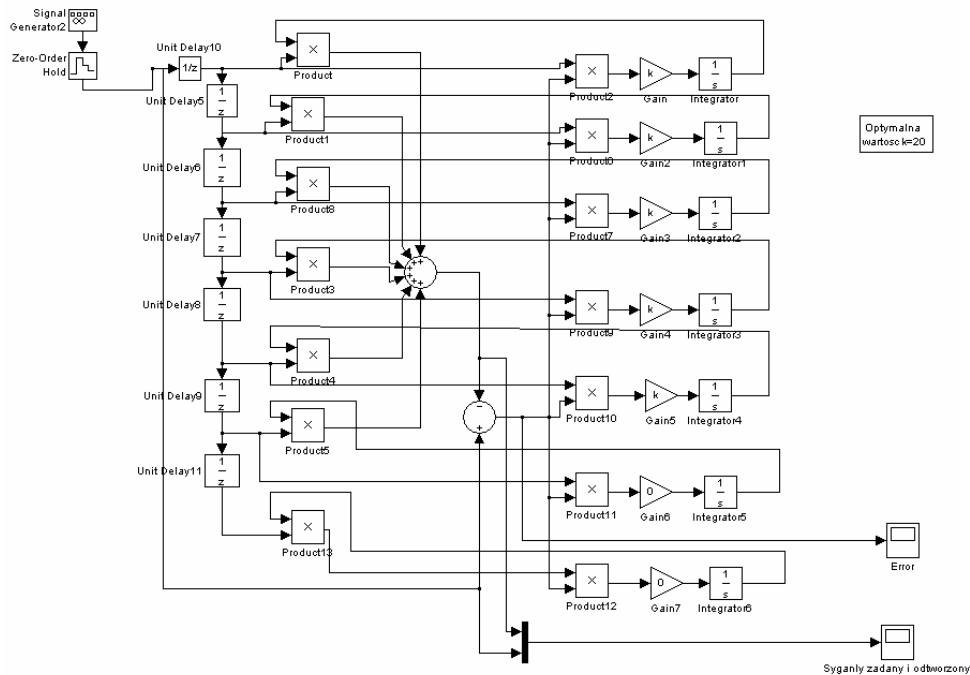


Fig. 3 Simulink model for the prediction of the time series

The signals under prediction are the signals produced by the signal generator (the sinusoidal, square and sawtooth waves). Fig. 3 presents the Simulink model of the adaptive system for prediction of the time series (file `ad_predykcja53.mdl`).

3. Program of the numerical experiments

The numerical experiments should be performed for each adaptive task using the specified files, suited for the individual problem. Before each run assign the value of the gain k in the workspace of Matlab.

1. **Identification of the dynamic plant** (file **ad_ident53.mdl**)

- Choose the SOI discrete filter as the dynamic plant under identification. Identify the adaptive model parameters by running the file. Assume different ranks of the plant (not exceeding 7). Compare the values of adapted parameters with the real ones.
- Choose the NOI discrete filter as the dynamic plant and identify the adaptive model parameters by running the file. Assume different ranks of the plant (not exceeding 4). Check for example the following positions of poles: [0 0.3 0.5], [0 0.1 0.2 0.5], [0 0.1 0.3 0.4]. Compare the errors in the case of SOI and NOI plants.

2. **Prediction of the time series** (file **ad_pre dykcja53.mdl**)

- Simulate the adaptive prediction of the time series of different shape: sinusoidal, square and sawtooth at suggested value of k .
- Using one type of signal (for example square) check the influence of the gain constant k (the value of k changing from 1 to 100)

3. **Elimination of interference noise** (file **ad_el_szum53.mdl**).

- Simulate the process of interference noise elimination using adaptive filtering at different shape of the useful signals (sinusoidal, square and sawtooth).
- Check the influence of the gain k used in simulation (change k value from 1 to 10) at one type of signals (for example sinusoidal wave).
- Check the influence of reducing the rank of the filter (for example by zeroing the value of k for the last channel of the filter).

Remark:

Before the experiments the suitable value of the gain k should be assigned for each adaptive system (for example $k=3$).