

Exercise No 7C
KALMAN FILTERING
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1. The aim of experiments

Learning the algorithm of Kalman filtering on the example of Wiener process simulation.

2. Model of the process filtering

Wiener process is described by the following state space equations:

$$\frac{dx}{dt} = u(t)$$

$$y = x(t)$$

Assign: $\mathbf{A}=0$, $\mathbf{G}=1$, $\mathbf{H}=1$. This choice corresponds to the transition matrix $\mathbf{\Phi} = e^{\mathbf{A}\Delta t} = 1$. Assume the standard deviation of the measurement equal 1/2. The excitation $u(t)$ is a white noise of the Gaussian distribution of the given unity variance and mean value equal zero. At such assumption the covariance matrix of the input signal is equal $\mathbf{Q}=1$ and the covariance matrix of the measurement \mathbf{R} is equal $\sigma^2=1/4$. Fig. 1 presents the Simulink model of the Kalman filtering of the Wiener process (file **Kalman1.mdl**).

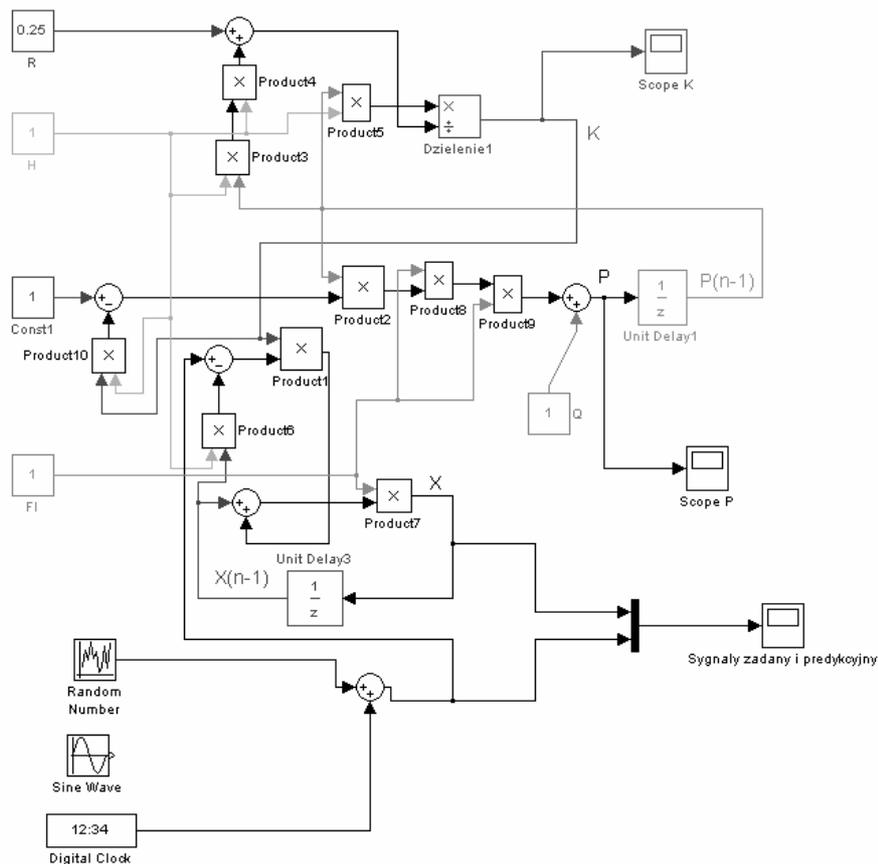


Fig. 1. Simulink model of the Kalman filtering of the Wiener process

3. Program of numerical experiments

- Trace the input signals by the Kalman filters at assumed values of parameters: $R=1/4$, $Q=1$, noise variance of the input signal equal zero. Try sinusoidal, square and sawtooth waveforms. Observe the values of the real (destination) and predicted signals.

- Trace the input signals by the Kalman filters at existence of the noise. Assign $R=1/4$, $Q=1$, noise variance of different nonzero value (for example variance of noise equal 0.2, 0.8). Try sinusoidal, square and sawtooth waveforms. Observe the values of the real (destination) and predicted signals.
- Check the properties of noise elimination of the Kalman filters by using different values of R . Assign sinusoidal waveform of unity magnitude and distorting noise of the variance equal one. Observe the shape of the estimated signal and the original distorted signal at different values of R , changing from $1/4$ up to 100.