UDC 621.317.7

M.V. Nakonechnyj, Doctor of Technical Sciences., Professor ,
M.V. Stepanyak, Ph.D., Associate Professor,
National University "Lviv Polytechnic", Lviv

SYNTHESIS OF A SPEED REGULATOR OF A MOBILE OBJECT BY METHOD OF PLACEMENT OF POLES

Abstract. The features of the synthesis of regulators by placing poles in a given area of the plane of the roots of the characteristic equation of a closed system are considered.

In the environment of MATLAB (Simulink) the PI regulator was synthesized using the method of placement of the poles in a given region of the complex plane of the roots and a simulation of the system of automatic control of the speed of motion of the moving object using the synthesized regulator was carried out.

Key words: PI-regulator, system of automatic control of the speed of motion of a moving object using a synthesized regulator.

The methods of synthesis of regulators that are currently used in the design of linear automatic control systems are based on the use of frequency characteristics or the root hodograph. These methods are convenient in practical use and most control systems are designed based on their various modifications.

One of the methods of synthesis based on the application of modern control theory is known as the method of placement or assignment of poles. The method of placement of the poles allows to realize the given position of all the poles of the transmission function of the closed system, whereas the method of the root hodograph allows the placement of only two dominant poles at given points. A feature of the method is that the placement of all poles of the transfer function at given points requires the measurement of many variables in the system. In practice, not all the necessary regulator synthesis variables can be measured due to the complexity or lack of appropriate converters. In such cases, those variables that can not be measured directly are subject to an estimate based on the variables obtained as a result of the measurement.

The synthesis of the regulator is carried out using the model of an object in the space of the state variables in the form

$$\dot{x}(t) = Ax(t) + Bu(t), \tag{1}$$

y (t) = Cx (t), y(t)= Cx(t),

where the vector is the derivative of time from the vector. .

In general, the entry of the control object u (t) is a function of the state variables:

$$u(t) = f[x(t)]. \tag{2}$$

Equation (2) defines the law of control in the system. In the synthesis of the regulator by placing the poles at given points of the complex plane, the control law is presented as:

$$u(t) = -K_1x_1(t) - K_2x_2(t) - ... - K_nx_n(t). \tag{3}$$

In this case, the problem of the synthesis of the regulator is to calculate the coefficients Ki, which provide a given location of the roots of the characteristic equation of the system on the complex plane.

One of the main requirements for most control systems is their ability to process a continuous input action with a minimal fixed error. In the classical synthesis, this is achieved with the help of PI regulators.

The control system, for which the synthesis of the regulator is carried out, has the structure, which is given in Fig. 1

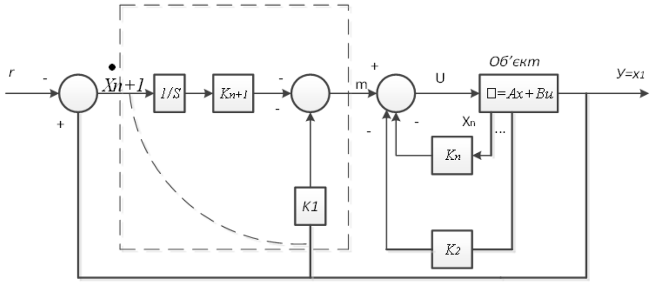

Fig.1. Generalized scheme of the system of regulation of the process using the PI-regulator

If necessary, the coefficient K1 can be introduced in a straight line parallel to the integrator with the Kn + 1 coefficient; the characteristic equation of the system thus does not change.

The expression for determining the coefficients Кi can be presented as:

$$|sI - A_a + B_aK_a| = s^{n+1} + a_n s^n + ... + a_1 s + a_0 . \qquad (4)$$

In this equation (n + 1) the values are known, and unknown (n + 1) coefficients are known. . To determine them, we can in equation (4) or equate the coefficients at the same steps s in the left and right portions and thus obtain a system with (n + 1) linear equations, or use the Ackerman formula [1]. The Ackerman formula for the solution of equation (4) has the form:

$$K_a = [0\ 0\ \dots\ 0\ 1][B_a\ A_aB_a\ \dots\ A_a^nB_a]^{-1} a_{ca}(A_a). \qquad (5)$$

Simulation of the system for controlling the speed of motion of a moving object was carried out in the SIMULINK environment [3].

The transition functions for two implementations of the K1 system in the feedback loop and K1 in the forward circle are shown in Fig. 2.

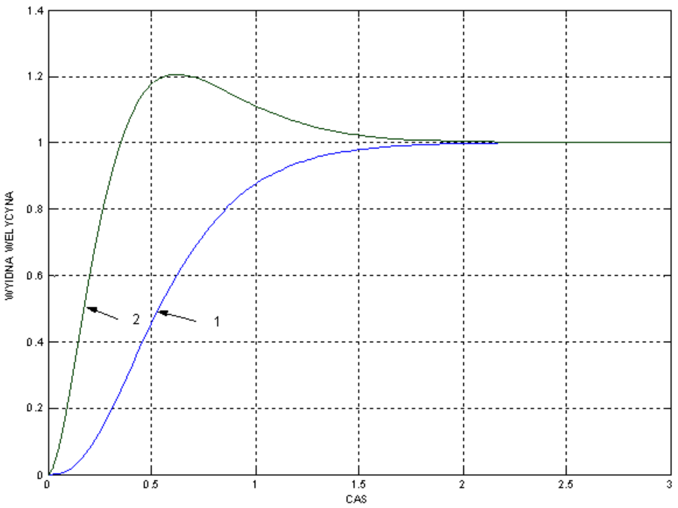

Fig. 2. Transition characteristics for two implementations of the system for controlling the speed of a moving object: curve 1 for K1 in the feedback loop; curve 2 for K1 in a straight circle

Conclusion

The procedure of synthesis of the speed controller of a moving object based on the placement of the poles of the transfer function of the closed system in the given points of the complex plane of the roots of the characteristic equation is considered. The practical implementation of this procedure requires that all variables of the state of the object be readily available for measurement. This requirement can be fulfilled in the implementation of modern procedures for the synthesis of regulators

References

1. C.L.Phillips and R.D. Harbor. Feedback Control Systems, 3rd ed. Upper Saddle River, NJ: Prentice Hall, 1996.
2. Carley, L. Antilock Brakes Becoming Standard On Today's Cars // Counterman, September, 1997.
3. Андрієвський Б.Р., Фрадаков А.Л. Вибрані розділи теорії автоматичного управління з прикладами на мові MATLAB: – СПб., 1999. – 200 с.