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«Research of the transient processes for discrete control systems»

B R Kassimova, A U Sadvakassova, L Zh Sansyzbay

Abstract

The analysis of the discrete control system on the stability and accuracy of the transient process is conducted. Conclusion: in a discrete system stability, accuracy and control quality depend on the parameters of the gain system and the time.

The discrete organization of the control unit

- **Following ratios were obtained:**

$u(t) = u_m = const,$

$u(t) = k\varepsilon(t),$

$\varepsilon(t) = g(t) - x(t).$

Let $g(t) = 0$, then $u_m = -kx(mT)$.

- **For the desired time interval, a subsequent differential equation could be derived:**

$dx/dt = u_m \Rightarrow x(t) = u_m t + c.$

- **The constant c could be found taking the time when $t = mT$:**

$x(mT) = -kx(mT)mT + c,$

$c = x(mT)\,(1 + kmT).$

- **As a result, following expression for $x(t)$ was obtained:**

$x(t) = x(mT)(1 - kt + kmT).$

- **Considering a time when $t = (m+1)T$:**

$x[(m+1)T] = x[mT](1 - k(m+1)T + kmT),$

$x[(m+1)T] = x[mT](1 - kmT - kT + kmT),$

$x[(m+1)T] = x[mT](1 - kT).$

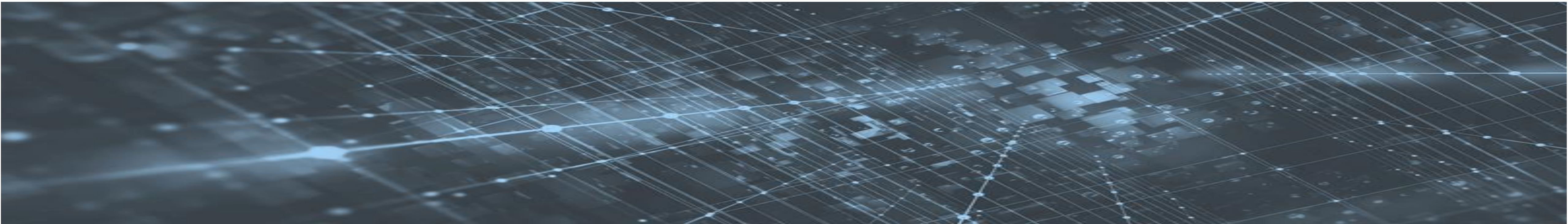
- **For a time $t = (m+2)T$, following could be derived:**

$x[(m+2)T] = x[(m+1)T](1 - kT) = x[mT](1 - kT)^2.$

- **For any arbitrary time:**

$x[nT] = x_0(1 - kT)^n,$

where x_0 is determined by the initial conditions.



Case 1

Table 1. Case 1. $kT < 1$, for example $kT = 0.5$.

n	0	1	2	3
$x[nT]$	x_0	$0.5x_0$	$0.25x_0$	$0.125x_0$

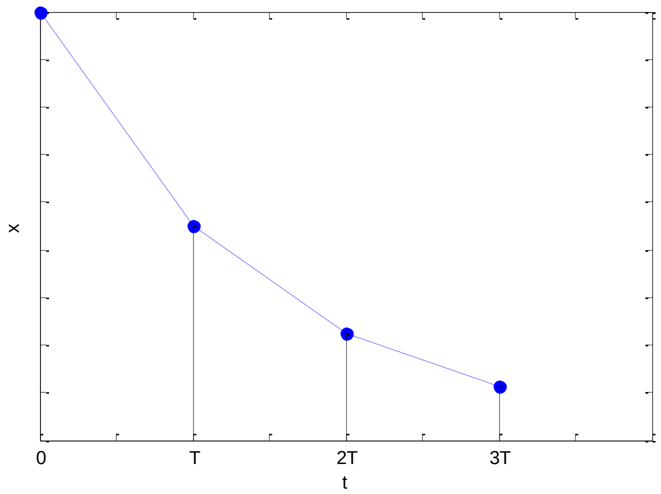


Figure 1. The transient response (Case 1).

In the chosen exemplification, a certain form of a periodic process can be observed (Figure 1).

Case 2

Table 2. Case 2. 1<kT<2, for example kT=1.5.

n	0	1	2	3
$x[nT]$	x_0	$-0.5x_0$	$0.25x_0$	$-0.125x_0$

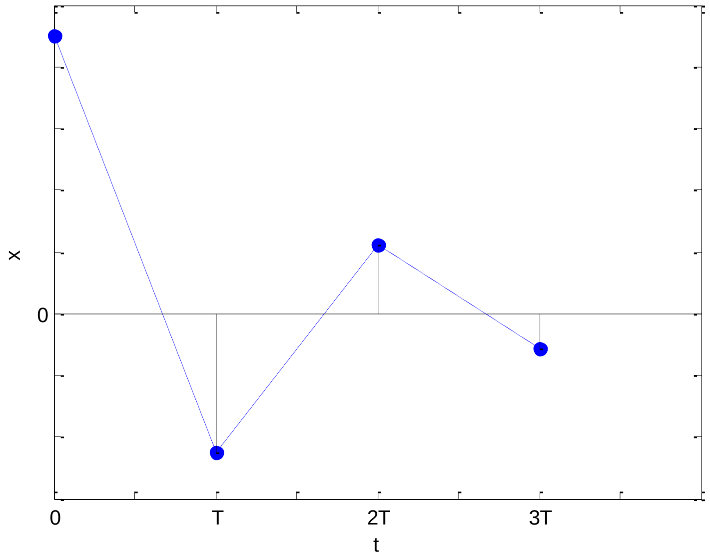


Figure 2. The transient response (Case 2).

Obtained values indicate an oscillating converging (stable) process as illustrated in Figure 2.

Case 3

Table 3. Case 3. kT>2, for example kT=2.5.

n	0	1	2	3
$x[nT]$	x_0	$-1.5x_0$	$2.25x_0$	$-3.375x_0$

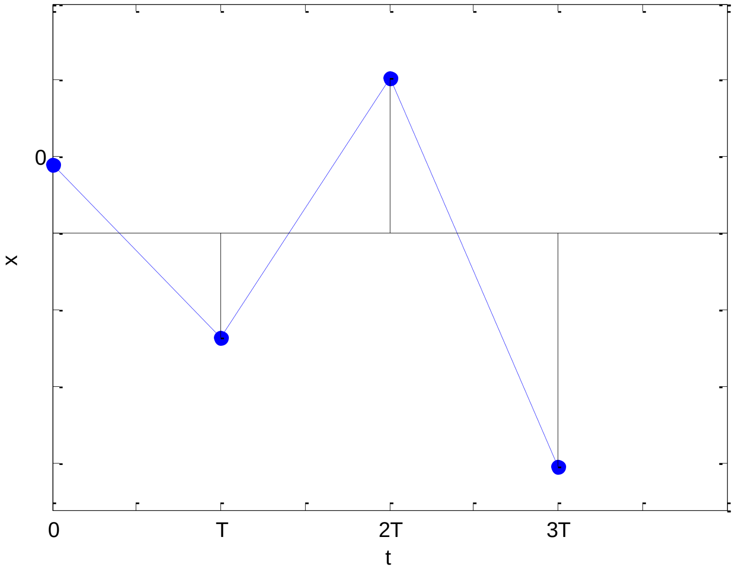


Figure 3. The transient response (Case 3).

An oscillating converging (unstable) process can be noticed in such case (Figure 7).

Conclusions

Results, implementation

- Thus, an apparent dependence of discrete system features such as stability, accuracy and quality of control on parameters of the system especially time variable T was demonstrated.
- Varying the values of kT can affect the stability of the system, with larger values worsening the type of the transient process.
- There are certain restrictions on the value of kT, with a particular limit upon exceeding kT which the system becomes unstable.
- Therefore, for a fixed value of T a fixed limit to the values of the gain k is present.
- If value of the gain k is assumed to be fixed, the indicators of the system worsen with an increase in the sampling period T, hence with T exceeding a certain limit value the system losing stability can be concluded.
- Based upon obtained results, the discrete system for linear control algorithms in terms of control process is not always worse than a continuous system.

Conclusions

Results, implementation

A discrete control system has two main advantages over a continuous system:

- ease of modernization (alteration of algorithm);
- higher efficiency when utilized with complex (non-linear, adaptive) control algorithms.

Contacts

B R Kassimova, A U Sadvakassova, L Zh Sansyzbay

Department of System analysis and Control, Faculty of Information Technologies, L.N.Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan

E-mail: sansyzbaylazzat@gmail.com