ABOUT THE DESCRIPTION OF 3D-NONLINEAR MODULAR SYSTEM IN THE FORM OF TWO VALUED ANALOGUES OF VOLTERRA'S POLYNOMIAL

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Discrete controlled systems mostly have been studied in cases of one and two parameters. But in practice often $3D$, $4D$ e.t.c. nD-systems are used [1, 2]. Such systems are a discrete model of many distributed systems. They are also called cellular systems and used, for example, at construction computing technique on the base of homogenous structures, by multidimensional digital processing of images and etc [3,4].

Finite value class of nD-systems is called as finite sequential-cellular machine. They also can call modular dynamical systems with distributing parameters.

In the report $3D$-modular dynamic system in which the first parameter represents time, second and third parameters represent accordingly coordinates of points in the area, is considered. Besides, the considered system is nonlinear system and input and output signals accept values in the Galois's field $GF(2)$ and the system is completely described as following functional relation:

$$y[n,c_1,c_2] = G\{u[m,c_1+p_1,c_2+p_2] \,|\, n-n_0 \le m \le n,\ p_1 \in P_1,\ p_2 \in P_2\}. \qquad (1)$$

Here

$$n \in T = \{0,1,2,...\},\ c_i \in \{...,-1,0,1,...\},\ i=\overline{1,2};\ y=[n,c_1,c_2] \in GF$$

and $u[n,c_1,c_2] \in GF(2)$ is output and input sequence of $3D$-system accordingly; n_0 is fixed depth of «memory», P_1 and P_2 are sets of limited connection by parameters c_1 and c_2 accordingly.

Lets

$$P_i = \{p_i(1),...,p_i(r_i)\},\ p_i(1) < ... < p_i(r_i),\ p_i(j) \in \{...,-1,0,1,...\},\ j=1,...,r_i;\ i=\overline{1,2},$$

also, $p_i(1)$ and $p_i(r_i)$ are finite numbers $i=\overline{1,2}$.

Lets $\bar{j} = (j_1,...,j_{\ell_1})$ and $\bar{\tau} = (\tau_1,...,\tau_{\ell_2})$ are collections accordingly in $L_1(\ell_1)$ and $L_2(\ell_2)$, where

$$\begin{aligned} L_1(\ell_1) &= \{(j_1,...,j_{\ell_1}) \,|\, 1 \le j_1 < ... < j_{\ell_1} \le r_1\}, \\ L_2(\ell_2) &= \{(\tau_1,...,\tau_{\ell_2}) \,|\, 1 \le \tau_1 < ... < \tau_{\ell_2} \le r_2\}; \end{aligned} \qquad (2)$$

$\bar{n}_{\alpha,\beta} = (n_1(\alpha,\beta,1),...,n_1(\alpha,\beta,m_{\alpha,\beta}))$ is collection from $\Gamma_1(m_{\alpha,\beta})$, where

$$\begin{aligned} \Gamma_1(m_{\alpha,\beta}) = \{\bar{n}_{\alpha,\beta} = (n_1(\alpha,\beta,1),...,n_1(\alpha,\beta,m_{\alpha,\beta})) \,|\, 0 \le n_1(\alpha,\beta,1) < ... \\ ... < n_1(\alpha,\beta,m_{\alpha,\beta}) \le n_0\}; \end{aligned} \qquad (3)$$

$$\bar{m} = (m_{1,1},...,m_{1,\ell_2},...,m_{\ell_1,\ell_2}),\ \bar{n}_2 = (\bar{n}_{1,1},...,\bar{n}_{1,\ell_2},...,\bar{n}_{\ell_1,\ell_2}); \qquad (4)$$

for all $\bar{n}_{\alpha,\beta} \in \Gamma_1(m_{\alpha,\beta})$, $\alpha = \overline{1,\ell_1}$, $\beta = \overline{1,\ell_2}$, set of all block vectors (collections) $\bar{n}_2$ is designated as $\Gamma(\ell_1,\ell_2,\bar{m})$;

$$F(i) = \{(\ell_1,\ell_2,\bar{m}) \,\Big|\, \sum_{\alpha=1}^{\ell_1}\sum_{\beta=1}^{\ell_2} m_{\alpha,\beta} = i,$$

$$m_{\alpha,\beta} \in \{0,...,n_0+1\},\ \alpha = \overline{1,\ell_1},\ \beta = \overline{1,\ell_2},\ \ell_i \in \{1,...,r_i\},\ i = \overline{1,2}\}\,. \qquad (5)$$

Theorem. Let have designations (2)-(5). Then for $3D$-nonlinear modular dynamical system (NMDS) with fixed memory n_0 and limited connection $P = P_1 \times P_2$ is right the following description as two valued analogue of Volterra's polynomials:

$$y[n,c_1,c_2] = \sum_{i=0}^{(n_0+1)r_1r_2} \sum_{(\ell_1,\ell_2,\overline{m})\in F(i)} \sum_{\bar{j}\in L_1(\ell_1)} \sum_{\bar{\tau}\in L_2(\ell_2)} \sum_{\overline{n}_2\in\Gamma(\ell_1,\ell_2,\overline{m})} h_{i,\ell_1,\ell_2,\overline{m}}[\bar{j},\bar{\tau},\overline{n}_2]\times$$
$$\times \prod_{\alpha=1}^{\ell_1}\prod_{\beta=1}^{\ell_2}\prod_{\sigma=1}^{m_{\alpha,\beta}} u[n-n_1(\alpha,\beta,\sigma), c_1+p_1(j_\alpha), c_2+p_2(\tau_\beta)],\ GF(2). \qquad (6)$$

Two valued analogue of Volterra's polynomial as (6) is common formula for $3D$-NMDS with fixed memory n_0 and limited connection $P = P_1 \times P_2$ and can be used in research its different properties, by giving and solution different mathematical problems and so on.

In the report the problem of definition of coefficients $h_{i,\ell_1,\ell_2,\overline{m}}[...]$ in (6) by certain values of input and output sequence $3D$-NMDS also is considered.

References

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