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THE PARALLEL BI-INDICATION ENCODING AND RENEWAL OF DATA IN BINARY POLYADIC SPACE

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The parallel bi-indication encoding and renewal of data in binary polyadic space, based on simultaneous processing of possible areas of binary bi-indication polyadic numbers is developed.

Розроблено методи паралельного двоознакого кодування й відновлення даних у двійковому поліадичному просторі, засновані на паралельній обробці допустимих зон двійкового двоознакового поліадичного числа.

Introduction

Urgent direction of modernization of the informative providing of automated systems of control is the development of methods reducing time on bringing the information [1–3].

Time on processing of data is relevant to the basic constituents of time (including encoding of data). Thus modern status of ACE development is characterized by the sharp increase of volumes of the processed and transmitted data.

Therefore even taking into account the use of the powerful computer systems time on processing is achieved at a few dozens of minutes [1–4]. Consequently, while developing new methods of compression it is necessary to provide the decline in time on processing equally with the increase of degree of compression.

The methods of structural presentation of binary information, providing the additional increase of degree of compression concerning the methods of the statistical encoding are expounded in works [5; 6]. At the same time the methods of the structural encoding are characterized by heavy temporal expenditures on processing. So the purpose of the article is the developments of methods of realization the structural encoding, which will allow to reduce temporal expenses on processing.

Development of parallel scheme of realization of bi-indication structural encoding of binary data in polyadic space

The method of the bi-indication polyadic encoding of binary data is set the following system of expressions [6]:

$$N\left(m,\Lambda,\Theta^{(x)}\right)_j = \sum_{z=1}^{Z}\sum_{i=1}^{m_z} a_{izj}\, p_{izj}^{(x)} \prod_{\phi=z+1}^{Z} V\left(\vartheta_\phi^{(x)}\right); \qquad (1)$$

$$V\left(\vartheta_\phi^{(x)}\right) = \frac{(m_\phi+1)!}{\left(2\vartheta_\phi^{(x)}\right)!\,\left(m_\phi+1-2\vartheta_\phi^{(x)}\right)!} \qquad (2)$$

where $p_{izj}^{(x)}$ is a gravimetric coefficient of $i\,j$ element of the possible z area of the processed sequence, depending on values m_z and $\vartheta_z^{(x)}$;

a_{izj} is $i\,j$ element of the possible z area of bi-indication binary polyadic number;

$V(\vartheta_z^{(x)})$ is an amount of binary subsequences, got for a possible z area on the amount of series of units, equal $\vartheta_z^{(x)}$ to a vector $\Theta^{(x)}$.

From the analysis of the system of expressions (1) and (2) follows, that forming of code-number $N\left(m,\Lambda,\Theta^{(x)}\right)_j$ is conducted a bi-indication polyadic number consistently, i.e. processing (calculation of gravimetric coefficients) of elements of z area is organized after $a_{i\gamma j}$ elements (where $\gamma=\overline{1,\, z-1}$) of previous areas were processed. At the same time the analysis of expression (1) shows, that the calculation of gravimetric $p_{izj}^{(x)}$ coefficients of a_{izj} elements can be conducted regardless of process of finding gravimetric $p_{i\gamma j}^{(x)}$ coefficients of $a_{i\gamma j}$ elements of other areas, i.e. $\gamma \neq z$.

Such independent processing of elements of separate areas is explained by property of polyadic bi-indication structural numbers in polyadic space. In this case $A_z^{(j)}$ sequence, consisting of elements of z area is the enlarged element of polyadic number.

So long as a_{izj} elements of z area satisfy the system of limitations by determination [6]:

$$\begin{cases} 0 \le a_{ij} \le \lambda_i - 1,\ i=\overline{1,m}; \\ \vartheta = \sum_{z=1}^{Z} \vartheta_z^{(x)}; \\ \vartheta_z^{(x)} = \vartheta_z,\ z=\overline{1,\, Z}, \end{cases}$$

a code-number $N(\vartheta_{zj}^{(x)})$ corresponds them:

$$N(\vartheta_{zj}^{(x)}) = f_{bic}(A_z^{(j)}, \vartheta_{zj}^{(x)}, x), \quad (3)$$

where $f_{bic}(\bullet)$ is functional of the successive bi-indication encoding set by the system of expressions (1), (2).

Taking into account expression (3) the value of code-number $N\left(m, \Lambda, \Theta^{(x)}\right)_j$ is formed for the sequence of $N(\vartheta_{zj}^{(x)})$, $z = \overline{1, Z}$ elements. Transforming correlation (1) with an account (3), we will get

$$N\left(m, \Lambda, \Theta^{(x)}\right)_j = \sum_{z=1}^{Z} N(\vartheta_{zj}^{(x)}) \prod_{\phi=z+1}^{Z} V(\vartheta_{\phi j}^{(x)}). \quad (4)$$

So along as a value of code-number of z area $N(\vartheta_{zj}^{(x)})$ is limited by determination from above with a $V(\vartheta_{zj}^{(x)}) - 1$ value, the accumulated product $\prod_{\phi=z+1}^{Z} V(\vartheta_{\phi j}^{(x)})$ is his gravimetric coefficient.

Expression (4) allows to organize forming of codes-numbers $N\left(m, \Lambda, \Theta^{(x)}\right)_j$ by zone. In this case $N(\vartheta_{zj}^{(x)})$ value is determined independently from $N(\vartheta_{\gamma j}^{(x)})$ value of other areas $\gamma = \overline{1, Z}$, $\gamma \neq z$. It follows, that there exists a possibility to organize parallel bi-indication structural encoding of binary data in polyadic space. This processing is in implementation of the followings stages (fig. 1).

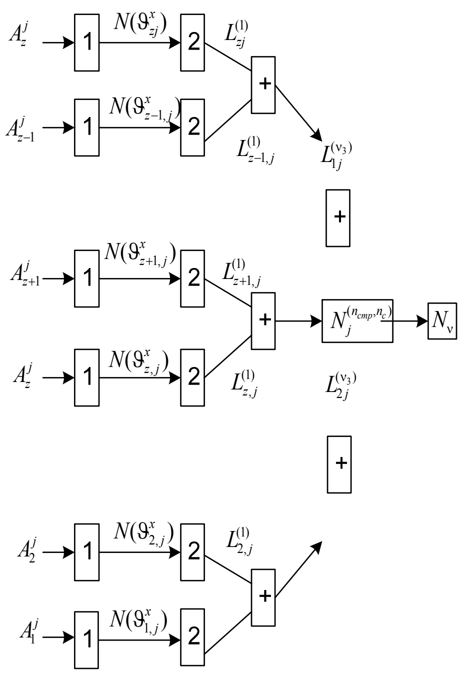

Fig. 1. Scheme of the parallel forming of code-number $N\left(m, \Lambda, \Theta^{(x)}\right)_j$

Stage 1. Simultaneous forming of codes-numbers $N(\vartheta_{zj}^{(x)})$ for all of areas $z = \overline{1, Z}$.

Forming of sizes $N(\vartheta_{zj}^{(x)})$ is carried out on the basis of functional $f_{\text{bic}}(\bullet)$.

Thus the parallel calculation of sizes $V(\vartheta_{\phi j}^{(x)})$ is organized for $\phi = \overline{2, Z}$.

Stage 2. The simultaneous calculation of products

$$N(\vartheta_{zj}^{(x)}) \prod_{\phi=z+1}^{Z} V(\vartheta_{\phi j}^{(x)})$$

is conducted for all of areas $z = \overline{1, Z}$.

Thus for $z = Z$ the value of the accumulated product is equal 1, i.e. the operation of productr is not conducted.

Stage 3. The value of code-number $N\left(m, \Lambda, \Theta^{(x)}\right)_j$ is formed on the basis of the parallel adding up of sizes

$$N(\vartheta_{zj}^{(x)}) \prod_{\phi=z+1}^{Z} V(\vartheta_{\phi j}^{(x)})$$

two by two (fig. 1).

On a fig. 1 transformations $f_{\text{bic}}(\bullet)$ and

$$N(\vartheta_{zj}^{(x)}) \prod_{\phi=z+1}^{Z} V(\vartheta_{\phi j}^{(x)})$$

are marked as operations «1» and «2» accordingly.

Thus at first level a size $L_{zj}^{(1)}$ is equal:

$$L_{zj}^{(1)} = N(\vartheta_{zj}^{(x)}) \prod_{\phi=z+1}^{Z} V(\vartheta_{\phi j}^{(x)}),$$

$$z = \overline{1, Z}.$$

At second level a size $L_{zj}^{(2)}$ is formed as a sum of two nearby sizes $L_{zj}^{(1)}$ and $L_{z+1,j}^{(1)}$:

$$L_{\frac{z+1}{2},j}^{(2)} = L_{zj}^{(1)} + L_{z+1,j}^{(1)},$$

$$z = \overline{1, Z}. \quad (5)$$

In general case on the ν stage of the adding up two by two a formula (5) will assume an air

$$L_{\frac{z+1}{\nu},j}^{(\nu)} = L_{zj}^{(\nu-1)} + L_{z+1,j}^{(\nu-1)},$$

$$z = \overline{1, \frac{Z}{\nu - 1}}.$$

On the finishing ν_f stage the value of code-number $N\left(m, \Lambda, \Theta^{(x)}\right)_j$ appears:

$$N\left(m, \Lambda, \Theta^{(x)}\right)_j = L_{1j}^{(\nu_f)} + L_{2,j}^{(\nu_f)},$$

where $\nu_f = \ell og_2 Z$.

Thus, parallel bi-indication presentation of binary data is worked out in polyadic space. Property of polyadic bi-indication structural numbers is taken into account in this case. It allows to form gravimetric coefficients for every possible area individually.

Temporal expenses for the simultaneous processing diminish on the average in Z times in relation to the sequential processing.

Creation of method of parallel renewal of bi-indication numbers is in binary polyadic space

Bi-indication polyadic decoding on the basis of the known values: code-number $N\left(m,\Lambda,\Theta^{(x)}\right)_j$, length of sequencem, vector of limitations on position of units $\Lambda=\{\lambda_i\}_{i=\overline{1,m}}$ and vector $\Theta^{(x)}$ of limits on the number of series of units in possible areas is set by the following system of expressions:

$$a_{izj}=\mathrm{sign}(1+\mathrm{sign}(Q_{i-1,zj}-f^{(x)}_{izj})), \quad (6)$$

where a_{izj} is ij element of the possible area of bi-indication of binary polyadic number;

$f^{(x)}_{izj}$ is an amount of bi-indication binary subsequences at which have i element is equal to the zero, i.e. $a_{izj}=0$;

Q_{izj} is a remaining value of code-number, got for a subsequence, consisting of

$$\left((m_z-i)+\sum_{\phi=z+1}^{Z} m_\phi \right)$$

binary elements:

$$A(i+1,z)_j=\{a_{i+1,zj},\ldots,a_{m_z,zj},\ a_{1,z+1,j},\ldots,$$

$$a_{m_{z+1},z+1,j},\ \ldots,a_{1Zj},\ldots,a_{m_Z,Zj}\}. \quad (7)$$

Recurrent correlation for the calculation of size Q_{izj} on i step to processing through the value of remaining code-number $Q_{i-1,zj}$ on a $(i-1)$ step looks like

$$Q_{izj}=Q_{i-1,zj}-a_{izj}\,f^{(x)}_{izj};$$

$$Q_{0zj}=N\left(m,\Lambda,\Theta^{(x)}\right)_j; \quad (8)$$

Q_{0zj}, $Q_{0,\,z+1,\,j}$

are initial values of remaining codes-numbers accordingly for possible zand $z+1$ areas;

$V(\vartheta^{(x)}_z)$ is an amount of binary subsequences (being possible zarea), got for a possible z area on the amount of series of units, equal $\vartheta^{(x)}_z$ for a vector $\Theta^{(x)}$.

Renewal of elements of binary is bi-indication polyadic number, set by expressions (6)–(8) is member wise. It is conditioned that the got system of expressions allows to recover a current *izj* element only after previous elements have been recovered

$$\left((\sum_{\phi=1}^{z-1} m_\phi) + (i-1) \right).$$

Atther same time from the analysis of expression:

$$N(m,\Lambda,\Theta^{(x)})_j=\sum_{z+1}^{z}\sum_{i=1}^{m_z} a_{izj}(r^{(x)}_{i,zj}-r^{(x)}_{i-1,zj})\prod_{\phi=z+1}^{z}\nu(\vartheta^{(x)}_\phi)=$$

$$=\sum_{z+1}^{z} N(\vartheta^{(x)}_\phi).$$

It follows for presentation of code-number $N\left(m,\Lambda,\Theta^{(x)}\right)_j$ of bi-indication of binary polyadic number, that a record (3) is a record for forming of code-number $N(\Theta^{(x)}_j)$ polyadic number, consisting of elements $N(\vartheta^{(x)}_{zj})$, where $z=\overline{1,Z}$:

$$N(\Theta^{(x)}_j)=\{N(\vartheta^{(x)}_{1j}),\ \ldots,\ N(\vartheta^{(x)}_{zj}),\ldots,\ N(\vartheta^{(x)}_{Zj})\}.$$

In this case foundation of element $N(\vartheta^{(x)}_{zj})$ will be a quantity $V(\vartheta^{(x)}_{zj})$:

$$N(\vartheta^{(x)}_{zj}) \le V(\vartheta^{(x)}_{zj})-1.$$

A gravimetric coefficient of element $N(\vartheta^{(x)}_{zj})$ of polyadic number will be a quantity $V(\Theta^{(x)})_{zj}$, equal to the accumulated produkt of values $V(\vartheta^{(x)}_{zj})$:

$$V(\Theta^{(x)})_{zj}=\prod_{\gamma=z+1}^{Z} V(\vartheta^{(x)}_{\gamma j}).$$

Then in accordance with properties of polyadic numbers renewal of z element of number $N(\Theta^{(x)}_j)$ is conducted on the basis of formula

$$N(\vartheta^{(x)}_{zj})=\left[\frac{N\left(m,\Lambda,\Theta^{(x)}\right)_j}{V(\Theta^{(x)})_{zj}}\right]-\left[\frac{N\left(m,\Lambda,\Theta^{(x)}\right)_j}{V(\vartheta^{(x)}_{zj})\,V(\Theta^{(x)})_{zj}}\right]V(\vartheta^{(x)}_{zj}). \quad (9)$$

Thus as the analysis of expression (9) shows, for the known quantities $V(\vartheta^{(x)}_{zj})$ and $V(\Theta^{(x)})_{zj}$ renewal of element $N(\vartheta^{(x)}_{zj})$ is conducted regardless of renewal of the rest elements, where $\gamma=\overline{1,Z}$ and $\gamma\ne z$.

From other side, when values

$V(\vartheta^{(x)}_{zj})$ $z=\overline{1,Z}$

are known, possibility appears for renewal of elements a_{izj} of binary bi-indication polyadic number independently from renewal of elements of other possible areas.

This renewal of elements of bi-indication polyadic number, being based on properties of polyadic presentation is by zone and is set by the followings stages.

Stage 1. The values of quantities $V(\vartheta_{zj}^{(x)})$ and $V(\Theta^{(x)})_{zj}$ are calculated. On the basis of these quantities renewal of values of codes-numbers $N(\vartheta_{zj}^{(x)})$ is conducted for every possible area (expression (13)).

Stage 2. On the known values of quantities $N(\vartheta_{zj}^{(x)})$, m_z and $\vartheta_z^{(x)}$ renewal of elements a_{izj} of current possible area is organized.

Stage 3. Inequality $i \le m_z$ is checked up.

If it is executed, the process of treatment passes to the stage 2.

If inequality is not executed, inequality $z \le Z$ is checked up. In the case of its implementation the process of treatment passes to the stage 1 for renewal of quantities $N(\vartheta_{z+1,\,j}^{(x)})$.

Otherwise the process of renewal is considered completed.

The scheme of renewal of elements of bi-indication binary polyadic number by zone allows to get the elements a_{izj} of z area independently from the elements of other areas, and determination of quantities $N(\vartheta_{zj}^{(x)})$ is carried out due to decoding of code-number $N\left(m,\Lambda,\Theta^{(x)}\right)_j$ independently from finding the elements $N(\vartheta_{\gamma j}^{(x)})$, where $\gamma=\overline{1,\,Z}$ and $\gamma \ne z$.

Therefore on the basis of the scheme it is possible to organize parallel renewal of elements a_{izj} for every possible area individually.

Graph-scheme of parallel renewal is presented on a fig. 2. On a fig. 2 the followings structural denotations are accepted:

$\boxed{1}$ is a device executing division $\left[\dfrac{N\left(m,\Lambda,\Theta^{(x)}\right)_j}{V(\Theta^{(x)})_{zj}}\right]$ with rounding off to lower whole;

$\boxed{2}$ is a device executing partaking with rounding off to lower whole of quantity $\left[\dfrac{N\left(m,\Lambda,\Theta^{(x)}\right)_j}{V(\Theta^{(x)})_{zj}}\right]$, got from the output of device 1 on foundation of the restored element $V(\vartheta_{zj}^{(x)})$;

$\boxed{\times}$ is a device executing multiplication of quantity $\left[\dfrac{N(m,\Lambda,\Theta^{(x)})_j}{V(\vartheta_{zj}^{(x)})\,V(\Theta^{(x)})_{zj}}\right]$, got from the output of device 2 on foundation of the restored element $V(\vartheta_{zj}^{(x)})$;

$\boxed{3}$ is a device executing renewal of sequence $A_{zj}^{(x)}$ of binary elements, contained in a possible area $A_{zj}^{(x)}=\{a_{1zj},\ldots,a_{m_z,zj}\}$;

$\boxed{-}$ is a device calculating value of difference of sizes $\left[\dfrac{N(m,\Lambda,\Theta^{(x)})_j}{V(\Theta^{(x)})_{zj}}\right]$ and

$$\left[\frac{N(m,\Lambda,\Theta^{(x)})_j}{V(\vartheta_{zj}^{(x)})\,V(\Theta^{(x)})_{zj}}\right]V(\vartheta_{zj}^{(x)}),$$

got accordingly from the outputs of device 1 and device 2.

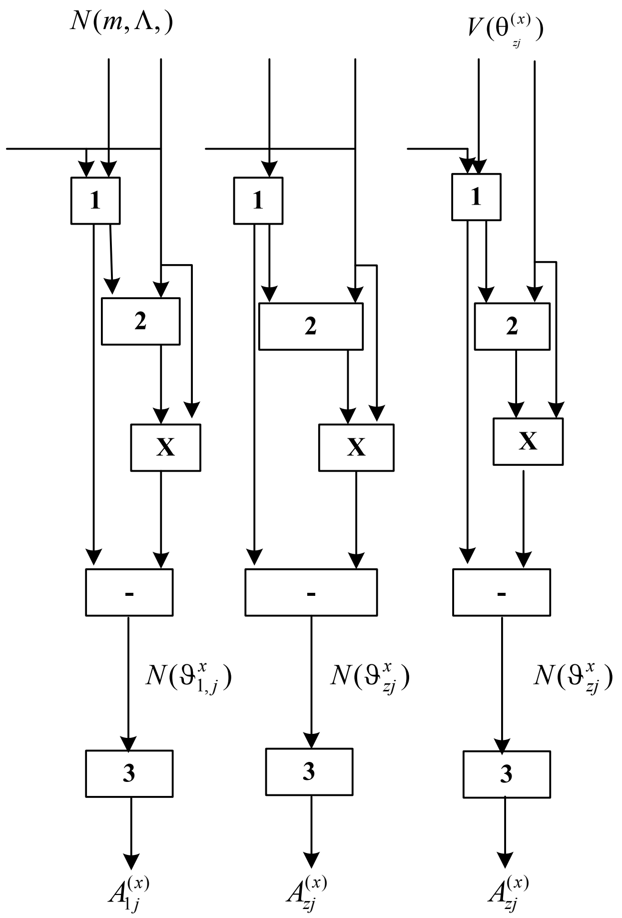

Fig. 2. Graph-scheme of parallel renewal of binary bi-indication polyadic numbers

A value of difference in obedience to expression (1) will be the value of element $N(\vartheta_{z\,j}^{(x)})$.

From the analysis of the stages of parallel renewal, it follows that dignities of bi-indication renewal one-indicatiion memberwise renewal are:

1) possibility to carry out renewal of elements of possible z area independently from the process of renewal of previous $(z-1)$ areas;

2) for the receipt of $a_{i\,z\,j}$ elements it is not required to calculate a quantity $\prod_{\phi=z+1}^{Z} V(\vartheta_{\phi}^{(\xi)})$ which is a constant within the processed area each time.

Conclusions

The method of parallel renewal of bi-indication numbers is developed in binary polyadic space. This method is based on possibility of parallel renewal of elements of bi-indication polyadic number independently the process of renewal of other elements. Such possibility is conditioned by polyadic properties of bi-indication of binary numbers in polyadic space.

Temporal expenses for the parallel processing diminish on the average in Z times relatively consistently-recurrent processing.

On the basis of given account it is possible to do the followings conclusions.

The parallel bi-indication encoding of data in binary polyadic space, based on simultaneous processing of possible areas of binary bi-indication polyadic numbers is developed. This property is conditioned polyadic properties of bi-indication binary numbers in polyadic space.

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