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A CONCEPTION FOR COMPARISON OF INTEGER DATA REPRESENTED IN A RESIDUE NUMBER SYSTEM

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Abstract: *The methods for comparison integer data that are represented in the residue number system (RNS) are described. The method of arithmetic comparison of integer data is developed, which improves the accuracy of processing of information presented in the RNS. The developed mathematical model and the method of precise arithmetic comparison of data in RNS, which are based on obtaining and using the positional feature of the non-position code, provide maximum reliability of the result of comparing numbers with a minimum amount of equipment of the comparator. The use of the developed method makes it possible to increase the efficiency of the operation of specialized computing devices in the RNS. Based on the developed method, a device was synthesized for the implementation of the comparison process in the RNS to which the patent of Ukraine was obtained, which confirms the novelty of the world and the practical significance of the results of this article.*

Keywords: *data processing system; residue number system; arithmetic integer comparison of data; accuracy processing of data; nulevization of number.*

1 Introduction

As is well known, the prime advantage of a position-independent residue number system (RNS) is the possibility to organize the process of fast processing of integers. The use of RNSs makes it possible to create methods and digital hardware of computer systems that improve user efficiency in solving definite classes of problems in which the operations of integer arithmetic addition, subtraction, and multiplication are applied. This is reached owing to the use of RNS properties such as independence, equality, and small length of residues whose totality $\{a_i\}$ represents a number $A_{RNS} = (a_1 \| a_2 \| \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n)$ in terms of n bases (moduli) of a given position-independent number system [1,2].

The need for solving a wide class of problems containing logical operations (*for example, the operation of comparison* $A_{RNS} = (a_1 \| a_2 \| \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n)$ *and* $B_{RNS} = (b_1 \| b_2 \| \ldots \| b_{i-1} \| b_i \| b_{i+1} \| \ldots \| b_n)$, which often occurs in control problems) along with arithmetic integer operations by a computer system that processes integer data (CSPID) and perform operations on RNS numbers reduces the overall efficiency of using a position-independent number system. This is stipulated by a considerable (*in comparison with the execution of the above-mentioned arithmetic modular operations*) time of execution of the data comparison operation in RNS. Therefore, the investigation and improvement of the existing methods and algorithms for hardware implementation of the operation of arithmetic comparison of data in RNS and also the development of new ones is an important and topical scientific and applied problem of creation of CSPIDs.

2 Methods for comparing numbers in a residue number system

As is well known, there are three groups of methods for comparing numbers in RNS [3,4]. The methods of direct comparison belong to the first group. They are based on the transformation of numbers A_{RNS} and B_{RNS} from an RNS code into the positional binary number system (PNS) $A_{PNS} = \overline{\alpha_\rho, \alpha_{\rho-1} .... \alpha_1}$ and $B_{PNS} = \overline{\beta_\rho, \beta_{\rho-1}, ... \beta_1}$ (ρ *is the digit capacity of the numbers* A_{PNS} *and* B_{PNS}) and their further comparison using binary positional adders. The methods based on the principle of nulevization belong to the second group. The procedure of the process of nulevization consists of the passage from the initial number $A_{RNS} = (a_1 \| a_2 \| ... \| a_{i-1} \| a_i \| a_{i+1} \| ... \| a_n)$ represented in an RNS to a number of the form $A^{(н)}{}_{RNS} = [0 \| 0 \| ... \| 0 \| \gamma_n^{(A_{RNS})}]$. With the help of the value of $\gamma_n^{(A_{RNS})}$, the numerical interval $[j_{A_{RNS}} m_n, (j_{A_{RNS}} + 1) m_n)$ is determined that contains the number A_{RNS}. The nulevization of the number $B_{RNS} = (b_1 \| b_2 \| ... \| b_{i-1} \| b_i \| \ \| b_{i+1} \| ... \| b_n)$ is similarly performed, whence we obtain the values of $\gamma_n^{(B_{RNS})}$. In this case, the value of $\gamma_n^{(B_{RNS})}$ determines the numerical interval $[j_{B_{RNS}} m_n, (j_{B_{RNS}} + 1) m_n)$ that contains the numbers B_{RNS}. The result of the operation of arithmetic comparison of the numbers A_{RNS} and B_{RNS} in RNS is determined by comparing the obtained values of $\gamma_n^{(A_{RNS})}$ and $\gamma_n^{(B_{RNS})}$ or the values of the corresponding quantities $j_{A_{RNS}}$ и $j_{B_{RNS}}$ ($j_{A_{RNS}}$, $j_{B_{RNS}} = \overline{0, \prod_{i=1}^{n-1} m_i}$).

The methods based on the determination of existing features or additional formation and use of special indicators of a number in RNS, i.e., the so-called position signs of a position-independent code (PIPIC) in RNS belong to the third group. Such signs (*for example, a rank r of a number*) contain information on the values of the numbers being compared and can be used for determining the value of a number in RNS. The use of PIPICs makes it possible to reduce the time of execution of the data comparison procedure in RNS in comparison with the first and second groups of methods.

The main drawback of the existing fast methods of arithmetic data comparison in RNS that are based on the use of PIPICs is the impossibility of ensuring the maximum accuracy in all cases of comparison of two numbers (A_{RNS} and B_{RNS}). This circumstance stipulates the obtainment of an uncertain result of comparison of numbers. The objective of this article is the development of a method for exact arithmetic comparison of two numbers $A_{RNS} = (a_1 \| a_2 \| ... \| a_{i-1} \| a_i \| a_{i+1} \| ... \| a_n)$ and $B_{RNS} = \ = (b_1 \| b_2 \| ... \| b_{i-1} \| b_i \| b_{i+1} \| ... \| b_n)$ in RNS on the basis of using PIPICs. The use of the proposed method of exact comparison of data will make it possible to reliably determine the result of the operation of arithmetic integer comparison of two numbers in RNS.

3 Method and algorithm for arithmetic comparison of numbers in RNS

We will briefly consider the essence of an existing method of arithmetic comparison of numbers $A_{RNS} = (a_1 \| a_2 \| ... \| a_{i-1} \| a_i \| a_{i+1} \| ... \| a_n)$ and $B_{RNS} = (b_1 \| b_2 \| ... \| b_{i-1} \| b_i \| b_{i+1} \| ... \| b_n)$ in RNS on the basis of using PIPICs. Let an RNS be specified by a collection $\{m_i\}$, $i = \overline{1, n}$ of pairwise primes. The greatest common divisor (GCD) of any pair of bases m_i and m_j ($i, j = \overline{1, n}$; $i \neq j$) is equal to one, i.e., GCD (m_i, m_j) = 1. For the sake of generality, we will consider that the RNS is ordered, i.e., $m_i < \mathrm{m}_{i+1}$. The essence of the well-known method consists of the formation and use of PIPICs on the basis of constructing a special code (SC) for each of the numbers A_{RNS} and B_{RNS} being compared. In this case, for an arbitrary module m_i, the RNS for the numbers A_{RNS} and B_{RNS} being compared is formed by a special code of the form $K_{N_{m_i}}^{(n_A)} = \{Z_{N_{m_i}-1}^{(A_{RNS})}\ Z_{N_{m_i}-2}^{(A_{RNS})} \ldots Z_2^{(A_{RNS})} Z_1^{(A_{RNS})}\ Z_0^{(A_{RNS})}\}$ and $K_{N_{m_i}}^{(n_B)} = \left\{Z_{N_{m_i}-1}^{(B_{RNS})}\ Z_{N_{m_i}-2}^{(B_{RNS})} \ldots Z_2^{(B_{RNS})}\ Z_1^{(B_{RNS})}\ Z_0^{(B_{RNS})}\right\}$.

The locations of zero bits $K_{N_{m_i}}^{(n_A)}$ and $K_{N_{m_i}}^{(n_B)}$ in the SC are determined by the PIPICs n_A and n_B of the numbers A_{RNS} and B_{RNS} respectively. The procedure of determining an SC is described in [5] in detail.

To understand the essence of the proposed comparison method, we will consider a geometrical interpretation of the process of comparison of two numbers. Figure 1 presents the scheme of partitioning a numerical interval [0, *M*) corresponding to the range of representation of the numbers $A_{RNS} = (a_1 \| a_2 \| \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n)$ and $B_{RNS} = (b_1 \| b_2 \| \ldots \| b_{i-1} \| b_i \| b_{i+1} \| \ldots \| b_n)$ being compared, where $M = \prod_{i=1}^{n} m_i$. This numerical interval [0, *M*) is divided into N_{m_i} equal intervals $[jm_i, (j+1)m_i)$ of length m_i. The operation of transformation of the numbers A_{RNS} and B_{RNS} being compared by the use of the so-called nulevization constants $KH_{m_i}^{(A_{RNS})} = (a_1' \| a_2' \| \ldots \| a_{i-1}' \| a_i \| a_{i+1}' \| \ldots \| a_n')$ and $KH_{m_i}^{(B_{RNS})} = (b_1' \| b_2' \| \ldots \| b_{i-1}' \| b_i \| b_{i+1}' \| \ldots \| b_n')$ to the form $A_{m_i} = A_{RNS} - KH_{m_i}^{(A_{RNS})} = (a_1 \| a_2 \| \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n) - (a_1' \| a_2' \| \ldots \| a_{i-1}' \| a_i \| a_{i+1}' \| \ldots \| a_n') = [a_1^{(1)} \| a_2^{(1)} \| \ldots \| a_{i-1}^{(1)} \| 0 \| a_{i+1}^{(1)} \| \ldots \| a_n^{(1)}]$ and $B_{m_i} = B_{RNS} - KH_{m_i}^{(B_{RNS})} = (b_1 \| b_2 \| \ldots \| b_{i-1} \| b_i \| b_{i+1} \| \ldots \| b_n) - (b_1' \| b_2' \| \ldots \| b_{i-1}' \| b_i \| b_{i+1}' \| \ldots \| b_n') = [b_1^{(1)} \| b_2^{(1)} \| \ldots \| b_{i-1}^{(1)} \| 0 \| b_{i+1}^{(1)} \| \ldots \| b_n^{(1)}]$ is equivalent the shift of these numbers A_{RNS} and B_{RNS} to the left edges of the corresponding numerical intervals $[j_1 m_i, (j_1+1)m_i)$ and $[j_2 m_i, (j_2+1)m_i)$ of their location, which corresponds to the reduction of them to numbers A_{m_i} and B_{m_i} that are multiple of the ith module m_i of the RNS. Then numbers $j_1 = n_A$ and $j_2 = n_B$ of these intervals are determined that, in this case, are position signs of a position-independent code in the RNS.

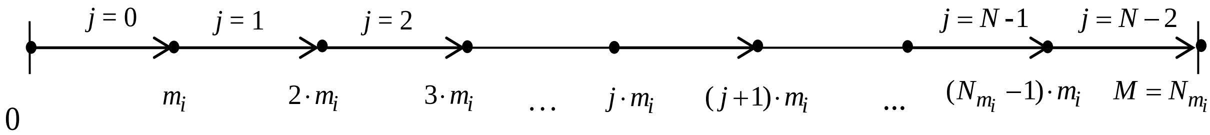

Fig. 1 – Scheme of partitioning a numerical interval [0, *M*) into equal intervals for an arbitrary base m_i of RNS

4 An indicator of an estimate for the accuracy of comparing numbers in RNS

As is well known, the most important characteristic of the process of comparison of numbers is the comparison accuracy W_{m_i}. In the general case, the accuracy W_{m_i} of comparison of two numbers $A_{RNS} = (a_1 \| a_2 \| \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n)$ and $B_{RNS} = (b_1 \| b_2 \| \ldots \| b_{i-1} \| b_i \| b_{i+1} \| \ldots \| b_n)$ in RNS depends on locations of intervals $[j_1 m_i, (j_1+1)m_i)$ and $[j_2 m_i, (j_2+1)m_i)$ of these numbers on the numerical axis $0 \div M$, i.e., on the numbers j_1 and j_2 of ranges of these intervals. If $j_1 \neq j_2$, then the accuracy W_{m_i} of comparison of two numbers A_{RNS} and B_{RNS} depends only on the locations of the intervals $[j_1 m_i, (j_1+1)m_i)$ and $[j_2 m_i, (j_2+1)m_i)$ on the numerical axis $0 \div M$. The process of comparison of two A_{RNS} and B_{RNS} is as follows. If $A_{RNS} > B_{RNS}$, and if $j_1 < j_2$, then $A_{RNS} < B_{RNS}$. If $j_1 = j_2$, then $A_{RNS} = B_{RNS}$. In this case, the comparison accuracy W_{m_i} depends only on the range of the interval $[j_1 m_i, (j_1+1)m_i)$ of location of the numbers A_{RNS} and B_{RNS}, i.e., on the value m_i of an RNS module. Proceeding from the aforesaid and also from the geometrical interpretation of the comparison process, it is obvious that, in the above case, the comparison accuracy W_{m_i} in RNS can be estimated using the relationship

$$W_{m_i} = 1/m_i . \qquad (1)$$

Note that, for an arbitrary value m_i of an RNS module, the amount of equipment N_{m_i} of the device for comparing two numbers A_{RNS} and B_{RNS} that mainly depends on the amount of the equipment of two groups of adders entering in it and implementing the operations $A_{m_i} - K_A \cdot m_i = Z_{K_A}^{(A_{RNS})}$ and $B_{m_i} - K_B \cdot m_i = Z_{K_B}^{(B_{RNS})}$ is defined as follows:

$$N_{m_i} = \prod_{\substack{k=1; \\ k \neq i.}}^{n-1} m_k . \qquad (2)$$

For large sizes of digit grids of CSPIDs, the value of $N_{m_i} = \prod_{\substack{k=1; \\ k \neq i.}}^{n-1} m_k$ can be rather sizeable.

Let us consider the process of comparison in the case when numbers $A_{RNS} = (a_1 \| a_2 \| ... \| a_{i-1} \| a_i \| a_{i+1} \| ... \| a_n)$ and $B_{RNS} = (b_1 \| b_2 \| ... \| b_{i-1} \| b_i \| b_{i+1} \| ... \| b_n)$ are in one interval $[jm_i, (j+1)m_i)$, i.e., $j_1 = j_2 = j$ ($A_{m_i} = B_{m_i} = j \cdot m_i$). Proceeding from the aforesaid, for this case of comparison, the numbers A_{RNS} and B_{RNS} will always be equal to each other, which is contrary to the facts in the majority of cases. To obtain a reliable result of comparison, the procedure of comparison of the numbers A_{RNS} and B_{RNS} should be additionally organized within the numerical interval $[jm_i, (j+1)m_i)$ itself to which they belong. To solve this problem (*with allowance made for the dependence on the magnitude of the module* m_i *being used*), we will consider variants of arithmetic comparison of numbers in RNS specified by an ordered collection $\{m_i\}$ $(i = \overline{1,n})$ of bases.

Variant 1. $m_i = m_n = \max$. In this case, the accuracy W_{m_n} of comparison in RNS is determined by the length m_n of the interval $[jm_n, (j+1)m_n)$, and it this length that will be minimal (see relationship (1)). In this case, the amount N_{m_n} of the equipment of the device for the comparison of two A_{RNS} numbers is minimal and is defined by the following expression:

$$N_{m_n} = \prod_{k=1}^{n-1} m_k . \qquad (3)$$

Variant 2. Let $m_i = m_1 = \min$. In any RNS, we have the minimum possible value of the module $m_i = m_1 = 2$. In this case, the maximum comparison accuracy $W_{m_1} = 1/2$ in the RNS is provided that is determined by the minimum value $m_1 = 2$ of the length of the interval $[jm_1, (j+1)m_1)$. In this variant, the amount of the equipment of the device for arithmetic comparison of two numbers A_{RNS} and B_{RNS} in RNS is maximum, $N_{m_1} = \prod_{k=2}^{n} m_k$.

Since the minimal value of a module for RNS is defined as $m_i = m_1 = 2$, it is obvious that, for both the first and second variants of comparison, the maximum accuracy $W_{\max} = 1$ of comparison of two numbers A_{RNS} and B_{RNS} cannot be reached. Hence, a method for arithmetic comparison should be developed whose result would be determined with the maximum accuracy $W_{\max} = 1$ and, at the same time, a minimum amount $N_{\min}$ of the equipment of the comparing unit would be provided, i.e., the implementation of the functional $F_{opt.} = W_{\max}(N_{\min})$ should be provided. For this method of arithmetic comparison of two numbers in RNS, which provides the implementation of the functional $F_{opt.}$, two conditions (*requirements*) should be fulfilled. The first (main) condition consists of ensuring the maximum comparison accuracy. In this case, the amount of equipment of the device for comparing two numbers (A_{RNS} and B_{RNS}) will be maximum (formula (2)). The second (secondary) condition consists of providing a minimum amount $N_{\min}$ of the equipment of the comparing device, whenever possible.

In the proposed new method of arithmetic data comparison, the above requirements are implemented as follows. First, the implementation is performed by choosing the maximum RNS base value $m_i = m_n = \max$. In this case, the numerical interval [0, *M*) contains the minimum number of equal numerical intervals $[jm_n, (j+1)m_n)$ (*see Fig. 1*) and thereby provides the fulfillment of the condition of the minimum amount $N_{m_n} = \prod_{k=1}^{n-1} m_k = \min$ of the equipment of the comparison device. Second, the method for comparing two numbers $A_{RNS} = (a_1 \| a_2 \| \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n)$ and $B_{RNS} = (b_1 \| b_2 \| \ldots \| b_{i-1} \| b_i \| b_{i+1} \| \ldots \| b_n)$ that are represented in RNS and belong to one numerical interval $[jm_n, (j+1)m_n)$ must contain an additional procedure of comparison of residues a_n and b_n of these numbers to the maximum RNS module $m_i = m_n = \max$. In this case, the maximum comparison accuracy $W_{\max} = 1$ is reached, namely, right up to unit length intervals, and the functional $F_{opt.}$ reaches its optimum ($W_{\max} = 1$ and $N_{\min} = \prod_{k=1}^{n-1} m_k$). In this case, the residues a_n and b_n are compared simultaneously with the process of formation of SCs.

5 Algorithm for exact arithmetic comparison of two numbers in RNS

When the values of a_n, b_n, n_A and n_B and also the procedure of comparison of two numbers $A_{RNS} = (a_1 \| a_2 \| \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n)$ and $B_{RNS} = (b_1 \| b_2 \| \ldots \| b_{i-1} \| b_i \| b_{i+1} \| \ldots \| b_n)$ are known, the algorithm of exact arithmetic comparison of two numbers in RNS can be represented in the form of the analytical relationships

$$A_{RNS} = B_{RNS}, \text{ if } [(n_A = n_B) \wedge (a_n = b_n)]; \tag{4}$$

$A_{RNS} > B_{RNS}$, if

$$\{(n_A > n_B) \vee [(n_A = n_B) \wedge (a_n > b_n)]\}; \tag{5}$$

$A_{RNS} < B_{RNS}$, if

$$(n_A < n_B) \vee [(n_A = n_B) \wedge (a_n < b_n)]. \tag{6}$$

The algorithm of exact arithmetic comparison of numbers (4)–(6) is used in the method of exact arithmetic comparison of two numbers (A_{RNS} and B_{RNS}) in RNS. The essence of the method is as follows.

1. Represent the numbers $A_{RNS} = (a_1 \| a_2 \| \ldots \ \ldots \| a_{i-1} \| a_i \| a_{i+1} \| \ldots \| a_n)$ and $B_{RNS} = (b_1 \| b_2 \| \ldots$ $\ldots \| b_{i-1} \| b_i \| b_{i+1} \| \ldots \| b_n)$ being compared in RNS.

2. Based on the values of a_n and b_n, choose nulevization constants of the form $KH_{m_n}^{(A_{RNS})} =$ $= (a_1' \| a_2' \| \ldots \| a_{i-1}' \| a_i' \| a_{i+1}' \| \ldots \| a_n)$ and $KH_{m_n}^{(B_{RNS})} = (b_1' \| b_2' \| \ldots \| b_{i-1}' \| b_i' \| b_{i+1}' \| \ldots \| b_n)$. Simultaneously compare the values of the residues a_n and b_n of the numbers A_{RNS} and B_{RNS}.

3. Determine the values of A_{m_n} and B_{m_n} multiple of the value of the RNS module m_n as follows:

$$A_{m_n} = A_{RNS} - KH_{m_n}^{(A_{RNS})} = (a_1 \| a_2 \| ... \| a_{i-1} \| a_i \| a_{i+1} \| ... \| a_n) - (a_1^{'} \| a_2^{'} \| ...$$
$$... \| a_{i-1}^{'} \| a_i^{'} \| a_{i+1}^{'} \| ... \| a_n) = [a_1^{(1)} \| a_2^{(1)} \| ... \| a_{i-1}^{(1)} \| a_i^{(1)} \| a_{i+1}^{(1)} \| ... \| 0];$$
$$B_{m_n} = B_{RNS} - KH_{m_n}^{(B_{RNS})} = (b_1 \| b_2 \| ... \| b_{i-1} \| b_i \| b_{i+1} \| ... \| b_n) -$$
$$- (b_1^{'} \| b_2^{'} \| ... \| b_{i-1}^{'} \| b_i^{'} \| b_{i+1}^{'} \| ... \| b_n) = [b_1^{(1)} \| b_2^{(1)} \| ... \| b_{i-1}^{(1)} \| b_i^{(1)} \| b_{i+1}^{(1)} \| ... \| 0].$$

4. Using adders, the collection of constants 0, $m_n, ..., (N-1) \cdot m_n$, and the formulas $A_{m_n} - K_A \cdot m_n = Z_{K_A}^{(A_{RNS})}$ and $B_{m_n} - K_B \cdot m_n = Z_{K_B}^{(B_{RNS})}$, determine the SC components $Z_i^{(A_{RNS})}$ and $Z_j^{(B_{RNS})}$ that are represented in the form $K_{N_{m_n}}^{(n_A)} = \{Z_{N_{m_n}-1}^{(A_{RNS})}\ Z_{N_{m_n}-2}^{(A_{RNS})} ...\ Z_2^{(A_{RNS})} Z_1^{(A_{RNS})}\ Z_0^{(A_{RNS})}\}$ и $K_{N_{m_n}}^{(n_B)} = \{Z_{N_{m_n}-1}^{(B_{RNS})}\ Z_{N_{m_n}-2}^{(B_{RNS})} ...\ Z_2^{(B_{RNS})}\ Z_1^{(B_{RNS})}\ Z_0^{(B_{RNS})}\}$.

5. Based on the obtained values of the SCs $K_{N_{m_n}}^{(n_A)} = \{Z_{N_{m_n}-1}^{(A_{RNS})}\ Z_{N_{m_n}-2}^{(A_{RNS})} ...\ Z_2^{(A_{RNS})} Z_1^{(A_{RNS})}\ Z_0^{(A_{RNS})}\}$ и $K_{N_{m_n}}^{(n_B)} = \ = \{Z_{N_{m_n}-1}^{(B_{RNS})}\ Z_{N_{m_n}-2}^{(B_{RNS})} ...\ Z_2^{(B_{RNS})}\ Z_1^{(B_{RNS})}\ Z_0^{(B_{RNS})}\}$, determine the values of the SC bits for which the conditions $Z_{n_A}^{(A_{RNS})} = 0$ and $Z_{n_B}^{(B_{RNS})} = 0$ are satisfied. Find the quantitative values of n_A and n_B of PIPICs.

6. Determine the final result of arithmetic comparison of the numbers A_{m_n} and B_{m_n} according to relationships (4)–(6).

Based on the presented method, a device is developed that implements the process of comparison in RNS, and the patent of Ukraine for this device is acquired [6]. This fact confirms the practical importance of the results of this article.

6 Conclusions of research

In this work, a method is developed for exact arithmetic comparison of data represented in RNS. The method is based on the obtainment and use of PIPICs and maximizes the validity of the result of comparison of numbers in RNS. It is recommended to use it when the operation of arithmetic comparison of data is implemented in hardware in CSPIDs operating in RNSs.

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Концепція порівняння цілочислових даних, що представлені у системі залишкових класів.

Анотація. Описано методи порівняння цілочислових даних, які представлені у системі залишкових класів (СЗК). Розроблено методику арифметичного порівняння цілочислових даних, яка підвищує точність обробки інформації, представленої у СЗК. Розроблені математична модель і метод точного арифметичного порівняння даних у СЗК, які засновані на отриманні та використанні позиційного ознаки непозиційного коду, забезпечують максимальну достовірність результату порівняння чисел при мінімальній кількості обладнання пристрою, що порівнює. Використання розробленого методу дозволяє підвищити ефективність функціонування спеціалізованих обчислювальних пристроїв у СЗК. На підставі розробленого методу, синтезовано пристрій для реалізації процесу порівняння у СОК, на яке отримано патент України, що підтверджує світову новизну та практичну значимість результатів даної статті.

Ключові слова: система обробки даних; система залишкових класів; цілочислове арифметичне порівняння даних; точність обробки даних; нулевізація числа.

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Концепция сравнения целочисленных данных, представленных в системе остаточных классов.

Аннотация. Описаны методы сравнения целочисленных данных, которые представлены в системе остаточных классов (СОК). Разработана методика арифметического сравнения целочисленных данных, которая повышает точность обработки информации, представленной в СОК. Разработанные математическая модель и метод точного арифметического сравнения данных в СОК, которые основаны на получении и использовании позиционного признака непозиционного кода, обеспечивают максимальную достоверность результата сравнения чисел при минимальном количестве оборудования сравнивающего устройства. Использования разработанного метода позволяет повысить эффективность функционирования специализированных вычислительных устройств в СОК. На основании разработанного метода, синтезировано устройство для реализации процесса сравнения в СОК, на которое получен патент Украины, что подтверждает мировую новизну и практическую значимость результатов данной статьи.

Ключевые слова: система обработки данных; система остаточных классов; целочисленное арифметическое сравнение данных; точность обработки данных; нулевизация числа.