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# A new Algorithm of Parallel Information Processing for Manufacturing Industrial

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**Abstract -** *Addition is one of basic statistical operations, and its calculation is often time-critical. Therefore is the search for faster parallel addition techniques. In this paper we present an algorithm for parallel calculation of N numbers in K steps, where K is the number of different values in the input. This is a generalized approach of the one produced in [2]. The main difference lies in utilization of different number representation.*

**Keywords -** *Operations, Calculation, Parallel system, Distributed, Algorithm, Index.*

## I. INTRODUCTION

Industrial production can be defined as the production of goods using machines, tools, and labor. As this term is widely used as a support to the process of converting raw materials to finished products under the influence of mechanical, thermal, chemical or other processing. Industrial production usually focuses on creating a large number of identical products. However, (artificial) samples can be unique or small tips. And industrial production differs from handicrafts and their production by increasing automation and computerization significantly, which leads to the abolition of the characteristics of the final product based on the qualifications of workers directly involved in production. Since there is no importance to the end product - it can be sold to other manufacturers or wholesalers, or even to end consumers. Non-standard methods of industrial production may exist, for example, prefabricated structures.

Modern industrial production includes all the processes necessary to create and integrate all components of the final product. The manufacturing sector is closely related to engineering and industrial design.

## II. PROBLEM FORMULATION

Addition is one of basic statistical operations, and its calculation is often time-critical. Therefore is the search for faster parallel addition techniques. The addition of N N-bit positive integers has been performed in O(log N) time using an N x N x N reconfigurable mesh [1,3,] and recently in O(1) time on an N x $N^2$ mesh [2]. In the latter case the fast result is achieved due to binary number representation.

In this paper we present an algorithm for parallel calculation of N numbers in K steps, where K is the number of different values in the input. This is a generalized approach of the one produced in [2]. The main difference lies in utilization of different number representation.

## III. NUMBER REPRESENTATION

The data in a parallel system may be represented in binary as well as in several other representations. Four different representations of integers I, $0 \le i \le N-1$can be employed for this task:

1. The usual binary representation (BIN).
2. 1UN representation: bits $b_k$ , $0 \le k \le I$ are assigned values 1, and the rest of the bits are assigned 0.
3. 2UN representation: $\sum_{k=0}^{N-1} b_k = i$. This is not a unique representation, as I, 1-signals may be arbitrarily distributed between the bits.

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4. POS representation: a single bit $b_i$ is assigned 1-signal.

The method is based on computing the carries simultaneously. For each of j bits rows, $0 \leq j \leq k-1$, the partial sum is computed as:

$$S_j = \sum_{k=0}^{N-1} x_{i,j}\,.$$

## IV. NEW ALGORITHM

Instead of using binary representation, as in [2, 4], we employ 1UN number representation, which enables extension of the algorithm to real values. The goal is to perform addition of the numbers in order to compute R partial sums where R is the number of the different values in the input. The expression of multistage spatial summation has been derived by Timchenco:

$$\sum_{i=0}^{N-i} X_i = \sum_{i=1}^{k} \left(N - \sum_{k=0}^{i=1} N_k \left(a^t - a^{t-1}\right)\right) \qquad (1)$$

WhereN$_k$ is the number of elements in, t- is the step of algorithm, and $a^t_{min}$ is the minimal element extracted at stage t. Initially $a^0_{min}$=0 and $N_0$=0. Proof of the equation (1) is provided as follows:

$$\sum_{j=1}^{R}\left(n - \sum_{k=0}^{j-1} n_k\right)\left(a^j - a^{j-1}\right)$$

$$= (n - n_0)(a^1 - a^0) + [n - (n_0 + n_1)](a^2 - a^1) + [n - (n_0 + n_1 + n_2)](a^3 - a^2) + \cdots$$
$$+ \left[n - \left(n_0 + n_1 + \cdots + n_{j-1}\right)\right](a^j - a^{j-1}) + [n - (n_0 + n_1 + \cdots + n_{R-1})](a^R - a^{R-1})$$
$$= na^0 + a^1[n - n_0 - n + (n_0 + n_1)] + a^2\left[n - \left(n_0 + n_1 + \cdots + n_{j-1} + n_j\right)\right] - n + (n_0 + n_1$$
$$+ \cdots + n_{j-1} + n_j)] + \cdots + a^R[n - (n_0 + n_1 + \cdots + n_{R-1})]$$
$$= na^0 + n_1 a^1 + n_2 a^2 + \ldots + n_j a^j + \cdots + n_R a^R = \sum_{j=1}^{R} n_j a^j = \sum_{i=1}^{n} a_i$$

Because $n_0$=0, $a^0$=0, and $n_1 + n_2 + \ldots + n_R$=n.

Let $z_1$ , $z_2$ , … $z_{j+1}$ , … , $z_R$ denote the data sets of each step, where R is the number of steps of the algorithm. The set $z_{j+1}$ is composed of nonzero values; each of them is calculated as the difference between the corresponding element in the set $z_j$ and the arbitrary $a^1$ extracted at the j-th step of the algorithm.

At the first step of the algorithm an minimal element $a^1_{min}$ is extracted from the initial dataset $z_1$= {$a_1$}, where i=1, 2, …, N and $a_1$ No 0. This extracted element is multiplied by N, and the product represents the first constituent on the right side of the equation.

The set $z_2$ can be created according to this rule as $z_2$ = {$a_1 - a^1$Si = 1, 2, …, n-$n_1$}, where $n_1$ is the number of the elements $a^1$. Therefore the number of nonzero elements in $z_2$ is n-$n_2$ . A minimal element ($a^2$-$a^1$) is extracted at the next stage. It is multiplied by the number of the elements in the set $z_2$, I.e. by (n-$n_1$). This product (n-$n_1$)($a^2$-$a^1$) is the second constituent on the right side of the equation (1).

It can be shown using the mathematical induction, that the algorithm at an arbitrary j$^{th}$ step calculates the product:

$$(n - \sum_{k=0}^{j-1} n_k)(a^j - a^{j-1})$$

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This is true for steps one and two, as is shown above. Assume that the equation (1) is true for the $j^{th}$ step. Then it can be shown to be true for the $(j+1)^{th}$ step. The set $z_{j+1}$ can be determined under the rule formulated above It is assumed that

$Z_j = \{a_i - a^{j-1} | i = 1, 2, \ldots, (n - \sum_{k=0}^{j-1} n_k)\}$.

An arbitrary element of the set $z_j$ is extracted and denoted as $(a^j - a^{j-1})$. Then the set $z_{j+1}$ can be shown as:

$\{(a_i - a^{j-1}) - (a^i - a^{j-1})\} = \{a_i - a^j\}$. Where i=1, 2, …, $(n - \sum_{k=0}^{j} n_k)$.

Then an arbitrary element $(a^{j+1} - a^j)$ can be extracted from the set $z_{j+1}$ .The produce of this element by the number of elements in $z_{j+1}$ is $(n - \sum_{k=0}^{j} n_k)(a^{j+1} - a^j)$.

Therefore the equation (1) is valid for the $(j+1)^{th}$ step. The product is a $(j+1)^{th}$ constitution on the right side of (1). That is, the equation (1) holds.

The first term at the right side of the equation (1) under the sign of summation represents the number of non-zero elements at stage t. The number of non-zero elements need not be calculated – it is readily available in the 2UN representation. The left part on the right side is the difference between the minimal elements, which are extracted at the t-th and t-1-th stages. The total sum of the input numbers is calculated as the sum of products computed during R stages. The process of calculation is shown in Fig. 1.

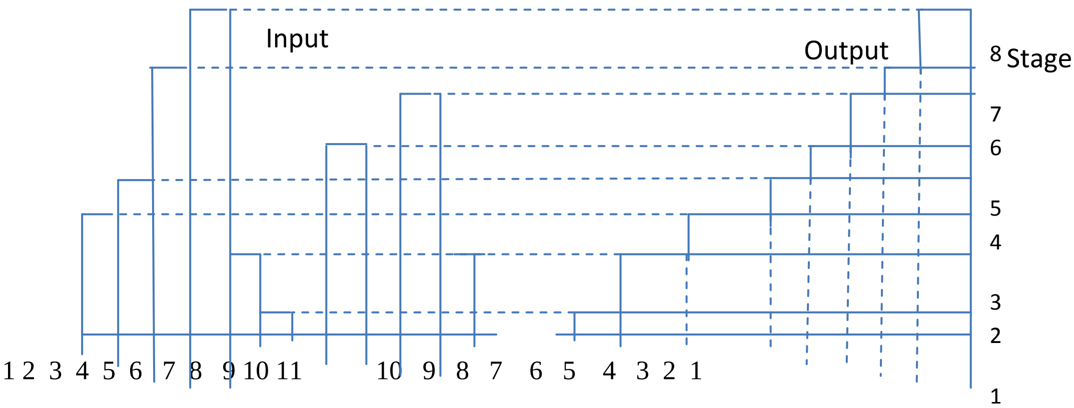


Fig.1. Parallel summation

The method is particularly useful when adding a large number of repeating values, so that the number of stages is small. In the case of adding real numbers, rounding of them can significantly speedup the calculations. Now the addition of the binary numbers can be shown as a partial case of the equation (1)

$$\sum_{i=0}^{N-1} X_i = \sum_{j=0}^{k-j} (\sum_{i=0}^{N-1} X_i \ AND \ 2^j)) \times 2^j \qquad (2)$$

Where k the number of bits.

Equation (1) can effectively describe the process of spatial summation in nervous system [3] and parallel multioperand addition in the signal and image processing and pattern recognition [5, 6]. This parallel algorithm can be reflected onto linear systolic computer net [6].

Peculiarity of algorithm of multioperand addition is that it belongs to a class of regular iterative algorithms (RIA) [7 -15]. In this algorithm variable (sum) in each point of index space is defined by equality

$$S_{ij} = S_{i,j} + q_j \cdot f_q,$$

Where$q_j = min\{a_{i,j-1}\}_{i=1}^{n}, f_q = \begin{cases} 1, \; if \; a_{ij} \geq 0 \\ 0, \; if \; a_{ij} < o \end{cases}$

Simultaneously set of operands A is formed on each j-th step of algorithm as

$$A_j = \{a_{ij}\}_{i=1}^{n} = \{a_{i,j} - q_j\}_{j=1}^{n}$$

## V. CONCLUSION

The approach, which considered in this paper, is oriented on application in problems of pattern recognition.The possibility exists to receive compact exposition of animage of recognized object ifto apply it three-level representation (8), and then with using of the formula (1) to present it as a population of principal components. Such compact exposition of images allows deciding enough complex recognition problems of objects which are insensitive to modifications of space animation in a real time scale.

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