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STRUCTURE OF THE HIGH-EFFICIENCY THE SPECIALIZED CALCULATOR FOR MODELLING PROBLEMS OF NAVIGATION

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The problem of computer modelling of problems of navigation and traffic control of an air vessel is considered. The organisation of high-efficiency specialised structure for calculation of the sums of pair products of matrixes for the purpose of improving productivity of control systems and simplification the structural organisation of airboard computers is offered.

Introduction. Modern control systems of flying machines represent complex dynamic systems with the onboard computers providing normal work of subsystems of navigation, traffic control of an air vessel, indication etc[1]. Increasing complexity of problems in navigation and the flight control, whichare solved in real time, provides airboard computer of high-efficiency specialised digital computing structures. The estimation of the basic characteristics of elements, knots and structures of systems of navigation and management at research of various flight situations is interfaced to the big computing expenses and is not always safe at carrying out of natural experiment. In this connection questions of computer modelling of problems of navigation and flight control are actual. One of ways of essential expansion of possibilities of computer modelling of flight is a working out and use of high-efficiency specialised structures and computing systems with the parallel organisation of calculations for improvement of productivity and reliability of control systems, and also for simplification of computer maintenance of airboard computers. At the decision of some navigating problems and problems of traffic control of an air vessel often there are trigonometrical functions and functions of calculation of base matrix operations.

Development of modern aircraft, is characterised by application of digital calculators in control systems of flight and a plane power-plant, allows to apply management laws with an integrated component and to solve questions of maintenance requirement stability, controllability and automatic performance, restrictions at high speed and demanded reliability in a new way. Application of computer modelling allows to realise adaptive optimum control. However the big computing capacity for realisation of algorithms to worth and adaptations onboard the plane is required. For example, in a case when the condition vector considers not only co-ordinates of the rigid plane and speed of deformations, but also speeds of controls, the order of solved system in the equations is defined by the formula.

$$N_{\Sigma}= 10+2N_q+2N_{dr}+N_{\alpha}+N_{tur},$$

where N_q the number –of gauges equals to number of considered elastic tones of fluctuations; N_{dr} –number of controls (drives); N_{α} – dimension of the forming filter reflecting non-stationary flows; N_{tur} – dimension of the forming filter on turbulence.

If to accept as an investigated variant the heavy plane with system of suppression of elastic fluctuations at flight in atmospheric turbulence systems so the equations demanded an order, solved by onboard digital machine, makes 72, and speed of 1,8 million –op. in second [2].

Work of an onboard complex of management is connected with constant recalculation of co-ordinates from one system of co-ordinates in another, with use of trigonometrical functions. The organisation of the specialised structures focused on performance of operations in an independent mode of calculations allows to reduce number of external conclusions, and as consequence to improve technology, to lower cost, to raise reliability and degree of integration of the superbig integrated schemes.

The analysis of last researches. For increase of productivity of computing structures at the expense of increase in number of processor elements it is necessary to reduce intensity of their reference to the RAM and (or) to the local STORAGE. The basic way of reducting size influence on operating ratio of a processor element is a reduction or a full exception transfer results intermediate calculations from a processor element in the local STORAGE.

One of effective ways of an transfer exception intermediate results calculations in the local STORAGE and exceptions the reference of a processor element to the RAM is the organisation in computing to structure of conveyor data processing which allows to exchange data between a processor element without RAM use. Because each layer of the conveyor includes register level, there is a possibility to remember intermediate results of calculations in the conveyor. Moreover, at use of a dynamic mode of calculations intermediate results can be absent in general. In this case it is not required AM as each layer of the conveyor because each layer rigidly connected with each other.

Advantages of structurally functional – organisation of computing structures for modelling of elementary functions and matrix-vectors operations on the basis of methods of decomposition and "figure behind figure"In a dynamic mode of calculations are:

– Combination of principles disparaelization and combination;

– Possibility of simultaneous realisation of parallel calculations on set of hierarchical levels of conveyor processing;

– Flexibility of dynamically reconstructed structure supposing direct interprocessor data exchange without use of the RAM and difficult switching subsystems;

– Absence of conflict situations at the reference to the RAM and other system resources;

– Simplicity of distribution of the resources which are carried out in a dynamic mode [3].

Work main objective is increasing productivity of specialised computing structures for the decision of navigation problems.

Features realisation of highly productive specialised calculator. . Use of updatings of a method "figure behind figure" in a dynamic mode of calculations is an effective remedy of increase of calculators speed intended for the decision of matrix operations. Realisation of algorithms of calculation the elementary functions provides performance of operations of multiplication and division, in a mode of a real time scale is inefficient, therefore it is necessary to prefer methods of calculation of elementary functions without division operation, in particular to a method "figure behind figure" in a dynamic mode of calculations.

Method "the figure behind figure" uses operations of summation, subtraction and the shift replacing multiplication, and, there for, provides relative uniformity of iterative computing process. The basic characteristics of computing process directly depend on the basis of a used notation and number of true result figures. Now there is no uniform approach to a substantiation of calculations by a method "figure behind figure" [3]. Therefore in a basis of the method having considerable number of updating modifications the account of a concrete kind solved substractive the equations is often put on. The algorithms of calculations realising a method "figure behind figure", are easily realised by hardware.

Dynamic computers, unlike independent, function in the course of data input, instead of after its termination. Target data, in process of their readiness are stood out, as a rule, during all time of functioning and at are used atonce on inputs of following DDM. Therefore DDM can work with the big overlapping in time even then when each subsequent computer is the consumer of target data the previous device.

At a dynamic mode of calculations operands are formed consistently in the course of operations performance, and j the result figure can be defined before formation $(j+\delta+1)$ figures of operands, where – δ a positive constant (a delay of dynamic work) [4]. For example, at $\delta=2$ on each step to a computer it is entered under one category of each operand result categories on a device exit will appear with a delay on $\delta=2$ steps concerning input of categories of operands with the same weight and number. In a dynamic mode of calculations each category of result is formed digit-by-digit and processed before reception of other younger categories. Therefore the size of data delay is defined by time of formation of this category.

The delay characterises level of operation combinations, which are reached at the expense of the organisation of a dynamic mode of calculations, and together with duration of a cycle is the basic indicator of device speed in a dynamic mode of calculations.

In figure it is presented the conveyor computing structure, intended for calculation of the sums of multiplactions and differing by the raised speed. The structure contains n choosing blocks ($n \times n$ word length – of operands), n correction blocks, the block of operating formation signals, the multiplaction, inputs of the first operand, the second operand and AM [5]. Everyone work of device contains two registers, two multiplaction-substractions and two switchboards. Each block of correction contains registers of a divider, weight, the partial rest, result, and also four multiplaction-substractions, coder , three triggers and two elements "And".

It is possibie to explain on an example of calculation of the sum of multiplaes a vector on a vector, a vector on a scalar, a scalar on a scalar by means of vector turn. It is necessary to multiply a vector with co-ordinates x_1 and y_1 by a vector with co-ordinates x_2 and y_2. In the beginning by means of operation "Vector" the turn corner $\Theta = arctg(y_2/x_2)$ is defined Θ. After operation performance "vector Turn" on a corner Θ decomposition of vectors on components, turns out system of three recurrent parities

$$x^* = K(x\cos\Theta + y\sin\Theta) = (x_1x_2 + y_1y_2)\frac{K}{\sqrt{x_2^2 + y_2^2}};$$

$$y^* = K(y\cos\Theta - x\sin\Theta) = (y_1x_2 - x_1y_2)\frac{K}{\sqrt{x_2^2 + y_2^2}};$$

$$\Theta = arctg(\frac{y_2}{x_2}),$$

where x, y value –of the Cartesian rectangular co-ordinates of an initial vector; x^*, y^* value –of co-ordinates of the vector turned on a corner Θ, K – of lengthening of a vector.

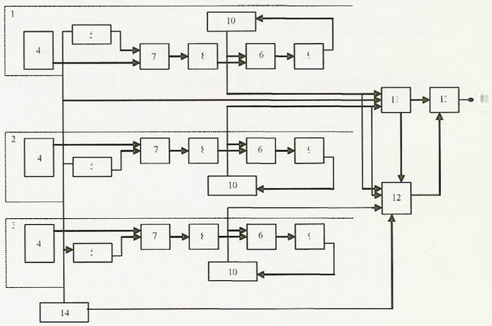

Fig. The block diagramme of the specialised calculator

The offered calculator possesses essential differences in comparison with known structures as in it data are processed on a step in process of their receipt, and also are in addition entered the block of correction for performance of simultaneous correction of results after i-й iterations that it is impossible to carry out by means of known structures. Speed of the offered calculator at processing of files of numbers is defined by time $T_2=t_{as}+t_s$, where t_{as} time –of performance of operation of addition (subtraction) for the adder (subtracter); t_s time –of performance of operation of shift, and speed known structure $-T_1=2n\ (t_{as}+t_s)$ [6].

The offered structure surpasses in speed known in $2n$ time, i.e. $T_1/T_2=2n$.

Conclusion.

The offered conveyor structure for iterative calculation of the sums pair multiplations matrixes allows to raise speed and accuracy of calculations at the introduction expense of high-speed means arguments correction. The use of offered computing structure as a part of the simulator in an aviation training apparatus allows to expand possibilities of simulators from the point of view in modelling flight of the plane in real time in extreme conditions.

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