**"Gyroscopy and Navigation" №2, 2001**

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| The following tendencies are among the main tendencies of Strapdown Inertial Navigation Systems (SINS) development: the miniaturization of all the components of SINS from sensors to board computer; the use of a redundant number of sensors and development of fault-tolerant SINS; the increase of the frequency of data processing in SINS.  If these tendencies are taken into consideration many widely used approaches to the development of various components of SINS are to be revised. For special purpose SINS processors it means first of all the development of technique for rational architectures construction.  The analysis of SINS algorithms has been resulted in selection of calculating operation like (1). On one hand this operation is a base one for most of known SINS algorithms. On the other hand it determines a set of possible architecture solutions. Operation (1) concerns directly the architecture of Processor Elements (PE) that are the base of developed Function-Oriented Processors (FOP) SINS. PE architecture consists of sum unit (SUM), multiplier (MULT) and memory (MEM). To compare different PE architectures between each other parameters of time complexity LT and data processing frequency F are introduced. The form of LT and F estimates shows that architecture of PE5 (fig. 6) is the most rational. The quantitative estimates presented in the table 3 allow selecting PE5 as a base calculation unit of SINS FOP.  The next stage of development is constructing of rational FOP architecture. It begins with transforming of initial algorithms.  The approach to transforming the algorithms is illustrated with the Savage algorithm (fig. 7) as an example. The initial graph contains a set of tops related to each other and tops (operators) do not contain practically base relations. The resulting graph is weakly related and its tops are maximally oriented to base operation (fig. 8, 10). Then the problem of "covering" the transformed algorithm graph by FOP architecture is to be solved. Efficiency of data processing on the architecture of multi-processor vector FOP for Savage algorithm depends essentially on a number of PE. On the class of vector architectures the FOP architecture containing three PE like PE5 (table 3) is maximally efficient.  The results of the theoretical study and simulating of FOP architectures are applied to two practical systems. One of them is vector FOP based on 9 PE. The type of architecture is SIMD. Mass is 1.5 kg. Equivalent performance on the class of SINS algorithms is 8x106 operations per second. It was developed in 1992.  The second of them is PE with RISC architecture. Mass is 0.5 kg. Equivalent performance is 107 operations per second. It was developed in 1995.  The results of the study may be used in implementation FOP as a fragment of VLSI. | |  |
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| In the abstract we examine the operation principle and mathematical model of the controlled stand made on the basis of the above-stated way for creation of the test means.  The controlled stand works in two modes. In the first mode - low-speed, from 2x10-4 up to 0.5 rad/sec. - as inertial sensitive elements there are used the angular velocity sensors (AVS) with electrical feedback and three precision quartz accelerometers, which are measuring tangential acceleration of points of their fastening to the stand platform located at the angles 120o from each other at distance R from the center of the platform. In the second mode - high-speed, from 0.5 up to 20 rad/sec. - as inertial sensitive elements there are used three precision quartz accelerometers, which are measuring acceleration, and three precision quartz accelerometers, which are measuring centripetal acceleration of points of fastening to the stand platform, also located at the angles 120? from each other at distance R1 from the center of the platform. Sensitive elements of stand measurement system are the same elements, which form control effect for each operation mode.  The tested device is fixed on the platform, which has a vertical rotation axis. Sensitive elements of stand control system, which are AVS and accelerometers, are fixed on the platform. Each of accelerometers has a feedback amplifier. The signals from feedback circuits of amplifiers come to the device that represents two-channel (channel 1- for centripetal acceleration meters, channel 2 - for tangential acceleration meters) summarizing amplifier.  he signals from outputs 1 and 2 of the amplifier come through DAC in PC to stand measurement system, as well as to engine control system through the adder. Thus in the range of small angular velocity (up to 0.5 rad/sec.) there is given out the command from PC providing the connection of adder input with output of feedback amplifier of AVS. During operation in the range of large angular velocity (more than 0.5 rad/sec.) similarly there is given out the command from PC providing the connection of adder input with output of summarizing amplifier channel, which ensures signal transmission of accelerometers measuring centripetal acceleration. The output of summarizing amplifier channel, which ensures signal transmission of accelerometers measuring tangential acceleration, is connected to the input of the adder in all operation modes. It means, that in the range of angular velocity values up to 0.5 rad/sec. stand control is carried out according signals of AVS and accelerometers measuring tangential acceleration. During operation in the range angular velocity values more than 0.5 rad/sec. stand control is carried out according signals of accelerometers measuring tangential and centripetal acceleration. The device of resistance moment minimization along rotation axis of the stand is entered into the controlled stand under the examined scheme, that's why a high stability of angular velocity specification is provided, especially in the range of small values. The friction moment in ball-bearing supports is minimized because the supports are completely unloosened from masses of the platform and tested device, this is achieved by "parrying" the weight of the platform with tested device by effort of torsion tension. Minimization of power supply devices moments is achieved at the expense of using of momentless face current-supplier and tracing mechanism, providing that the upper limit of angle of mismatching of current-supplier shoes positions is no more than 3o. Differential equations system of the controlled stand is received on the basis of the theorem about change of the movement quantity moment. For each operation mode of the controlled stand it is reasonable to make its own differential equations system.  Results of frequency characteristics calculation and mathematical modeling proves the stable work of precision stand with parameters of the selected correcting parts, thus in the first mode: reserve in amplitude - not less than 25 dB; reserve in phase - not less than 43o; cut-off frequency - not less than 13 Hz; scale factor (constant) - 3o/sec V. In the second mode: reserve in amplitude - 22-25 dB; reserve in phase - not less than 35-67o; cut-off frequency - 10-12 Hz; scale factor (alternating) - not less 20o/sec V.  The instability of specified angular velocity during stand operation in modes 1 and 2 was investigated by integration of differential equations (1) and (2) at i=3 by a method of Runge - Kutt. The results of integration have shown that examined interferences create instability of specified angular velocity in mode 1 - 1.6x10-7rad/sec., in mode 2 - 1.5x10-6 rad/sec. | |  |

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