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Distributed measurement system in space applications

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Computer-based systems with reference to application and problem range may be classified as: digital control systems, information systems, measurement systems, inform ability control systems, automated technology control systems, measurement computer systems. Such systems based on computer science are specified with: common functions such as data on environment and specified object and respective transmit to computer-aided facilities, real time data processing in agreement with users defined software. In brief such systems will be examined further on as distributed measurement systems (DMS).

DMS are designed for relatively restricted class of problems preserving their reliability throughout the duration of real time transmission. The application of DMS for solving determined class of problems, i. e. their specialization may be obtained in several ways: via hardware approach to computer algorithms for cases when computers cannot satisfy requirements such as accuracy, fast performance, cost and reliability, via general purpose computers compatible with specific requirements for computing resources, relevant to given environment, via adequate problem oriented software when using high technology automated software design system.

Problem

The problems resolved by the DMS methods reflect more or less the relevance of its operation. This relevance is justified with the solution of systematic hardware and software problems, subdivided into respective hierarchy dependent subproblems. And vice versa the designer starts from development of elementary problem definition in order to achieve non alternative solution of the respective subproblem [1].

When applying DMS method to analyze physical processes it applies the following two simultaneous approaches: the solution of the basic functional problems and aiming at adequate interpretation of the processes and supplementary — optimizing the pattern of adequate interpretation. Functional

problems may be subdivided into ranks as each of them is specified with different algorithms and solution approaches. The first rank solution is characterized with data asquisition and preliminary signal processing. This comprises analog and digital signal processing, the second rank resolves problems on preliminary data processing, the third refers to signal processing and optimizes data processing in view of finding functional extreme under defined restriction which is already the subject of applied mathematics and the fourth level solution applies problems on data presentation relevant to the operator, i. e. the possibility of taking complete control on processes [2].

The secondary problems are hierarchically independent, they are not subject to informational ranking, and are subdvided into three groups: expanding the operational capacity of the host computer efficiency and high reliability in diagnostics of all DMS components and full advantage usage of the computer facilities [3].

The DMS design process is a multicriterion interactive process. It may be represented as a combination of two design stages: external (systematic) and internal (technological). Based on user requirements we define at the external stage the exploration, economic and technical parameters, i. e. we define the concept of the system. The second (internal) stage includes the solution of engineering problems related with determined standards. Out of convenience we shall divide the requirements to the different DMS elements into three groups: requirements sensor elements, to computer control units and to the subject of analysis. Usually the design is made with a priori defined parameters and characteristics of sensors and analyzed subject. In this case it is necessary to define the systematic requirements of the control unit most important of them being reliability and cost.

This paper shall examine as well the problem of compatibility between the form of the informational presentation from sensor to subject. In this case the control unit will become computer channel processing the compatible form. This channel will be defined as combination of technical means by which the sensor signals will be received, processed and transmitted to control unit or analyzed subject. In the generalized case this channel represents multipole is shown in Fig. 1.

The expression for the operator is:

$$S_C(t)=[S_S(t),\ S_N(t)]P_N P_C, \tag{1}$$

where $S_S(t)$ — signal source; $S_N(t)$ — noise source; $S_C(t)$ — signal obtained with the channel; P_N — noise operator; P_C — channel operator.

Various modes of multipole combinations allow for obtaining of various channel structures for data processing is shown in Fig. 2.

The operation of the information signal transmission has the form of:

$$S_C(t_i)=\{[S_{S1}(t)S_{N1}(t)]P_{N1}P_{C1}P_{M1}\ ;\ [S_{S2}(t)S_{N2}(t)]P_{N2}P_{C2}P_{M2}\}P_{mux}P_T, \tag{2}$$

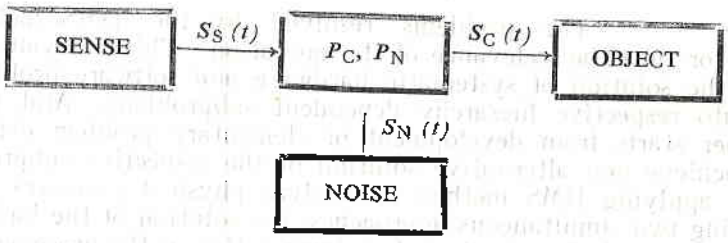

Fig. 1. The functional scheme of the study measurement system

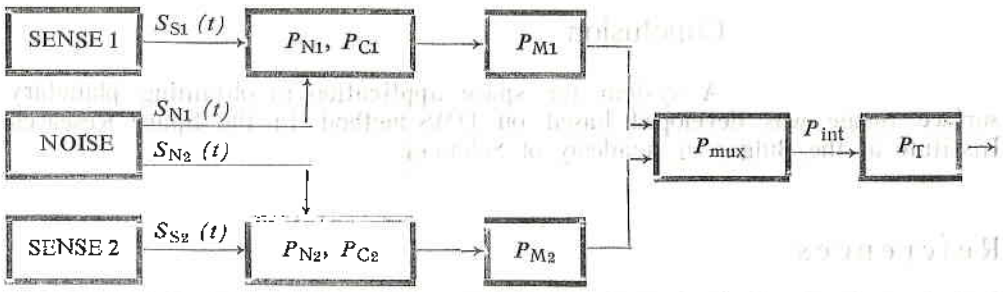

Fig. 2. Two channel structure for data processing

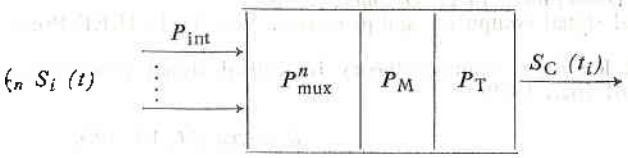

Fig. 3. The measurement system with centralized data processing

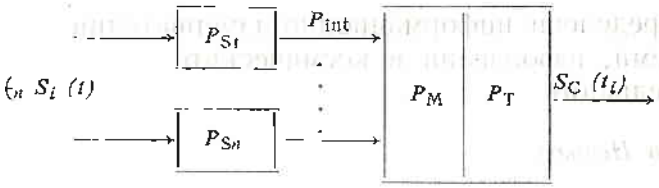

Fig. 4. The measurement system with decentralized data processing

where P_M — modifying operator; P_{mux} — multiplexing operator; P_{int} — interface operator; P_T — transmission operator.

These structures have important specifics - they assume alternative analog-to-digital conversion and allow for alternation from controlling to controlled function in dependence on the specific requirements. Therefore, we shall examine the possible classification under the following structural signatures: centralized and decentralized signal processing, un-level and multi-level commutation of channel configuration. The structural scheme corresponding to centralized data processing is shown in Fig. 3.

The operation of the informational signal transmission has the form of:

$$S_C(t_i) = \epsilon_n [S_i(t) P_{int}] P^n_{mux} P_M P_T, \tag{3}$$

where ϵ_n shows that there is a subset of n independent signal sources or operators; P^n_{mux} — operator corresponding to a given channel in discrete time interval. Since the system is reversible and may be written for the output informational flow:

$$\epsilon_n S_i(t) = S_C(t_i) P_T P^n_{mux} \epsilon P_{int}. \tag{4}$$

The case of decentralized or distributed data processing is shown in Fig. 4.

This analysis of the structures did not treat the problems of commutation control and processing algorithms, etc. In fact, various structures exist which may be reduced to the above mentioned ones [4].

Conclusion

A system for space application in obtaining planetary surface image was developed based on DMS method in the Space Research Institute at the Bulgarian Academy of Sciences.

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Разпределени информационно-измервателни системи, използвани в космическите изследвания

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(Р е з ю м е)

Разпределените информационно-измервателни системи са предназначени за относително тесен клас задачи в космическите изследвания, характеризиращи се с постоянство в течение на жизнения цикъл на бордовите системи. Структурирането на тези разпределени в работното пространство измервателни системи към решаването на даден клас задачи, т. е. специализацията, е постигнато в работата по различни начини: чрез апаратурна реализация на изчислителните алгоритми в случаите, когато стандартизираните компютри не отговарят по характеристики на поставените цели; чрез използване на стандартни управляващи компютри и създаване на специализирани подсистеми за обмен на данни, максимално приближаващи се до изискванията на работната среда; чрез разработване на математическо и програмно осигуряване за управляващите компютри с различна проблемна ориентация при използването на високоавтоматизирани технически и програмни средства за генериране на програмни продукти.