INFORMATION AND DIAGNOSTICS SYSTEMS

[1]**Maksym G. Lutskiy,** Candidate of Engeneering, Prof.
[2]**Aleksandr V. Ponomarenko,** Post-graduate student

THE ACOUSTICS EMISSION SYSTEM OF THE CRACKS PLACE LOCATION

National Aviation University
[1]E-mail: lutskyi.maksym@rada.gov.ua
[2]E-mail: PonomarenkoS_200@ukr.net

The structure of the construction of the acoustics emission system of the place location of through defects is considered in product lines. It is shown that the use of technology of LabCard allows to conduct the redistribution of functions between electronic and programmatic facilities of the system. The structure of electronic program facilities are considered. The forming principles of the multilevel control system are shown, that allows to conduct modification of the system without the change of its electronic facilities. The examples of work of programmatic facilities of the system are resulted.

Розглянуто структуру побудови акусто-емісійної системи локації місцеположення наскрізних дефектів в продуктопроводах. Показано, що використання технології LabCard дозволяє провести перерозподіл функцій між електронними і програмними засобами системи. Наведено структуру електронних і програмних засобів, принципи формування багаторівневої системи управління, що дозволяє проводити модифікацію системи без зміни її електронних засобів. Розглянуто приклади роботи програмних засобів системи.

Рассмотрена структура построения акусто-эмиссионной системы локации местоположения сквозных дефектов в продуктопроводах. Показано, что использование технологии Labcard позволяет провести перераспределение функций между электронными и программными средствами системы. Приведены структура электронных и программних средств, принципы формирования многоуровневой системы управления, что позволяет проводить модификацию системы без изменения ее электронных средств. Рассмотрены примеры работы программных средств системы.

Statement of purpose

In the process of the long-term exploitation of prolonged product lines, which are used for transporting of liquid or gases environments, rises up the propensity of their materials to destruction. It is related to the accumulation in them of defects, internal tensions and, on in some cases, serving of structural changes.

The presence of such processes on a minimazed level, at their gradual development become to the great defect. Among all great types of defects which arise up in product line, the defects of unwholeness (through or cracks) become to the following out the matters of gases or liquid, which are transported. Investigation of it is not only economic losses, but also considerable ecological consequences.

That is why development of a new and perfection of existent methods of determination a place of the cracks location is the important problem of increase of reliability of diagnostics of wares.

Also, in such situation, it is very important to create a mobile system of the diagnostics, which must work in the use condidion.

Analysis of the last researches and publications

For the exposure of various defects in materials, which product line are made of, there are plenty methods of undestructive control [1; 2; 3; 4].

However, for prolonged product line, that setting for transporting of gases or liquid matters, access to which is limited, for example, presence of protective layers, location in earth on a certain depth, location in protective channels and so all, aim to use methods which allow to localize the place of location of defects for realization of next repair of imperfect area. For the exposure of defects of unwholeness, during conducting of technical diagnostics and control of product lines there are two basic

methods wich have most distribution: method of acoustic emission (AE) and method of escape search [5; 6; 7; 8].

The method of escape search is more used, which condition on defect protection of the instrument, that works in a sphere of short frequency and with another factors. Works, which connected with use of this methods, are direct to increase of authential define the through defects [9; 10; 11].

For example, due to frequency filtration or application of methods which provide statistical firmness of basic signal of mutual correlation function (MCF). After its sentinel position is determined the location of defects. However, due to difficult combination of influenced factors it is hard to receive the stable position of great MCF. However, as showed the researches [12;13; 14], the method of AE is the method which takes considerable advantages at determination of the cracks places of location.

It is related with, that the method of AE has more wide line of admission, when there is not time to use signals filtration. In addition in the method of AE it is possible to use the location place of through defect not after position of basic peak of MCF, but after sentinel position of gravity centre of the basic peak of MCF. As the result showed, this is provided increase authentic defines of the cracks place location. During realization of method hardwares have an important value, because they which must provide treatment of far of the registered information, its statistical analysis for multiplying authenticity and exactness of place location of through defects.

Position of task researches

The structure of construction of the mobile acoustics emission system of define the through defects can be considered in prolonged product lines, which are based on facilities of technology of LabCard. The structure of electronic programme facilities of this system can be shown through this facilities which are based on the redistribution of functions between them. Also general principles of forming of the control system can be considered during conducting of measuring and treatment of information.

The structure of construction of the system of the cracks localization

Acoustic emission system for the place location of the cracks in product lines, which works under pressure, as well as any informatively measuring system is based on three basic elements: conceptual part, internal device and man-machine interface. Conceptual part is a static picture of passing informative streams in the system. This part allows to conduct the redistribution of functions between facilities of vehicles and programmatic of the system from positions of minimizations of electronic facilities.

For the location position of the cracks at the source of environment which is transported, in the linear raising on a pipeline are set two receiving transformer of AE (fig. 1). They carry out converting of acoustic noise into an electric signal. As signals of AE on the output of sensors are small for their direct treatment, it is necessary to do strengthening and selection of by-pass signals which are registered. For possibility of the digital signal of analogs processing with the use of the personal computer (PC) it must be conducted converting of entrance signal into digital codes with their memorizing in the PC.

Then the algorithm of mathematical treatment is built on determination of sentinel delay which correspond to maximal amplitude of mutual correlation function or sentinel position of gravity centre of the basic peak of the MCF and next location position of radiant AE. Use the PC provides the possibility of conducting of the wide statistical treatment results of measurings in the certain periods of time, with the use of middle, both after the sentinel delay of the conducted measurings and middle after the co-ordinate the place position of the source of AE. In addition, use the PC allows to form the arrays of information, which based in the result of tests, and also to conduct treatment of parameters of processes which are registered (middle amplitude and energy AE of radiation, his total energy and so all) with presentation of results as dependences of their change in time.

The obligatory condition of system work is testing or tuning on the control object. It is caused, that the control objects can be made from different materials, which have different physical and mechanical descriptions, different sizes, different sensors location during their setting on the object of control.

General flow diagram of construction of AE of the system of location position of the cracks in product lines, working under pressure with taking into account the orientation of the system on minimization of electronic equipment and maximal use of flexible programmatic facilities, resulted in the fig.1.

In the system it is possible to select two groups of facilities: outward electric devices and devices which enter in the complement of the personal(mobile) computer (PC, MC). Existence of these groups of facilities are forming two groups of operations which are executed in the system. As all operations which are related to work the PC is the programmatic accessible operations, it is allowed to distribute functions which are executed in the system, between electronic and programmatic facilities. Electronic facilities of the system are works in a hard unchanging algorithms, in that time when programmatic facilities provide possibility of construction of flexible algorithms with their operative necessary modification.

Thus the basic loading lies down on programmatic facilities, which provide possibility not only conducting of the mathematical processing of information with forming of logical arrays and introduce the analysed results but also possibility of control of the measurings processes of (beginning from the operations of the analog signal of transformation into digital codes), control after the parameters of the system state, and also implementation and control of all testing (tuning) operations of the system in the object of control.

Such forming of the internal deviceof the system, provides possibility to construct flexible management interface. Thus the presence of electronic facilities which are included in architecture construction of the PC, which have a programmatic access, allows to form the programmatic interface of management and control, by facilities of both vehicles and programmatic system in whole. Thus, all parameters of the control object and informatively measuring system (IMS) can be saved in a programmatic accessible base. It provides the universality of the management and control system, and also provides the universality of implementation the measurings operations, processing of information and presentation of their results.
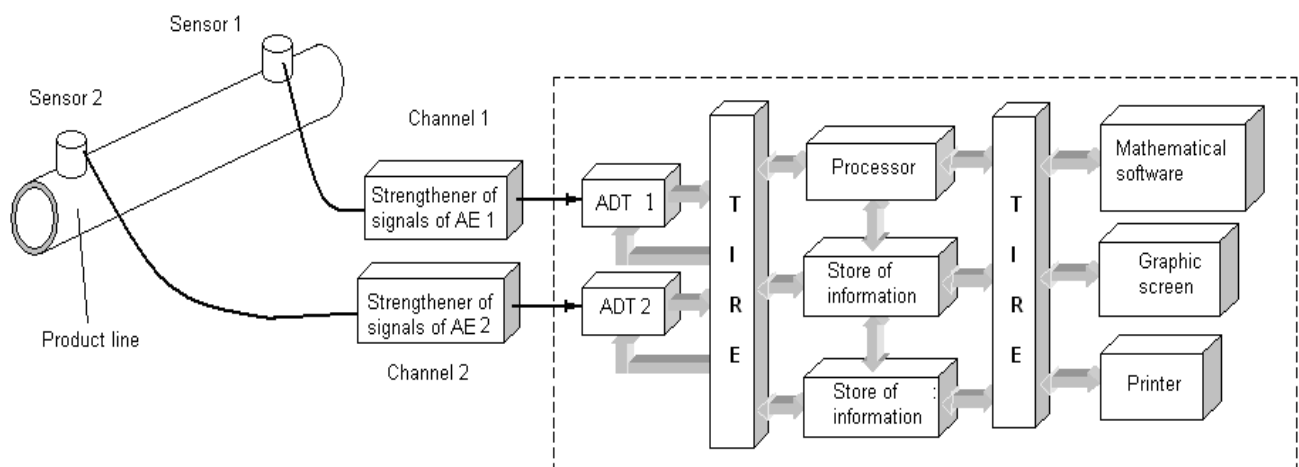

Fig. 1. A general flow diagram of mobile AE system of location position
of the cracks are in product lines: ADT is an analog-digital transformers

It should be noted that at the construction of AE of the system of location position of the crack in the product lines, which work under the pressure, there are not limits on the type of used PC. In the case of application the PC in the terms of the field (as ACMII) of AE IMS becomes the mobile system, when it can be used in any external environments.

In such construction of AE system it has minimum configuration of electronic facilities, which works in the hard unchanging algorithms. The receiving sensors of AE, strengtheners of signals of AE with the selection of them by-pass, facilities of forming of signals of tests, transformer for excitation of noises of tests are belongs to these facilities All other facilities, including analog-digital transformers, belong to the PC and have a programmatic access through a general tire the PC.

Structure of electric facilities of the system

Determination of co-ordinates of location of through defects by AE are based on principles of passive location. At linear location the amount minimally necessary channels are two.

At continuous, defect similar signal of AE the most effective method of location is the use of MCF, as a result of the signal processing from two sensors, which are set about. Features of AE signals (difficult character, low power level, wide range of frequencies, large dynamic range, etc.), and also the considerable level of industrial noises in the places of AE sensors location put down following basic requirements to the receiving highway: minimum distortions of signals form and their sentinels parameters, high sensitiveness and large amplification factor, minimum level of own noises.

These requirements behave to the outward devices of the AE system, that is called electronic facilities.

The analysis of existent AE systems shows that the basic parameters of their electronic part are in the followings ranges: workings frequencies – 0,1–1,5 Mhz, sensitiveness of amplifying highway (at a relation signal/noise of 6 db) not less 20 mKV, amplification factor – 60,100 db, dynamic range is not menshe 30 db.

The general flow diagram of electronic part of the AE system of through defects location is resulted in the fig. 2.
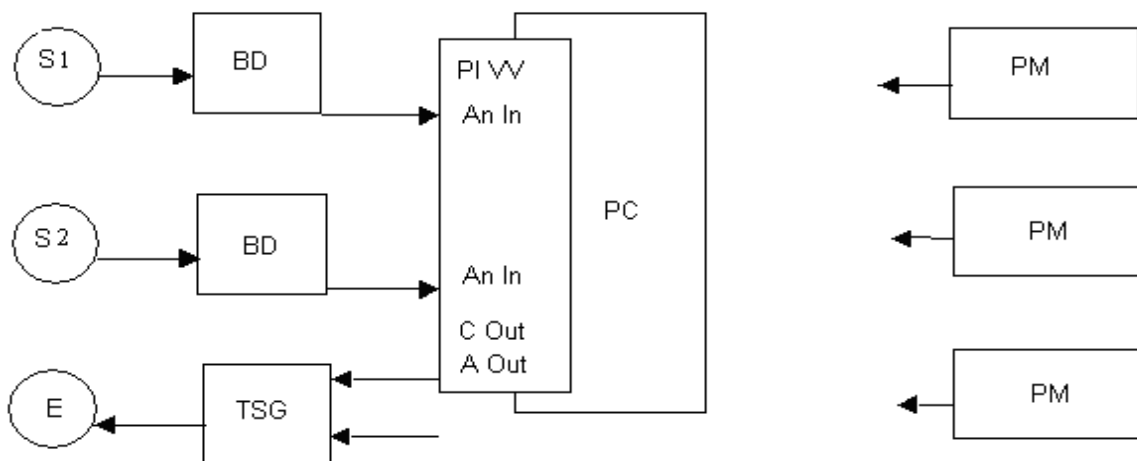

Fig. 2. Flow diagram of the electronic part of the acoustics emission system of the crack location in product line, which work under pressure of gases or liquid environment:
S is AE sensor;
E is emitter;
BD is bearing-out device;
BPSP is block of the previous signal processing

The sensor S1 and S2 are a widely line piezoelectric transformers of mechanical vibrations into the electric signal of AE. Initial tension of the sensors by a high-frequency wire acts on the entrance of bearing-out device, which provides the necessary strengthening of signals, their detection and smoothing. By-pass of the AE signal by the wire given on the first and second entrances of analog ports of introduction-destroying (ID), which is located in the PC (fig. 2).

A selftesting channel is belong to outward electronic devices too. The selftesting channel is intended for speed measuring distribution of sound in materials, and also at verification of capacity of highways of primary analogs signal of the AE. It consists of emitter (fig. 2, E) and test signal generator (fig. 2, TSG). An emitter (E) is need for the signals imitation of AE. It looks like widely line piezoelectric transformers of mechanical vibrations, that spreads in a construction. Excitation of emitter is provided initial tension of TSG. Test signal generator generates two types of test signals: radio impulse with the high-frequency filling in a kind of meandru and continiously line signal of noise which has normal law of division.

Thus duration of radio impulse is set from the digital output of ID, and filling frequency is determined by the size of permanent tension which is given from the analog output of ID. To electronic facilities are also belong three autonomous networks power modules (fig. 2, PM) which provide necessary tension for the devices of bearing-outs and TSG.

Structure of programmatic facilities of the mobile location position system of the cracks

Division of functions between electronic and programmatic facilities, provides possibility of forming the flexible programmatic system of the information treatment which is registered, and flexible programmatic system checking and management all elements which are included in the system. It is meant that basic functions which are executed in the system are translated on a programmatic mathematical complex (PMC), including a management interface. In accordance with conceptual part of mobile AE system of location position of the cracks, the general structure of PMC is shown on fig. 3.

Programmatic mathematical complex is a set of the independent modules which can be divided into a few groups. This division takes place in accordance with their functional setting: group of operations, which is related to forming of graphic management interface; group of operations from forming of prompt to the user; group of operations, which is related to forming and control of the system state; a group of operations from visualization of entrance process which is registered; a group of operations from testing of the system; a group of operations from testing control object; a group of operations from treatment of parameters of initial process; a group of operations from forming of parameters which are needed for realization of treatment algorithms.

Access to every group of operations will be organized only through a man-machine interface or management interface (MI). In this aspect MI is the noncontiguous item of PMC. It is intended for the choice of necessary groups of operations, forming of parameters of all programmatic modes of control and management the state, both electronic and programmatic facilities of mobile AE system. Management interface is a full screen graphic interface with forming of bars of tools the load of which provides the call of necessary group of operations.

Their load on implementation, in the turn, leads to forming of programmatic mini interfaces (PMI) which serve this group of operations. Thus structures of construction of MI and PMI of the same types. In their basis, forming of successive lines and reverse transitions lies with the use of the manegment keys.

Thus in the process of every transition is formed the base of parameters of in-outs, intended for implementation operations of control and prevention of origin f failures of softwares.
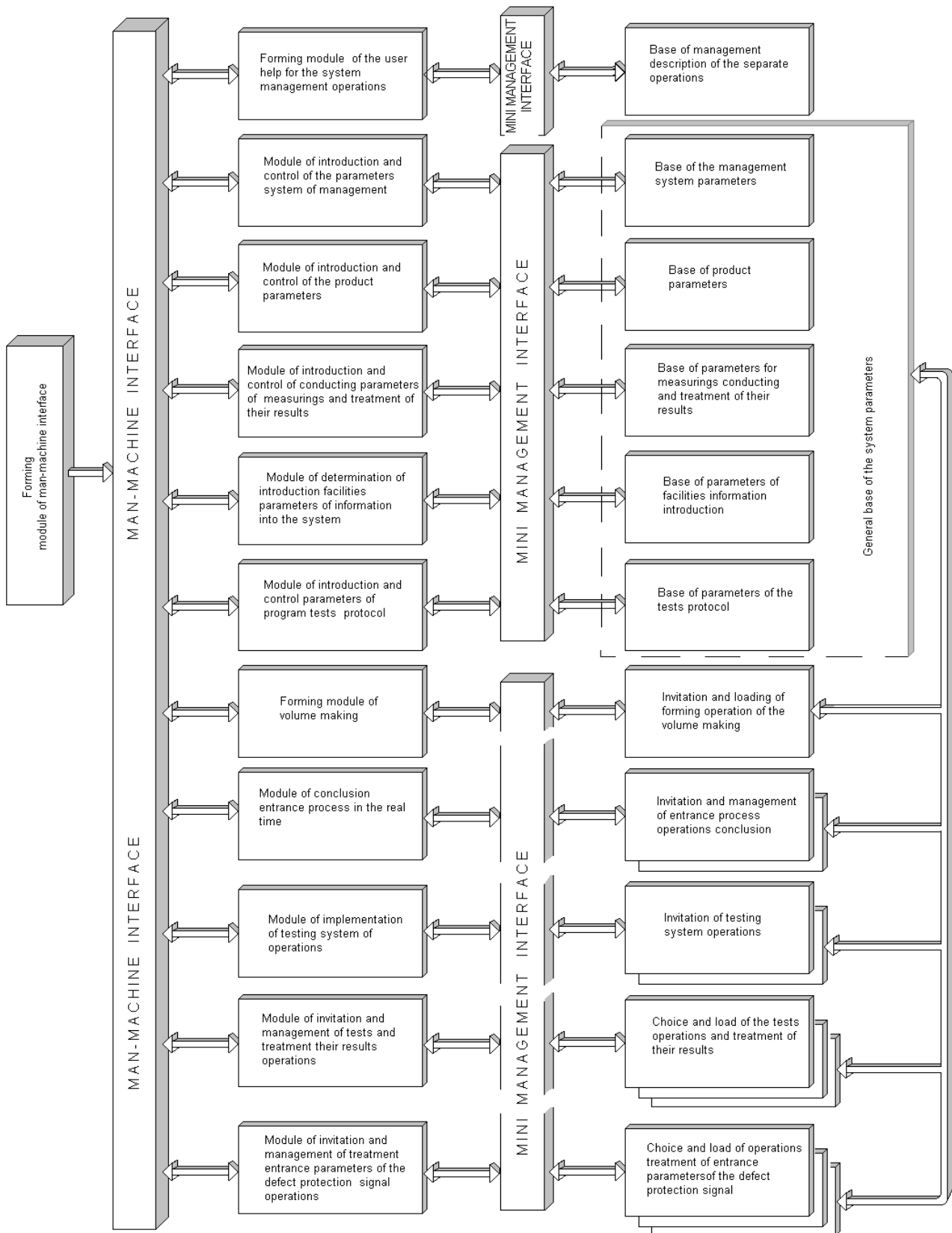
Fig. 3. A structure of programmatic mathematical complex of the mobile acoustics emission system of location position system of the cracks in product lines

Every bar of tools (executing the modules), from the point of view work of all PMC, is independent, that can be loaded independently one from another. However at implementation of operations which are included in independent groups, they are linked through the bases of menegment and controls parameters of the state system.

The full independent group of operations (by an independent load image) is the module of forming the prompt to the user. It has the PMC with the bars of tools, proper the panels of MI, the load of which provides destroying of thumbnail sketch of groups of operations and work with them. At the sane time, not only the description groups of operations are formed, but also are formed description of the management used keys. Description of operations is saved in an internal base, to which the operations of the module of prompt have an access only to the user.

All elements of the system, what are placed on a tire of the PC, have a programmatic access. It provides a checking and management their state feature by programmatic facilities.

Thus the management is carried out introduction and change of values of the proper parameters. It is carried out with the use of group of operations of the managment parameters of the state system.

They include the row of the modules (fig. 3) which have the following setting: management of devices parameters the PC; management facilities of introduction the information parameters in the PC; management of conducting measurings and treatment of their results parameters; introduction and change parameters of control object; introduction and change parameters of protocol of the tests.

Every module has the base of parameters which in an aggregate make the general base of the system. Access to the base is provided, both through MI with the invitation of proper module and implementation the operations of measuring, processing of infofmation, and also

operations of analysis and destroying of results. However, the last operations have an access to the bases given only for reading of necessary parameters which support their work.

A group of operations from visualization of initial process, which is registered, belongs to the group of operations of services and partly used for adjusting the system (fig. 3).

These group of operations includes the row of the modules which is realize a few modes of showing an information, both in the real time and in the mode of remembering generator.

It keeps initial information which written down on a hard disk at physical level of his construction. Operations are independent, and access to them is carried out through PMC, which is formed at the load of the proper control panel in MI.

Programmatic mathematical complex, as well as MI, contains the bars of tools which are loaded in time of implementation for the inviting of necessary operation. At shown out information in the real time, the modules support work of row of the modes of the system: registration of information; its converting into digital codes and showing on a monitor screen. Actually the modules will realize the modes of oscillographs which provide the invitation of the same thingarctic or twogarctic signals.

These modes are used not only for the revision of signal which is registered but also at adjusting the parameters of the system: electronic part of the system; threshold of limitation subject to the condition of presence the noises signals, and also for current control of parameters of initial process.

Third module is the generator realization mode which keeps initial information is used for a revision control of parameters of the treated process which the logical arrays of data are formed after.

The important group of operations are operations from testing of the system. The groups of operations are given provide adjusting the system on the object of control taking into account his descriptions and proper placing on him AE sensors.

Operations support all work of electronic and programmatic facilities systems which is realize the mode of the real measurings: introduction of information in the PC, its storage and treatment in the real time with invitation the results on the monitor screen.

Thus on the monitor screen the user windows with continuous visualization, both dependences of change of mutual correlation function and places of location of AE source of radiation on the object of control, are formed in relation to placing of sensors. Simultaneously with visualization of treatment results in the user window the sizes of distance hatch to the radiant. Realization of operations of testing, after the load of the proper bar of tools in MI, is carried out continuous appearance, and completion of work is carried out an user in the hand mode.

Thus for completion of testing of the system the mode provides possibility of saving of results as structures of files. The group of operations on testing of the system can be realized at presence of noise signal, which is provided the external generator of noise through a sensor, which is set on the control object.

In the process of testing is carried out the rightness control of calculation of co-ordinates, in accordance with the co-ordinates of the AE sensors setting. For prevention the errors during conducting of the system testing in the control object there must not be working pressure which can result in the source of working environment through the crack, and, as a result, to appearance of additional source of AE noise.

In a time of implementation control of the object the group of operations are used for testing. Algorithms, similar algorithms testing of the system, can be realized in this group of operations, however by the source of AE noise, there are noises which arise up at the source of working environment through the croaks. Work of this group of operations is based on the parameters of all bases of the system. As well as operations of testing, the group of operations is given support all work of electronic and programmatic facilities systems which are

realize the mode of the real measurings: introduction of information in the PC, its storage and treatment is in the real time. However on a difference of the system testing, the results of measurings and processing of data are saved as structures of the files.

Their subsequent analysis and introduction the results on the monitor screen carried out with the use of operations which are included in group testing operations. Their choice and load on implementation is carried out with the use of bars of tools of PMC, which are formed after the load of panel of testing general MI. Operations on introduction the results of tests use not only the bases of parameters of the system but also base of protocol of the tests.

Except the basic task PMC allows to conduct parameters treatment of initial process with forming of information arrays and introduction the results on the monitor screen. For this is purpose the group of operations for parameters treatment of initial process.

The group of operations has sectional architecture, which consists of row of the independent modules, the introduction of which is carried out after the load of the proper bar of tools which are formed in PMC. During the work of this operation group are creating the autonomous arrays of data after the parameters of process which is registered, and also taking into account the parameters of the system state and tests protocol. As, an outgoing process of AE is the continuous signal, to basic processed parameters belong: middle amplitude on the middle set interval; middle energy on the middle set interval; total energy on the set interval of analysis and others.

Except considered groups of operations PMC also provides implementation of the another number of services operations which realized the function of the operating system of MS DOS. That is why PMC, on the whole, is the integrated environment, which provides independent implementation of all operations in the system, which are supported from the operating system of MS DOS.

Conclusion

Developed structure of the mobile system of location position of the cracks in the product line, which work under pressure of the gases or liquid environments. The general algorithm of its work is created with the division of executable functions. In basis of the system construction is used the technology of LabCard, which allows to conduct the division of functions between the elements of the system from minimal use electronic and by the maximal use of programmatic facilities.

The presence of the unique programmatic attached devices of inside part of the system is provide the possibility of forming the unique algorithm of management in basis of which lies forming and transmission of informative streams.

Structure and setting of the last, define the setting and management tasks, in accordance with conceptual part of the system. It is allowed to create the unique interface of management. Every direction must be supported by the informative stream, that means the management stream and the stream of information.

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