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SOFTWARE DEVELOPMENT OF AVIATION BENCH TESTS

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Analysis and selection of software architecture for the implementation of control system of automated control base-plates shakers at their rising to a predetermined height, holding in vibration test and lowering to the supports are analyzed. It is shown that the software implements are a dynamic process, which depends on the quality of further vibration testing.

Keywords: base-plate, algorithm, foundation bench, software architecture.

The relevance of the research. The current level of development of aviation and space technology requires the use of automated controls in the tests. The maximum efficiency, reliability during testing of large and heavy structures is achieved through the use of automated control systems. The equipment, that was used to raise the base plates of the bench, did not provide sufficient accuracy, reliability, and security that depend on the human factor. Therefore there is an urgent need to develop an automated system, including reliable software that implements the rise of fundamental plates by operator in the policy regime.

Problem statement. Software development for control and disposition of bench foundation with high precision is required in the test space technology. Software implementation of coordination in space of relative position of two foundations or foundation and large-sized test object is considered.

Description of the bench. Objects whose positions need to be monitored and adjusted regarding to the supports, located on a foundation or building structures test facility are (fig. 1):

FP1 – 1st foundation plate of foundation bench 136–2000;
FP2 – 2nd foundation plate of foundation bench 136–2000;
FP3 – foundation plate of foundation bench 137–2841;
VNS – vertical pneumatic support of bench foundation.

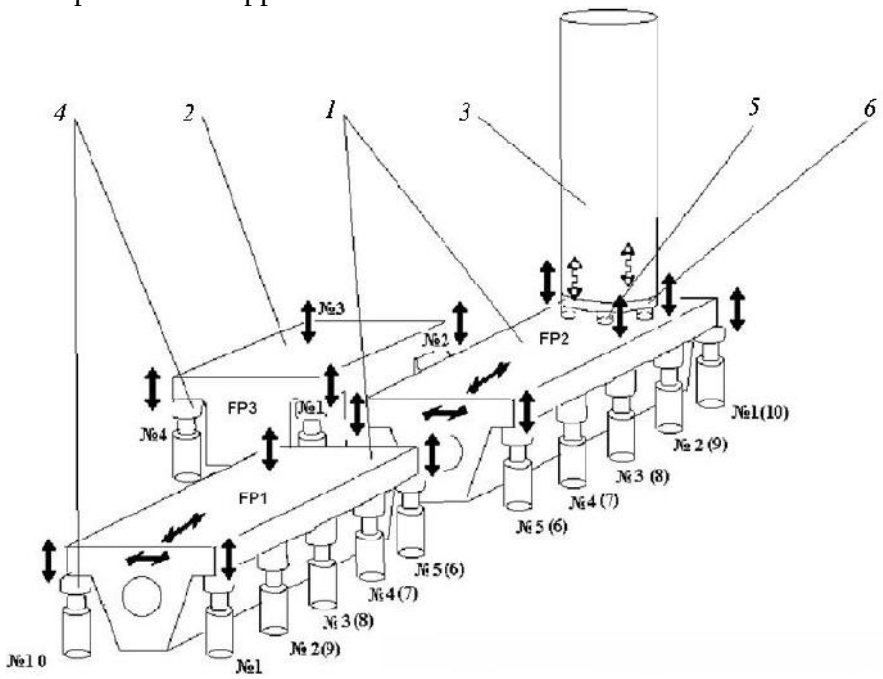

Fig. 1. Sheme of placing of mechanical motion sensors number of channels of FP: *1* – foundation plates of the bench 136-2000; *2* – foundation plate of the bench 137-2841; *3* – product; *4* – vertical pneumatic support; *5* – pneumatic supports; *6* – vibroplatform

136–2000 foundation bench is a 2 foundation plates (FP) – concrete blocks with dimensions and weight 15000×8000×5500 mm and mass 1100 *t* each.

137–2841 foundation bench is a concrete block with dimensions and weight of 5000×5000×4500 mm and mass 260 *t*.

Lifting of FP bench 136–2000 is provided by 10 vertical pneumatic supports (VNS), and bench 137–2841 – 4 VNS.

General Structure Of Software. The software system for automated control of lifting boards on given height is implemented on the base of algorithmic software of the system, which includes the following components: object, operator, and algorithm for evaluating of measurement results and primary processing, control algorithm in emergency mode, algorithm of remedial control.

Information from the pressure sensors and the height from pneumatic supports go to computer, where the primary signal processing is performed in order to eliminate obstacles and solving problems of smoothing and elimination of abnormal failures.

The processed information is also presented on the screen for informing the operator about the current values of the pressure and height measurement results. Based on the obtained information synthesized first channel control and corrective channels is performed (2, 3, 4), which also appears on screen as prompts for the following actions of operator. In case of emergency, automated control system automatically stops the recovery and synthesizes adjustment control to prevent rollover of plate.

The overall structure of software systems is presented in fig. 2.

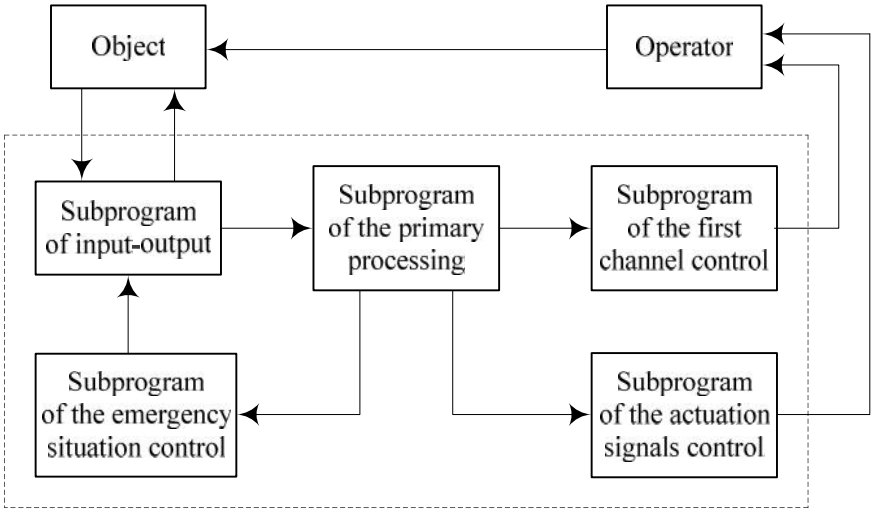

Fig. 2. Structure of software system

System software includes the following subprograms: input-output, primary processing, first channel control, handling of emergency situations, control channels management. The results of the first channel control subprogram and controlling channels management are displayed on the screen. In case of emergency, emergency control through I/O subprograming directly displayed on the valves of pneumatic supports.

Description of Input Signals. The input data for the system software should be: pressure resistance of each platform (P_i – defined by pressure sensors) and coordinates (height) of each lift support platform (X_i – determined by position sensor). To adjust the platform it is necessary to obtain coordinates of each lift support platform (X_i). Data of pressures in the supports is needed to create a database for future use.

Input data will come from external devices in the form of voltage. It will have the format of an analog signal. The amplitude of the input signal will vary depending on the signal supplied from the sensors. At the entrance to the workstation (PC), these data are processed by the digitally and

numerical values are obtained according to the received signal from the outside. Processing should be done at the software level using the software by the type of driver (controller hardware). Data is obtained in digital format by processing program and after processing is sent to control devices.

Input pressure is needed for start checking platform and to check the status between the stages of recovery. On this basis it is possible to conclude that the emergency increase in pressure in one of the supports, or more, for example, as a result of failure of one of the supports when the pressure of it becomes zero. Input data about coordinates is needed at all times of platform rise and adjustment of position of platform. The format of the input data is format with a fixed point.

Description of Output Data. Output data should be pressures to be submitted to each of the three regulatory channels supports platforms and the pressure separately for the main channel recovery. If the platform is in a state of imbalance, a program using the pressure values for certain supports eliminates bias. This operation must be performed at each iteration recovery. The output value is a digital value. This data should be processed using the software by the type of driver to the level of electrical signals and get to the feed pressure regulators to pneumatic supports. Since there is no specific depending of pressure on the height of supports, the output value of the pressure at leveling must have a minimum value for maximum accuracy. These values will be submitted to the supports to complete their alignment.

P_5 – output pressure value of the 5th regulatory support.

P_6 – output pressure value of the 6th regulatory support.

P_{10} – output pressure value of the 10th regulatory support.

$P_{1–4, 7–9}$ – output pressure value 1st – 4th and 7th – 9th regulatory supports that are on the same channel, and cannot be regulated separately. Control output signals will be values P_5, P_6, P_{10}.

The format of the output data – format with fixed point.

Description of Block Diagram of Adjustment Control. P_i is the pressure of each support of the main channel, which is registered by pressure sensors (fig. 3).

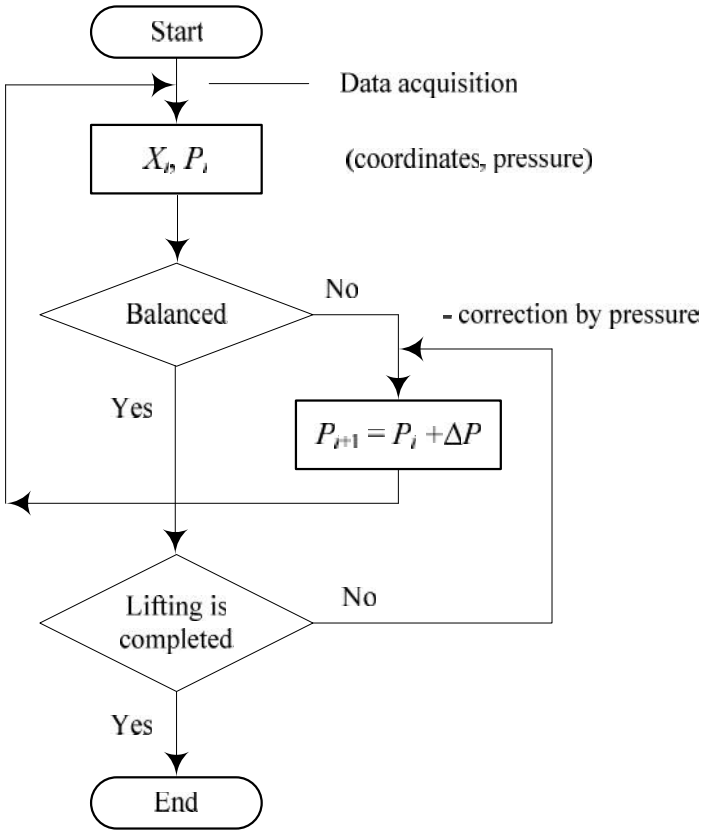

Fig. 3. Block Diagram of Adjustment Control

The value of ΔP is the change of pressure in each of the three supports, the main value for platform adjustment. There are ΔP_5, ΔP_6, ΔP_{10} in a real system as there are three control supports (fifth, sixth and tenth). Each control support is a single channel and is regulated and monitored by a position sensor to accurately define their position. The position of each support is output data X_i – which is controlled by sensors position. Values are registered from each of the supports.

Conclusion. Based on the developed algorithmic software structure software is offered, which consists of input-output subprograms, primary processing subprogram, subprogram of control of the first channel, emergency situations handling subprogram, control channels management.

Using the proposed software for automated control system will improve the quality of lifting plates to a given height and provide failure-free operation.

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Програмне забезпечення випробувань авіаційних конструкцій

Проведено аналіз та вибір архітектури програмного забезпечення для реалізації автоматизованої системи керування фундаментними плитами вібростенда під час їх підйому на задану висоту, утриманні при вібраційних випробуваннях і відпусканні на опори. Показано, що програмне забезпечення реалізує динамічний процес від якості якого залежать подальші вібраційні випробування.

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Программное обеспечение испытаний авиационных конструкций

Проведен анализ и выбор архитектуры программного обеспечения автоматизированной системы управления фундаментными плитами вибростендов при их подъеме на заданную высоту, удержании при вибрационных испытаниях и отпускании на опоры. Показано, что программное обеспечение реализует динамический процесс от качества которого зависят дальнейшие вибрационные испытания.