SSAU NANOSATELLITE PROJECT FOR THE NAVIGATION AND CONTROL TECHNOLOGIES DEMONSTRATION

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Effective way to make experiments in space and operational development of new technologies is using nanosatellites CubeSat standard. This satellites looks like cube with sizes 10x10x30 cm. Nanosatellites have a short development period and caring out like piggy back payload.

The increasing complexity of the problems solved by such satellites requires the creation of more efficient and fault-tolerant communication, navigation and control subsystems. In SSAU developed nanosatellite SamSat-218 to demonstrate new technologies that give satellite fault tolerance by improving navigation and control algorithms, the use of low-altitude satellite communication systems Globalstar/Iridium, the application of the original approach to the construction of on-board control unit, the use of artificial intelligence technologies.

Planed to create a new devices and to perform the following experiments:

- Building on the analysis of the local video vertical
- Determination of the initial conditions of the motion analysis of video images of the separation obtained by a camera with are mounted on a nanosatellite;
- An experiment in the field of satellite navigation, aimed at increasing the accuracy of determination of the parameters of motion due to the co-processing of navigation measurements on board and on the ground station while in the area of mutual visibility;
- Testing the technology on-board self-control device in case of emergency situations and the failure of individual sensors and systems;
- Testing of the algorithm controlling the orientation and stabilization of nanosatellite on the testimony of integrated measurement tools given the limitations on the computational power onboard computer;
- Testing of remote control technology nanosatellite through low-altitude satellite communication systems.

Appearance nanosatellite without solar panels is shown in Figure 1 It is composed of the following on-board systems: on-board computer, power supply system (EPS), telemetry system and command radio link, satellite modems Iridium and GlobalStar, attitude control subsystem (ACS), navigation receiver, the system disclosure of solar panels (SP).

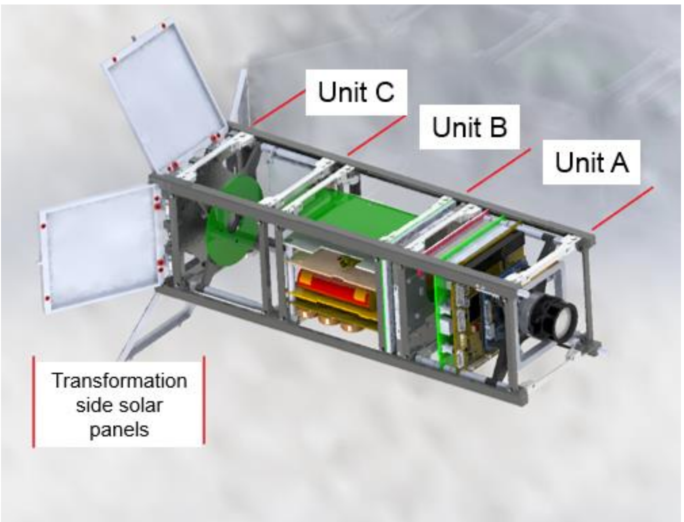

Fig. 1 – External view nanosatellite SamSat-218

The main part of nanosatellite's ACD is on-board computer having a resilient configuration flight qualification which is scheduled for late 2015. Measuring complex includes a horoscope, accelerometers, magnetometers, light sensors built into SP, video cameras, an experimental video vertical system and navigation receiver. Magnetic coils are integrated into the SP.

The experimental system is designed to determine video vertical deviation from the longitudinal axis of the nanosatellite to the local vertical analysis of Earth observation images obtained with four miniature cameras mounted on the sides.

Reliability and survivability nanosatellite are primarily determined by the decisions of the system laid down by the creation of onboard control device [1,2].

There are two approaches to the management of on-board systems nanosatellite. In the first - the central role in the formation of the operating cycle of onboard systems, to analyze the status and troubleshooting, is given to the staff the Mission Control Center (MCC). In this case, there might be a delay in decision-making and reduce the effectiveness of target mission as a whole. In another approach, as the central control element is used on-board digital computer (microprocessor), which serves as part of the MCC. This approach allows to achieve high autonomy of the onboard control system and the satellite is becoming more and more popular with the development of digital technology.

Effectiveness of the implementation of the objective nanosatellite function is linked to ensuring the survivability of nanosatellite, which is understood as the ability to adapt to the current situation, to resist and to save the set of critical functions under unforeseen effects on the nanosatellite. Therefore, the project SamSat-218 was tasked with developing on the basis of the commercial component of the complex on-board navigation systems, communication and control systems capable of ensuring the efficient operation of nanosatellite on the whole time of its active existence of conditions to minimize the loss of target information in case of failure of individual components and systems.

There are various approaches and methods to control the persistence of technical systems. Widespread use are those which are based on increasing the reliability of all the structural elements of the system. Another common method - multiple "hot" and "cold" backup of the structural elements, ie construction of reliable systems from unreliable elements. Both of these methods are not economical and may not be suitable for Nanosatellites. In nanosatellites is proposed to implement for complex use of all on-board resources due to centralized management and use of all the hidden reserves of information on the functioning of the onboard systems. In this case, the on-board system nanosatellite will satisfy the following properties: - adaptability (due to the implementation of on-board motion mathematical models, decision support systems, using, if necessary, resources MCC calibration algorithms critical systems in flight) - autonomy (control and diagnostics of systems nanosatellite, testing on-board equipment, efficiency of collection and delivery of information for analysis through the use of rapid communication channel through the low-altitude communication networks Globalstar / Iridium, identify contingency); - Management and reconfiguration (includes management of redundancy, flash random access memory, the algorithms operate in abnormal situations and disaster recovery nanosatellite).

The implementation of these properties allow nanosatellites bring the actual period of his active life in orbit to the estimated date. System survivability nanosatellite should provide a high battery life in the absence of frequent sessions with ground control. In the event of a refusal to comply with the relevant prescribed action scripts. In the case of an unknown failure onboard control system must shift to a supporting only communication with the ground control to communicate the emergency situation and taking control commands.

At the design stage nanosatellite were investigated possible strategies to restore health. As a basic approach chosen decentralization of management nanosatellite. In this case, the central core of the control system it is advisable to download the overall objectives of management survivability, and private specialized tasks impose on peripheral software modules. This allows you to offload the CPU, as well as to solve problems, including self-monitoring and diagnosis of airborne, without introducing any additional onboard control equipment. Since the system survivability nanosatellite is realized only by software, its reliability is always higher than the reliability of other hardware and software building blocks.

Building an effective system to ensure survivability nanosatellites will make space experiments more qualitative and effective, as well as to enter the new stage of development nanosatellites.

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