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Traffic control systems of nanosatellites in the zone of the international space station

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Abstract

Ways and the automated devices for precision traffic control of nanosatellites (NS) in a zone of the Russian ISS segment are described. The complexity of management of these systems concerns the magnetic-induction system of separation of NS in the set directions specialized by NS supplied with ionic micromotors. The magnetic-induction system of separation contains a microprocessor system of management which allows high-precision start of the nanosatellite in the set azimuthal and zenith directions concerning the coordinate system connected with the ISS. The thrust vector of the ionic micromotors set on NS is regulated by means of a management system executed on microcontrollers. This combination of devices allows practically any trajectory to be set for NS concerned with the ISS.

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Keywords: small spacecraft, nanosatellite, space station, magnetic-induction system of department, traffic control of SSC

Nomenclature

SA	space aircraft
IE	ionic engine
APP	application program package
PCS	polar coordinate system

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CCS	Cartesian coordinate system
NS	nanosatellites
LRE	liquid reactive engine
WC	working chamber
P	draft of IPE
I_{sp}	specific impulse of draft
η	efficiency
N	power of the IPE power source
U^+	acceleration voltage
I_{eff}	current of an ionic bunch
η_d	efficiency taking into account divergence of an ionic bunch from a nozzle
m*	full expense of a working body
j_i	density of an ionic bunch
e	elementary charge
α	half of a corner of divergence of an ionic bunch
T_i	temperature ionic components
U_p	plasma potential in WC of rather this electrode
η_m	coefficient of ionization of a working body

1. Introduction

With development of a configuration of space stations there are a set of tasks for small spacecraft's including nanosatellites to service the needs of the station including towage of rescue ropes, tools for astronauts, removal of space debris from the zone of the ISS, etc. In other words, today a problem existed in the organization of technological activity in an area of the ISS using automatic robotic systems which carry out tasks either completely independently or with the assistance of the operator. For solution of a number of tasks, such as towing of constructional elements in the set space points, rendering of a rescue rope to the astronaut, correction of disclosure is more than dimensional antennas and so forth SSC including NS equipped with ionic or plasma engines of a small draft, several tens watts can be used. Traffic control of such devices is exercised by means of the onboard microprocessor systems giving the chance change in direction of the movement and speed of SSC.

Electro reactive engines (ERE) opened a new direction in space engine construction. ERE differ from the existing space engines working with chemical fuels, as to higher profitability, but at the same time considerably smaller thrust-weight ratio, the possibility to receive small unit impulses, a large number of inclusions. At the same time, division of power sources and working substance in ERE and the use of an electromagnetic field for acceleration of working substance allows a specific impulse to be increased considerably (by one-two orders), and respectively the profitability of ERE in comparison with chemical reactive engines. This predetermines areas of applicability of EREI for space aircraft with long times of active functioning (5 - 10) years.

On the other hand, considering NS sizes like Cube Sat, it is possible to install only miniature IPE on such devices, developing draft of several watt. Today spacecraft's in the form of a cube with an edge of ten centimeters already receive their own ionic engines for correction of an orbit. It should be noted that the micro motor has the size, as a rule, of about a human nail and does not occupy more than a third of the internal volume of the satellite. It is clear, that this circumstance complicates management processes of NS and considerably increases time of its movement along the set trajectory. For solution of such tasks, it is reasonable to report an initial impulse in the set direction with an initial speed (0.5-2) m/s to the nanosatellite by means of magnetic-induction system of start (department) [2].

With such organization of the movement NS in a zone, for example, the ISS of IE set onboard the satellite will carry out a role of engines of orientation - to adjust a trajectory. For effective work of such MISO + NS complexes, the magnetic-induction system of a department should have an opportunity to orient the main axis of NS in the set zenith and azimuthal directions concerned with the coordinate system connected with space station. MISO of this kind contain microprocessor management systems [3] connected with the ISS onboard computer modules.