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SMALL SATELLITE ATTITUDE DETERMINATION USING NAVIGATIONAL RECEIVER AND  
MAGNETOMETER

**Abstract**

The main idea of report is the utilization of navigating receiver not only for the mass center movement parameters definition, but also for the approached estimation of orientation of the phase center of the reception navigating antenna under the analysis of visibility / invisibility of navigating satellites are due to small satellite constructional features. For one-stage operative definition of small satellites orientation the information from three-axis magnetometer (measuring of an Earth magnetic field intensity vector in the connected coordinates system) is processed together with results of the approached estimation of orientation of the phase center of the reception navigating antenna. In work are considered closely coupled and loosely coupled integrating scheme. Under closely coupled integrating scheme is understood the integrating scheme at which the problem of orientation definition is solved with simultaneous use of all measuring information. Under loosely coupled integrating scheme is understood the integrating scheme at which the problem of orientation definition is solved stage by stage, involving as required this or that kind of measurements. Algorithmic support includes the following algorithms. Algorithm 1 - algorithm of the small satellite axis orientation definition (orientation of the phase center of the reception navigating antenna) under the analysis of spatial position of GLONASS/GPS navigating satellites (definition of two orientation angles at presence of one antenna). Algorithm 2 - algorithm of the small satellite orientation under the analysis of spatial position of GLONASS/GPS navigating satellites (definition of three angles of orientation at presence of three antennas) without use of an interferometer principle. Algorithm 3 - algorithm of small satellites orientation definition on a basis of closely coupled integrating scheme the chosen structure of the measuring information. Algorithm 4 - algorithm of definition of orientation of small satellites on a basis of loosely coupled integrating scheme the chosen structure of the measuring information. The basic idea of algorithms 1 and 2 consists that for the majority of small satellites the reception antenna allocated down on the case of satellite. Thereof the part of navigating satellites which should be seen by virtue of its site in space is shaded. This information on spatial position of visible/invisible navigating satellites can be used for definition of the small satellite axis orientation in case of presence of one antenna or full orientation of the small satellite for a case of three antennas located orthogonally, without use of a interferometer principle. The navigating satellites shaded by the Earth, preliminary are excluded from consideration. The basic idea of algorithms 1 and 2 consists that for the majority of small satellites the reception antenna allocated down on the case of satellite. The method of the vector coordination is put in a basis of algorithms 3 and 4. Thus in algorithm 3 for definition of the small satellite orientation the Wahba tasks is solved. In algorithm 4 the task of orientation definition is reduced to the consecutive decision of system of two nonlinear equations and two linear equations. Efficiency of the developed algorithms was investigated on modeling tasks, and also on the real measurements received during flight spacecraft "Foton-M2".