IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Flight & Ground Operations aspects of Human Spaceflight - Joint Session of the IAF Human Spaceflight and IAF Space Operations Symposia (4-B6.4)

Author: Dr. Sergey Bronnikov
S.P. Korolev Rocket and Space Corporation Energia, Russian Federation, Sergey.Bronnikov@rsce.ru

Dr. Dmitry Karavaev
S.P. Korolev Rocket and Space Corporation Energia, Russian Federation, dmitry.karavaev@rsce.ru
Mr. Alexander Rozhkov
S.P. Korolev Rocket and Space Corporation Energia, Russian Federation, alexander.rozhkov@rsce.ru
Dr. Dmitry Rulev
S.P. Korolev Rocket and Space Corporation Energia, Russian Federation, dmitry.rulev@rsce.ru

ENHANCED METHOD TO PERFORM CREW EARTH OBSERVATION ONBOARD THE ISS WITH USE OF RELOCATABLE CAMERAS

Abstract

While performing various geophysical observations and research aboard the International Space Station (ISS), the astronauts perform a lot of Earth imaging with freely moving cameras. However, the position of a camera with respect to the space vehicle in the moment of shooting is unknown that significantly complicates time-coordinate referencing of the images. In the frame of the Vizir space experiment on the Russian Segment of the ISS, various versions of portable angle-measuring systems have been developed to determine the position of an autonomous camera relative to the associated spacecraft coordinate system and the technologies for using these measurements to solve various tasks. Angle-measuring systems based on two rigidly connected synchronized cameras; based on a fiber-optic gyroscope; based on an angular velocity sensor; based on ultrasonic sensors were investigated. The choice of the last of the listed options as the best is justified. The developed technologies include: a) image binding technology, which includes calculating the position of the spacecraft, determining the angular position of the camera lens axis relative to the spacecraft and recording this data to an image file; based on the data recorded in the image file, when processing the received image, the coordinates of the intersection of the lens axis with the earth's surface are calculated, the image is identified and coordinate-linked, the image is converted into an orthophotoplan and loaded into the database; b) the technology to support the astronaut pointing the camera at ground objects, including the calculations of the current space vehicle's position, definition of the camera lens' axis angular position with respect to the space vehicle, calculation of the lens axis/Earth surface intersection coordinates, displaying on an additional display the current position of the photography subject relative to the camera's field of view and forming guidance instructions to the astronaut; c) the planning technology for ground objects observation including the space vehicle orbit prediction, the photography objects positions calculation along the space vehicle ground trace, crew time estimation for camera pointing at each individual object and for camera repositioning between observations, evaluation of the number of crewmembers and cameras required for the imaging. The description includes the configuration of the developed systems, basic specifications, utilized calculation methods and algorithms. The developed technologies significantly improves the effectiveness of the Earth surface imaging performed by the crew (especially, in clouds, at night, with no visual references) and efficiency of targeted image processing