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OPTIMIZING ALGORITHMS FOR VISUAL AND INSTRUMENTAL OBSERVATIONS TAKEN BY THE CREW OF THE RUSSIAN SEGMENT OF THE INTERNATIONAL SPACE STATION

Abstract

The paper proposes optimal planning methods for scientific observations that require pointing research instruments onboard the International Space Station (ISS) at terrestrial and celestial targets. The crew usually points handheld scientific equipment at the targets through the portholes. Besides that, a new mobile pointing platform SOVA (System for Orienting the Videospectral Apparatus) was sent to the ISS. It is controlled with the special software installed on the Russian crew support computer.

Operations involved in sequential tracking of several targets with one scientific instrument can be subdivided into two major types: tracking an individual target, and transitioning from tracking one target to tracking another target.

Possible algorithms for tracking an individual target are determined by objectives of the study and are constrained, primarily, by the target visibility from onboard the ISS, limiting angles and the maximum slewing rate of the instrument sensitivity axis. Examples of such observations are: taking one photographic image of the target, spectrographic study of the target through its entire zone of visibility, sequential piecemeal shooting of a relatively large target, etc. These operations are characterized by: expected tracking start and end times, directions of the instrument sensitivity axis at the start and at the end of tracking, quantitative estimate of the value of scientific data acquired from the study of the target.

Taking these data into account, the observation planning algorithm should select the targets and the sequence of transitions between them for each of the scientific instruments. Furthermore, the task could be set to maximize the sum total of the values of target observations by the full suite of instruments, or to minimize the sum of the scientific instruments slew angles, provided that the total value of observations does not go below a specified value. Moreover, the time interval spent on the observation planning should not exceed a certain limiting value.

Special algorithms were developed to address these tasks. Approximate solutions are provided in those cases where precise solutions involve an unacceptable amount of computations. Full or partial analogies with the transportation vehicle routing problems are used.

These methods have been implemented within special software supporting experiments on the Russion crew support computer and are used for optimal planning and photographic and spectrometric imaging of the Earth surface. The crew point cameras at the targets with the aid of special hardware and software. Optionally, the mobile platform SOVA can point scientific equipment simultaneously with the cosmonauts.