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Title

Optimal Time Terrestrial Mapping Scheduling for Spaceborne Push-broom Imagers

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Abstract

Optimally allocating satellite imaging capability is essential in operating satellite systems concerning its immense operation cost. When it comes to terrestrial mapping, it is of utmost importance to meticulously schedule the imaging time and area since the field of regard of the satellite is limited per orbit. If one can exploit the imaging chances to the extent possible, it can directly reduce the operation hour and cost of the satellite system. However, since the possible combination of the satellite image schedules is infinite, one should carefully manipulate the problem into a solvable format.

This paper concentrates on the minimum acquisition time problem of satellite imagery when mapping the predefined terrestrial landmass. Here, a terrestrial mapping problem is defined as an optimal scheduling problem where the goal is to acquire a set of images of the given area of landmass as soon as possible. It can be thought of as a practical variation of a set covering problem, which considers the ways to cover the whole set with finite subsets. The landmass of interest could be a city, a country, or any random polygon with a width greater than the swath width of the imager. The satellite system of interest is an Electro-Optic (EO) push-broom imager on a circular orbit with a fixed inclination angle, acquiring strips of images with fixed roll angles. A number of prior research on optimal satellite operation scheduling exist[1], but the targets were mostly limited to point targets. To the authors' knowledge, the terrestrial mapping problem is rarely covered in the literature, which highlights the novelty of this work.

We suggest a scheduling framework based on Mixed Integer Linear Programming (MILP) technique. Thanks to the property of MILP, the generated optimization problem can be solved using widely used commercial solvers within a reasonable computational effort. Furthermore, formulating the problem in the MILP framework enables the user to easily manipulate the problem into a minimum time full coverage schedules, a minimum time partial coverage schedules, or even a minimum-time coverage schedules with a priority on high-value targets. The generated schedules propose optimal imaging time slots and optimal roll angles of the satellite. The problem is formulated considering the swath width of the imager and the overlap of the acquired strip image due to the earth's curvature. The effectiveness of the suggested approach is demonstrated with a simulated example.

References

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