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Author: Mr. Jonathan Bonnet
IRT Saint Exupéry, France

Dr. Elsy Kaddoum
France
Prof. Marie-Pierre Gleizes
France
Dr. Serge Rainjonneau
IRT Saint Exupéry, France

RAPID AND ADAPTIVE MISSION PLANNER FOR MULTI-SATELLITE MISSIONS USING A SELF-ADAPTIVE MULTI-AGENT SYSTEM

Abstract

A constellation of observation satellites allows to cover a large Earth surface, with a good revisit frequency, ensuring different kinds of pictures and the robustness of the system. Planning a mission for a constellation is a complex task: a lot of parameters and constraints, often contradictory, must be taken into account. This huge number of entities make this problem highly combinatorial. Nowadays, the number of constellations of satellites drastically increases, as the number of satellites that compose them (i.e. Google Skybox project). Such a system must dynamically take into account new requests, but this dynamism cannot be taken into account in current approaches. This paper contributes to this challenge with a new way to plan on-ground the mission of satellites: the ATLAS planning system (Adaptive saTellites pLanning for dynAmic earth obServation). ATLAS is an Adaptive Multi-Agent System, designed to plan missions of constellations of Earth observation satellites.

The proposed system brings a major contribution: it is an open and continuous planning system. It has the capability to handle in real-time changes of constraints and/or new request arrivals. First, ATLAS possesses self-adaptation mechanism in order to locally self-adapt itself according to the dynamic arrival of requests to plan or to new constraints (i.e. weather forecast update). Thus, ATLAS can dynamically reorganize the mission plan in order to propose a better one (integrating the changes). Because changes are made locally, the whole plan is not challenged and the new plan is provided in a reasonable time. Secondly, ATLAS can be stopped at any time and provides a good mission plan. Indeed, ATLAS globally makes the mission plan by local interactions: perturbations and conflicts are locally resolved. On the contrary, in the current systems, the plan is constructed iteratively.

To enable this capability for real-time adaptation, we use the Adaptive Multi-Agent Systems theory (AMAS). AMAS based systems naturally provide self-adaptation capabilities required to solve this kind of problem. To design our system, we rely on the Adaptive Multi-Agent System For Optimization agent model. It provides some design patterns to solve optimization problems using AMAS. In this model, agents are designed as close as possible to the natural description of the problem entities. ATLAS is based on this model, and enhances it. In order to assess the real-time adaption of ATLAS, several experiments were conducted in which new request arrivals or constraints (new weather forecast for example) occurs during the planning process.