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APP4AD, THE ADVANCED PAYLOAD DATA PROCESSING FOR AUTONOMY & DECISION AGENT FOR FUTURE EO AND PLANETARY EXPLORATION MISSIONS

Abstract

With the goal of evolving the current "concepts of operations" of space systems such as Earth Observation and planetary exploration, it is necessary to increase, including by means of artificial intelligence techniques, the system's autonomous and timely reaction capabilities to external events and unplanned situations, and responding to the need for reduced control by the Earth ground station. Therefore, an on-board software component (for satellites or planetary rovers) has been designed and developed that implements and makes available known (and classified) object and event recognition and "novelty" capabilities, acting in fully automatic mode and in (near) real-time. There are two reference scenarios. The first concerns the EO domain and aims at the identification of events with rapid evolution and transient phenomena, which justify new acquisitions (with different modes and resolutions or with different sensors), but which may become extinct if data processing requires operator intervention or otherwise has

significant time, e.g., oil spills detection with Synthetic Aperture Radar data. The second scenario, which includes rovers for planetary science (Moon/Mars), responds to the trade-off between the minimum level of detail of observations required to avoid "losing" objects of scientific interest, the resources required for data transmission and processing, and the time devoted (which reduces the number of possible searches). In both cases, a system that enables fully automatic recognition of anomalies and novel elements in the acquired data is also capable of implementing behavior that is sensitive to the information content of the acquired data. The ability, therefore, to assess already on board, in real time, the information content of the data and to decide accordingly, adapting behaviors to the situation, establishes an extremely novel element with respect to current operational scenarios. Furthermore, the lack of the expected information in the data (under unsuitable acquisition conditions or due to the absence of events of interest) also introduces new possibilities for optimizing on-board resources (mass-memory, communication bandwidth, power). Accompanying this algorithmic design is implemented a SW infrastructure capable of being deployed on all currently used/under development computing architectures, aiming at the definition of a flexible HW/SW ecosystem responsive to the ever-increasing capabilities of embedded computing systems for Space environment. This activity is being performed by a consortium of three Italian SMEs, of which Planetek Italia is the prime along with, Geophysical Applications Processing and S.A.T.E. Systems Advanced Technologies Engineering, on behalf of the Italian Space Agency (ASI).