Get to know our ULTIMATE partners

Thales Alenia Space's team

Mohamad Akoum leads for TAS the Ultimate project. He was in charge of the management of the TAS Digital System Quality Department before joining in 2018 the TAS Telecom Business Line for which he is currently leading AI-based Transformation, Product Sustainability and Ecodesign Engineering.

Anne Giovannini is an R&D engineer in AOCS (Attitude and Orbit Control System). She manages for TAS the Ultimate requirements study and system specification and contributes in particular to the generation of Space Use Case data, integration of AI component within this use case and so, evaluation of AI performances.

Regis de Ferluc is WPM of Early Phases projects, and R&D coordinator at Software Engineering Competence Center (CCSE). He manages for TAS the Ultimate software activities and contributes in particular to the definition of the demonstrator objectives.

Andrés Troya-Galvis is a Data Scientist and AI specialist, using ML/DL techniques on industrial use-cases (remote sensing image analysis, satellite telemetry-based anomaly detection). He is focusing on trustworthy AI (robustness, explainability, uncertainty quantification) and manages for TAS the evaluation of Ultimate AI performance and trust level.

Aurélien Bobey is an R&D engineer in satellite on board software. On Ultimate, he is responsible for TAS of the architecture and realization of the demonstrator on target for the Space Use Case.

Drawing on over 40 years of experience and a unique combination of skills, expertise and cultures, **Thales Alenia Space** delivers cost-effective solutions for telecommunications, navigation, Earth observation, environmental management, exploration, science and orbital infrastructures. Governments and private industry alike count on Thales Alenia Space to design satellite-based systems that provide anytime, anywhere connections and positioning, monitor our planet, enhance management of its resources, and explore our Solar System and beyond.

Smart FDIR for Satellite on-board Autonomy with satellite reaction wheel

The Thales Alenia Space Use Case is exploring the capacity of AI to enhance the classical on-board FDIR (Failure Detection Isolation and Recovery) which is currently in charge of on-board anomaly monitoring and diagnostic, thanks to **preventive failure monitoring and prognostics**. This approach leverages on recent works exploring the processing of spacecraft telemetries to support Operations teams in detecting unexpected behaviors or situations thanks to AI capabilities, but goes one step further as it consists of performing the **inference on-board**, thanks to a **Trustworthy AI implemented** within the system itself, and thus having access to all the on-board parameters.

Among the potential satellite equipment's that may benefit of on-board AI unexpected behaviors detection, Reaction Wheels (RW) have been chosen to validate the approach. Reaction Wheels are very common actuators used to control the spacecraft attitude. Depending on the mission, coarse or fine pointing of

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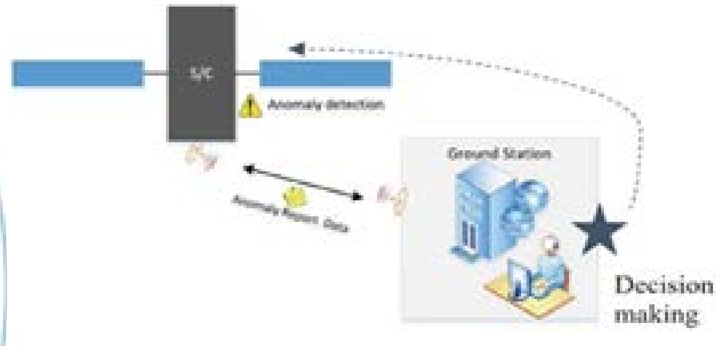

the satellite payload (optical instrument, or telecommunication antenna, ...) is required. A failure of one of the RW (typically, 4 RWs are used for simple satellites) can propagate to a mission failure if not handled properly by the FDIR sub-system. Moreover, Reaction Wheels degradations and failures cannot be early detected thanks to classical means, offering an ideal UC for on board AI evaluation.

- Several kinds of degradations can affect Reaction Wheels: bearing degradations (because of cage instability for ex.) are the most frequent, but others mechanical defects can emerge (for example contacts at rotor level like in the Fuse mission). Those degradations appear and evolve gradually in most cases, over periods of few weeks to few months. The main visible symptoms are increase of the dry friction, increase if the viscous friction, apparition or worsening of friction peaks and of friction plateaus. The two last (worsening of friction peaks and of friction plateaus) cannot be detected by Ground support Operations teams because of the very low frequency of telemetries, and the monitoring of the two first (dry and viscous friction) is time consuming for ground teams if a continuous health monitoring is expected.

- On the other hand, FDIR only monitors the RW health through “anomaly zones”, so that teams on ground can only take corrective actions once a RW exhibits abnormal behavior, i.e. once it is already seriously damaged, or irremediably damaged, or even out of order. At this point, the ground team can only take a corrective action (RW shut down), or try to extend its lifespan to a certain point through protective actions, knowing that this attempt will probably bring a very limited gain as the RW is already greatly damaged.

- Implementation of an AI-based FDIR could allow to **automatically detect RW damages** at a much lower stage, since the very first weak signals. With such an early detection, the ground team could **set up preventive/protective actions with potential great benefits and long lifespan extension**.

ULTIMATE Partners wish you a Happy New Year !

In 2024, ULTIMATE invites you to the Trustworthy Artificial Intelligence Workshop held remotely on the 2nd of February morning.

Please register here:
https://evenium-site.com/site/ULTIMATE-Workshop-Trustworthy-AI

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